Operating Instructions

confocalDT 2411/2416 Ethernet

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Confocal chromatic distance and thickness measurement

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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 controller

The surface of the sensors or controller heats up to a temperature of over 50°C when all interfaces are used.

> Risk of injury

NOTICE

The supply voltage must not exceed the specified limits.

> Damage to or destruction of the controller

Avoid shocks and impacts to the controller and the sensor.

> Damage to or destruction of the components

Never fold the optical fiber and do not bend it in tight radii.

> Damage to or destruction of the optical fiber, failure of measuring device

Protect the ends of the optical fiber against contamination (use protective caps).

> Incorrect measurement

> Failure of the measuring device

Protect the cables against damage.

> Failure of the measuring device

1.3 Notes on Product Marking

1.3.1 Notes on CE Marking

Please note the following for the confocalDT 2411/2416 measuring system:

- EU Directive 2014/30/EU
- EU Directive 2011/65/EU

Products which carry the CE mark satisfy the requirements of the EU directives cited and the relevant applicable harmonized European standards (EN). The IFD241x is designed for use in industrial and home applications and meets the requirements.

The EU Declaration of Conformity is available to the responsible authorities according to EU Directive, Article 10.

1.3.2 Notes on UKCA Marking

Please note the following for the confocalDT 2411/2416 measuring system:

- SI 2016 No. 1091:2016-11-16 The Electromagnetic Compatibility Regulations 2016
- SI 2012 No. 3032:2012-12-07 The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

Products which bear the CE mark meet the requirements of the EU directives cited and the relevant applicable harmonized European standards. The IFD241x is designed for use in industrial environments.

The UKCA marking and the technical documentation are available to the responsible authorities according to UKCA directives.

1.4 Intended Use

- The IFC241x is designed for use in an industrial environment. It is used for
  - Displacement, distance, movement and thickness measurement,
  - measuring the position of parts or machine components
- The IFC241x must only be operated within the limits specified in the technical data see Chap. 2.4.

➡ The measuring system must only be used in such a way that no persons are endangered or machines are damaged in the event of malfunction or total failure of the sensor.

➡ Take additional precautions for safety and damage prevention in case of safety-related applications.

1.5 Proper Environment

	confocalDT 2411/2416	
	Sensor	Controller
Protection class	IP64, front side	IP40
Operating temperature range	+5 ... +70 °C	+5 ... +50 °C
Storage temperature range	-20 ... +70 °C	
Humidity	5 ... 95% (non-condensing)	
Ambient pressure:	Atmospheric pressure	
Shock (DIN EN 60068-2-27)	15 g/6 ms on XY axis, 1000 shocks each	
Vibration (DIN EN 60068-2-6)	2 g / 20 ... 500 Hz on XY axis, 10 cycles each	
EMC	As per EN 61000-6-3 / EN 61326-1 (Class B) Emitted interference; EN 61000-6-2 / EN 61326-1 Immunity to interference	

2. Functional Principle, Technical Data

2.1 Short Description

The measuring systems consists of:

Controller
(IFC2411)

Optical fiber (sensor cable)

Sensor
(IFSxxx)

confocalDT 2411/2416

IFC241x series controllers can be operated with different sensors. The calibration tables of the sensors required to do so need to be saved in the controller.

The measuring systems use a white LED as an internal light source.

The IFSxxx sensor is passive, since it does not contain any heat sources or moving parts. This prevents heat expansion, which makes for a highly accurate measurement process.

The controller converts the light signals received from the sensor with a spectrometer, calculates distance or thickness values with the integrated signal processor (CPU) and transfers the measured data via the interfaces or analog output.

2.2 Measuring Principle

Polychromatic light (white light) is beamed through the sensor onto the target surface. The sensor's lenses are designed to focus each wavelength of light used at a specific distance through controlled chromatic aberrations. The light reflected by the target surface is received by the sensor on the way back and directed to the controller. This is followed by spectral analysis and the calculation of distances using calibration data saved in the controller.

i The sensor and controller form a single unit, as the linearization table of the sensor is saved in the controller.

This unique measuring principle enables high-precision measurement of applications. It can capture both diffuse and reflective surfaces. With transparent layer materials, a direct thickness measurement can be carried out in addition to the displacement measurement. The transmitter and receiver are arranged on one axis to prevent shadowing.

Excellent resolution and small light spot diameter make it possible to measure surface structures. However, it should be noted that deviations in measured values can occur as soon as the structure is in the order of magnitude of the light spot diameter or the permissible tilt is exceeded, for example at groove walls.

2.3 Term Definitions, Glossary

SMR Start of measuring range. A start of measuring range (SMR) must be kept between each sensor and the target. Minimal distance between the front sensor face and the target.

MMR Mid of measuring range

EMR End of measuring range (start of measuring range + measuring range)

Maximum distance between the front sensor face and the target.

MB Measuring range

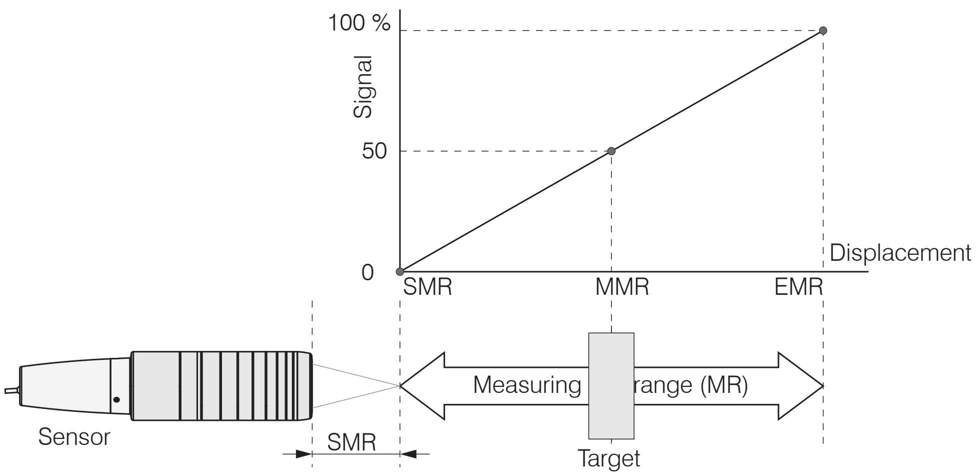


Fig. 1 Measuring range and output measuring system

Minimum target thickness	see Chapter Technical Data
Maximum target thickness	Sensor measuring range x refractive index of target

2.4 Technical Data for confocalDT IFC2411

Model		IFC2411	IFC2411/IE
Resolution	Ethernet	2 nm	-
	Industrial Ethernet	-	2 nm
	RS422	18 bit	
	Analog	16 bits (teachable)	
Measuring rate		Continuously adjustable from 100 Hz to 8 kHz	
Linearity [1]		typ. < ±0.03 % FSO (depends on sensor)	
Multi-peak measurement		1 layer	
Light source		Internal white LED	
No. of characteristic curves		up to 10 characteristic curves for different sensors per channel, selection via table in the menu	
Permissible ambient light [2]		30.000 lx	
Synchronization		yes	
Supply voltage		24 VDC ±10 %	
Power consumption		< 7 W (24V)	
Signal input		Sync-in / trig-in; 1x encoder (A+, A-, B+, B-, index)	
Digital interface		Ethernet / RS422	EtherCAT / PROFINET / EtherNet/IP / RS422
Analog output		Current: 4 … 20 mA; voltage: 0 ... 5V & 0 … 10 V (16 bit D/A converter)	
Digital output		Sync-out	
Connection	Optical	pluggable optical fiber via E2000 socket, length 2 m ... 50 m, min. bending radius 30 mm)	
	Electrical	3-pin supply terminal block; 6-pin I/O terminal block (max. cable length 30 m); 17-pin M12 connector for RS422, analog and encoder; RJ45 connector for Ethernet) (max. cable length 100 m)	3-pin supply terminal block; 5-pin I/O terminal block (max. cable length 30 m); 17-pin M12 connector for RS422, analog and encoder; RJ45 connector for Industrial Ethernet (max. cable length 100 m)
Mounting		free-standing, DIN rail mounting	
Temperature range	Storage	-20 … +70 °C	
	Operation	+5 … +50 °C	
Shock (DIN EN 60068-2-27)		15 g/6 ms on XYZ axis, 1000 shocks each	
Vibration (DIN EN 60068-2-6)		2 g / 20 ... 500 Hz in XYZ axis, 10 cycles each	
Protection class (DIN EN 60529)		IP40	
Material		Aluminum	
Weight		approx. 335 g	
Compatibility		compatible with all confocalDT sensors	
No. of measurement channels		1	
Control and indicator elements		Web interface for setup and settings Multifunction button: interface selection, two adjustable functions and reset to factory settings after 10 s; 4x color LEDs for intensity, range, link and data	Multifunction button: interface selection, two adjustable functions and reset to factory settings after 10 s; 4x color LEDs for Intensity, Range, RUN and ERR

1 FSO = Full Scale Output
2 Illuminant: light bulb

2.5 Technical Data confocalDT IFC2416

Model		IFC2416
Resolution	Ethernet	2 nm
	RS422	18 bit
	Analog	16 bits (teachable)
Measuring rate		Continuously adjustable from 100 Hz to 25 kHz
Linearity [1]		typ. < ±0.03 % FSO (depends on sensor)
Multi-peak measurement		5 layers
Light source		Internal white LED
No. of characteristic curves		up to 10 characteristic curves for different sensors per channel, selection via table in the menu
Permissible ambient light [2]		30.000 lx
Synchronization		yes
Supply voltage		24 VDC ±10 %
Power consumption		< 8.5 W (24V)
Synchronization		Sync-in / trig-in ; 2x encoders (A+, A-, B+, B-, index) or 3x encoders (A+ , A-, B+, B-)
Digital interface		Ethernet / RS422
Analog output		Current: 4 … 20 mA; voltage: 0 ... 5V & 0 … 10 V (16 bit D/A converter)
Digital output		Sync-out; error-out
Connection	Optical	pluggable optical fiber via E2000 socket, length 2 m ... 50 m, min. bending radius 30 mm)
	Electrical	3-pin supply terminal block; 6-pin I/O terminal block (max. cable length 30 m); 17-pin M12 connector for RS422, analog and encoder; RJ45 connector for Ethernet) (max. cable length 100 m)
Mounting		free-standing, DIN rail mounting
Temperature range	Storage	-20 … +70 °C
	Operation	+5 … +50 °C
Shock (DIN EN 60068-2-27)		15 g/6 ms on XYZ axis, 1000 shocks each
Vibration (DIN EN 60068-2-6)		2 g / 20 ... 500 Hz in XYZ axis, 10 cycles each
Protection class (DIN EN 60529)		IP40
Material		Aluminum
Weight		approx. 460 g
Compatibility		compatible with all confocalDT sensors
No. of measurement channels		1
Control and indicator elements		Web interface for setup and settings Multifunction button: interface selection, two adjustable functions and reset to factory settings after 10 s; 4x color LEDs for intensity, range, link and data

1 FSO = Full Scale Output
2 Illuminant: light bulb

2.6 Technical Data IFS2402

Model		IFS2402-0.5	IFS2402-1,5	IFS2402-4
Measuring range		0.5 mm	1.5 mm	3.5 mm
Start of measuring range	approx.	1.7 mm	0.9 mm	1.9 mm
Resolution	Static [1]	16 nm	60 nm	100 nm
	Dynamic [2]	48 nm	192 nm	480 nm
Linearity [3]	Displacement and distance	< ±0.15 µm	< ± 1.2 µm	< ±3 µm
Light spot diameter		10 µm	20 µm	20 µm
Maximum measuring angle [4]		±27°	±5°	±3°
Numerical aperture (NA)		0.40	0.20	0.10
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass) [5]		
Connection		integrated optical fiber 2 m with E2000/APC connector; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm		
Mounting		Radial clamping (mounting adapter see accessories)		
Temperature range	Storage	-20 °C ... +70 °C		
	Operation	+5 °C ... +70 °C		
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each		
Protection class (DIN EN 60529)		IP64 (front)		
Material		Stainless steel housing, glass lenses		
Weight		approx. 186 g (incl. optical fiber)		

1 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
2 RMS noise relates to mid of measuring range (1 kHz)
3 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
4 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values
5 No thickness measurement possible. Distance measurement only possible if thickness of glass > measuring range. Measurements on metal only possible to a limited extent.

2.7 Technical Data IFS2402/90

Model		IFS2402/90-1,5	IFS2402/90-4
Measuring range		1.5 mm	2.5 mm
Start of measuring range	approx.	2.5 mm [1]	2.5 mm [1]
Resolution	Static [2]	60 nm	100 nm
	Dynamic [3]	192 nm	480 nm
Linearity [4]	Displacement and distance	< ±1.2 µm	±3 µm
Light spot diameter		20 µm	20 µm
Maximum measuring angle [5]		±5°	±3°
Numerical aperture (NA)		0.20	0.10
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass) [6]	
Connection		integrated optical fiber 2 m with E2000/APC connector; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm	
Mounting		Radial clamping (mounting adapter see accessories)	
Temperature range	Storage	-20 °C ... +70 °C	
	Operation	+5 °C ... +70 °C	
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each	
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each	
Protection class (DIN EN 60529)		IP40	
Material		Stainless steel housing, glass lenses	
Weight		approx. 186 g (incl. optical fiber)	

1 Start of measuring range measured from sensor axis
2 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
3 RMS noise relates to mid of measuring range (1 kHz)
4 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
5 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values
6 No thickness measurement possible. Distance measurement only possible if thickness of glass > measuring range. Measurements on metal only possible to a limited extent.

2.8 Technical Data IFS2403

Model		IFS2403-0.4	IFS2403-1.5	IFS2403-4	IFS2403-10
Measuring range		0.4 mm	1.5 mm	4 mm	10 mm
Start of measuring range	approx.	2.5 mm	8 mm	14.7 mm	11 mm
Resolution	Static [1]	16 nm	60 nm	100 nm	250 nm
	Dynamic [2]	47 nm	186 nm	460 nm	1250 nm
Linearity [3]	Displacement and distance	$< \pm 0.3\,\mu m$	$< \pm 1.2\,\mu m$	$< \pm 3\,\mu m$	$< \pm 8\,\mu m$
	Thickness	$< \pm 0.6\,\mu m$	$< \pm 2.4\,\mu m$	$< \pm 6\,\mu m$	$< \pm 16\,\mu m$
Light spot diameter		9 μm	15 μm	28 μm	56 μm
Maximum measuring angle [4]		±20°	±16°	±6°	±6°
Numerical aperture (NA)		0.50	0.30	0.15	0.15
Min. target thickness [5]		0.06 mm	0.23 mm	0.6 mm	1.5 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)			
Connection		integrated optical fiber 2 m with E2000/APC connector; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm			
Mounting		Radial clamping (mounting adapter see accessories)			
Temperature range	Storage	-20 °C ... +70 °C			
	Operation	+5 °C ... +70 °C			
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each			
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each			
Protection class (DIN EN 60529)		IP64 (front)			
Material		Stainless steel housing, glass lenses			
Weight		approx. 200 g (incl. optical fiber)			

1 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
2 RMS noise relates to mid of measuring range (1 kHz)
3 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
4 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values
5 Pane of glass with refractive index n = 1.5 in mid of measuring range

2.9 Technical Data IFS2403/90

Model		IFS2403/90-1.5	IFS2403/90-4	IFS2403/90-10
Measuring range		1.5 mm	4 mm	10 mm
Start of measuring range	approx.	4.9 mm [1]	12 mm [1]	8.6 mm [1]
Resolution	Static [2]	60 nm	100 nm	250 nm
	Dynamic [3]	186 nm	460 nm	1250 nm
Linearity [4]	Displacement and distance	$< \pm 1.2\,\mu m$	$< \pm 3\,\mu m$	$< \pm 8\,\mu m$
	Thickness	$< \pm 2.4\,\mu m$	$< \pm 6\,\mu m$	$< \pm 16\,\mu m$
Light spot diameter		15 μm	28 μm	56 μm
Maximum measuring angle [5]		$\pm 16°$	$\pm 6°$	$\pm 6°$
Numerical aperture (NA)		0.30	0.15	0.15
Min. target thickness [6]		0.23 mm	0.6 mm	1.5 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)		
Connection		integrated optical fiber 2 m with E2000/APC connector; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm		
Mounting		Radial clamping (mounting adapter see accessories)		
Temperature range	Storage	-20 °C ... +70 °C		
	Operation	+5 °C ... +70 °C		
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each		
Protection class (DIN EN 60529)		IP64 (front)		
Material		Stainless steel housing, glass lenses		
Weight		approx. 200 g (incl. optical fiber)		

1 Start of measuring range measured from sensor axis
2 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
3 RMS noise relates to mid of measuring range (1 kHz)
4 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
5 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values
6 Pane of glass with refractive index n = 1.5 in mid of measuring range

2.10 Technical Data IFS2404

Model		IFS2404-1	IFS2404-2	IFS2404-3	IFS2404-6
Measuring range		1 mm	2 mm	3 mm	6 mm
Start of measuring range	approx.	15 mm	14 mm	25 mm	35 mm
Resolution	Static [1]	< 12 nm	40 nm	< 40 nm	< 80 nm
	Dynamic [2]	< 50 nm	125 nm	< 125 nm	< 250 nm
Linearity [3]	Displacement and distance	< ±0.3 µm	< ±1 µm	< ±0.9 µm	< ±1.8 µm
	Thickness	< ±0.6 µm	< ±2 µm	< ±1.8 µm	< ±3.6 µm
Light spot diameter		12 µm	10 µm	18 µm	24 µm
Maximum measuring angle [4]		±25°	±12°	±19°	±10°
Numerical aperture (NA)		0.45	0.25	0.35	0.18
Min. target thickness [5]		0.05 mm	0.1 mm	0.15 mm	0.3 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)			
Connection		Pluggable fiber optic cable via FC socket, type CS242-x/CS2401; standard length 2 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm			
Mounting		Radial clamping (mounting adapter see accessories)			
Temperature range	Storage	-20 ... +70 °C			
	Operation	5 ... 70 °C			
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each			
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each			
Protection class (DIN EN 60529)		IP64			
Material		Aluminum housing, glass lenses	Stainless steel housing, glass lenses	Aluminum housing, glass lenses	
Weight [6]		approx. 100 g	Approx. 20 g	approx. 100 g	approx. 100 g

1 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
2 RMS noise relates to mid of measuring range (1 kHz)
3 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
4 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values
5 Glass sheet with refractive index n = 1.5 throughout the entire measuring range. In the mid of the measuring range, also thinner layers can be measured.
6 Sensor weight without optical fiber

Continuation Technical Data IFS2404

Model		IFS2404-2	IFS2404/90-2	IFS2404-2(001)
Measuring range		2 mm	2 mm	2 mm
Start of measuring range	approx.	14 mm	9.6 mm [1]	14 mm
Resolution	Static [2]	40 nm	40 nm	40 nm
	Dynamic [3]	125 nm	125 nm	125 nm
Linearity [4]	Displacement and distance	< ±1 µm	< ±1 µm	< ±1 µm
	Thickness	< ±2 µm	< ±2 µm	< ±2 µm
Light spot diameter		10 µm	10 µm	10 µm
Maximum measuring angle [5]		±12°	±12°	±12°
Numerical aperture (NA)		0.25	0.25	0.25
Min. target thickness [6]		0.1 mm	0.1 mm	0.1 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)		
Connection		Pluggable fiber optic cable via FC socket, type CS242-x/CS2401; standard length 2 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm		Pluggable fiber optic cable via FC socket, standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm
Mounting		Radial clamping (mounting adapter see accessories)		
Temperature range	Storage	-20 °C ... +70 °C		
	Operation	+5 °C ... +70 °C		
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each		
Protection class (DIN EN 60529)		IP64		
Material		Stainless steel housing, glass lenses		
Weight [7]		Approx. 20 g	Approx. 30 g	Approx. 40 g

1 Start of measuring range measured from sensor axis
2 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
3 RMS noise relates to mid of measuring range (1 kHz)
4 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
5 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values
6 Glass sheet with refractive index n = 1.5 throughout the entire measuring range. In the mid of the measuring range, also thinner layers can be measured.
7 Sensor weight without optical fiber

2.11 Technical Data IFS2405

Model		IFS2405-0.3	IFS2405-1	IFS2405-3
Measuring range		0.3 mm	1 mm	3 mm
Start of measuring range	approx.	6 mm	10 mm	20 mm
Resolution	Static [1]	4 nm	8 nm	15 nm
	Dynamic [2]	18 nm	38 nm	80 nm
Linearity [3]	Displacement and distance	< ±0.1 µm	< ±0.25 µm	< ±0.75 µm
	Thickness	< ±0.2 µm	< ±0.5 µm	< ±1.5 µm
Light spot diameter		6 µm	8 µm	9 µm
Maximum measuring angle [4]		±34°	±30°	±24°
Numerical aperture (NA)		0.60	0.55	0.45
Min. target thickness [5]		0.015 mm	0.05 mm	0.15 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)		
Connection		Pluggable fiber optic cable via FC socket, standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm		
Mounting		Radial clamping (mounting adapter see accessories)		
Temperature range	Storage	-20 °C ... +70 °C		
	Operation	+5 °C ... +70 °C		
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each		
Protection class (DIN EN 60529)		IP64 (front)		
Material		Aluminum housing, glass lenses		
Weight [6]		Approx. 140 g	Approx. 125 g	Approx. 225 g

1 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
2 RMS noise relates to mid of measuring range (1 kHz)
3 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
4 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values
5 Glass sheet with refractive index n = 1.5 throughout the entire measuring range. In the mid of the measuring range, also thinner layers can be measured.
6 Sensor weight without optical fiber

Continuation Technical Data IFS2405

Model		IFS2405-6	IFS2405/90-6	IFS2405-10
Measuring range		6 mm	6 mm	10 mm
Start of measuring range	approx.	63 mm	41 mm [1]	50 mm
Resolution	Static [2]	34 nm	34 nm	36 nm
	Dynamic [3]	190 nm	190 nm	204 nm
Linearity [4]	Displacement and distance	< ±1.5 µm	< ±1.5 µm	< ±2 µm
	Thickness	< ±3 µm	< ±3 µm	< ±4 µm
Light spot diameter		31 µm	31 µm	16 µm
Maximum measuring angle [5]		±10°	±10°	±17°
Numerical aperture (NA)		0.22	0.22	0.30
Min. target thickness [6]		0.3 mm	0.3 mm	0.5 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)		
Connection		Pluggable fiber optic cable via FC socket, standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm		
Mounting		Radial clamping (mounting adapter see accessories)		
Temperature range	Storage	-20 °C ... +70 °C		
	Operation	+5 °C ... +70 °C		
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each		
Protection class (DIN EN 60529)		IP64 (front)		
Material		Aluminum housing, glass lenses		
Weight [7]		Approx. 260 g	Approx. 315 g	Approx. 500 g

1 Start of measuring range measured from sensor axis

2 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat

3 RMS noise relates to mid of measuring range (1 kHz)

4 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.

5 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values

6 Glass sheet with refractive index n = 1.5 throughout the entire measuring range. In the mid of the measuring range, also thinner layers can be measured.

7 Sensor weight without optical fiber

2.12 Technical Data IFS2406

Model		IFS2406-2,5/VAC(003)	IFS2406/90-2,5/VAC(001)
Measuring range		2.5 mm	2.5 mm
Start of measuring range	approx.	17.2 mm	12.6 mm [1]
Resolution	Static [2]	18 nm	18 nm
	Dynamic [3]	97 nm	97 nm
Linearity [4]	Displacement and distance	< ±0.75 µm	< ±0.75 µm
	Thickness	< ±1.5 µm	< ±1.5 µm
Light spot diameter		10 µm	10 µm
Maximum measuring angle [5]		±16°	±16°
Numerical aperture (NA)		0.30	0.30
Min. target thickness [6]		0.125 mm	0.125 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)	
Connection		Pluggable fiber optic cable via FC socket, type C240x-x (01); standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm	
Mounting		Radial clamping (mounting adapter see accessories)	
Temperature range	Storage	-20 °C ... +70 °C	
	Operation	+5 °C ... +70 °C	
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each	
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each	
Protection class (DIN EN 60529)		IP40 (vacuum compatible)	
Material		Stainless steel housing, glass lenses	
Weight [7]		Approx. 105 g	Approx. 130 g

1 Start of measuring range measured from sensor axis
2 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
3 RMS noise relates to mid of measuring range (1 kHz)
4 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
5 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values
6 Glass sheet with refractive index n = 1.5 throughout the entire measuring range. In the mid of the measuring range, also thinner layers can be measured.
7 Sensor weight without optical fiber

Continuation Technical Data IFS2406

Model		IFS2406-3	IFS2406-10	IFS2406-10/ VAC(001)	IFS2406-3/VAC(001)
Measuring range		3 mm	10 mm		3 mm
Start of measuring range	approx.	75 mm	27 mm		75 mm
Resolution	Static [1]	32 nm	38 nm		50 nm
	Dynamic [2]	168 nm	207 nm		168 nm
Linearity [3]	Displacement and distance	$< \pm 1.5\ \mu m$	$< \pm 2\ \mu m$		$< \pm 1.5\ \mu m$
	Thickness	$< \pm 3\ \mu m$	$< \pm 4\ \mu m$		$< \pm 3\ \mu m$
Light spot diameter		35 μm	15 μm		35 μm
Maximum measuring angle [4]		±6.5°	±13.5°		±6.5°
Numerical aperture (NA)		0.14	0.25		0.14
Min. target thickness [5]		0.15 mm	0.5 mm		0.15 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)			
Connection		Pluggable fiber optic cable via FC socket, type C240x-x (01); standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm			Pluggable fiber optic cable via FC socket, type C240x-x/VAC(01); standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm
Mounting		Radial clamping (mounting adapter see accessories)			
Temperature range	Storage	-20 °C ... +70 °C			
	Operation	+5 °C ... +70 °C			
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each			
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each			
Protection class (DIN EN 60529)		IP65 (front)		IP40 (vacuum compatible)	IP40 (vacuum compat-ible)
Material		Aluminum housing, glass lenses		Stainless steel housing, anod-ized aluminum housing	Stainless steel housing (1.4305), glass lenses
Weight [6]		Approx. 99 g	Approx. 128 g		Approx. 250 g

1 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
2 RMS noise relates to mid of measuring range (1 kHz)
3 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
4 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy de-creasing toward the limit values
5 Glass sheet with refractive index n = 1.5 throughout the entire measuring range. In the mid of the measuring range, also thinner layers can be measured.
6 Sensor weight without optical fiber

2.13 Technical Data IFS2407

Model		IFS2407-0.1	IFS2407-0.1(001)	IFS2407-0.8
Measuring range		0.1 mm	0.1 mm	0.8 mm
Start of measuring range	approx.	1 mm	1 mm	5.9 mm
Resolution	Static [1]	3 nm	3 nm	24 nm
	Dynamic [2]	6 nm	6 nm	75 nm
Linearity [3]	Displacement and distance	< ±0.05 µm	< ±0.05 µm	< ±0.2 µm
	Thickness	< ±0.1 µm	< ±0.1 µm	< ±0.4 µm
Light spot diameter		3 µm	4 µm	6 µm
Maximum measuring angle [4]		±48°	±48°	±30°
Numerical aperture (NA)		0.80	0.70	0.50
Min. target thickness [5]		0.005 mm	0.005 mm	0.04 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)		
Connection		Pluggable fiber optic cable via FC socket, standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm		
Mounting		Radial clamping (mounting adapter see accessories)		
Temperature range	Storage	-20 °C ... +70 °C		
	Operation	+5 °C ... +70 °C		
Shock (DIN EN 60068-2-27)		15 g / 6 ms in XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz in XY axis, 10 cycles each		
Protection class (DIN EN 60529)		IP65 (front)		
Material		Stainless steel housing, glass lenses		
Weight [6]		Approx. 36 g	Approx. 36 g	Approx. 40 g
Special features		Sensor with high numerical aperture	Light-intensive sensor	-

1 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat
2 RMS noise relates to mid of measuring range (1 kHz)
3 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.
4 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values
5 Glass sheet with refractive index n = 1.5 throughout the entire measuring range. In the mid of the measuring range, also thinner layers can be measured.
6 Sensor weight without optical fiber

Continuation Technical Data IFS2407

Model		IFS2407/90-0,3	IFS2407-1,5	IFS2407-3
Measuring range		0.3 mm	1.5 mm	3 mm
Start of measuring range	approx.	5.3 mm	17 mm	28 mm
Resolution	Static [1]	6 nm	6 nm	13 nm
	Dynamic [2]	20 nm	36 nm	63 nm
Linearity [3]	Displacement and distance	< ±0.15 µm	< ±0.3 µm	< ±0.5 µm
	Thickness	< ±0.3 µm	< ±0.6 µm	< ±1 µm
Light spot diameter		6 µm	5.5 µm	9 µm
Maximum measuring angle [4]		±27°	±43° (±70°) [5]	±30°
Numerical aperture (NA)		0.50	0.70	0.53
Min. target thickness [6]		0.015 mm	0.075 mm	0.15 mm
Target material				
Connection		Pluggable fiber optic cable via DIN socket, type C2407-x; standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm	Pluggable fiber optic cable via FC socket, standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm	
Mounting		Mounting holes (2x M2)	Radial clamping (mounting adapter see accessories)	
Temperature range	Storage	-20 °C... +70 °C		
	Operation	+5 °C... +70 °C		
Shock (DIN EN 60068-2-27)		15 g / 6 ms in XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz in XY axis, 10 cycles each		
Protection class (DIN EN 60529)		IP65 (front)		
Material		Stainless steel housing, glass lenses	Aluminum housing, glass lenses	
Weight [7]		approx. 30 g	approx. 800 g	approx. 550 g

1 Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat

2 RMS noise relates to mid of measuring range (1 kHz)

3 All data at constant ambient temperature (25 ±1 °C) against optical flat; specifications can change when measuring different materials.

4 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values

5 Maximum sensor measuring angle up to which a usable signal can be achieved on reflective surfaces, with accuracy decreasing toward the limit values

6 Glass sheet with refractive index n = 1.5 throughout the entire measuring range. In the mid of the measuring range, also thinner layers can be measured.

7 Sensor weight without optical fiber

3. Delivery

3.1 Scope of Delivery confocalDT IFD2410/2415

1 Controller	IFC2411 or IFC2416
1 Sensor	IFS240x-x
1 RJ patch cable Cat5	2 m
1 acceptance report	
1 quick manual	

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

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
e-mail info@micro-epsilon.com

3.2 Storage

Temperature range for storage: -20 ... +70 °C

Humidity: 5 ... 95% (non-condensing)

i Protect the lens of the sensor from getting dirty.
Protect the ends of the sensor cable (optical fibers) from getting dirty (applies to the IFD2411).

4. Mounting

4.1 Preliminary Remarks

The optical sensors/measuring systems of the confocalDT 2411/2416 series measure in the nanometer range. Observe the maximum tilt between sensor and target.

i Ensure careful handling during installation and operation!

4.2 IFC2411, IFC2416 Controller

The IFC241x controller can be placed on a flat surface or mounted with a TH 35 top-hat rail according to DIN EN 60715, e.g. in a control cabinet. Mindestabstand benachbarter Controller beträgt 10 mm. The minimum distance between controllers is 10 mm.

i Position the controller so that the connections, controls and displays are not concealed.

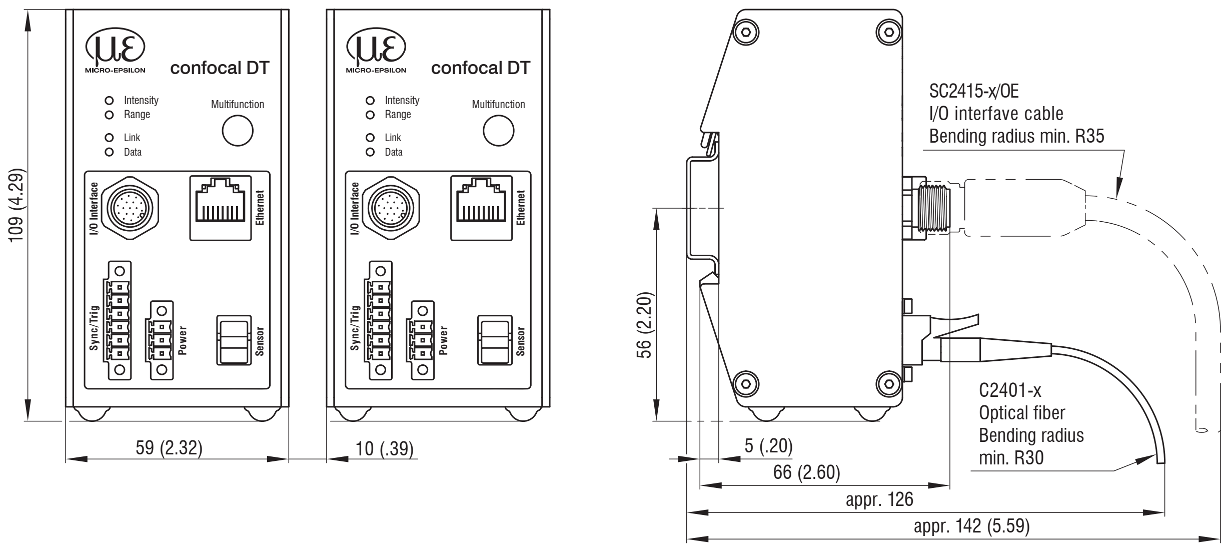


Fig. 2 IFC2411 dimensional drawing, dimensions *in mm*

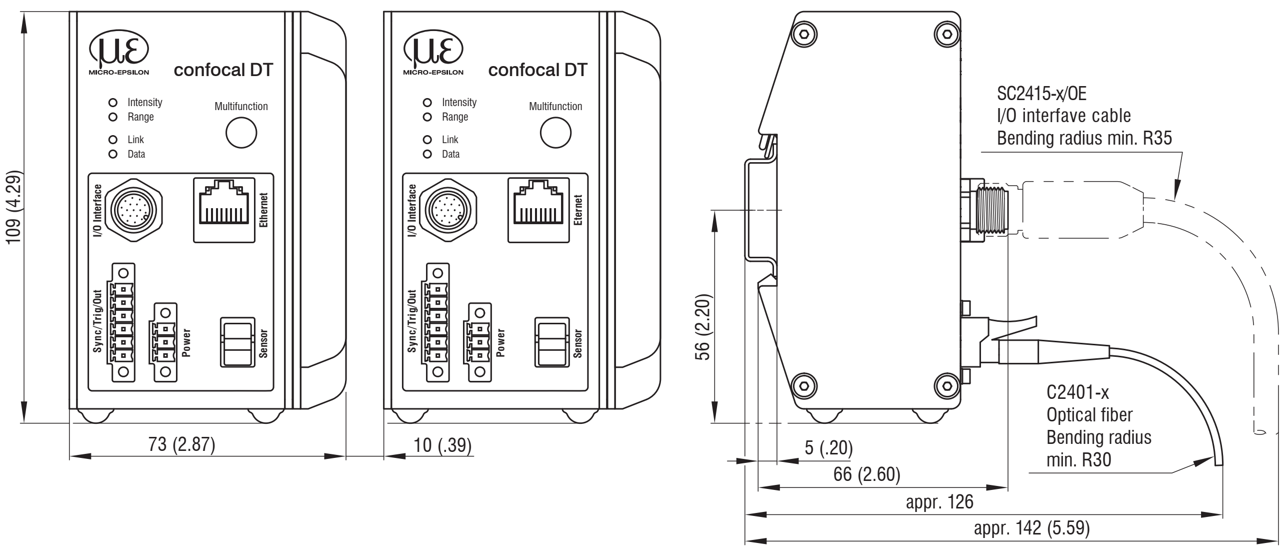


Fig. 3 IFC2416 dimensional drawing, dimensions *in mm*

4.3 Sensor Cable, Optical Fiber

The sensor is connected to the controller by means of an optical fiber.

- Do not shorten or extend the optical fiber.
- Do not pull or carry the sensor by the cable.
- The glass fiber has a diameter of 50 µm.

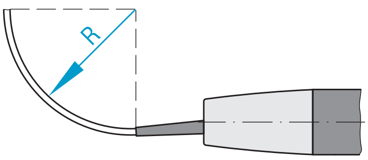
The connector must not be dirty under any circumstances, as this will cause particles to build up in the controller and severe loss of light. The plugs may only be cleaned by persons with the appropriate expertise using a fiber microscope for control.

General Rules

Do not

- getting the plugs dirty, e.g. through dust or fingerprints, and unnecessary plugging operations
- applying any mechanical stress to the optical fiber (bending, pinching, pulling, drilling, knotting, etc.)
- tight curvature of the cable, because the glass fiber is damaged in the process and this causes permanent damage through microscopic cracks

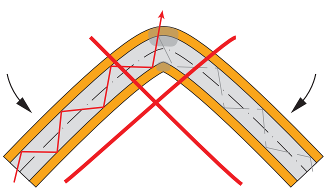
Never bend the sensor cable more tightly than the permitted bending radius.



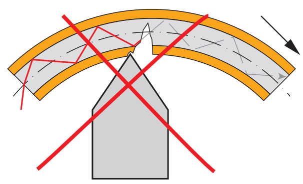
If the cable is immovably routed:
R = 30 mm or more

If the cable is movably routed:
R = 40 mm or more

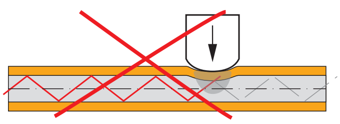
Do not kink the sensor cable.



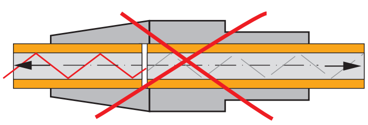
Do not pull the sensor cable over sharp edges.



Do not crush the sensor cable, do not use cable ties to secure it.



Do not pull on the sensor cable.

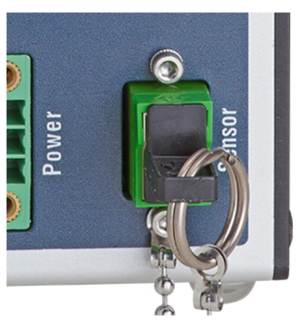


Connect sensor cable to controller

➡ Remove the dummy plug of the green optical fiber socket `sensor` on the controller.

➡ Plug the sensor cable with green plug (E2000/APC) into the optical fiber socket, making sure that the sensor connector is properly oriented.

➡ Insert the sensor plug until it locks into place.



Connect sensor cable to controller

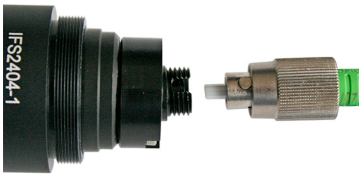
➡ Press down the release lever on the sensor plug and pull the sensor connector out of the socket.

➡ Re-insert the dummy plug.

Close the optical inputs/outputs with protective caps when no optical fiber cable is connected.

Connect sensor cable to sensor

- Remove the dummy plugs from the sensor and sensor cable.
- Insert the sensor cable into the optical fiber socket. Make sure that the sensor connector is properly oriented.
- Screw the sensor and sensor cable together with the knurled-head screw on the sensor cable.



i Pay attention to the orientation of the socket and guide lug.

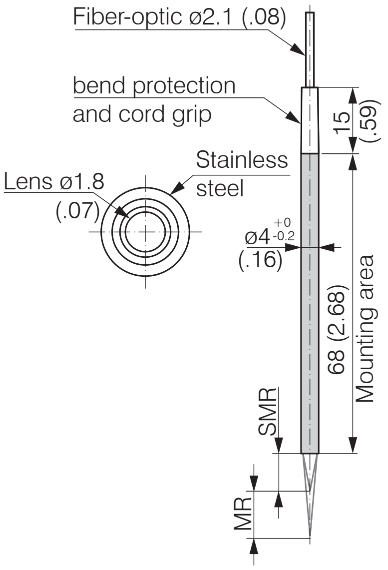
Fig. 4 Groove of the socket on the sensor (left) and guide lug of an FC sensor plug (right)

Connect sensor cable to sensor

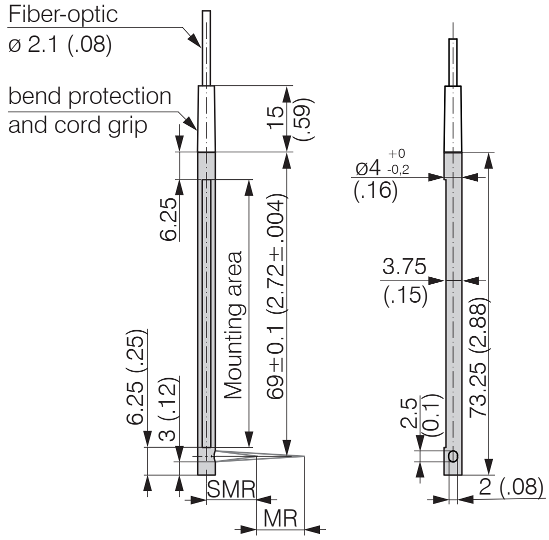
- Open the knurled-head screw on the sensor cable. Disconnect the sensor cable from the sensor.
- Stop up the sensor and sensor cable with the dummy plugs.

4.4 Sensors

4.4.1 Dimensions IFS2402 Sensors



IFS2402-0,5/1,5/4/10

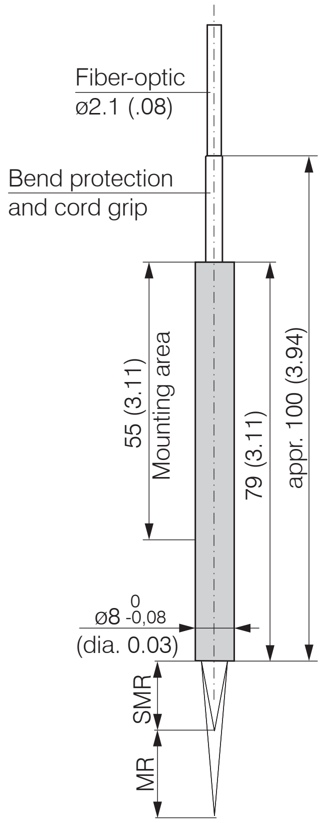


IFS2402/90-1,5/4/10

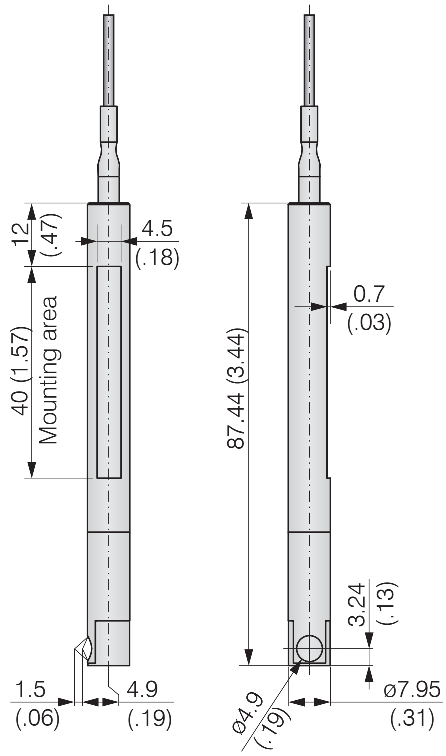
Dimensions in mm (inches, rounded off)

MR = Measuring range
SMR = Start of measuring range

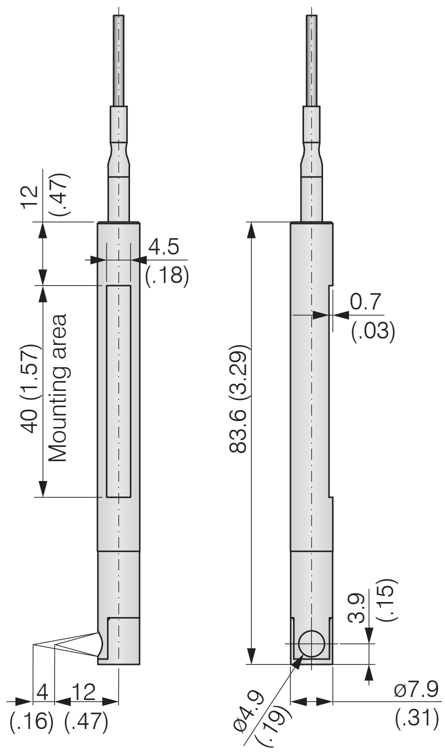
4.4.2 Dimensions IFS2403 Sensors



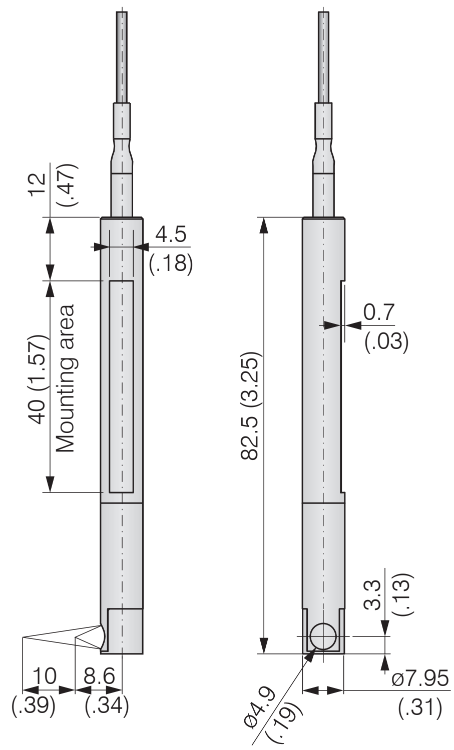
IFS2403-0,4/1,5/4/10



IFS2403/90-1,5



IFS2403/90-4

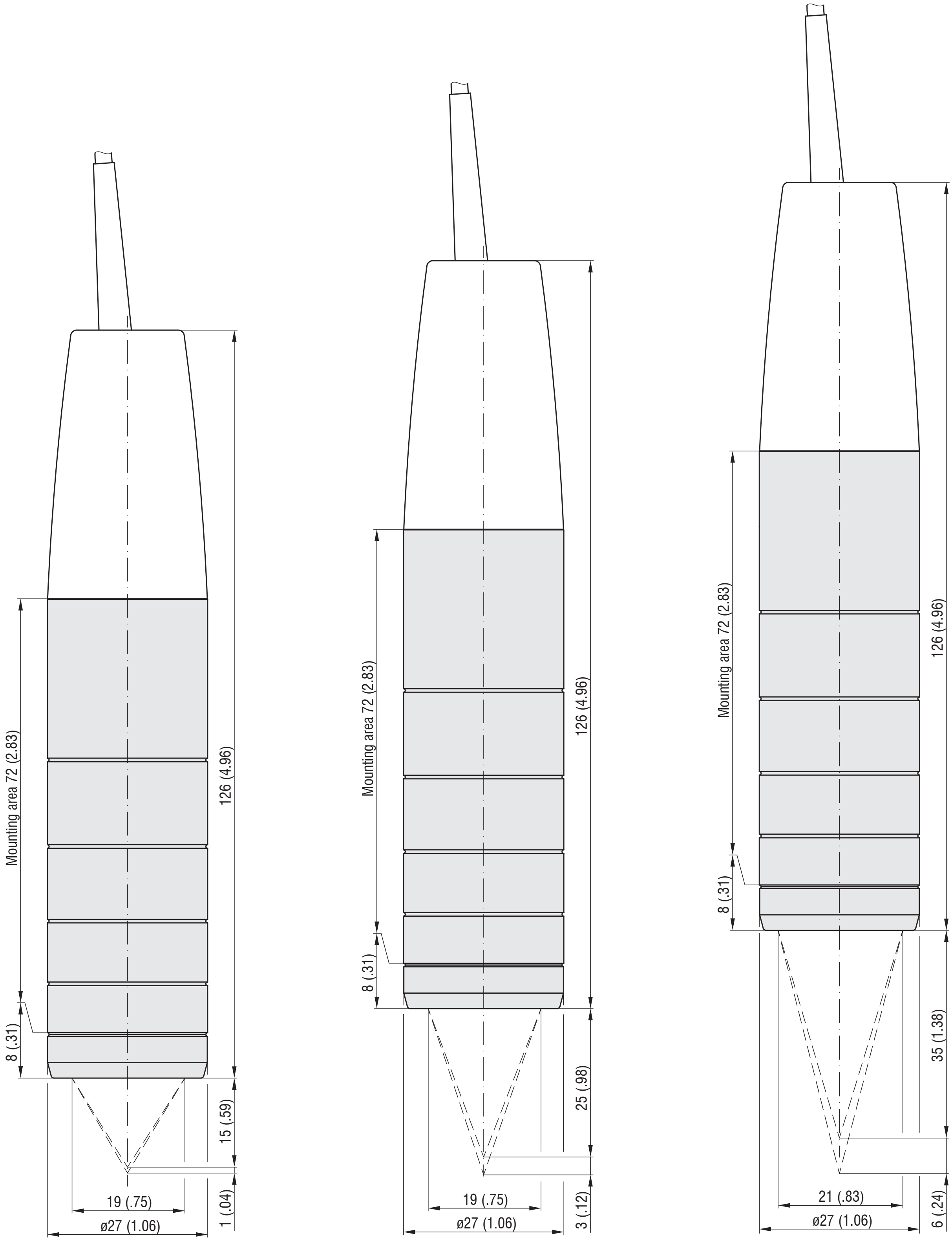


IFS2403/90-10

MR = Measuring range
SMR = Start of measuring range

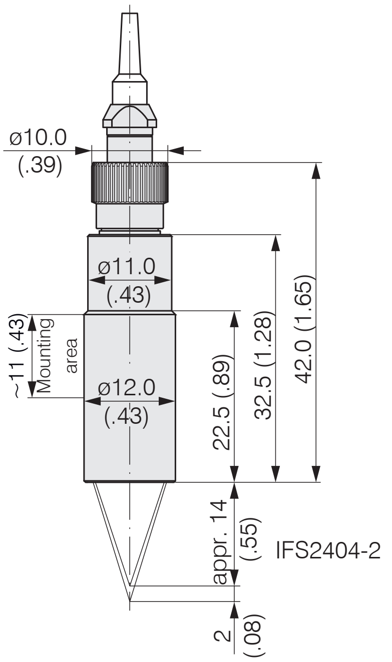
Dimensions in mm (inches, rounded off)

4.4.3 Dimensions IFS2404 Sensors

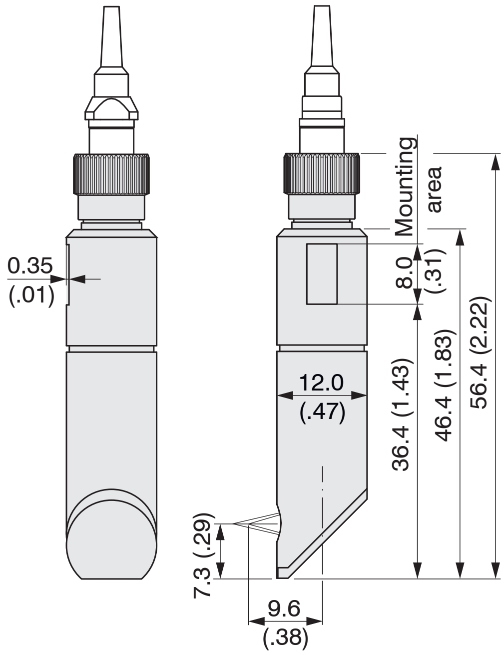


IFS2404-1 IFS2404-3 IFS2404-6

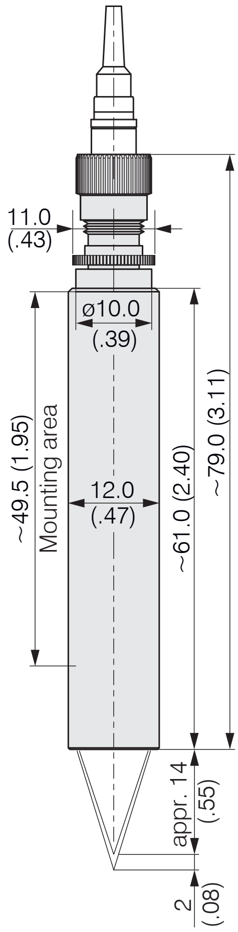
Dimensions in mm (inches, rounded off)



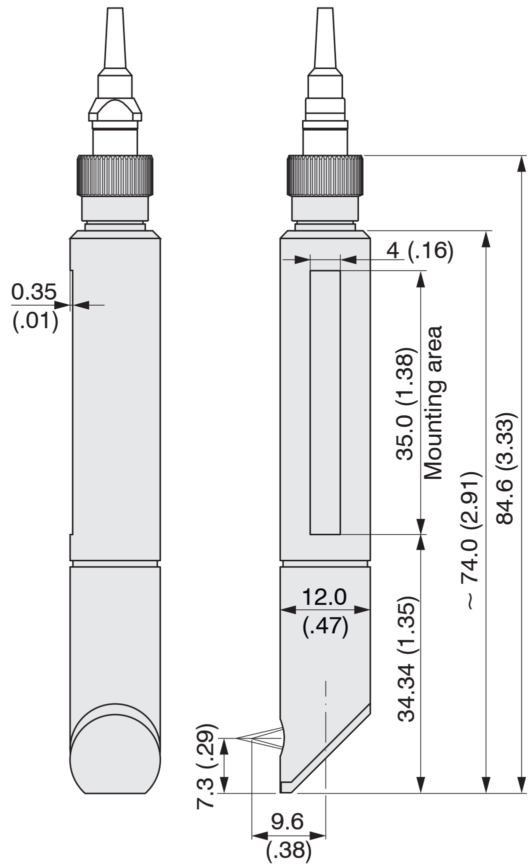
IFS2404-2



IFS2404/90-2



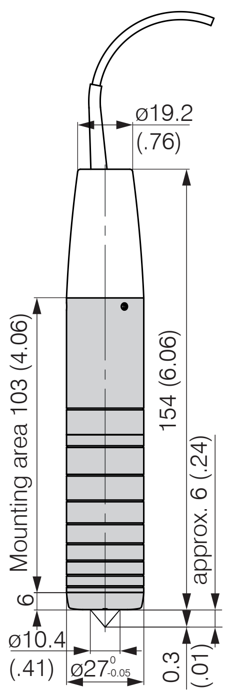
IFS2404-2(001)



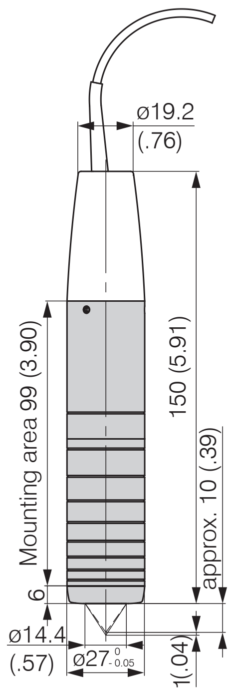
IFS2404/90-2(001)

Dimensions in mm (inches, rounded off)

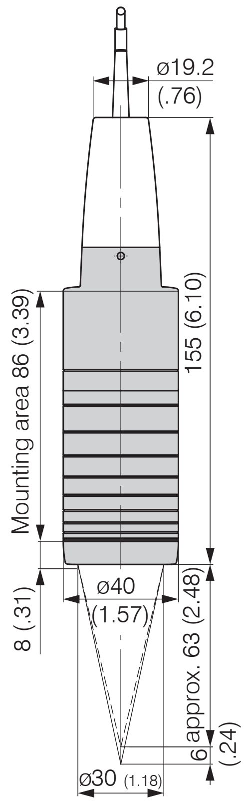
4.4.4 Dimensions IFS2405 Sensors



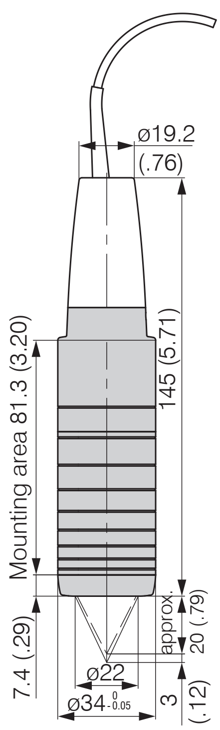
IFS2405-0,3



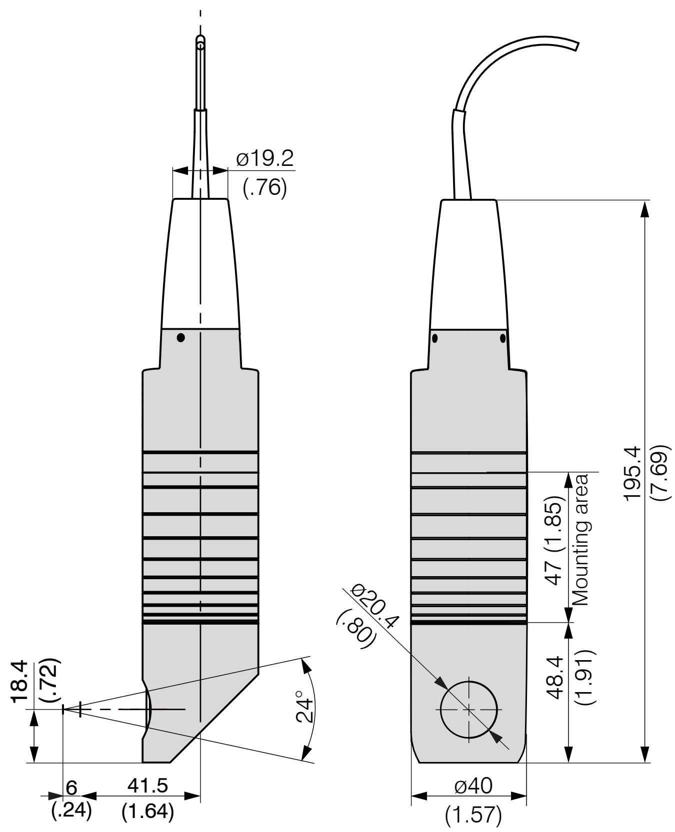
IFS2405-1



IFS2405-6

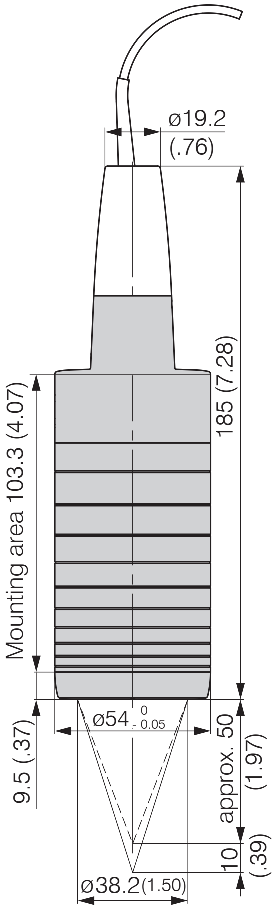


IFS2405-3

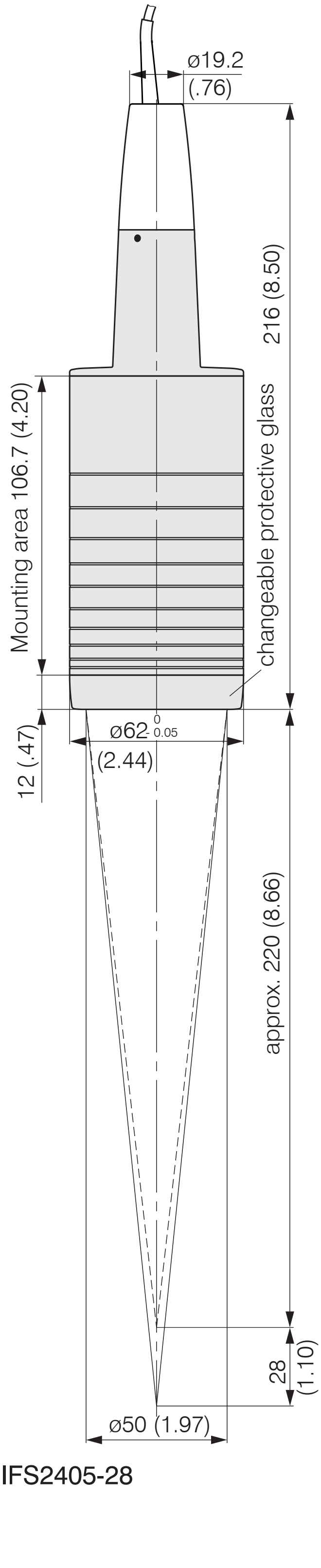


IFS2405/90-6

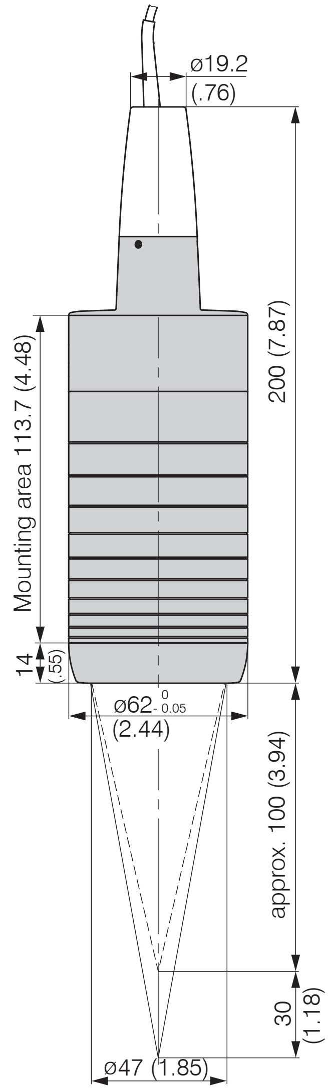
Dimensions in mm (inches, rounded off)



IFS2405-10



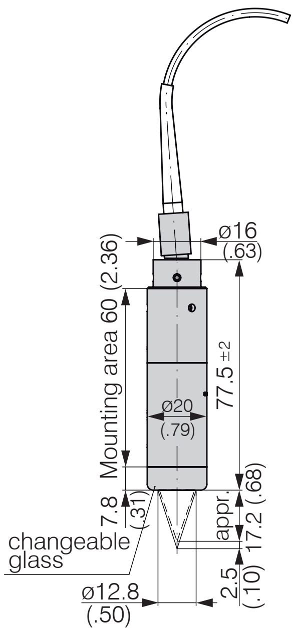
IFS2405-28



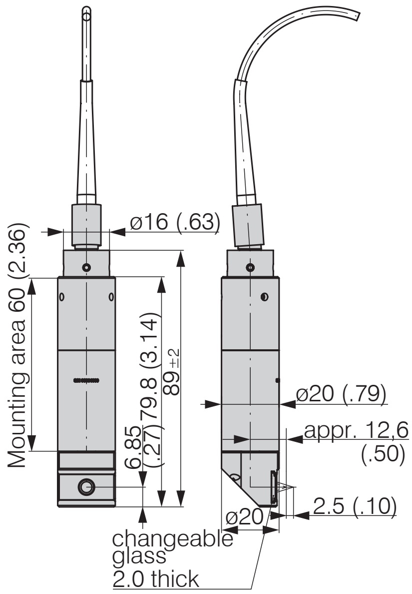
IFS2405-30

Dimensions in mm (inches, rounded off)

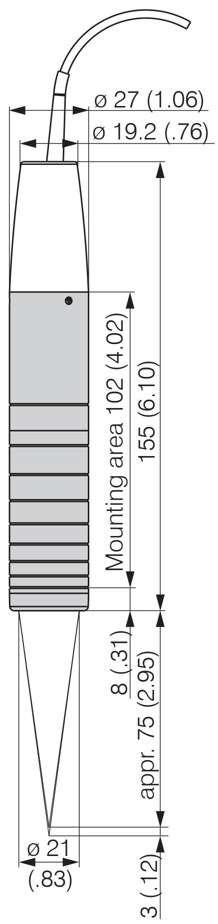
4.4.5 Dimensions IFS2406 Sensors



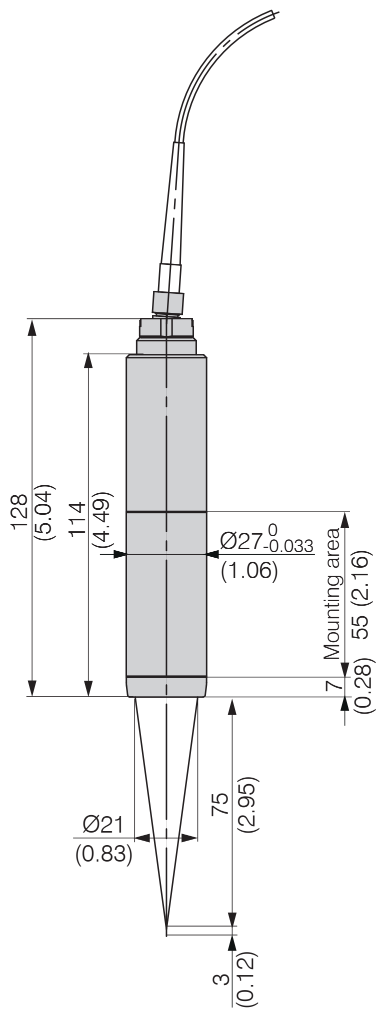
IFS2406-2,5/VAC(003)



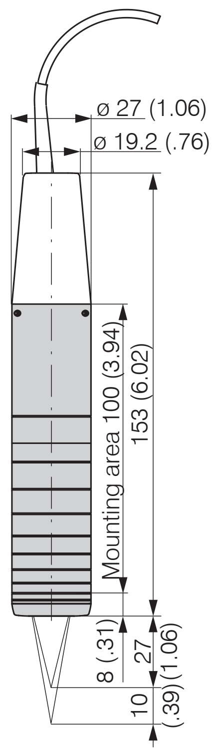
IFS2406/90-2,5/VAC(001)



IFS2406-3



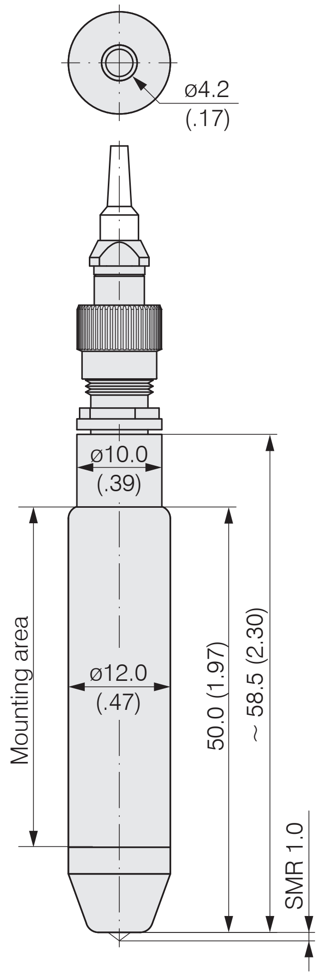
IFS2406-3/VAC(001)



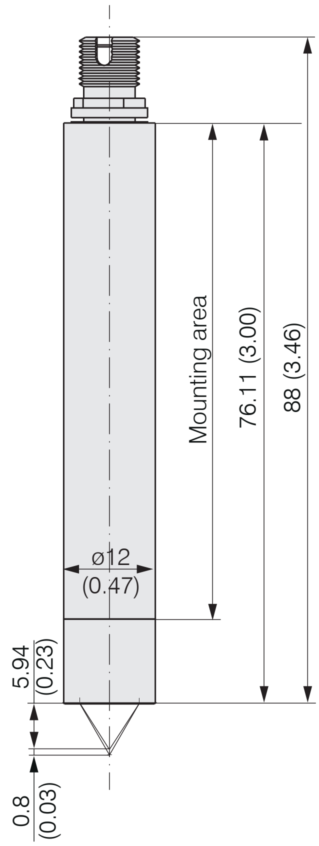
IFS2406-10

Dimensions in mm (inches, rounded off)

4.4.6 Dimensions IFS2407 Sensors

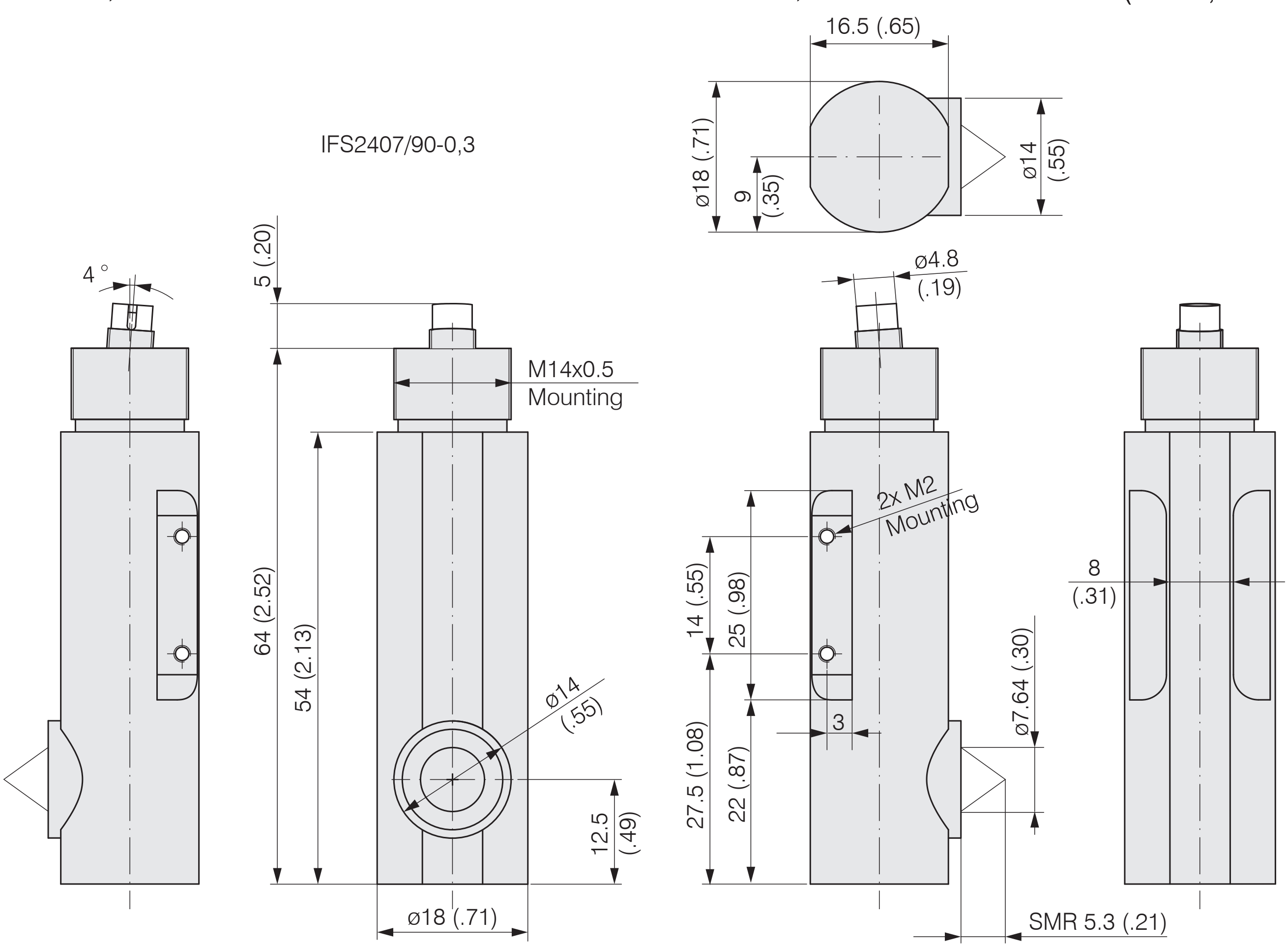


IFS2407-0,1

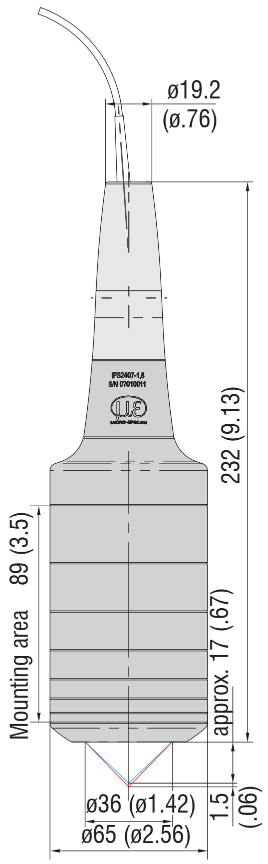


IFS2407-0,8

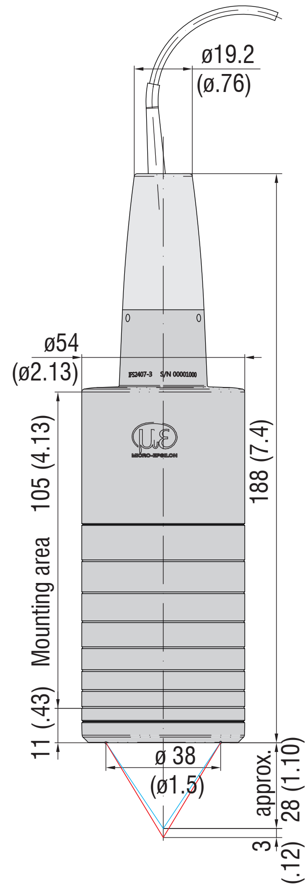
Dimensions in mm (inches, rounded off)



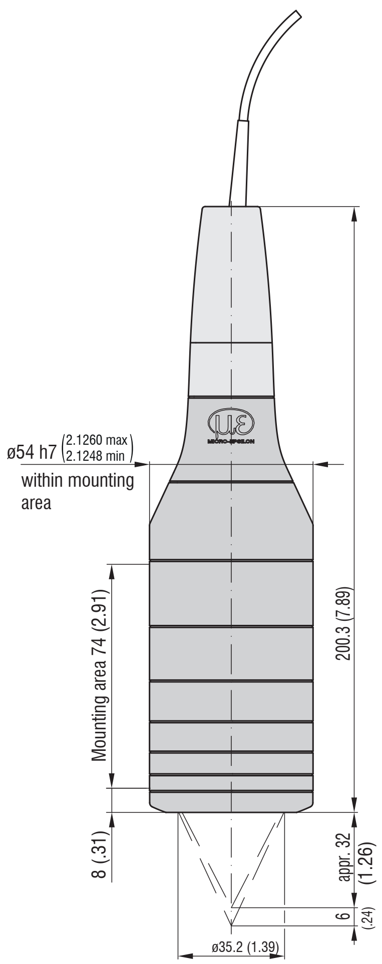
IFS2407/90-0,3



IFS2407-1,5



IFS2407-3



IFS2407-6

Dimensions in mm (inches, rounded off)

4.5 Start of Measuring Range

A base distance (SMR) must be maintained for each sensor.

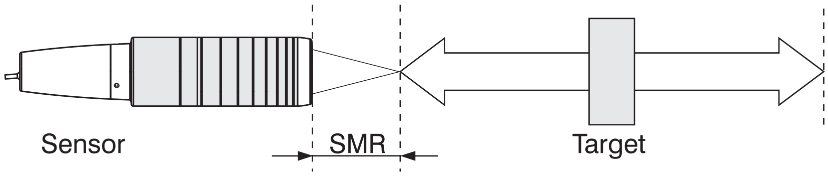


Fig. 5 Start of measuring range (SMR), the smallest distance between the sensor surface and the target.

SMR = Start of measuring range, approximate values

Sensor	SMR
IFS2402-0,5	1.7 mm
IFS2402-1,5	0.9 mm
IFS2402/90-1,5	2.5 mm [1]
IFS2402-4	1.9 mm
IFS2402/90-4	2.5 mm [1]
IFS2402-10	2.5 mm
IFS2402/90-10	3.5 mm [1]

Sensor	SMR
IFS2403-0,4	2.8 mm
IFS2403-1,5	8.1 mm
IFS2403/90-1,5	4.9 mm [1]
IFS2403-4	14.7 mm
IFS2403/90-4	12 mm [1]
IFS2403-10	11 mm
IFS2403/90-10	8.6 mm [1]

Sensor	SMR
IFS24041	15 mm
IFS2404-2	14 mm
IFS2404-2(001)	14 mm
IFS2404/90-2	9.6 mm [1]
IFS2404/90-2(001)	9.6 mm [1]
IFS2404-3	25 mm
IFS2404-6	35 mm

Sensor	SMR
IFS2405-0,3	6 mm
IFS2405-1	10 mm
IFS2405-3	20 mm
IFS2405-6	63 mm
IFS2405/90-6	41 mm [1]
IFS2405-10	50 mm
IFS2405-28	220 mm
IFS2405-28/VAC(001)	220 mm
IFS2405-30	100 mm

Sensor	SMR
IFS2406-2,5/VAC(003)	17.3 mm
IFS2406/90-2,5/VAC(001)	12.6 mm [1]
IFS2406-3	75 mm
IFS2406-3/VAC(001)	75 mm
IFS2406-10	27 mm
IFS2406-10/VAC(001)	27 mm

Sensor	SMR
IFS2407-0,1	1.0 mm
IFS2407/90-0,3	5.3 mm
IFS2407-0,8	5.9 mm
IFS2407-1,5	17 mm
IFS2407-3	28 mm

1) Start of measuring range measured from sensor axis.

4.6 Fastening, Mounting Adapter

4.6.1 General

The sensors of series IFS240x are optical sensors that operate in micrometers.

i Please ensure careful handling during installation and operation!

Mount the sensors with an outer clamp. This type of sensor installation ensures the highest level of reliability because the sensor's cylindrical cover is clamped over a relatively large area. It must be used in complex installation environments, such as machines, production systems etc.

4.6.2 IFS2402 Sensors

➡ Use an installation bracket MA2402 to mount IFS2402 sensors.

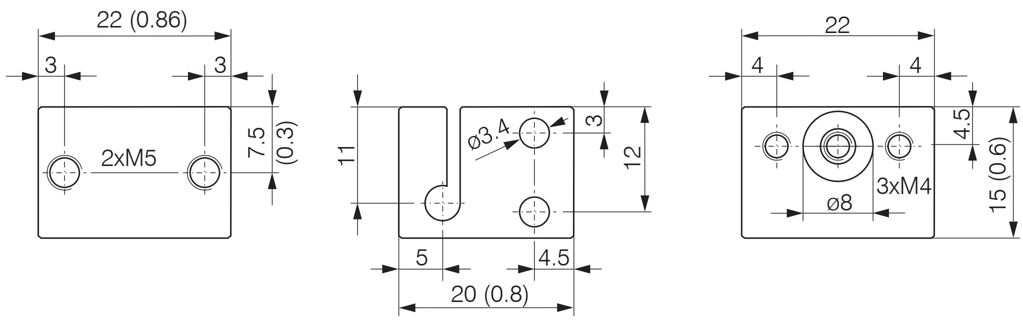


Fig. 6 MA2402-4 installation bracket

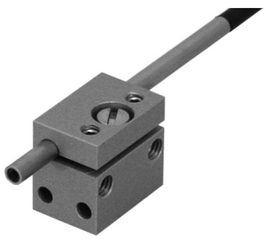


Fig. 7 Outer clamps with MA2402 for IFS2402 sensors

4.6.3 IFS2403 Sensors

➡ Use an installation bracket MA2403 to mount IFS 2403 sensors.

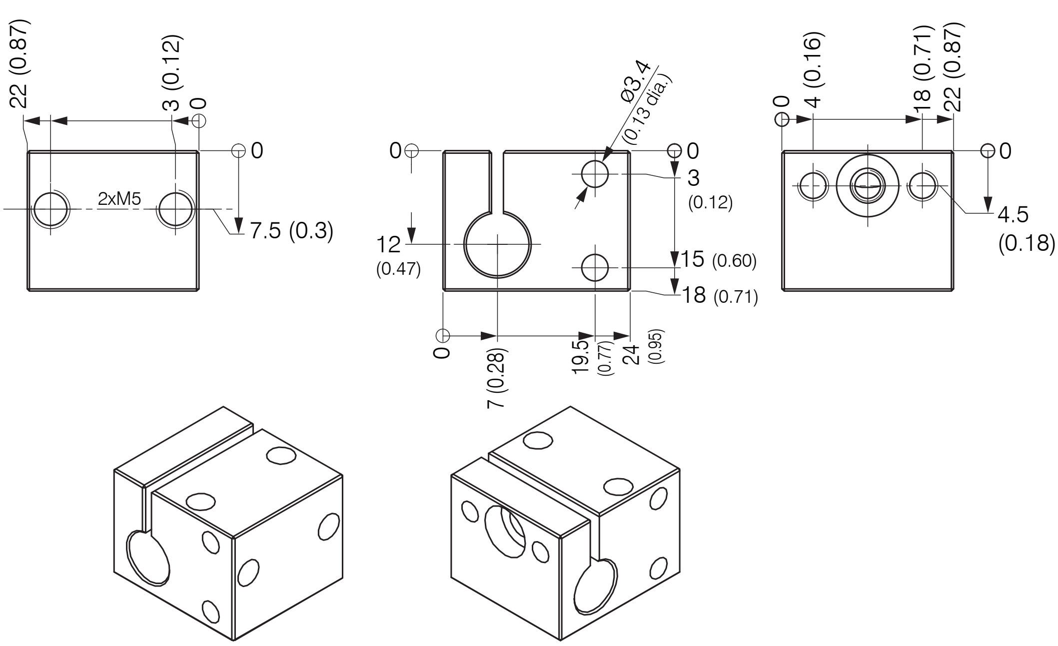
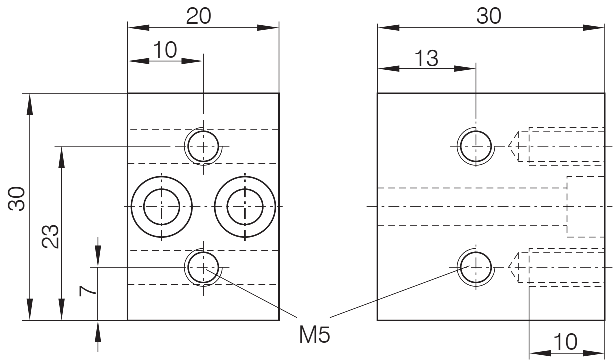


Fig. 8 MA2403 installation bracket

Dimensions in mm (inches, rounded off)

4.6.4 IFS2405, IFS2406 and IFS2407 Sensors

- Use an installation bracket MA240x to mount IFS2404-1, IFS2404-3 and IFS2404-6 sensors.
- Use an installation bracket MA240x to mount IFS2405, IFS2406 and IFS2407 sensors.



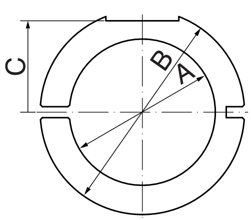
Mounting ring		Dimension A	Dimension B	Dimension C	Sensor
MA2400-27		ø27	ø46	19.75	IFS2404-1 IFS2404-3 IFS2404-6 IFS2405-0.3 IFS2405-1 IFS2406-3 IFS2406-10
MA2405-34		ø34	ø50	22	IFS2405-3
MA2405-40		ø40	ø56	25	IFS2405-6
MA2405-54		ø54	ø70	32	IFS2405-10 IFS2407-3 IFS2407-6
MA2405-62		ø62	ø78	36.5	IFS2405-28 IFS2405-30
MA2406-20		ø20	ø36	14.5	IFS2406-2,5
MA2407-65		ø65	ø81	18	IFS2407-1,5

Fig. 9 MA240x mounting block and ring

Fig. 10 Outer clamps with installation bracket MA240x for IFS2405, IFS2406 and IFS2407 sensors, consisting of mounting block and mounting ring

4.7 Electrical Connections, Pin Assignment

4.7.1 IFC2411

Source	Cable/power supply	Interface	Terminal

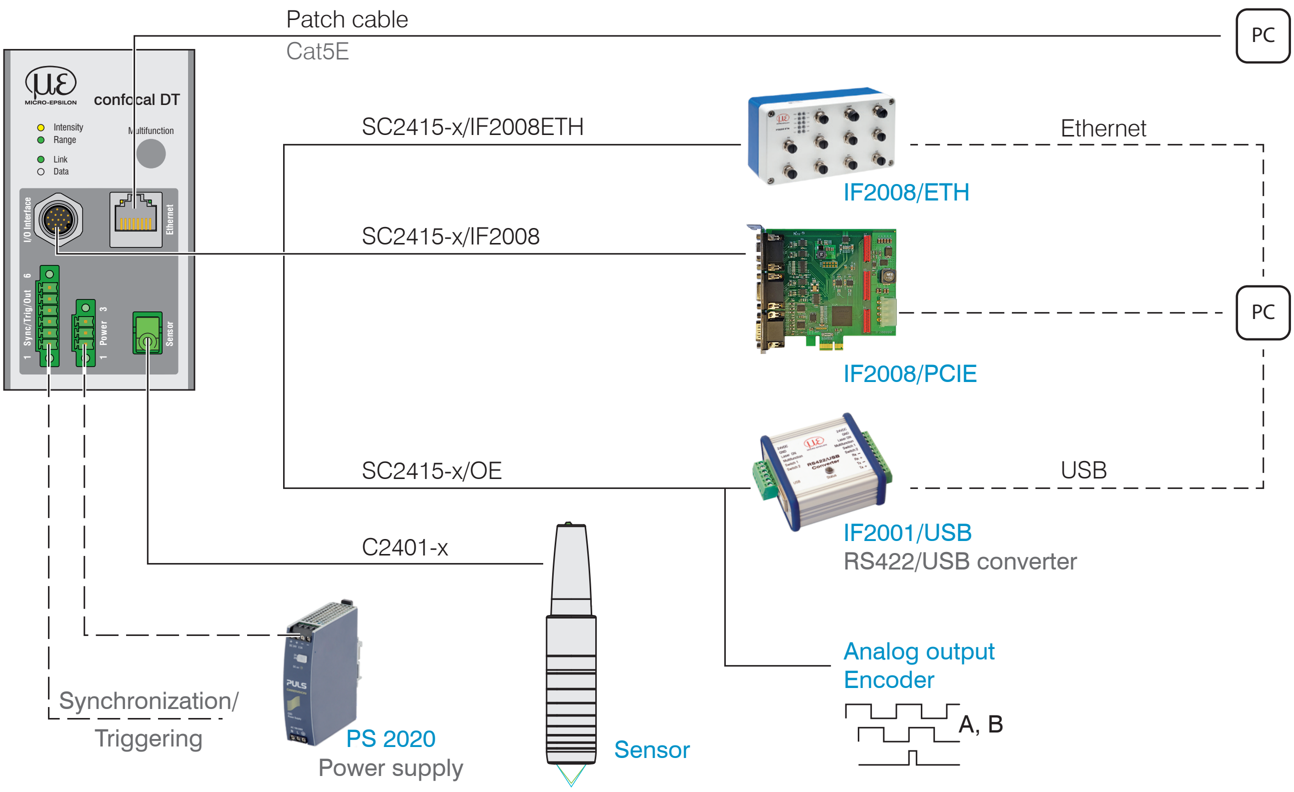
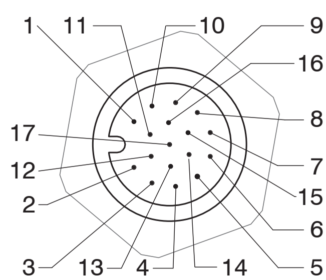


Fig. 11 Connection examples for confocalDT IFD2411

IFC2411 17-pin connector	SC2415-x/OE Wire color	IFC2411
1	White [1]	Analog output
2	Black [1]	Analog GND
3	Black	Data Tx -
5	Red	n.c.
8	Grey	Encoder 1B+
9	Green	Encoder 1Ref+
10	Brown	Data Rx+
11	White	Data Rx -
12	Red/Blue	Encoder 1A -
13	Purple	Data Tx+
14	Blue	n.c.
15	Pink	Encoder 1B -
16	Yellow	Encoder 1Ref -
17	Grey/Pink	Encoder 1A+

The SC2415-x/OE cable is available as an optional accessory.



17-pin sensor connector, pin side

Fig. 12 Pin assignment for 17-pin controller connector, pin side

4.7.2 IFC2416

Source	Cable/power supply	Interface	Terminal

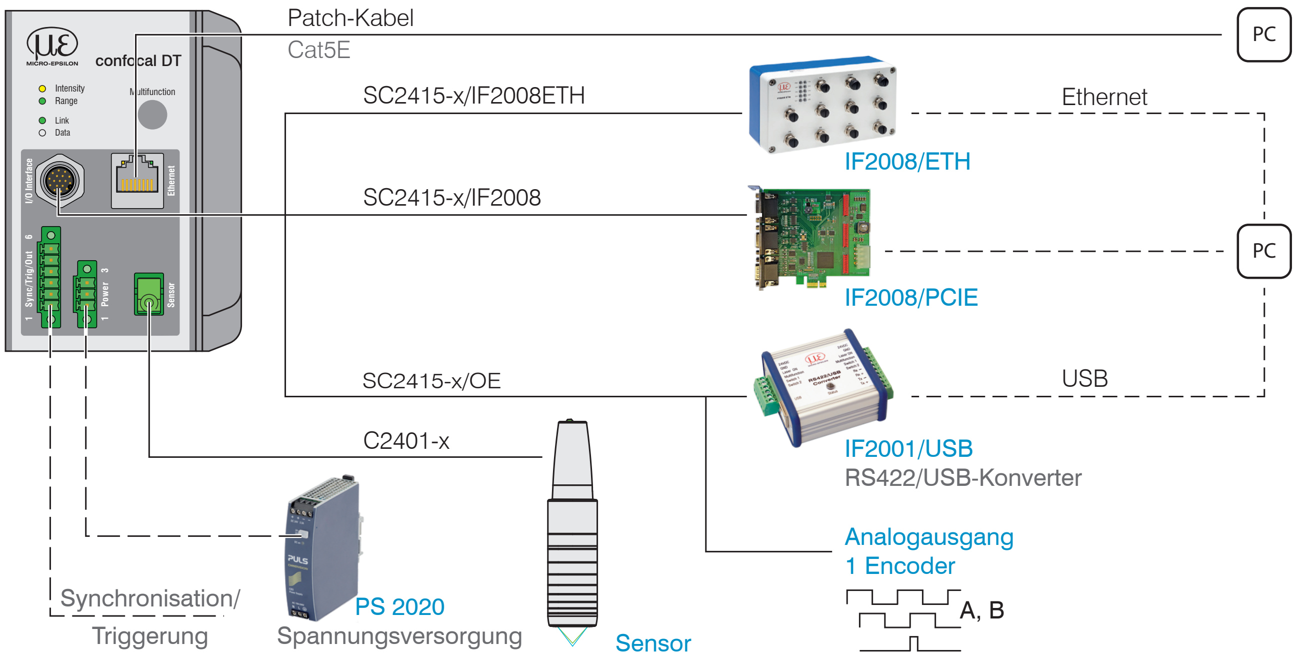


Fig. 13 Connection examples for confocalDT IFD2416 with one encoder

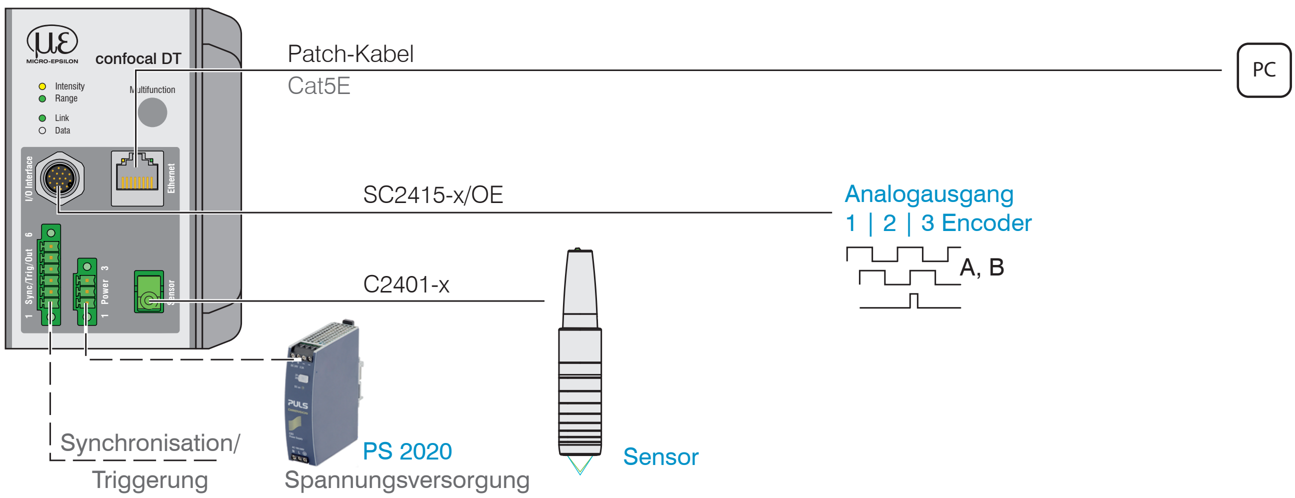
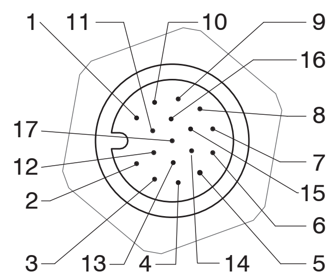


Fig. 14 Connection examples for confocalDT IFD2416 with three encoders

IFC2416 17-pin connector	**SC2415-x/OE Wire color**	**IFC2416** Standard	Alternative
1	White [1]	Analog output	
2	Black [1]	Analog GND	
3	Black	Data Tx -	Encoder 2B -
5	Red	Encoder 2Ref+	Encoder 2Ref+
8	Grey	Encoder 1B+	
9	Green	Encoder 1Ref+	
10	Brown	Data Rx+	Encoder 2A+
11	White	Data Rx -	Encoder 2A -
12	Red/Blue	Encoder 1A -	
13	Purple	Data Tx+	Encoder 2B+
14	Blue	Encoder 2Ref -	Encoder 2Ref -
15	Pink	Encoder 1B -	
16	Yellow	Encoder 1Ref -	
17	Grey/Pink	Encoder 1A+	

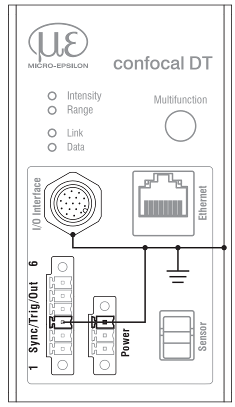
The SC2415-x/OE cable is available as an optional accessory.



17-pin sensor connector, pin side

Fig. 15 Pin assignment for 17-pin controller connector, pin side

4.7.3 Grounding Concept, Shielding



All inputs and outputs are galvanically connected to the power supply ground (`supply GND`); the Ethernet/EtherCAT connections are potential-free.

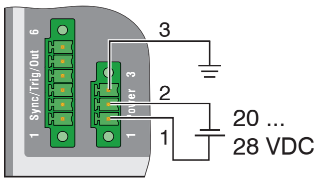
The ground connections (`supply GND` and `analog GND`) of each connection group are galvanically connected to one another by filters.

The shield connections of each connection group are only connected to the controller housing. They are used to connect the cable shieldings for individual connections (power, analog output, switching outputs, synchronization and trigger input).

i For reasons of interference resistance, use the corresponding GND connection for the analog output.
Only use shielded cables shorter than 30 m and connect the cable shield to the shield or the connector housings.

4.7.4 Supply Voltage (Power)

Nominal value: 24 V DC (20 ... 28 V, P < 7 W).



IFC241x 3-pin clamping sleeve	Power supply
1	V_+
2	GND
3	Shield

Only turn on the power supply after wiring has been completed.

➡ Connect the inputs for pin 1 and pin 2 on the controller to a 24 V power supply.

i Power supply only for measuring devices, not to be used for drives or similar sources of pulse interference at the same time. MICRO-EPSILON recommends using the optionally available PS2020 power supply, for the sensor.

4.7.5 RS422

In addition to Industrial Ethernet, the IFC241x also supports serial communication via RS422. The SC2415-x/OE cable enables serial communication. The IF2001/USB RS422-to-USB converter is available as an optional accessory.

- Differential signals to EIA-422, galvanically connected to supply voltage.
- Receiver Rx with 120 Ohm internal terminating resistor.

➡ Use a shielded cable with twisted wires. Cable length less than 30 m.

➡ Connect the ground connections.

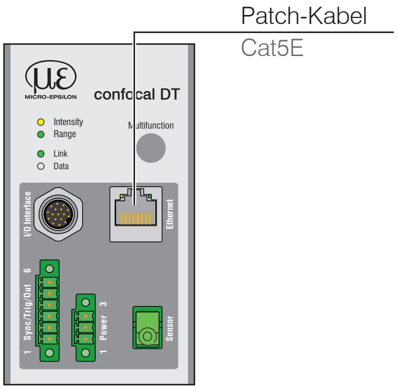
IFC241x 17-pin connector	Signal	SC2415-x/OE	IF2001/USB
3	Tx -	Black	Rx -
13	Tx +	Purple	Rx +
10	Rx +	Brown	Tx +
11	Rx -	White	Tx -
Housing	Shield	Cable shield	---

The IFC2411/2416 controllers always support the use of a single encoder, regardless of whether Ethernet or RS422 communication is used.

i However, in the case of the IFC2416, serial communication via RS422 is not possible if two or three encoders are going to be connected. When the controller is operated in conjunction with two or three encoders, the RS422 connections are used for the encoders.

4.7.6 Ethernet

Connection with an Ethernet network (PC).



➡ Connect the IFC241x and network with a shielded Ethernet cable (Cat5E, 2 m patch cable from the scope of delivery, total cable length shorter than 100 m).

The two LEDs `LINK` and `DATA` indicate that the connection was successful and is active.

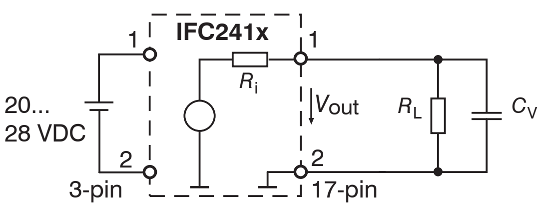
The measuring device can be configured via the web interface or by ASCII commands at command level (e.g. Tera Term).

4.7.7 Analog Output

The alternative analog output (voltage or current) is connected to the 17-pin connector and is galvanically connected to the supply voltage.

IFC241x, 17-pin connector		**SC2415-x/OE**
Signal	Pin	Wire color
Analog output	1	White, inside
Analog GND	2	Black [1]
Shield	Housing	Black

Voltage: Pin V/I_{out} and Pin GND,

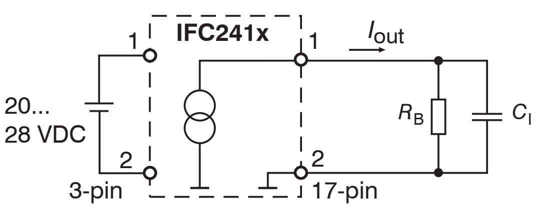


R_i approx. 50 Ohm, R_L > 10 MOhm

Slew rate (without C_V, $R_L \geq 1$ kOhm) typ. 0.5 V/μs

Slew rate (with C_V = 10 nF, $R_L \geq 1$ kOhm) typ. 0.4 V/μs

Current: Pin U/I_{out} and Pin GND



$R_B \leq 500$ Ohm

Slew rate (without C_I, R_B = 500 Ohm) typ. 1.6 mA/μs

Slew rate (with C_I= 10 nF, R_B = 500 Ohm) typ. 0.6 mA/μs

➡ Use a shielded cable. Cable length less than 30 m.

As an alternative, the output range can be set to the following values:

Voltage: 0 ... 5 V; 0 ... 10 V;

Current: 4 ... 20 mA.

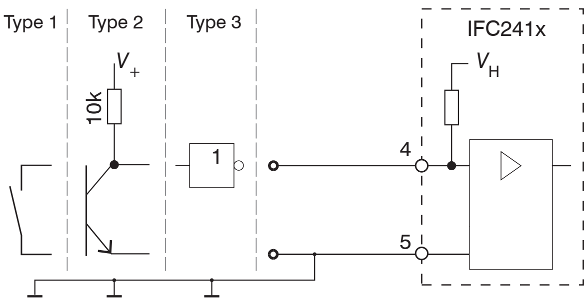
The measured values can only be output as voltage or current.

1) Analog output in shielded cable area

4.7.8 Multifunction Input

The multifunction input (pin 4 on the 6-pin plug-in screw terminal) can be used for external synchronization or for triggering.

A switching transistor with an open collector (e.g. in an optocoupler), a relay contact or a digital TTL or HTL signal are suitable for switching.



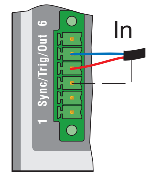
24V logic (HTL): Low ≤ 3 V; High ≥ 8 V (max 30 V),

5V logic (TTL): Low ≤ 0.8 V; High ≥ 2 V

Minimal pulse width 50 µs

Internal pull-up resistor, an open input is detected as High.

Maximum switching frequency 25 kHz



An external resistor is not required for current limitation. The ground of the logic circuit must be galvanically connected to the supply ground.

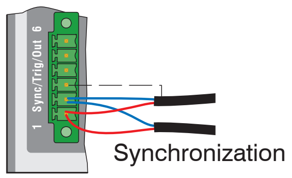
4.7.9 Synchronization (Inputs/Outputs)

4.7.9.1 General

- The `SYNC+` and `Sync-` pins on the 6-pin clamping sleeve: Symmetrical output/input for synchronization of two or more controllers
- The pin `multifunction input 1` on the 6-pin clamping sleeve: Input for synchronization of a controller with an external synchronization source, such as a function generator
- The termination resistor R_T (120 Ohm) can be switched on or off via software.

4.7.9.2 Internal Synchronization

One IFC241x controller (master) synchronizes one or more controllers (slaves).



IFC241x 6-pin clamping sleeve	Signal	Level
1	Sync +	RS422
2	Sync -	RS422
3	Cable shield	
5	GND	

Fig. 16 Connections and signal level internal synchronization

➡ Activate the termination resistor (120 Ohm) in the last controller (slave n) in the chain.

Star synchronization

➡ Connect pins `Sync+` and `Sync-` from controller 1 (master) in a star shape to pins `Sync+` and `Sync-` from controller 2 (slave) to controller n, in order to synchronize two or more controller to one another, see Fig. 17

- Sub-loop length less than 30 m in star synchronization

Chain synchronization

➡ Connect pins `Sync+` and `Sync-` from controller 1 (master) to pins `Sync+` and `Sync-` from controller 2 (slave 1).
Connect the pins of the following controller to synchronize two or more controller to one another, see Fig. 17

- Total line length less than 30 m in chain synchronization

➡ Use shielded cables with twisted wires.

➡ Connect the cable shield to pin 3 of the 6-pin terminal block.

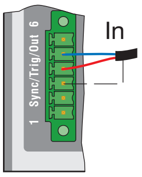
➡ Program controller 1 to `Master` and all other controller to `Slave`.

Fig. 17 Synchronization of multiple controllers, star-shaped on the left, daisy-chained on the right

➡ Connect all GND connections of the supply to one another if the controllers are not fed by a common power supply.

4.7.9.3 External Synchronization Controller

An external synchronous source synchronizes one or more controller (slaves).



IFC241x 6-pin clamping sleeve	Signal	Level
4	Multifunction	TTL or HTL
3	Cable shield	
5	GND	

Fig. 18 Connections external synchronization

Level	
TTL Low Level ≤ 0.8 V; High Level ≥ 2 V Minimal pulse width 50 µs	HTL Low Level ≤ 3 V; High Level ≥ 8 V (max. 30 V) Minimal pulse width 50 µs

Fig. 19 Signal level external synchronization/triggering

➡ Activate the termination resistor (120 Ohm) in the last controller (slave n) in the chain.

Star synchronization

➡ Connect the `multifunction` pin of slave 1 to the external synchronization source.

➡ Connect the `GND` of the controller to the ground connection of the synchronization source.

Further controllers can be synchronized in the same schematic.

- Sub-loop length less than 30 m in star synchronization

➡ Use shielded cables with twisted wires.

➡ Connect the cable shield to pin 3 of the 6-pin terminal block.

➡ Program all controllers to `Slave`.

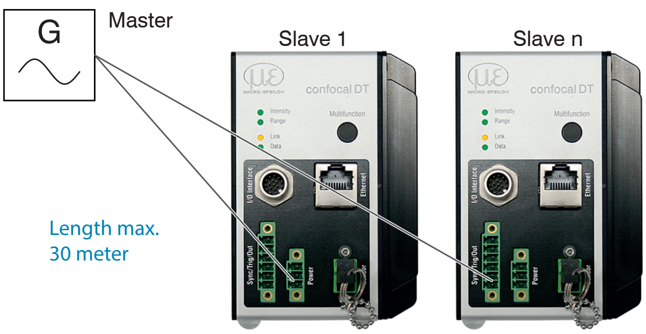


Fig. 20 Synchronization of multiple controllers, star-shaped

➡ Connect all GND connections of the supply to one another if the controllers are not fed by a common power supply.

4.7.10 Triggering

4.7.10.1 General

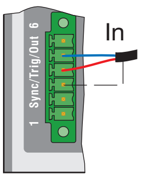
Data recording or output can be triggered with:

- the multifunction input,
- synchronization inputs Sync+ and Sync-,
- encoder 1 or encoder 2 [1].

➡ Use a shielded cable with twisted wires. Cable length less than 30 m.

Switching contacts, transistors (NPN, N-channel FET) or PLC outputs can be used as trigger sources.

4.7.10.2 Triggering with Multifunction Input



IFC241x 6-pin clamping sleeve	Signal	Level
4	Multifunction	TTL or HTL
3	Cable shield	
5	GND	

Fig. 21 Connections triggering with switching input

Level	
TTL Low Level ≤ 0.8 V; High Level ≥ 2 V Minimal pulse width 50 µs	HTL Low Level ≤ 3 V; High Level ≥ 8 V (max. 30 V) Minimal pulse width 50 µs

Fig. 22 Signal level external synchronization/triggering

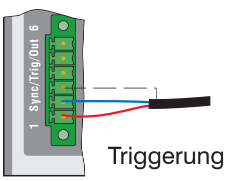
➡ Connect the `multifunction` pin to the external trigger source.

➡ Connect the `GND` of the controller to the ground connection of the external trigger source.

➡ Connect the trigger cable shielding to pin 3.

Program the controller's `multifunction` connection to the trigger input function.

4.7.10.3 Triggering with Synchronization Input



IFC241x 6-pin clamping sleeve	Signal	Level
1	Sync +	RS422
2	Sync -	RS422
3	Cable shield	

➡ Connect pin 1 (`Sync+`) and pin 2 (Sync-) to the external trigger source.

➡ Connect the trigger cable shielding to pin 3.

Program the controller's `multifunction` connection to the trigger input function.

The trigger source (master) must supply a symmetrical output signal according to the RS422 standard. For asymmetrical trigger sources, Micro-Epsilon recommends inserting the SU4 level converter (3 channels TTL/HTL to RS422) between trigger signal source and sensor.

1) The IFC2416 allows triggering to be performed with the second encoder.

4.7.10.4 Triggering with Input Encoder 1 | 2

A connected encoder at the input of encoder 1 can be used for triggering.

IFC2411, IFC2416 17-pin connector				**SC2415-x/OE**
Signal	Pin	Level		Wire color
Encoder 1B+	8	RS422 (EIA422)		Gray
Encoder 1B -	15			Pink
Encoder 1A -	12			Red/blue
Encoder 1A+	17			Gray/pink

IFC2416 [1] 17-pin connector				**SC2415-x/OE**
Signal	Pin	Level		Wire color
Encoder 2B+	13	RS422 (EIA422)		Gray
Encoder 2B -	3			Pink
Encoder 2A -	11			Red/blue
Encoder 2A+	10			Gray/pink

Program the controller's encoder connections to the trigger input function.

1) The IFC2416 allows triggering to be performed with the second encoder.

4.7.11 Encoder Input IFC2411

The controller supports one encoder.

Encoder inputs:

- Incremental signals A, B
- Reference pulse

The maximum pulse frequency is 1 MHz.

RS422 level (symmetrical) for A, B, Ref

The encoder supply is not provided.

IFC2411, 17-pin connector			**SC2415-x/OE**
Signal	Pin		Wire color
Encoder 1B+	8		Gray
Encoder 1B -	15		Pink
Encoder 1Ref+	9		Green
Encoder 1Ref -	16		Yellow
Encoder 1A -	12		Red/blue
Encoder 1A+	17		Gray/pink

Fig. 23 Pin assignment for encoder input

Use a shielded cable. Cable length shorter than 3 m. Connect the cable shield to the housing.

Connection conditions

- The encoders must supply signals with TTL level.

4.7.12 Encoder Input IFC2416

The controller supports up to three encoders.

Two encoder inputs:

- Incremental signals A, B
- Reference pulse

The maximum pulse frequency is 1 MHz.

RS422 level (symmetrical) for A, B, Ref

The encoder supply is not provided.

IFC2416, 17-pin connector		**SC2415-x/OE**
Signal	Pin	Wire color
Encoder 2A+ [1]	10	Brown
Encoder 2A -	11	White
Encoder 2B+	13	Purple
Encoder 2B -	3	Black
Encoder 2Ref+	5	Red
Encoder 2Ref -	14	Blue

IFC2416, 17-pin connector		**SC2415-x/OE**
Signal	Pin	Wire color
Encoder 1A+	17	Grey/pink
Encoder 1A -	12	Red/blue
Encoder 1B+	8	Grey
Encoder 1B -	15	Pink
Encoder 1Ref+	9	Green
Encoder 1Ref -	16	Yellow

Fig. 24 Pin assignment for two encoder inputs

Three encoder inputs:

- Incremental signals A, B

The maximum pulse frequency is 1 MHz, no reference pulse.

RS422 level (symmetrical) for A, B, Ref

The encoder supply is not provided.

IFC2416, 17-pin connector		**SC2415-x/OE**
Signal	Pin	Wire color
Encoder 2A+ [1]	10	Brown
Encoder 2A-	11	White
Encoder 2B+	13	Purple
Encoder 2B -	3	Black
Encoder 3B+	5	Red
Encoder 3B -	14	Blue

IFC2416, 17-pin connector		**SC2415-x/OE**
Signal	Pin	Wire color
Encoder 1A+	17	Grey/pink
Encoder 1A -	12	Red/Blue
Encoder 1B+	8	Grey
Encoder 1B -	15	Pink
Encoder 3A+	9	Green
Encoder 3A -	16	Yellow

Fig. 25 Pin assignment for three encoder inputs

➡ Use a shielded cable. Cable length shorter than 3 m. Connect the cable shield to the housing.

Connection conditions

- The encoders must supply signals with TTL level.
- If there are no RS422 outputs on the encoder, Micro-Epsilon recommends inserting the SU4 level converter (3 channels TTL/HTL to RS422) between trigger signal source and controller.

1) If encoders 2 and 3 are used, no serial communication via RS422 will be possible.

4.7.13 Switching Output

The IFC2416 controller features a switching output.

The switching output on the 6-pin pluggable screw terminal are electrically connected to the supply voltage. The switching behavior (NPN, PNP, Push-Pull) is programmable, $I_{max.}$ 70 mA.

The maximum auxiliary voltage for a switching output with NPN switching behavior is 30 V.

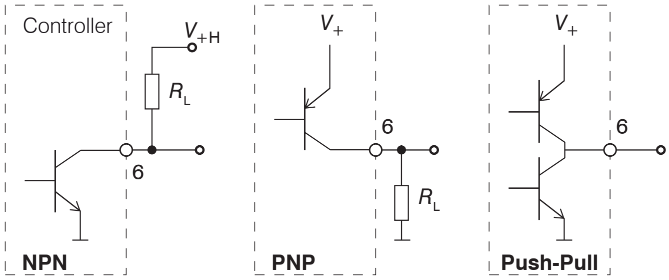


Fig. 26 Output behavior and wiring of the switching output

➡ Connect pins 6 and 5 to the following evaluation unit using a cable with a length of less than 30 m.

Output level (no load resistance), with a supply voltage of 24 VDC	Low < 1 V; High > 23 V	
Saturation voltage at I_{max} = 70 mA	Low < 2,5 V (Output - GND)	
	High < 2,5 V (Output - V_+)	

The saturation voltage is measured between output and GND, with output = Low, or between output and V_+, with output = High.

Description	Pin	Output active	Output passive
NPN (Low side)	6	GND	V_+
PNP (High side)		V_+	GND
Push-Pull		V_+	GND
Push-Pull, negiert		GND	V_+

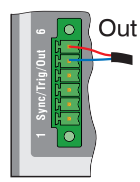


Fig. 27 Switching behavior of the error output

NOTICE The load resistance R_L can be dimensioned according to the limit values (I max = 70 mA, $V_{+, max}$ = 30 V) and requirements. Do not connect inductive loads, e.g. a relay without parallel protection diodes.

4.7.14 Handling of the Plug-In Screw Terminals

The controller has two plug-in screw terminals for supply, synchronization and triggering. These are included as accessories.

➡ Remove the insulation of the connection wires (0.14 ... 1.5 mm²) over a length of 7 mm.

➡ Connect the connection wires.

i The screw terminals can be fastened with two captured screws.

4.7.15 Dark Correction IFD241x

A dark correction must be carried out after the sensor or sensor cable is changed. Find the details on this in the `Commissioning` see Chap. 5 section.

4.8 LEDs

LED	Color	Status	Meaning
Intensity	Red	flashes	Dark signal acquisition in progress
	Red	illuminated	Signal saturated
	Yellow	illuminated	Signal too low
	Green	illuminated	Signal OK
Range	Red	flashes	Dark signal acquisition in progress
	Red	illuminated	No target present, outside of measuring range
	Yellow	illuminated	Target close to mid of measuring range
	Green	illuminated	Target within the measuring range

Fig. 28 Meaning of LEDs on measuring system

4.9 Multifunction Key

The `Multifunction` key is assigned for multiple functions. The key is assigned the `dark correction` function from the factory.

Function	Dark correction	*Dark correction starts*
	Factory settings	Resets the device and measurement settings to factory settings.

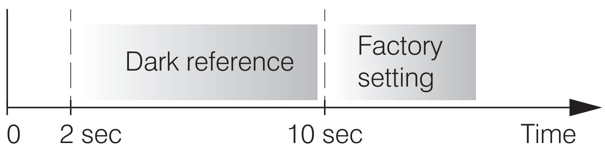


Fig. 29 `Multifunction` *key actuation time*

The key is not assigned a key lock from the factory. You can optionally deactivate or lock the key to prevent incorrect operation.

Set to factory setting: Hold the key for longer than 10 s.

5. Commissioning

5.1 Communication Options

i The measuring system is ready for operation approx. 3 s after the supply voltage is applied. To ensure precise measurements, let the measuring system warm up for approx. 50 minutes.

The measuring system starts with Ethernet.

Communication with the controller

Ethernet communication

- Programming via web interface,
- Output of measurement data via Ethernet
- Programming at command level, e.g. via Tera Term,

➡ Connect the measuring system and PC with a LAN cable.

➡ Start your web browser and type the standard IP address of the sensor 169.254.168.150 into the address bar.

RS422 Communication

- Programming via web interface,
- Programming at command level, e.g. via Tera Term,
- Output of measurement data not via RS422

➡ Connect the measuring system to a PC e.g. via an RS422 converter IF2001/USB from Micro-Epsilon via USB.

➡ Start the `sensorTOOL` program.

Download at https://www.micro-epsilon.de/download/software/sensorTOOL.exe.

➡ Click the `sensor` button.

The program searches for connected measuring systems.

➡ Select the desired measuring system. Click on the `Open website` button.

Saved settings remain residually in the measuring system and across interfaces.

1) The IFC2411/2416 controllers always support the use of a single encoder, regardless of whether Ethernet or RS422 communication is used. However, in the case of the IFC2416, serial communication via RS422 is not possible if two or three encoders are going to be connected.

5.2 Access via Web Interface

➡ Launch the web interface of the measuring system, see Chap. 5.1.

Interactive web pages for configuring the measuring system now appear in the web browser. The measuring system is active and provides measured values. Real-time measurement with the web interface is not guaranteed. The ongoing measurement can be controlled with the function buttons in the `chart type`.

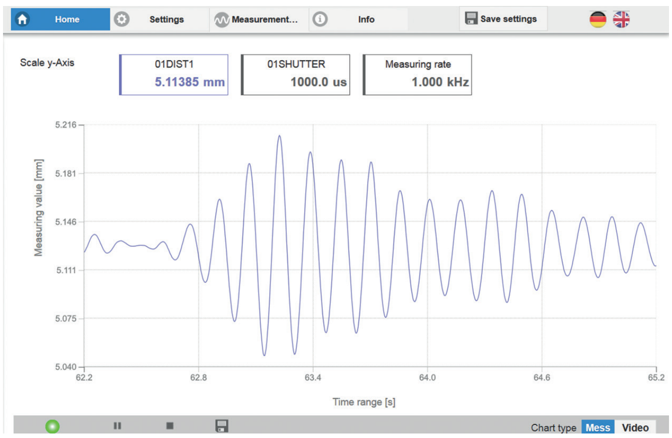


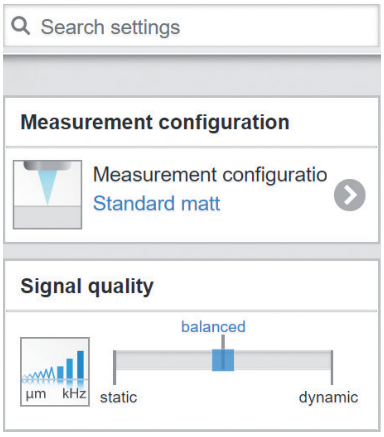
Fig. 30 Start page after accessing the web interface in Ethernet mode

You can switch between the video signal and a display of the measured values over time for configuration. The appearance of the web sites can change depending on the functions. Dynamic help texts with excerpts from the operating instructions aid you in configuring the measuring system.

i Depending on the selected measuring rate and the PC used, there may be a dynamic reduction of the measured value in the display. This means that not all measured values are sent to the webinterface for display and saving.

The horizontal navigation contains the following functions:

- Home. The web interface automatically starts in this view with measurement chart, measurement configuration and signal quality.
- Settings. Configuration parameters, including triggering, measuring rate and zeroing/mastering.
- Measurement chart. Measurement chart or show video signal.
- Info. Contains information on the sensor, including measuring range, serial number and software version.
- Web interface language selection

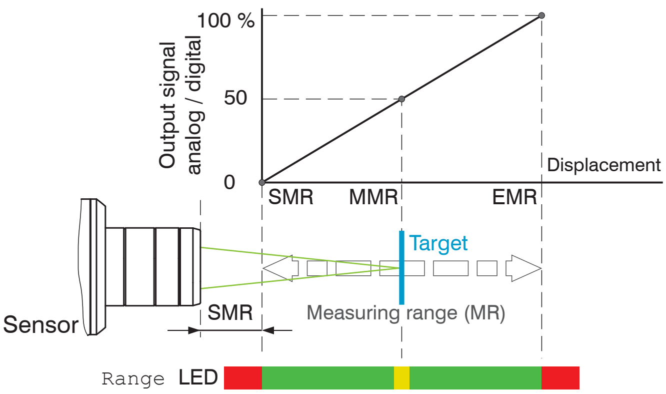


The vertical navigation is related to the context of the selection in the horizontal navigation and contains the following functions for the Home menu:

- The Find settings function enables time-saving access to functions and parameters.
- Measurement configuration. Enables selection of predefined measurement settings.
- Signal quality. You can switch between three predefined basic settings for the measuring rate and averaging with a mouse click.

5.3 Positioning the Target

➡ Position the target as centrally as possible within the measuring range.



LED Range	
Red	No target present or target outside of measuring range
Yellow	Target close to mid of measuring range
Green	Target within the measuring range

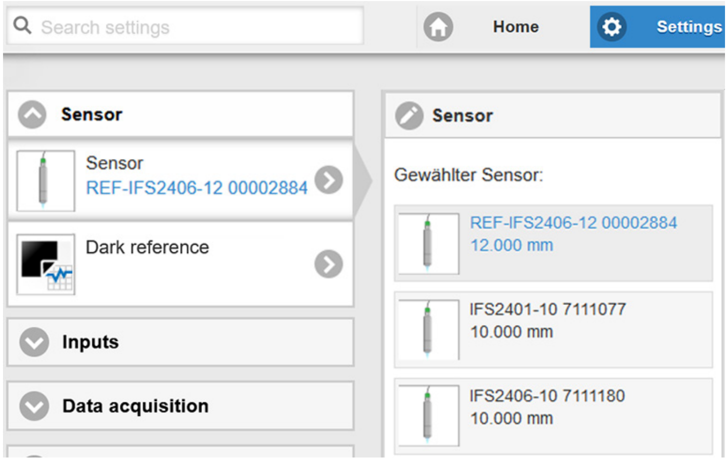
The Range LED on the front of the measuring system indicates the position of the target relative to the sensor.

5.4 Select Sensor

Controller and sensor(s) are coordinated to one another at the factory.

➡ Go to the `Settings > Sensor` menu.

➡ Select the required sensor from the list.

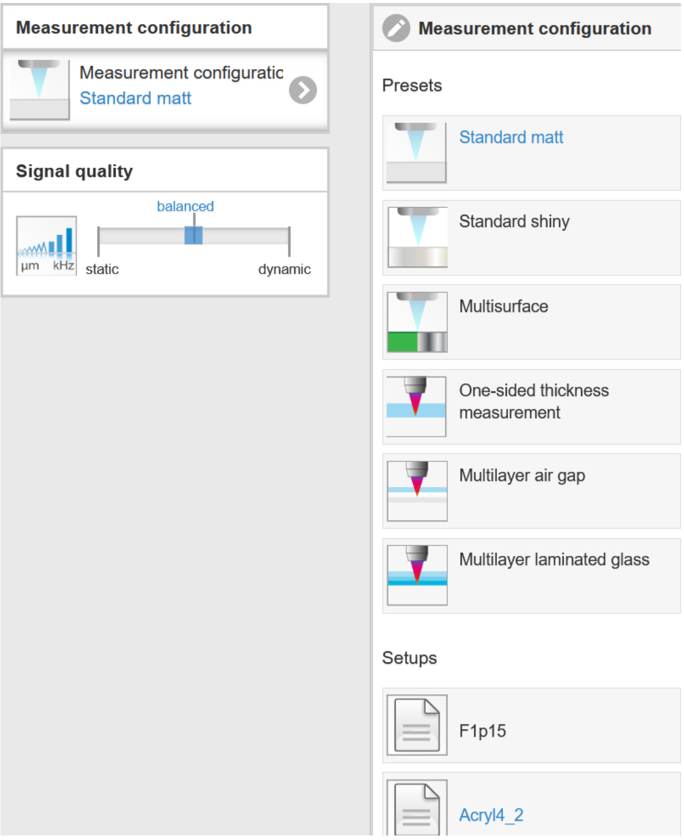


The calibration data of up to 20 different sensors can be saved in the controller. Calibration is only possible at Micro-Epsilon.

5.5 Presets, Setups, Measurement Configuration Selection

Definition

- Preset: Manufacturer-specific program containing settings for common measuring tasks that cannot be overwritten
- Setup: User-specific program containing the relevant settings for a measuring task
- Initial setup upon boot-up (start measuring system): a favorite setting which is automatically activated upon start-up can be selected from the setups. If no favorite is selected from the setups, the measuring system activates the `Standard` preset upon start-up.



Upon delivery of the measuring system from the factory:

- the presets `Standard`, `Standard shiny`, `Multisurface` and `One-sided thickness measurement` are available
- for the IFD2416 controller, the presets `Multilayer airgap` and `Multilayer laminated glass` are additionally available,
- no setup is present.

You can select a preset in the tab

`Home` > `Measurement configuration`

You can select a setup in the tab

`Home` > `Measurement configuration` or

`Settings` in menu `System Settings` > `Load & Save`

A setup can be permanently saved in the measuring system.

These presets allow for a quick start in the individual measuring task. Basic features to suit the target surface, such as peak and material selection and the calculation functions are already set in the preset.

Standard matt	Distance measurement e.g. for ceramic material, non-transparent plastics. Highest peak, averaging, distance calculation.
Standard shiny	Distance measurement e.g. for metal, polished surfaces. Highest peak, median over 5 values, distance calculation.
Multisurface	Distance measurement e.g. for PCBs, hybrid materials. Highest peak, median over 9 values, distance calculation.
One-sided thickness measurement	One-sided thickness measurement e.g. against glass, material BK7. First and second peak, averaging, thickness calculation.
Multilayer air gap	One-sided thickness measurement [1] against glass, 1st layer BK7, 2nd layer vacuum, first and second peak, 3 measured values, median over five values, moving averaging over 16 values, thickness calculation.
Multilayer laminated glass	Layer thickness measurement [1] against laminated glass e.g. windshield, 1st layer BK7, 2nd layer PC, 3rd layer BK7, first and second peak, 4 measured values, thickness calculation, moving averaging over 16 values.

1) Possible with IFC2416 controller only.

5.6 Video Signal

➡ Go to the `Measurement chart` menu. Show video signal display with `Video`.

The diagram in the large graphic window on the right shows the video signal of the receiver line in different post-processing states.

The video signal in the graphics window shows the spectral distribution over the pixels of the receiver line. Left 0 % (small distance) and right 100 % (large distance). The corresponding measured value is marked by a vertical line (peak marking).

The diagram starts automatically when the website is accessed.

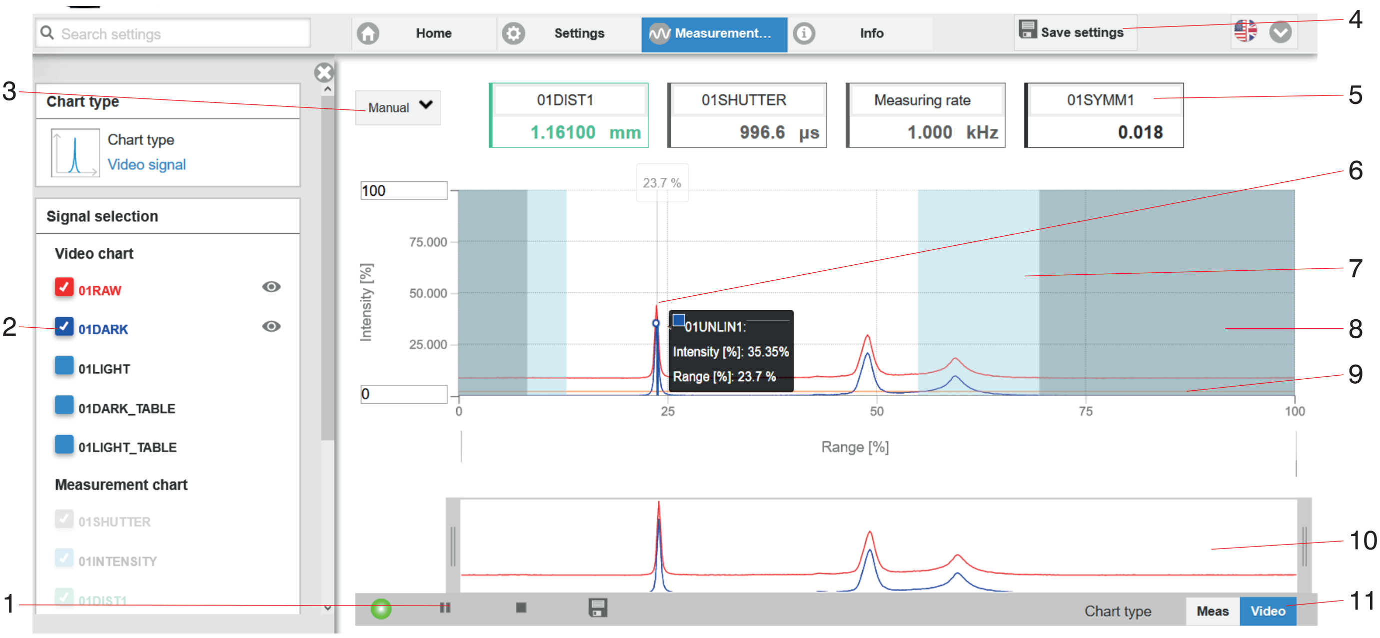


Fig. 31 `Video signal` *website*

The `Video Signal` website contains the following functions:

1 The LED visualizes the state of measurement value transmission.
- green: measured value transmission in progress
- yellow: waiting for data in trigger state
- gray: measured value transmission paused

The data query is controlled with the `Play/Pause/Stop/Save` buttons of the measured values transmitted. `Stop` stops the diagram; you can still continue to use the data selection and zoom functions. `Pause` pauses the recording. `Save` opens the Windows selection dialog for the file name and the save location to save the selected video signals to a CSV file. This contains all pixels, their (selected) intensity in % and other parameters.

➡ Click on the button ▶ (Start), display the measurement results.

2 In the left-hand window, the video curves to be displayed can be switched on or off during or after the measurement. Inactive curves are grayed out and can be added by clicking on the check mark. The changes become effective when you save the settings.
You can show or hide the individual signals using the eye symbols 👁. The calculation continues in the background.
- 0xRAW: Raw signal (uncorrected CCD signal)
- 0xDARK: Dark corrected signal (raw signal minus dark level table)
- 0xLIGHT: Light corrected signal (dark corrected signal corrected with the light source table)
- 0xDARK_TABLE: Dark value table (generated in response to dark referencing)
- 0xLIGHT_TABLE: Light value table (generated in response to light referencing)

3 To scale the intensity axis in the graph for the measured values (Y axis), you can use `Auto` (= automatic scaling) or `Manual` (= manual scaling).

4 All changes only become effective when you click on the `Save settings` button.

5 The current values, such as exposure time and selected measuring rate, are additionally displayed above the graphic.

6 Mouseover function. Moving the mouse over the graph, marks curve points or the peak marking with a circle symbol and displays the corresponding intensity. The corresponding x-position in % appears above the graph field.

7 The range of interest can be restricted if ambient light of a certain wavelength (blue, red, IR) causes interference in the video signal, for example. The value for the “Start of range” must be less than the value for the “End of range”. Value range between 0 and 100 %.

8 The linearized range lies between the gray shades in the diagram and cannot be changed. Only peaks whose middles lie within this range can be calculated as a measured value. The masked area can be restricted if necessary and is then limited by an additional light blue shading on the right and left. The peaks remaining in the resulting range are used for the evaluation.

9 The detection threshold, in relation to the dark corrected signal, is a horizontal straight line corresponding to the preselected value. It should be just high enough so that no unwanted peaks in the video signal are included in the evaluation. Aim for the lowest possible threshold to get a good signal-to-noise ratio. The detection threshold should not be changed if possible.

10 X axis scaling: The diagram shown above can be enlarged (zoomed in on) with the two sliders on the right and left in the lower entire signal. It can also be moved sideways with the mouse in the middle of the zoom window (four-sided arrow).

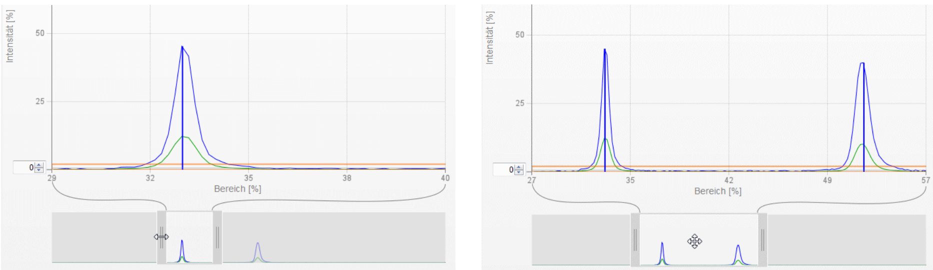


Fig. 32 Zooming with slider: one-sided or shifting range with four-sided arrow

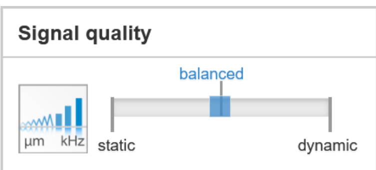
11 The two buttons allow you to switch between the display of the video signal and the measured value.

5.7 Signal Quality

A good measurement result can be achieved if the video signal is sufficiently intense. Reducing the measuring rate increases the exposure time for the CCD row and thus improves the measurement quality.

You can switch between three basic settings (Static, Balanced and Dynamic) in the `Signal quality` section. The reaction in the chart and system configuration is immediately visible.

➡ Go to the `Home` > `Signal quality` menu and adjust the measurement dynamics as required. Monitor the result in the video signal.



	Measuring rate	Averaging [1]
`Static`	200 Hz	Moving, 128 values
`Balanced`	1 kHz	Moving, 16 values
`Dynamic`	5 kHz	Moving, 4 values

i If the controller starts up with a user-defined configuration (Setup), see Chap. 5.5, the signal quality cannot be changed.

1) Applies to the presets `Standard` and One-sided thickness measurement.

5.8 Distance Measurement with Website Display

➡ Align the sensor perpendicularly to the object to be measured.

➡ Then, remotely, move the sensor (or the target) closer and closer until the start of the measuring range for the relevant sensor is approximately reached.

As soon as the object is within the measuring field of the sensor, this is shown by the `Range` LED (green or yellow). Alternatively, you can watch the video signal.

LED	Status	Description
Intensity	Red	Signal saturated
	Yellow	Signal too low
	Green	Signal OK
Range	Red	No target or target outside of measuring range
	Yellow	Target in center of measuring range
	Green	Target within the measuring range

Fig. 33 Meaning of LEDs during distance measurement

Opening `Measurement Chart > ` Chart type `Measure` opens the following website. The chart starts automatically when the website is accessed. The diagram in the large graphic window on the right shows the measured value-time diagram.

Fig. 34 `Measurement` *(distance measurement) web page*

1 The LED visualizes the state of measured value transmission.

- green: measured value transmission in progress
- yellow: waiting for data in trigger state
- gray: measured value transmission paused

The data query is controlled with the `Play/Pause/Stop/Save` buttons of the measured values transmitted. `Stop` stops the diagram; you can still continue to use the data selection and zoom functions. `Pause` pauses the recording. `Save` opens a Windows selection dialog for the file name and save location to save the last 10,000 values in a CSV file (separation using semicolon).

➡ Click on the button ▶ (Start), display the measurement results.

2 In the left-hand window, the signals of channel 1/2 to be displayed can be switched on or off during or after the measurement. Inactive curves are grayed out and can be added by clicking on the check mark. The changes become effective when you save the settings.
You can show or hide the individual signals using the eye symbols 👁. The calculation continues in the background.

- 0xSHUTTER: Exposure time
- 0xINTENSITY: Signal quality of the underlying peak in the video signal
- 0xDIST: Distance signal curve over time

3 To scale the axis in the graph for the measured values (Y axis), you can use `Auto` (= automatic scaling) or `Manual` (= manual scaling).

4 All changes only become effective when you click on the `Save settings` button.

5 Current values for distance, exposure time, current measuring rate and time stamp are shown in the text boxes above the graph. Errors are also displayed.

6 Mouseover function. When the chart has been stopped and you move the mouse over the graph, points on the curve are marked with a circle and the associated values are displayed in the text boxes above the graph. The intensity bars are also updated.

7 Peak intensity is displayed as a bar chart.

8 X axis scaling: During an ongoing measurement, you can use the left-hand slider to enlarge the entire signal (zoom). The time range can also be defined using an input field under the time axis. When the chart has been stopped, the right-hand slider can also be used. You can also move the zoom window with the mouse in the center of the zoom window (four-sided arrow).

5.9 Save/Load Settings

This menu enables you to save current device settings in the controller or activate saved settings. You can permanently save eight different parameter sets in the controller.

Unsaved settings will be lost when the device is switched off. Save your settings in Setups.

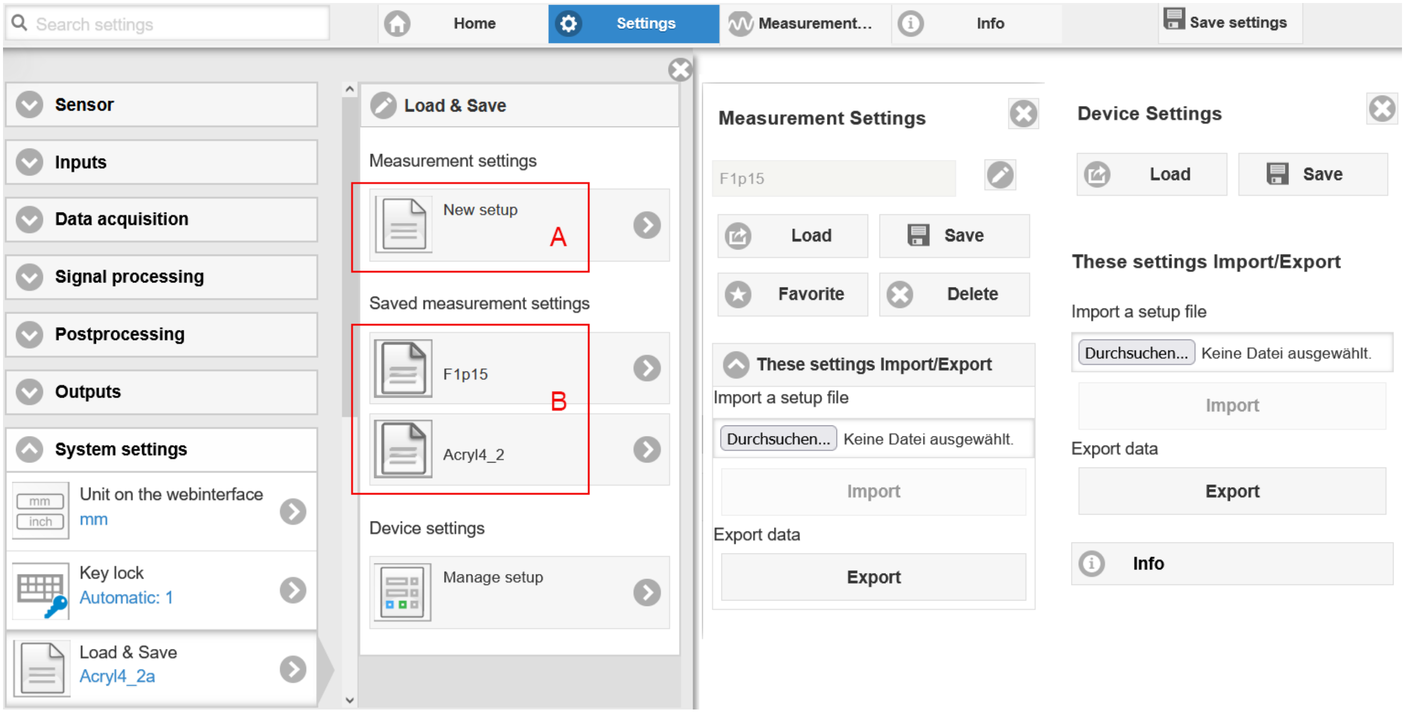


Fig. 35 Manage user programs

➡ Switch to the `Settings > Load & Save` menu.

Manage setups in the controller, options and sequence			
Saving the Settings	**Existing setup active**	**Save change in active setup**	**Determine setup after booting**
Menu `New Setup`, Range A	Menu `Load & Save`	Menu bar	Menu `Load & Save`
➡ Enter the name for the setup in the `Individual setup name` field, such as F1p15, and confirm the entry with the `Save` button.	➡ Click on the desired setup with the left mouse button, area B. The `Measurement Settings` dialog will open. ➡ Click on the `Load` button.	➡ Click on the `Save settings` button.	➡ Click on the desired setup with the left mouse button, area B. The `Measurement Settings` dialog will open. ➡ Click on the `Favorite` button.

The current settings will also be available in the controller after it has been switched off/on.

You can also use the `Save Settings` button at top right, in each settings page as quick cache for the last parameter set saved.

ℹ The last parameter set saved in the controller is loaded when switched on.

Switch setups with PC/notebook, options	
Save setup on PC	**Load setup from PC**
Menu `Load & Save`	Menu `Load & Save`
➡ Click on the desired setup with the left mouse button, area B. The `Measurement Settings` dialog will open. ➡ Click on the `Export` button.	➡ Click on `Create setup` with the left mouse button. The `Measurement Settings` dialog will open. ➡ Click on the `Search` button. A Windows dialogue for file selection opens. ➡ Select the desired file and click the `Open` button. ➡ Click on the `IMPORT` button.

5.10 Dark Correction

The measuring system requires a warm-up time of approx. 30 min. before performing dark correction.

A dark correction is required after:

- Replacing a sensor
- Replacing a sensor cable
- Prolonged operating period, sensor getting dirty

The dark correction depends on the sensor and is saved separately in the controller for each measuring system. For that reason, the desired sensor must be connected before correction. For the IFC241x, the sensor must be selected in the `Settings > Sensor` menu.

Work steps:

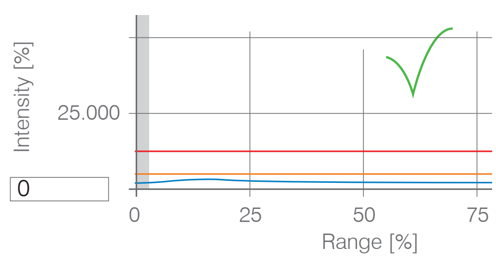
➡ Remove the target from the measuring range or cover the sensor front with a piece of dark paper.

i During the dark correction, there must be no objects within the measuring range nor ambient light reaching the sensor under any circumstances.

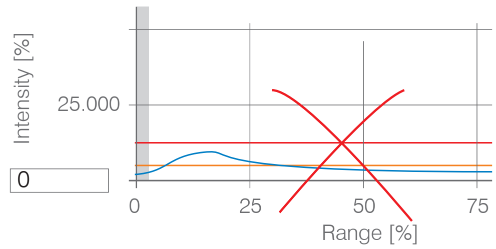
Correction with key function	Correction via software/web interface
IFC2411/2416	
➡ Press the `multifunction` key on the IFC241x for approx. 4 s [1] in order to start the correction.	➡ Switch to the `Settings > Sensor > Dark correction` menu. ➡ Click on the `Start` button to start the correction.

The LEDs `Intensity` and `Range` start to flash. The sensor now records the current dark signal for about 50 s.

The dark corrected video signal after the adjustment is characterized by a signal curve that is an almost smooth directly at the X axis.

Dark signal evaluation	IFC2411/2416
 Dark signal OK	➡ Remove the paper cover from the sensor. This sensor can be used normally again.

1) If the key is pressed for more than 10 seconds, the factory setting is loaded.

 Dark signal too high	➡ Carefully clean the front surface of the E2000 connector of the sensor cable and the socket on the controller, see Chap. A 4. ➡ Repeat the dark correction.

With each new dark correction, the current brightness value is determined as the quotient of the sum of all intensities and the current exposure time. If a major change is detected from the previously saved value, this can be interpreted as a degree of contamination and a warning is given.

You can also ignore this message. For time-critical measurements, however, you should remember the current exposure time.

Exclusively use pure alcohol and fresh lens cleaning paper for cleaning.

If cleaning the components does not have the desired result, the sensor cable may also have been damaged or the fiber connector in the controller may have become dirty.

Replace the sensor cable or send the entire system in for inspection.

You can use an ASCII command to set the warning threshold for contamination if required

- permissible deviation in %,
- the factory setting is 50 %.

The warning threshold is saved so that it is specific to the setup.

6. Set Sensor Parameters, Web Interface

6.1 Inputs

6.1.1 Synchronization

➡ Switch to the `Settings` tab in the `Inputs` menu.

Synchronization	*Master / Slave / Multifunction input 1* *Inactive*	*If multiple measuring systems are to measure the same target at the same time, the controllers can be synchronized with one another. The synchronization output of the first controller (master) controls the controllers (slaves) connected at the synchronization inputs, see* Chap. 4.7.9.

6.1.2 Encoder Inputs

6.1.2.1 Overview, Menu

The IFD2411 supports one encoder, see Chap. 4.7.11.

The IFD2416 supports up to three encoders, see Chap. 4.7.12.

Encoder values can be assigned to the measuring data exactly, output and also used as triggering condition. This exact assignment to the measured values is ensured by the fact that precisely those encoder values are output that were present in half of the exposure time of the measured value (the exposure time can vary due to the regulation). Tracks A and B enable direction recognition.

Encoder 1 / 2 / 3	Interpolation	*single / double / quadruple resolution*
	Maximum Value	*Value*
	Effect on Reference Track	*no effect / set once for mark / set for all marks*
	Set to Value	*Value*
	Set encoder value via software	
	Reset the detection of the first reference mark	

6.1.2.2 Number of Encoders

The number of encoders determines how many of the encoders are used. With 2 encoders, data output via RS422 and synchronization cannot be used. With 3 encoders, the reference tracks of encoder 1 and encoder 2 cannot be used.

6.1.2.3 Interpolation

Interpolation increases the resolution of an encoder. The counter reading is incremented or decremented with each interpolated pulse edge.

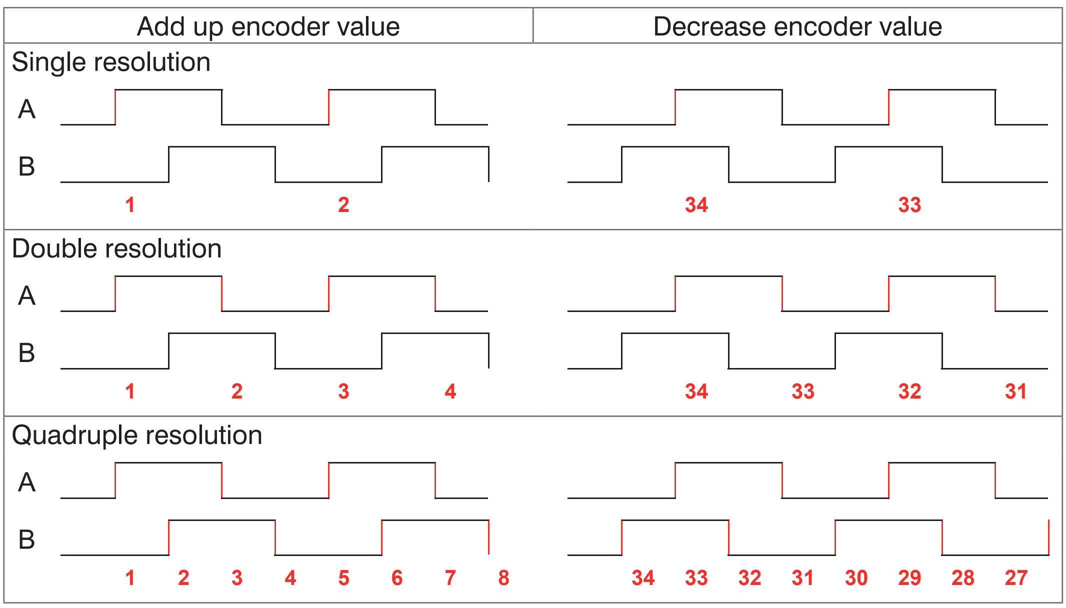


Fig. 36 Pulse image encoder signals

[gray box] Fields with gray background require a selection. *Value* Fields with dark border require entry of a value.

6.1.2.4 Maximum Value

If the encoder exceeds this maximum value, the encoder counter restarts the count at zero. This could be the pulse count of an encoder without zero pulse (reference track). The maximum counter reading before an overflow is 4,294,967,295 (2 ^ 32-1).

6.1.2.5 Effect of Reference Track

`No effect`. The encoder counter keeps on counting; the resetting takes place when the controller is switched on or when the `Set to value` button is pressed.

`One-time setting to value at marker`. Sets the encoder counter to the defined value when the first reference marker is reached. The first mark after the controller is switched on applies; without it being switching off, the marker only applies after pressing the `Use next marker` button.

`Set for all marks`. Sets the encoder counter to the starting value for all marks or when the marker is reached again, e.g. for traversing movements.

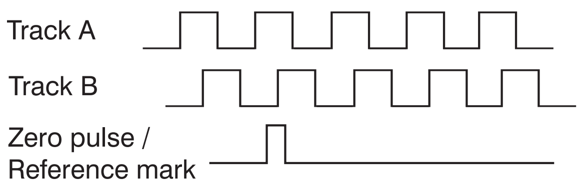


Fig. 37 Reference signal of an encoder

6.1.2.6 Set to Value

This function sets the encoders to this value

- every time the controller is switched on,
- with the `Set to value` button.

The start value must be less than the maximum value and is max. 4,294,967,294 (2 ^ 32-2).

6.1.2.7 Reset Reference Marker

Resets the reference marker detection.

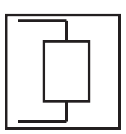
6.1.3 Level Function Inputs

The level must be selected for the inputs:

- Synchronization
- Multifunction

Input level	*TTL / HTL*	*Defines the input level for the input stages.* *TTL: Low ≤ 0.8 V, High ≥ 2 V* *HTL: Low ≤ 3 V; High ≥ 8 V*

6.1.4 Terminating Resistor



The terminating resistor at the Sync/Trig synchronization input is switched on or off to avoid reflections.
On: With terminating resistor
Off: No terminating resistor

The terminating resistor with 120 Ohm must be activated in the last slave.

6.2 Data Recording

6.2.1 Measuring Rate

IFC2411: The measuring rate can be set continuously in a range from 0.1 kHz to 8 kHz. The increment is 1 Hz.

IFC2416: The measuring rate can be set continuously in a range from 0.1 kHz to 25 kHz. The increment is 1 Hz.

The selection of the measuring rate is made in the menu `Settings` > `Data recording` > `Measuring rate`.

➡ Select the desired measuring rate.

Observing the video signal is useful for selecting the measuring rate.

Procedure:

➡ Position the target in the middle of the measuring range, see Fig. 38. Keep adjusting the measuring rate until you get a high signal intensity that is not oversaturated.

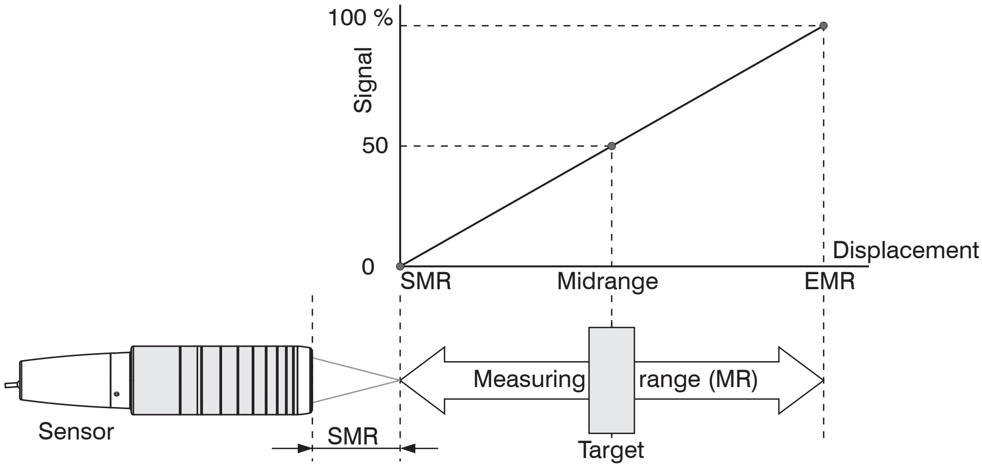


Fig. 38 Defining measuring range and output signal

➡ To do this, observe the `Intensity` LED.

LED	Status	Description
Intensity	Red	Signal saturated
	Yellow	Signal too low
	Green	Signal OK

- If the `Intensity` LED changes to red, increase the measuring rate.
- If the `Intensity` LED changes to yellow, increase the measuring rate.

➡ Choose a measuring rate that makes the `Intensity` LED light up green.

➡ If necessary, change the exposure mode, use the `manual mode`, see Chap. 6.2.5

➡ Use the required measuring rate, and adjust the exposure time. Or let the exposure time define possible measuring rates.

If the signal is low (`Intensity` LED is yellow) or saturated (`Intensity` LED is red), the controller will carry out measurements, but measuring accuracy might not correspond to the specified technical data.

6.2.2 Triggering Data Acquisition

6.2.2.1 General

The data recording on the confocalDT IFC241x can be controlled using an external electrical trigger signal or commands.

- The triggering does not affect the preselected measuring rate.
- Factory setting: no triggering, the controller starts with the data transmission output immediately after being switched on.
- The pulse of the trigger signal is at least 5 µs.

Sync / Multifunction input 1	Trigger type	*Level*	Trigger level	Low / falling edge	
		Edge	Trigger level	High / increasing edge	
			Number of measured values	*manual selection*	*Value*
				infinite	
Software			Number of measured values	*manual selection*	*Value*
				infinite	
Encoder 1 / Encoder 2			Lower limit		*Value*
			Upper limit		*Value*
			Increment		*Value*
Inactive			*Continuous data recording*		

`Level triggering`. Continuous data recording/output as long as the selected level is present. After that, the controller stops the data recording. The pulse duration must be at least as long as one cycle. The subsequent pause must also be at least as long as one cycle.

W = Displacement signal

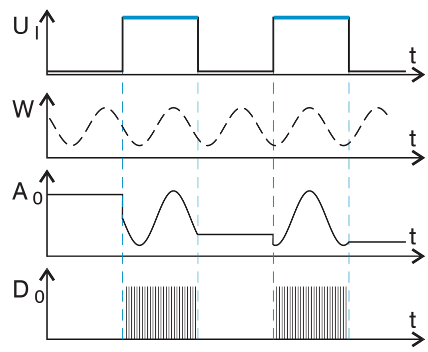


Fig. 39 Triggering with active high level (U_I), associated analog signal (A_O) and digital signal (D_O)

`Edge triggering`. Starts measured value input/output as soon as the selected edge is active to the trigger input. The pulse must be at least 5 µs.

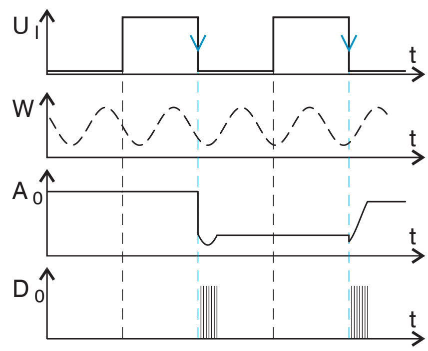


Fig. 40 Triggering with falling edge (U_I), associated analog signal (A_O) and digital signal (D_O)

`Software triggering`. Starts data recording as soon as a software command (instead of the trigger input) or the `Initiate trigger` button is activated.

`Encoder triggering`. Starts the data recording through Encoder 1 or Encoder 2.

6.2.2.2 Triggering Measured Value Acquisition

The current array signal is only processed and measured values are calculated from it after a valid trigger event. The measurement data is then transferred for further calculation (e.g. averaging), as well as the output via a digital or analog interface.

When calculating averages, measured values immediately before the trigger event cannot be included; instead older measured values are used, which had been entered during previous trigger events.

Fields with gray background require a selection. | *Value* Fields with dark border require entry of a value.

6.2.2.3 Trigger Time Difference

Since the exposure time is not started directly by the trigger input, the respective time difference to the measurement cycle can be output. This measured value can, for example, serve to accurately assign measurements to one place, when measuring objects are scanned at a constant speed and when each track starts with a trigger pulse.

The time from the start of the cycle until the trigger event is defined as a trigger time difference. The output of the time determined occurs 3 cycles later, due to the internal processing.

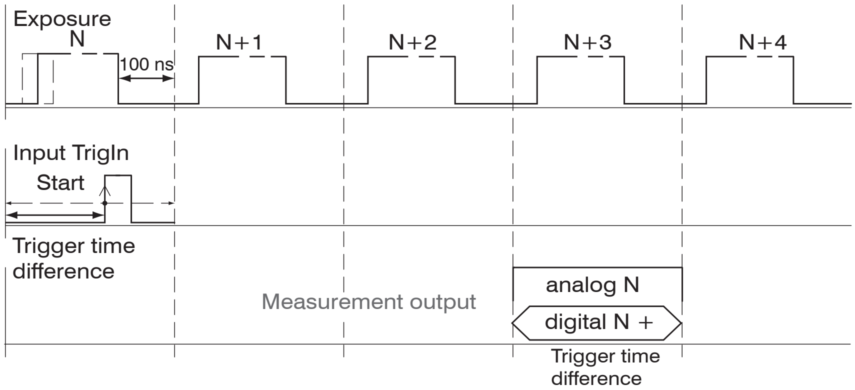


Fig. 41 Definition of the trigger time difference

i The start of the cycle does not mean the start of the exposure time. There is only a fixed difference of 100 ns between the start of the cycle and the end of the exposure time.

6.2.3 Reset Counter

The measured value counter can be used to check if the data are output completely or if a package is missing. Counting begins at zero. Time stamps and measured value counter can be reset by pressing the respective button.

6.2.4 Range of Interest Masking

Masking limits the range that the video signal uses for distance or thickness calculations. This feature is used, for example, if ambient light with certain wavelengths (blue, red, IR) causes video signal interference. It is also possible to mask the background if it reaches into the measuring range.

Masking (start and end) is entered into the two boxes on the left (in %). The factory settings are 0 % (start) and 100 % (end).

i If you limit the video signal area, a peak is detected only if it lies completely within the masked area, i. e. above the threshold. This can reduce the measuring range.

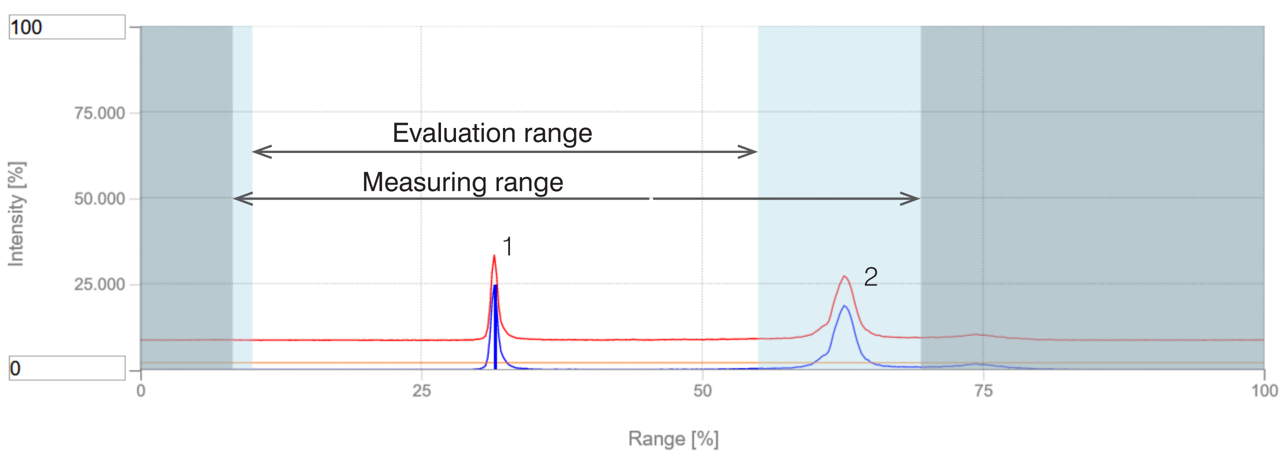


Fig. 42 Limiting the video signal used

The example shown in the figure uses peak (1) for the evaluation while peak (2) is not used.

6.2.5 Exposure Mode

Measurement mode		
Manual mode	Exposure time 1 in µs	*IFC2411: Value (3 µs ... 10,000 µs)* *IFC2416: Value (3 µs ... 10,000 µs)*
Alternating two-time mode	Exposure time 1 in µs	*IFC2411: Value (3 µs ... 10,000 µs)* *IFC2416: Value (3 µs ... 10,000 µs)*
	Exposure time 2 (shorter) in µs	*Value (value is lower than exposure time 1)*
Automatic two-time mode	Exposure time 1 in µs	*IFC2411: Value (3 µs ... 10,000 µs)* *IFC2416: Value (3 µs ... 10,000 µs)*
	Exposure time 2 (shorter) in µs	*Value (value is lower than exposure time 1)*

➡ Select the desired exposure type.

`Measurement mode`. The required or appropriate measuring rate is maintained and only the exposure time is controlled. A smaller control range is used to achieve faster results. This mode also enables the user to work with targets with different reflections that have the same measuring rates. Lasts 1 up to a maximum of 7 measurement cycles (change from no target to good reflective target with 0.1 kHz measuring rate).

`Manual mode`. No automatic adjustments. Set optimized parameters are maintained. This makes sense for fast changes due to targets with identical surfaces moving in and out or for highly dynamic movements (no overshooting). It is not recommended to use this mode for strongly varying target surfaces. Manual mode can also be used for several layers if the brightest peak should not be captured. The video signal display can acquire suitable measuring rates and exposure times from automatic mode.

`Alternating two-time mode`. Operating mode with two manually preset exposure times that are always used alternately. Suitable for two very different high peaks when measuring thickness. We recommend using this mode in particular if the smaller peak disappears or the higher peak is overmodulated. Any video averaging which may be set is ignored here.

`Automatic two-time mode`. Fastest mode with two manually preset exposure times. The more suitable time is automatically selected. We recommend using this mode to measure distances for rapidly changing surface properties, such as mirrored or anti-glare glass.

Fields with gray background require a selection.

Value Fields with dark border require entry of a value.

6.2.6 Peak Separation

6.2.6.1 Peak Modulation

Peak modulation is used e.g. when measuring thin layers. A peak detected with the detection threshold may consist of two or more overlapping peaks. The peak modulation indicates to which degree the video signal must be modulated in order to separate the peak again for the subsequent signal processing.

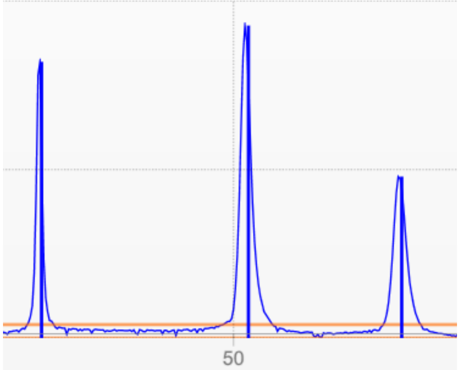


Fig. 43 Separated peaks: Measurement possible

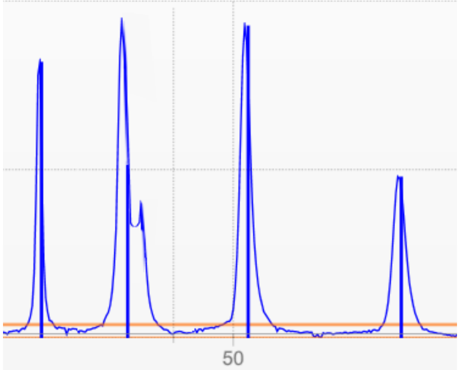


Fig. 44 Peaks interlocking: Measurement inaccuracy likely

The modulation is individually evaluated for each peak detected with the detection threshold.

Default value is 50 % as a compromise between the separability of the peaks and the measurement uncertainty due to mutual peak interference.

- Increase the value when the controller separates peaks which should be processed together.
- Decrease the value when the controller does not separate peaks which should be processed separately.

Example 1: With the default setting, no peak separation is carried out. The controller determines a distance from the center of gravity in the video signal.

Example 2: With a lower peak modulation value, the controller detects two separate peaks in the video signal and calculates the two distances.

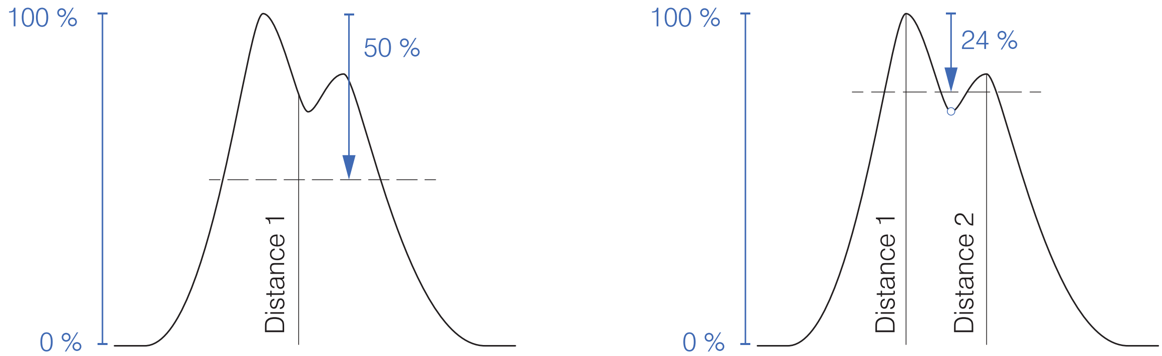


Fig. 45 Examples for peak modulation

Changing the `peak modulation` is only necessary in special cases. Use this function carefully.

6.2.6.2 Detection Threshold

The detection threshold (in % relative to the dark-corrected signal) defines the intensity as of which a peak in the video signal is included in the analysis. For that reason, it is essential to evaluate the video curve for this determination.

Minimum threshold	*Value*	*Value in %, default 2 %*

Defining the detection threshold.

- For very weak signals typical of extremely high measuring rates, choose a low detection threshold, as only signal parts above this threshold will be included in the calculation.
- In general, set the threshold high enough to prevent any interfering video signal peaks from being detected.

The detection threshold affects linearity, so it is recommended to adjust it as little as possible.

6.2.7 Number of Peaks, Peak Selection

The number of peaks is equivalent to the number of transitions between different materials of a target within the measuring range.

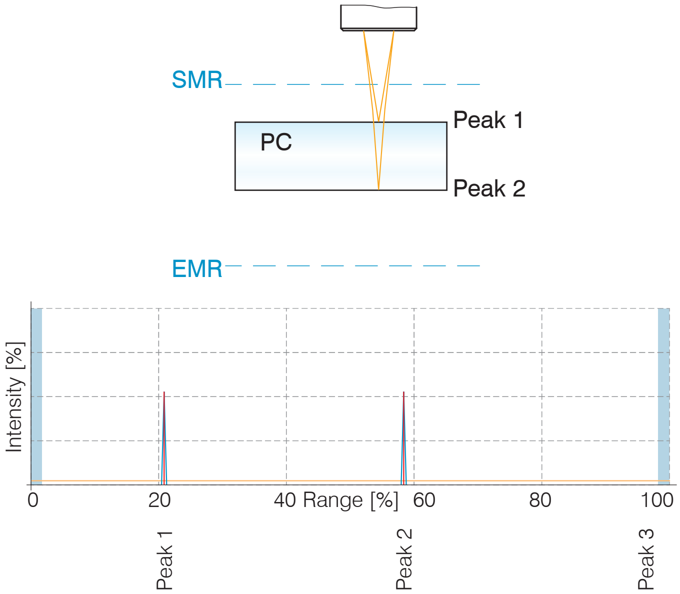


Fig. 46 Transparent target with one layer

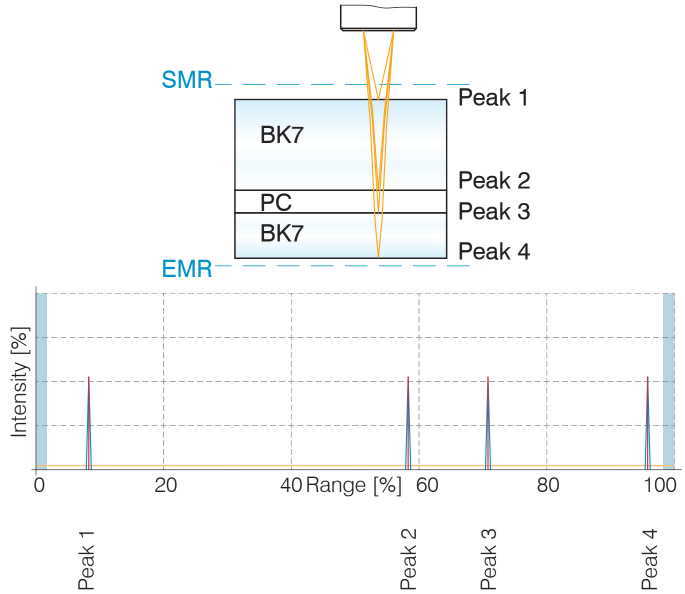
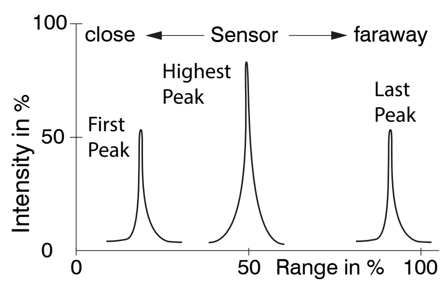


Fig. 47 Transparent target with three layers

i This function is used if, before or between the useful peaks, a material has even smaller interfering peaks caused by thin layers on the target. This function should be used with caution and should only be used by product specialists.

The selection of peak/peaks dictates which regions in the signal are used for the distance or thickness measurement. In the case of a target consisting of several transparent layers, the material must be assigned to the individual layers, see Chap. 6.2.8.

The peaks are counted starting at the start of the measuring range toward the end of the measuring range.

Peak selection	*First peak / Highest peak / Last peak*	*Defines which signal in the array signal is used for the evaluation.* *First peak: Closest peak to the sensor.* *Highest peak: Standard, peak with the highest intensity.* *Last peak: Farthest peak from the sensor.*	

IFC2411	IFC2416	Measured values	Peak selection
•	•	1 measured value	First peak / Highest peak / Last peak
•	•	2 measured values	first and second peak / first and last peak / highest and second highest peak / second to last and last peak
	•	3 measured values	Individual
	•	4 measured values	Individual
	•	5 measured values	Individual
	•	6 measured values	Individual

Fig. 48 Options for peak selection

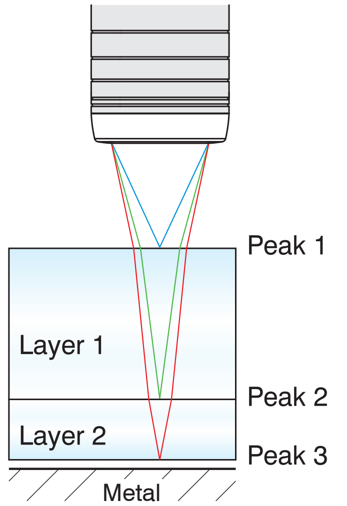
The determination of the peak heights is performed based on light corrected signal.

The refractivity correction is performed with the standard setting. However, if more than two peaks are within the measuring range, an exact refractivity correction is performed with the same amount of peaks only. If, for example, the first or last peak of 3 peaks sometimes leaves the measuring range, it is better to switch off the refractivity correction, because then the refractivity correction will be applied to a different layer, it will not be possible to clearly assign the material.

	Fields with gray background require a selection.	*Value*	Fields with dark border require entry of a value.

6.2.8 Material Selection

Before selecting a material, define the number of layers of the target or the number of peaks to be expected in the video signal, see Chap. 6.2.7. Otherwise, it will not be possible to assign the material.

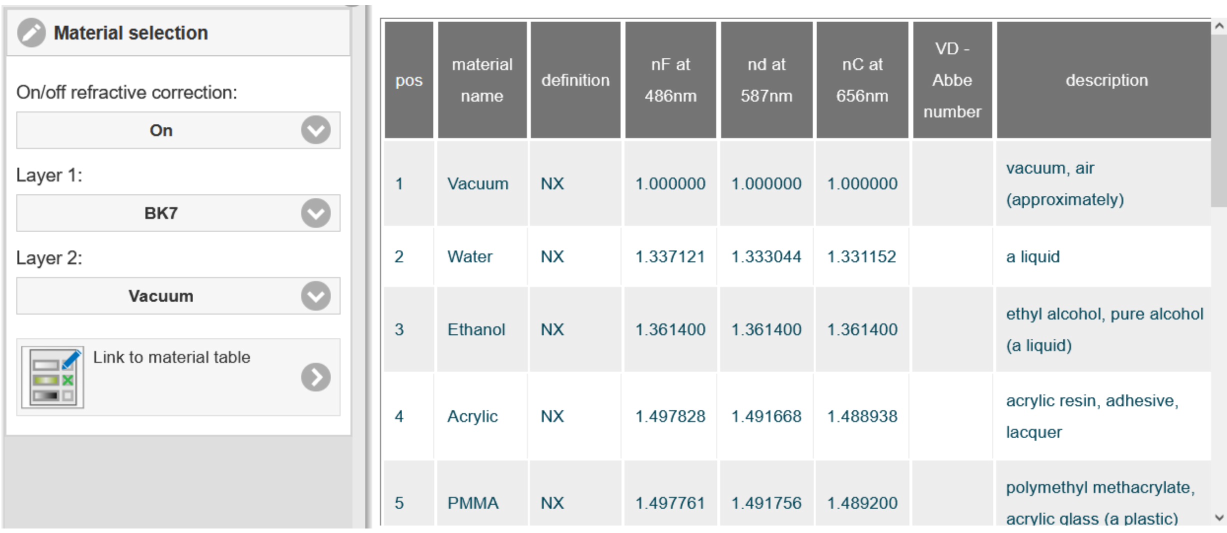


The refractive index needs to be corrected in the controller for an exact distance or thickness measurement.

- Switch to the menu `Settings` > `Data recording` > `Material selection`.
- Activate the refractivity correction. To do so, click the `On` button in the menu `On/off refractivity correction`.
- Assign the materials to the individual layers according to the target used.

Fig. 49 Layer structure of a target

The `Link to material table` button can be used to expand or reduce the material database in the controller. For a new material, a refractive index and the Abbe number v_d are required or three refractive index numbers are required if there are different wavelengths (also approximately the same).



pos	material name	definition	nF at 486nm	nd at 587nm	nC at 656nm	VD - Abbe number	description
1	Vacuum	NX	1.000000	1.000000	1.000000		vacuum, air (approximately)
2	Water	NX	1.337121	1.333044	1.331152		a liquid
3	Ethanol	NX	1.361400	1.361400	1.361400		ethyl alcohol, pure alcohol (a liquid)
4	Acrylic	NX	1.497828	1.491668	1.488938		acrylic resin, adhesive, lacquer
5	PMMA	NX	1.497761	1.491756	1.489200		polymethyl methacrylate, acrylic glass (a plastic)

Fig. 50 Selection of material-specific refractivity indices

6.3 Signal Processing, Calculation

6.3.1 Data Source, Parameters, Calculation Programs

One calculation operation can be performed in each calculation block. The calculation program, the data sources and the parameters of the calculation program must be set for this.

`Thickness`	Calculating the difference	Two signals or results, Signal distance B < Signal distance A
Formula	Distance A - Distance B	
`Calculation`	Summation	Two signals or results
Formula	Factor 1 * Distance A + Factor 2 * Distance B + Offset	
`Median`	The measured values are sorted and the mean value is output as median	
`Moving averaging`	The arithmetic mean is formed	
`Recursive averaging`	Each new measured value is weighted and added to the sum of the previous mean values.	
`Duplicate`	Creates a copy of a signal	

Fig. 51 Available calculation programs

Sequence for creating a calculation block, see Fig. 52:

- Select a program ① , e.g. average.
- Define the parameters ② .
- Define the data source(s) ③ .
- Enter a block name ④ .
- Click on the `Apply calculation` button.

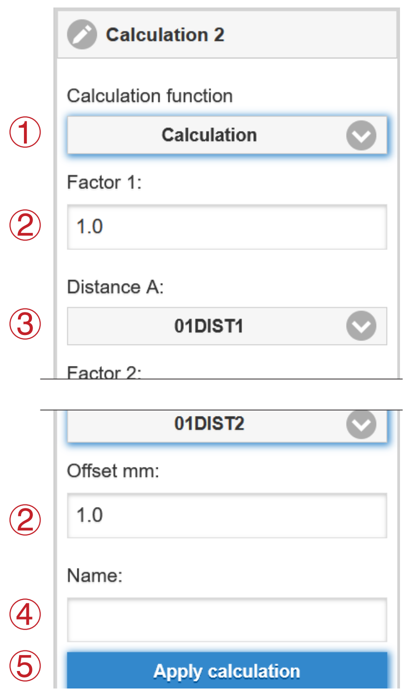


Fig. 52 Sequence for the program selection

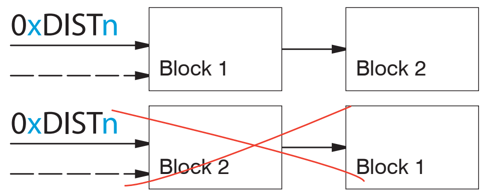
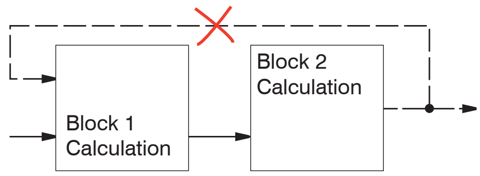
The programs calculation and thickness have two data sources. Averaging programs each have one data source.

Calculation parameters (calculation program)	Factor 1 / 2	*Value*	-32768.0 ... 32767.0
	Offset	*Value*	-2147.0 ... 2147.0
Calculation parameters (Averaging)	Averaging type	Recursive / Moving / Median	
	Number of values	*Value*	Recursive: 2 ... 32000
			Moving: 2 / 4 / 8 / 16 / 32 / 64 / 128 / 256 / 512 / 1024 / 2048 / 4096
			Median: 3/5/7/9
The number of values states over how many sequential measured values in the controller should be averaged before a new measured value is output.			

Fields with gray background require a selection.

Value Fields with dark border require entry of a value.

6.3.2 Definitions

<table>
<tr><td>Distance value(s)</td><td>01DIST1, 01DIST2, ... 01DIST6</td></tr>
<tr><td>Max. 10 calculation blocks per channel/sensor. The calculation blocks are processed sequentially.</td><td>
</td></tr>
<tr><td>Feedback couplings (algebraic loops) over one or several blocks are not possible. Only the distance values or the calculated results from the previous calculation blocks can be used as data sources.</td><td>
</td></tr>
<tr><td>Processing sequence:
1. Unlinearized distances
2. Linearization of distances
3. Refractivity correction of distances
4. Error handling in the case of no valid measured value
5. Spike correction of distances
6. Calculation blocks
7. Statistics</td><td></td></tr>
</table>

6.3.3 Measurement Averaging

Measurement averaging is performed after measured values have been calculated, and before they are issued or processed through the relevant interfaces.

Measurement averaging

- improves the resolution,
- allows masking individual interference points, and
- "smoothes" the reading.

i Linearity is not affected by averaging. Averaging has no effect on measuring rate and output rate.
The internal average value is re-calculated for each measuring cycle.

i The defined type of average value and the number of values must be saved in the controller to ensure they are maintained after it has been switched off.

The controller is delivered with "moving average, averaging value = 16" as factory settings, i.e. averaging is not enabled by default.

Moving Average

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

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

MV = measured value,
N = averaging value,
k = continuous index (in the window)
M_{mov} = average value or output value

Each new measured value is added, and the first (oldest) value is removed from the averaging (from the window). This produces short settling times in case of measurement jumps.

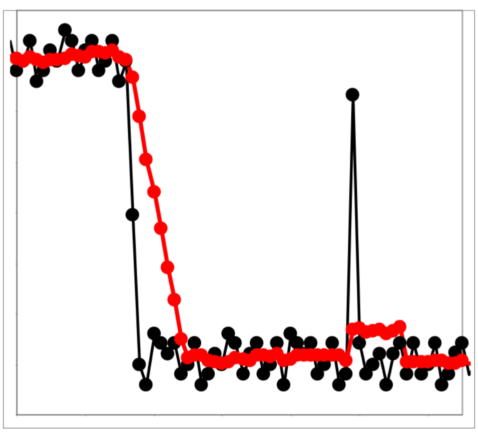
Example: N = 4

Measured values: ... 0, 1, 2, 2, 1, 3 and ... 1, 2, 2, 1, 3, 4

Output value:

$$\frac{2, 2, 1, 3}{4} = M_{mov}(n) \qquad \frac{2, 1, 3, 4}{4} = M_{mov}(n+1)$$

i Moving average in the controller allows only potentials of 2 for N. The highest averaging value is 1024.



Signal without averaging
Signal with averaging

Fig. 53 Moving average, N = 8

Application tips

- Smoothing of measured values
- The effect can be finely controlled in comparison with the recursive averaging
- With uniform noise of the measured values without spikes
- In case of a slightly rough surface, in which the roughness should be eliminated
- Also suitable for measured value jumps with relatively short settling times

Recursive average

Formula:

$$M_{rec}(n) = \frac{MV_{(n)} + (N\text{-}1) \times M_{rec\,(n\text{-}1)}}{N}$$

MV = measured value,

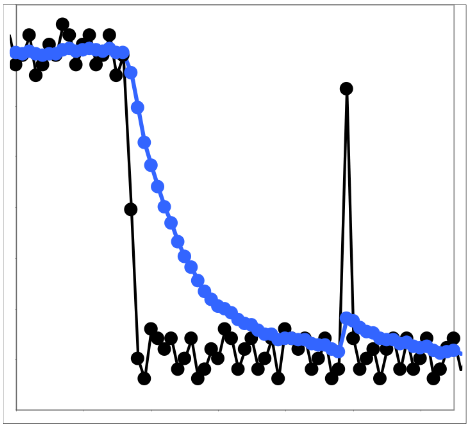
N = averaging value, N = 1 ... 32768

n = Measured value index

M_{rec} = average or output value

The weighted value of each new measured value MV(n) is added to the sum of the previous average values M_{rec} (n-1).

Recursive averaging allows for very strong smoothing of the measurements, however it requires long response times for measurement jumps. The recursive average value shows low-pass behavior.



Signal without averaging
Signal with averaging

Fig. 54 Recursive average, N = 8

Application tips

- Permits a high degree of smoothing of the measured values. Long transient recovery times in case of measured value jumps (low-pass behavior)
- High degree of smoothing for noise without strong spikes
- To especially smooth signal noise for static measurements
- To eliminate the roughness for dynamic measurements on rough surface, e.g. roughness of paper
- To eliminate structures, e.g., parts with uniform groove structures, knurled turned parts or coarsely milled parts
- Unsuitable for highly dynamic measurements

Median

A median value is formed from a preselected number of measured values.

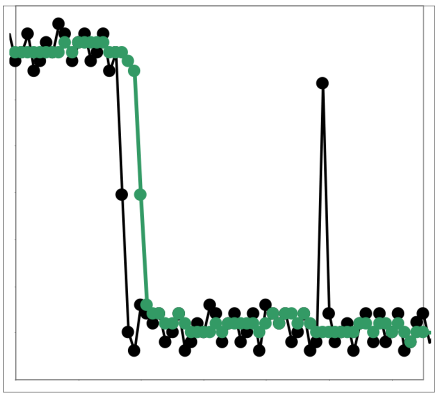
When creating a median value for the controller, incoming measured values are sorted after each measurement. Then the average value is provided as the median value.

3, 5, 7 or 9 readings are taken into account. This means that individual interference pulses can be suppressed. However, smoothing of the measurement curves is not very strong.

Example: Median value from five readings

... 0 1 2 4 5 1 3 → Sorted measurement values: 1 2 [3] 4 5 Median $_{(n)}$ = 3

... 1 2 4 5 1 3 5 → Sorted measurement values: 1 3 [4] 5 5 Median $_{(n+1)}$ = 4



Signal without averaging
Signal with averaging

Fig. 55 Median, N = 7

Application tips

- The measured value curve is not smoothed to a great extent; it primarily eliminates spikes
- Suppresses individual interference pulses
- In short, strong signal peaks (spikes)
- Also suitable for edge jumps (only minor influence)
- To eliminate dirt or roughness in a rough, dusty or dirty environment
- Further averaging can be used after the median filter

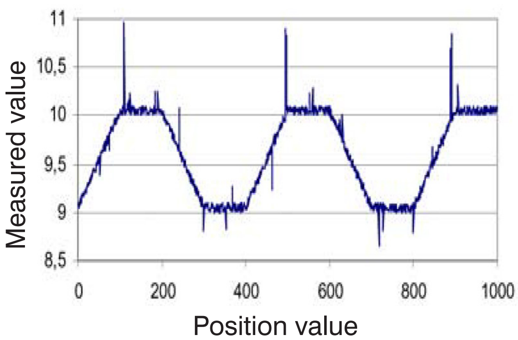


Fig. 56 Profile, original

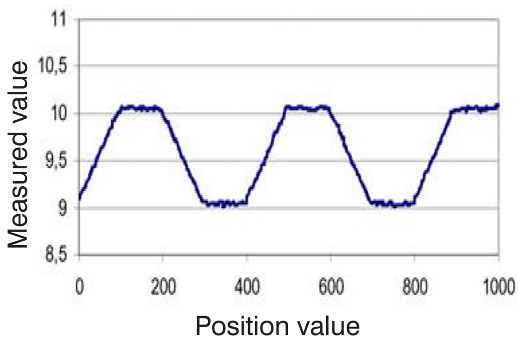


Fig. 57 Profile with median, N = 9

6.4 Post-Processing

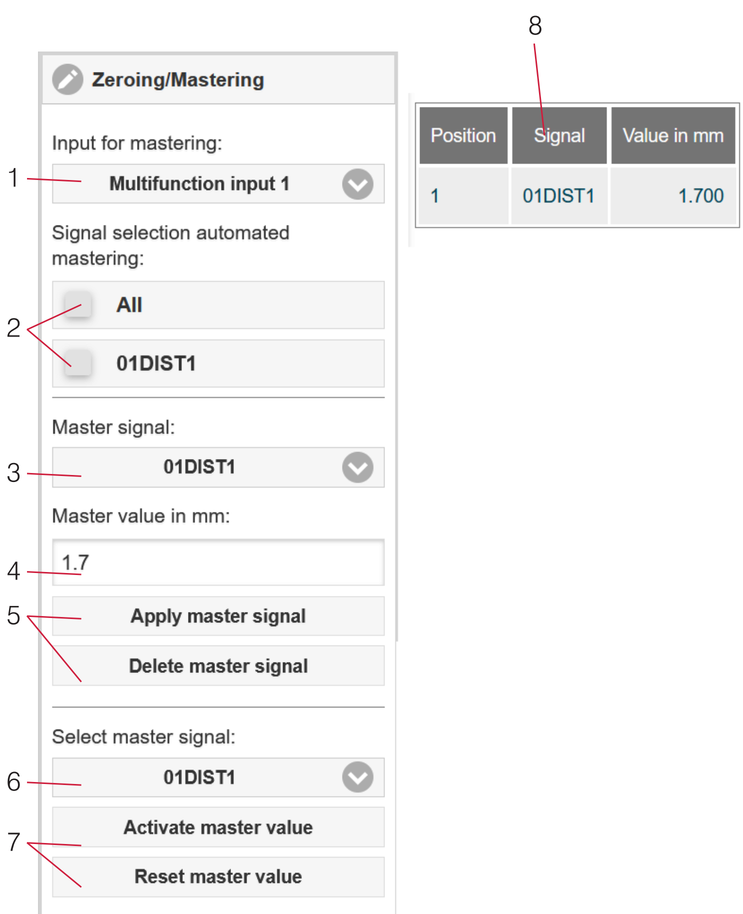
6.4.1 Zeroing, Mastering

Use zeroing and mastering to define a nominal value within the measuring range. This shifts the output range. This feature can be useful, for example, when several sensors carry out measurements simultaneously in thickness and planarity measurements. When measuring the thickness of a transparent target, you need to specify the actual thickness of a master object as `Master value`.

Master value in mm	*Value*	*Specify the thickness (or other parameter) of a master object. Value range: -2147.0 ... +2147.0 mm*

Mastering (setting masters) is used to compensate for mechanical tolerances in the sensor measurement setup or to correct chronological (thermal) changes to the measuring system. The master value, also called calibration value, is defined as the nominal value.

The `master value` is the reading that is issued as result of measuring a master object. Zeroing is a special feature of mastering, since the master value is "0" here.



The mastering/zeroing function is not channel-specific. The controller manages up to 10 master signals. These 10 signals can be applied to any internally determined value, including calculated values.

i "Mastering" or "zeroing" requires a target object to be present in the measuring range. "Mastering" and "zeroing" affect both analog and digital outputs, as well as the web interface display.

1 Trigger or undo mastering via multifunction inputs MFI 1/2 through an external source.

2 Selection of signals to be mastered via the multi-function inputs (1).
Overview of all existing signals for the function.

3 Selection of a signal to assign the master value with (4) and (5).

4 Enter master value.

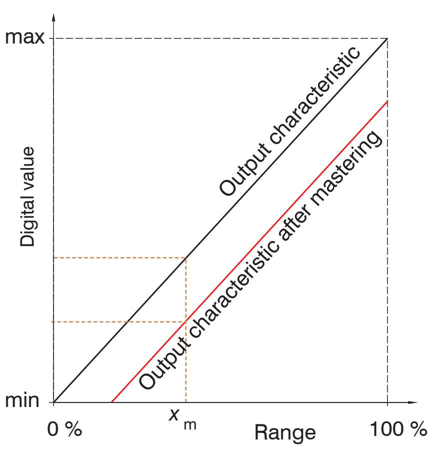
5 Button for storing or deleting a signal from (3).

6 Apply selection of a specific signal or master to all defined signals (8).

7 Start or stop function for signal (6) via software.

8 Overview of all existing signals and their master value for the function.

Fig. 58 Mastering dialog, overview of individual master values



When setting a master, the output characteristic is moved in parallel. Moving the characteristic reduces the relevant measuring range of a sensor (the further master value and master position are located, the greater the reduction).

Mastering / Zeroing Sequence:

➡ Place target and sensor into their desired positions to one another.

➡ Define the `Master value` (web interface/ASCII).

After setting the master, the controller will issue new readings that relate to the master value. If you click the `Reset master value` button to undo the mastering process, the system reverts to the state that existed before the master was set.

Fig. 59 Moving the characteristic when mastering

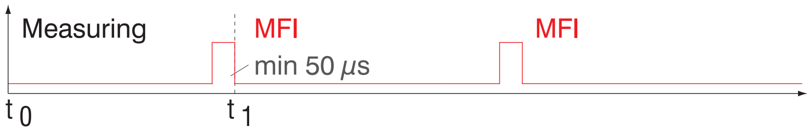


Fig. 60 Flowchart for zeroing, mastering (Multifunction key)

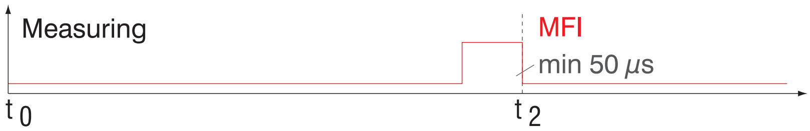


Fig. 61 Flowchart for undoing zeroing/mastering

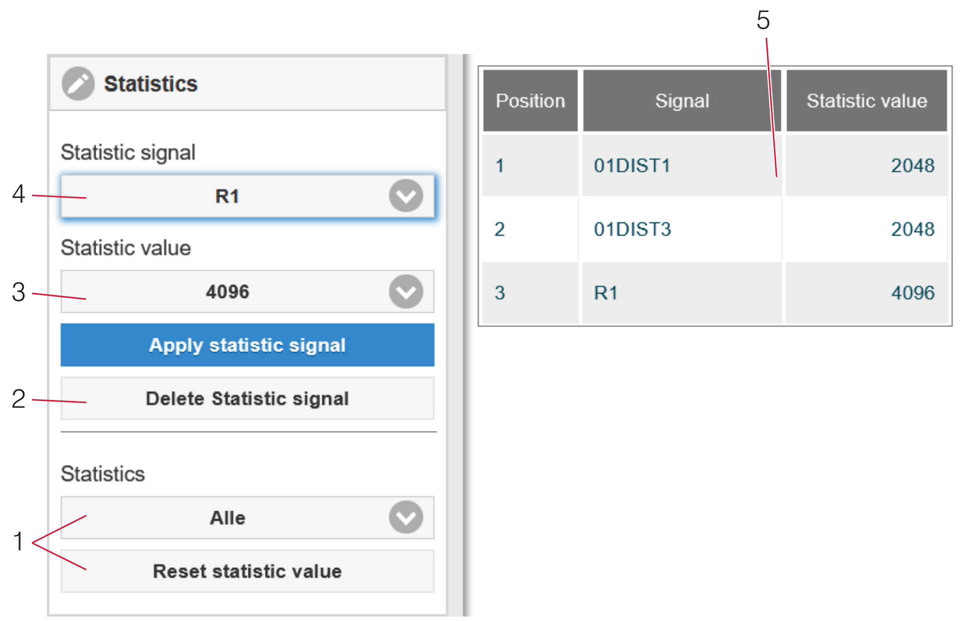
The zeroing/mastering function can be applied several times in a row.

6.4.2 Statistics

The controller derives the following statistical values from the measurement result:

- Minimum,
- Maximum and
- Peak-to-Peak.

Statistical values are calculated from measured values within the evaluation range. The evaluation range is updated with every new measurement value. Statistical values are displayed in the web interface, the `measurement chart` or are output via the interfaces.



The statistical values are not channel-specific. The controller manages up to 10 statistical values. These 10 signals can be applied to any internally determined value. This also applies for calculated values.

Fig. 62 Statistics dialog, overview of individual statistic values

1 Use the `Reset statistic value` button to reset a certain signal or all statistic signals in order to start a new evaluation cycle (storage period). When a new cycle starts, previous statistical values are deleted.

2 Deletes a signal.

3 Number of measurement values based on which minimum, maximum and peak-to-peak are determined for a signal. The range of values used for calculation can be between 2 and 16384 (in powers of 2) or include all measured values.

4 Selects a signal for the function.

5 Overview of all existing signals for the function.

Sequence for creating a statistical evaluation:

- Change to the tab `Settings > Postprocessing > Statistics`.
- Choose a signal (4) for which the statistical values should be calculated.
- Define the evaluation range via the `statistic value`.

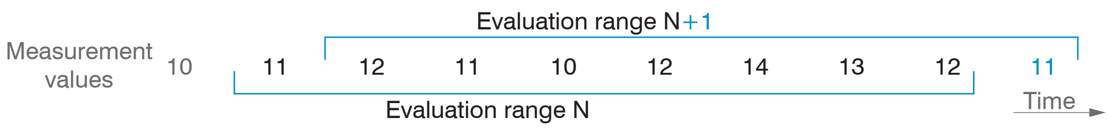


Fig. 63 Dynamic update of evaluation range via measurement values, statistical value = 8

6.4.3 Data Reduction, Output Data Rate

Data reduction	Value	*Instructs the controller which data are excluded from the output, thus reducing the volume of data transmitted.*
Reduction applies to	RS422 / Analog / Ethernet	*The interfaces which are provided for the sub-sampling are to be selected with the checkbox.*

You can reduce the measurement output in the sensor if you set the output of every nth measured value in the web interface or by command. Data reductions causes only every nth measured value to be output. The other measured values are rejected. The reduction value n can range from 1 (each measured value) to 3,000,000. This allows you to adjust slower processes, such as a PLC, to the fast sensor without having to reduce the measuring rate.

6.4.4 Error Handling (Hold Last Value)

If no valid measured value can be determined, an error is output. Alternatively, if this interferes with further processing, the last valid value can be held, i.e. output repeatedly, for a certain amount of time.

Error handling	Error output, no measured value	*Interfaces output an error instead of a value.*	
	Hold last value infinitely	*Interfaces output the last valid value until a new, valid measured value is available.*	
	Hold last value	Value	*Possible number of values to be maintained between 1 and 1024. When number = 0, the last value is maintained until a new, valid value is displayed.*

Fields with gray background require a selection.

Value Fields with dark border require entry of a value.

6.5 Outputs

6.5.1 RS422

6.5.1.1 InterfaceParameter, Output Values

The RS422 interface has a maximum baud rate of 4000 kBaud. The baud rate is set to 921.6 kBaud when the interface is delivered. Use ASCII commands or the web interface to configure.

Transfer settings for controller and PC must match.

Data format: Binary. Interface parameters: 8 data bits, no parity, one stop bit (8N1). Selectable baud rate.

The RS422 interface transmits 18 bits per output value. The maximum number of measured values that can be transmitted for a measuring point depends on the measuring rate of the controller and the transmission rate set for the RS422 interface. Use the maximum available transmission rate (baud rate) where possible.

Parallel output of measuring data is possible via RS422 and Ethernet.

The selection of output data from all internally determined values and from the calculated values from the computing modules is done separately for both interfaces. These data are output in a rigidly defined order.

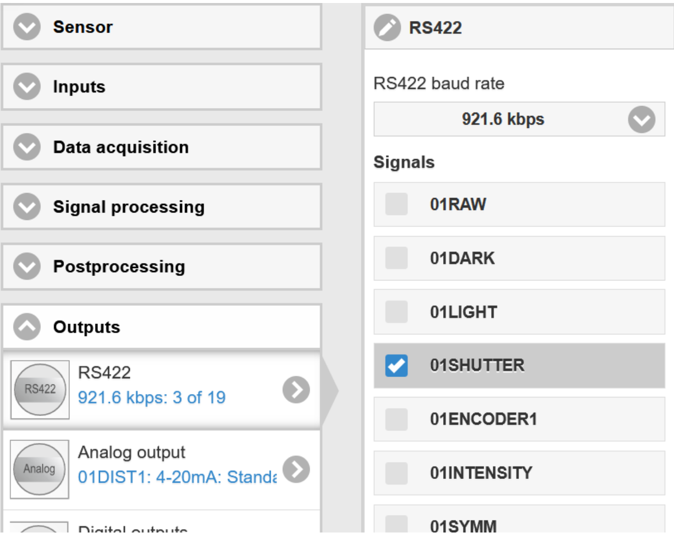


Fig. 64 Selecting the output data for RS422

Signal name	RS422, min	RS422, max	Scaling	Unit	IFC2411	IFC2416
01RAW (512 x 16Bit)	0	4095	value / 4096 * 100	%	X	X
01DARK (512 x 16Bit)	0	4095	value / 4096 * 100	%	X	X
01LIGHT (512 x 16Bit)	0	65535	value / 65536 * 100	%	X	X
01SHUTTER	0	65536	value / 9	µs	X	X
01ENCODER1	0	262143	value	Encoder ticks	X	X
01ENCODER2	none	none	none	Encoder ticks		
01ENCODER3	none	none	none	Encoder ticks		
01INTENSITY[1..6]	0	2048	value / 1024 * 100	%	X	X
01DIST[1..6]	0	262071	(value - 98232) / 65536 * Measuring range	mm	X	X
01SYMM[1..6]	0	262143	value / 16	Center of gravity	X	X
MEASRATE	2250	180000	18000 / value	kHz	X	
MEASRATE	720	180000	18000 / value	kHz		X
TIMESTAMP	0	262143	value	µs	X	X
TIMESTAMP_HI	0	65535	value * 65536	µs	X	X
TIMESTAMP_LO	0	65535	value	µs	X	X
COUNTER	0	262143	value		X	X
*	0	262071	identical with 01DIST*	nm	X	X
*_MIN	0	262071	identical with 01DIST*	nm	X	X
*_PEAK	0	262071	identical with 01DIST*	nm	X	X
*_MAX	0	262071	identical with 01DIST*	nm	X	X

Fig. 65 Output values with RS422

6.5.1.2 Data Format RS422 Interface

Video data

<Preamble>	**<Size>**	**<video data>**	**<End>**
Start identifier 64 bit 0xFFFF00FFFF000000	Size 32 bit Volume of video data in bytes	16 Bit unsigned	End identifier 32 Bit 0xFEFE0000

Fig. 66 Structure of a video frame

Measured values

The output of distance measured values and other measured values via RS422 requires subsequent conversion into the relevant unit. The measurement data, if requested, always follows a video frame.

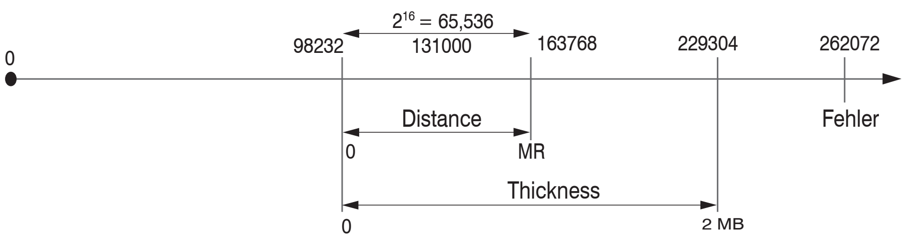
Output value 1:

	Preamble		Data bits					
L-Byte	0	0	D5	D4	D3	D2	D1	D0
M-Byte	0	1	D11	D10	D9	D8	D7	D6
H-Byte	1	0	D17	D16	D15	D14	D13	D12

Output values 2 ... 32:

	Preamble		Data bits					
L-Byte	0	0	D5	D4	D3	D2	D1	D0
M-Byte	0	1	D11	D10	D9	D8	D7	D6
H-Byte	1	1	D17	D16	D15	D14	D13	D12

Value range for the distance and thickness measurement:



131000 = mid of measuring range for the distance measurement

MR = measuring range

The linearized measured values can be converted into millimeters according to the following formula:

$$x = \frac{(d_{OUT} - 98232) * MR}{65536}$$

x = distance / thickness in mm

d_{OUT} = digital output value

MR = measuring range in mm

6.5.1.3 Error Codes RS422

All values greater than 262072 are error values and are defined as follows:

Error code	Description
262073	Scaling error RS422 interface underflow
262074	Scaling error RS422 interface overflow
262075	Data volume too large for baud rate selected [1]
262076	No peak is present
262077	Peak is before the measuring range (MR)
262078	Peak is behind the measuring range (MR)
262079	Measured value cannot be calculated

For all other data outputs except the measured value data, the limitations are defined in the relevant sections.

1) This error occurs when more data is to be output than can be transmitted at the selected baud rate at the selected measuring frequency. There are the following options of rectifying this error:

- Increase baud rate, see Chap. 6.5.1.1
- Decrease measuring frequency, see Chap. 6.2.1
- Reduce data volume; if 2 data words were selected, reduce to one data word
- Reduce output data rate, see Chap. 6.4.3

6.5.2 Ethernet

6.5.2.1 Output Values

As with the RS422 interface, you can select which values or data should be output in accordance with your individual requirements. Measurement data can be output via Ethernet and RS422 in parallel.

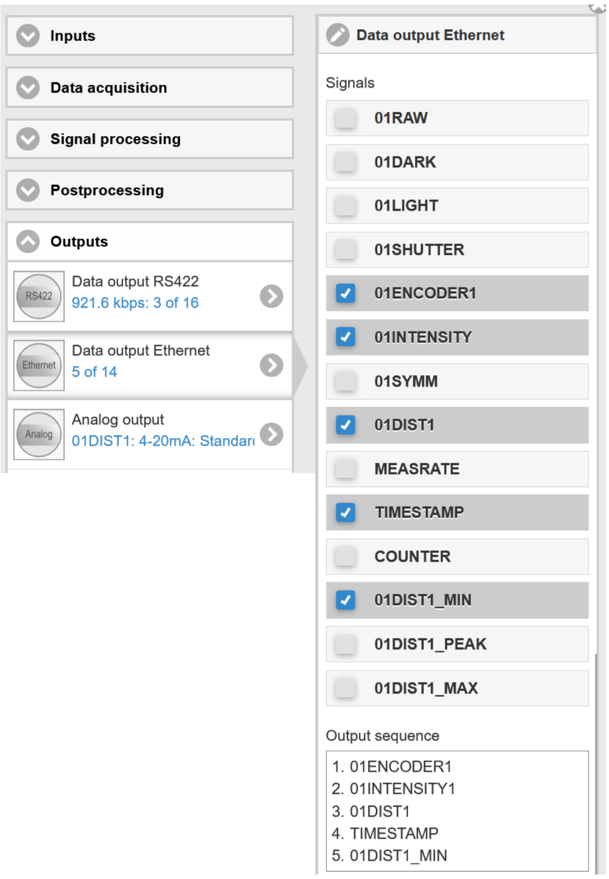


Fig. 67 Selecting the output data for Ethernet

Signal name	Ethernet, min	Ethernet, max	Scaling	Unit	IFC2411	IFC2416
01RAW (512 x 16Bit)	0	4095	value / 4096 * 100	%	X	X
01DARK (512 x 16Bit)	0	4095	value / 4096 * 100	%	X	X
01LIGHT (512 x 16Bit)	0	65535	value / 65536 * 100	%	X	X
01SHUTTER	0	UINT32_MAX	value / 36	µs	X	X
01ENCODER1	0	UINT32_MAX	value	Encoder ticks	X	X
01ENCODER2	0	UINT32_MAX	value	Encoder ticks		X
01ENCODER3	0	UINT32_MAX	value	Encoder ticks		X
01INTENSITY[1..6]	0	0x3fffffff	(value & 0x7ff) / 1024 * 100	%	X	X
01DIST[1..6]	INT32_MIN	0x7ffffeff	value / 1000000	mm	X	X
01SYMM[1..6]	INT32_MIN	INT32_MAX	value / 262144	Center of gravity	X	X
MEASRATE	4500	360000	36000 / value	kHz	X	
MEASRATE	1440	360000	36000 / value	kHz		X
TIMESTAMP	0	UINT32_MAX	value	µs	X	X
TIMESTAMP_HI	none	none		µs	X	X
TIMESTAMP_LO	none	none		µs	X	X
COUNTER	0	UINT32_MAX	value		X	X
*	INT32_MIN	0x7ffffeff	identical with 01DIST*	nm	X	X
*_MIN	INT32_MIN	0x7ffffeff	identical with 01DIST*	nm	X	X
*_PEAK	INT32_MIN	0x7ffffeff	identical with 01DIST*	nm	X	X
*_MAX	INT32_MIN	0x7ffffeff	identical with 01DIST*	nm	X	X

Fig. 68 Output values with Ethernet

6.5.2.2 Measurement Data Transmission to a Server via Ethernet

During the measurement data transmission to a measurement value server the sensor transmits each measurement value to the measurement value server or to the connected client after successful connection (TCP or UDP). Therefore no explicit requirement is necessary.

Any distances and additional information to be transmitted that are logged at one point in time are combined to form a value frame. Different measurement value frames are combined to a measurement value block, which contains a header and fits a TCP/IP or UDP/IP packet. The header is mandatory at the start of a UDP or TCP packet. In case of changes of the transferred data or the frame rate a new header is automatically sent.

All measurement data and the header are transmitted in the little Endian format..

Preamble (32 Bit)
Order number (32 Bit)
Serial number (32 Bit)
Length video data (32 Bit)
Length measurement data (32 Bit)
Frame number (32 Bit)
Counter (32 Bit)

The structure of a header for video and measurement data transfer is the same.

Header entry	**Description**
Preamble	uint32_t - 0x41544144 “DATA”
Order number	
Serial number	
Length video data	[Byte]
Length measurement data	[Byte]
Frame number	Number of frames, that cover this header. With video output, the field for the number of measurement data frames is set to one in the packet.
Counter	Counter on the number of processed measurement values

Example: The data encoder 1, distance and intensity are transmitted.

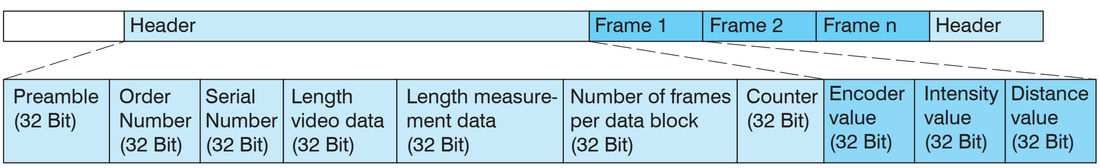


Fig. 69 Example for data transmission with Ethernet

6.5.2.3 Example

The following example explains how to output the exposure time, distance 1, distance 2 and the intensity.

- Determine two peaks to be evaluated:

```
PEAKCOUNT 2
```

- Set the signals with OUT_ETH:

```
OUT_ETH 01SHUTTER 01DIST1 01DIST2 01INTENSITY
```

- Query the signal sequence in the measurement frame:

```
GETOUTINFO_ETH 01SHUTTER 01INTENSITY1 01DIST1 01INTENSITY2 01DIST2
```

- Start der Ausgabe:

```
OUTPUT Ethernet
```

6.5.2.4 Error Codes Ethernet Interface

Within the distance values, see Chap. 6.5.2.1 , a range from 0x7FFFFF00 to 0x7FFFFFFF is reserved for error values/ codes. The following error codes are defined:

Error code	Description
0x7FFFFF04	There is no peak present
0x7FFFFF05	Peak is located in front of the measuring range (MR)
0x7FFFFF06	Peak is located behind of the measuring range (MR)
0x7FFFFF07	Measuring value cannot be calculated
0x7FFFFF08	Measuring value is outside the representable area

6.5.3 Analog Output

Only one measured value can be transmitted. The resolution of the analog output is 16 bit.

Output signal	*01DIST1 / ... 01DIST6 / ...*	*The data selection depends on the current setting and includes the results from the calculation modules as well as the distance values.*	
Output range	*4 ... 20 mA / 0 ... 5 V / 0 ... 10 V*	*Either the voltage or the current output can be used on the IFD241x.*	
Scaling	*Standard scaling*	*Scaling to 0 ... Measuring range*	
	Two-point scaling	Start of range corresponds to (in mm):	*Value*
		End of range corresponds to (in mm):	*Value*

The first value corresponds to the start of the measuring range and the second value to the end of the measuring range. If the analog range needs to be moved, we recommend using the zeroing or mastering function.

Two-point scaling enables the user to specify separate start and end values (in mm) for the sensor's measuring range. The available output range of the analog output is then spread between the minimum and maximum measured values. This allows for decreasing analog characteristics, see Fig. 70.

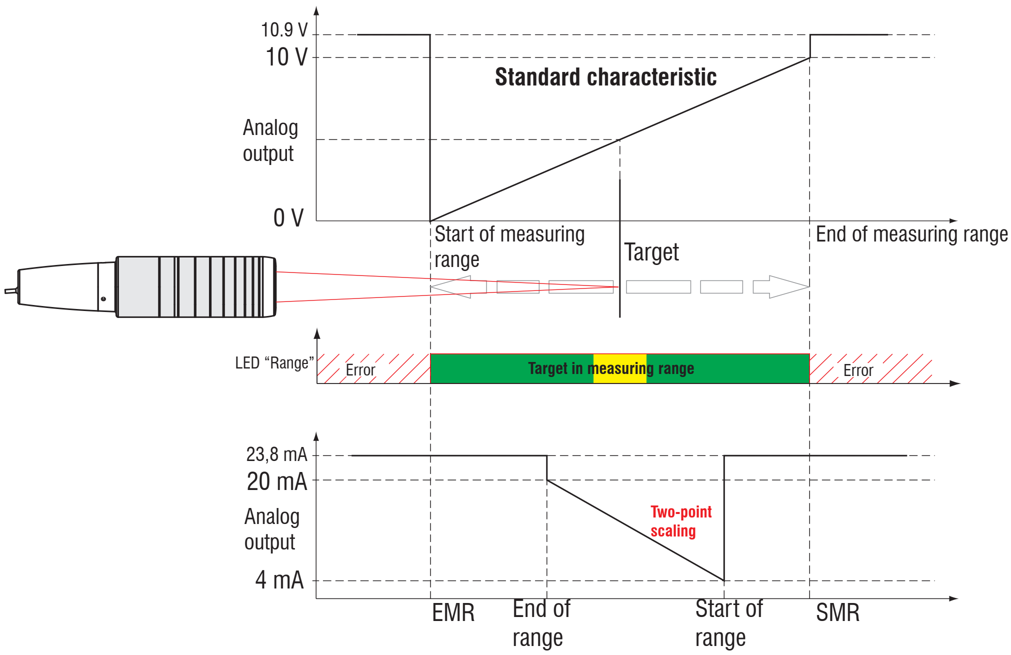


Fig. 70 Scaling the analog signal

6.5.3.1 Calculating Measured Value from Current Output

Current output (without mastering, without two-point scaling)

Variables	Value range	Formula
I_{OUT} = Current [mA]	[3.8; <4] SMR reserve [4; 20] measuring range [>20; 20.2] EMR reserve	$d = \frac{(I_{OUT} - 4)}{16} * MR$
MR = measuring range [mm]	{/1/2/3/6/10}	
d = Distance [mm]	[-0.01MB; 1.01MB]	

Current output (with two-point scaling)

Variables	Value range	Formula
I_{OUT} = Current [mA]	[3.8; <4] SMR reserve [4; 20] measuring range [>20; 20.2] EMR reserve	$d = \frac{(I_{OUT} - 4)}{16} * \lvert n - m \rvert$
MR = measuring range [mm]	{/1/2/3/6/10}	
m, n = Teach range [mm]	[0; MR]	
d = Distance [mm]	[m; n]	

6.5.3.2 Calculation measured value from Voltage Output

Voltage output (without mastering, without two-point scaling)

Variables	Value range	Formula
U_{OUT} = voltage [V]	[-0.05; <0] SMR reserve [0; 5] measuring range [>5; 5.05] EMR reserve	$d = \frac{V_{OUT}}{5} * MR$
	[-0.1; <0] SMR reserve [0; 10] measuring range [>10; 10.1] EMR reserve	$d = \frac{V_{OUT}}{10} * MR$
MR = measuring range [mm]	{/1/2/3/6/10}	
d = Distance [mm]	[-0.01MB; 1.01MB]	

Current output (with two-point scaling)

Variables	Value range	Formula
U_{OUT} = voltage [V]	[-0.05; <0] SMR reserve [0; 5] measuring range [>5; 5.05] EMR reserve	$d = \frac{V_{OUT}}{5} * \lvert n - m \rvert$
	[-0.1; <0] SMR reserve [0; 10] measuring range [>10; 10.1] EMR reserve	$d = \frac{V_{OUT}}{10} * \lvert n - m \rvert$
MR = measuring range [mm]	{/1/2/3/6/10}	
m, n = Teach range [mm]	[0; MR]	
d = Distance [mm]	[m; n]	

6.5.4 Switching Output

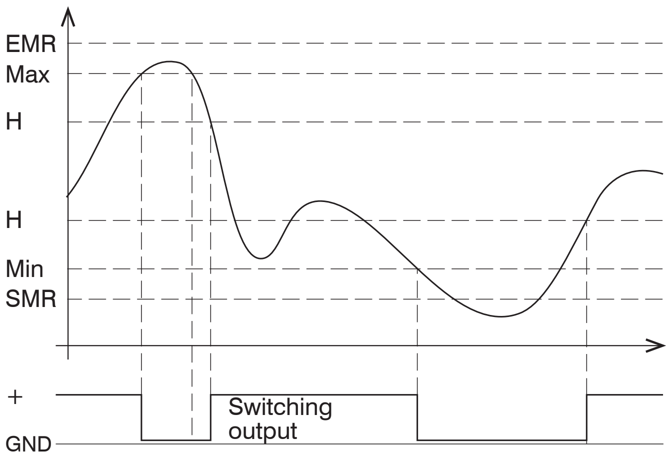
The IFC2416 controller features a switching output. The switching output can, for example, be used to monitor errors and limit values in relation to the 01DIST1 (distance) output value or in relation to calculated values.

<table>
<tr><td>Signal</td><td colspan="4">01DIST1 / / ... 01DIST6 / ...calculated vales</td></tr>
<tr><td>Switching level with error</td><td colspan="4">PNP / NPN / Push-Pull / Push pull negated</td></tr>
<tr><td rowspan="5">Configuration</td><td colspan="4">Intensity error / Measurement range error / Intensity or Measurement range error</td></tr>
<tr><td rowspan="4">Limits for measurements</td><td>Hysteresis (in mm)</td><td colspan="2">Value</td></tr>
<tr><td rowspan="3">Limit values</td><td>Upper limit (in mm)</td><td>Value</td></tr>
<tr><td>Lower limit (in mm)</td><td>Value</td></tr>
<tr><td>Both limits (in mm)</td><td>Value</td></tr>
</table>

The switching output is activated based on the set switching behavior.

Example

- Switching output: Distance outside limit values, both, NPN switching level



EMR = End of measuring range
Max = Maximum
H = Hysteresis value
Min = Minimum
SMR = Start of measuring range

Fig. 71 Switching output with limit values (both limits, NPN)

When the upper limit value (Max) is exceeded, the switching output with NPN switching behavior is activated (conducting state). It is deactivated again as soon as the hysteresis value is subsequently undershot. The same principle applies when the lower limit value is undershot (Min).

The function of the switching output is generally independent of the analog output.

In the active state, the relevant transistor of a switching output is conducting. The switching output is short-circuit proof.

Resetting the short-circuit protection:

- Eliminate external short circuit,
- Switch sensor off and on again, or
- Send Reset software command to sensor.

6.5.5 Data Output

Output interfaces	RS422 / Analog output / Ethernet	Decides on the interface used for outputting the measured value. The measured values are output in parallel via the interfaces selected.

In the case of the IFC2416, serial communication via RS422 is not possible if two or three encoders are connected or selected. If the RS422 interface is activated in spite of this, the choice of encoder will be restricted to encoder 1. The web interface will alert you to this.

6.5.6 Ethernet Settings

Address type	*static / DHCP*	*Values for IP Address / Gateway / Netmask. With static address only*		
Ethernet measurement value transmission	*Server TCP/IP*	Server port	*Value*	
		Send keep-alive signal	Active / Inactive	
		Number of frames per packet	Automatic	
			Set number	*Value*
	Client TCP/IP *Client UDP/IP*	Server address	*Value*	
		Port	*Value*	
		Send keep-alive signal	Active / Inactive	
		Number of frames per packet	Automatic	
			Set number	*Value*
	Inaktiv			

When using a static IP address it is necessary to enter the values for the IP address, Gateway and Subnet mask; this is not required when DHCP is used.

The controller is set at the factory to the static IP address 169.254.168.150.

The controller transmits the Ethernet packets at a transmission rate of 10 Mbit/s or 100 Mbit/s, which is set automatically according to the network or PC that is connected.

All output values and additional information intended for transmission that were captured at a certain time are consolidated into a measured value frame. Several measured value frames are consolidated into a measured value block. A header is added to the start of each measured value frame.

During transfer of measured value data, the controller sends each measured value (measured value frame) to its connected counterpart after the connection has been successfully set up.

No specific request is required for this.

In the event of changes to the transmitted data or the frame rate, a new header is sent automatically. The measured distance and thickness values are transmitted as a 32-bit signed integer.

This measured value frame can also consist of several Ethernet packets, depending on the size of the FFT signal.

Fields with gray background require a selection. *Value* Fields with dark border require entry of a value.

6.6 System Settings

6.6.1 Web Interface Unit

The web interface supports units in millimeters (mm) and inches in the display of the measurement results. The language in the web interface can be set to German or English. Switch the language in the menu bar.

6.6.2 Key Lock

The key lock prevents unauthorized or unintentional execution of the key functions. A key lock can be set individually for the `Multifunction` key.

Key Lock	Automatic	Value (1 ... 60 min)	*The button function will be blocked after a defined period of time has elapsed.*
	Active		*The key function is blocked immediately*
	Inactive		*No key lock*

The key lock can only be deactivated with `Professional` access authorization.

6.6.3 Loading and Saving

This chapter describes how

- to save a setup with either measurement settings or with device settings,
- functions for importing and exporting the setups, see Chap. 5.9.

6.6.4 Access Authorization

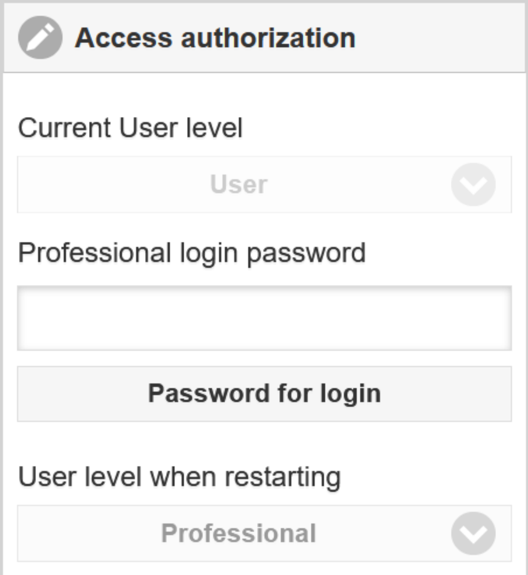
Assigning passwords prevents unauthorized changes to settings in the system. Password protection is not activated in the delivery state. The controller works on user level `Professional`. Once the controller has been configured, the password protection should be activated. The standard password for the Professional level is “000”.

i A software update will not change the standard password or a user-defined password. The Professional password is independent of the setup and is therefore not loaded or saved together with the setup.

Users have the following functions available:

	User	**Professional**
Password required	no	yes
View settings	yes	yes
Change settings, change passwords	no	yes
View measured values, video signals	yes	yes
Scale graphs	yes	yes
Restore factory settings	no	yes

Fig. 72 Rights in the user hierarchy



Type the standard password “000” or a user-defined password in the `Password` field and confirm the entry with `Login`.

Fig. 73 Switch to user level Professional

The user management enables the assignment of a user-defined password in operating mode `Professional`.

Password	*Value*	*All passwords are case-sensitive; numbers are allowed. Special characters are not permitted.*
User level when restarting	*User / Professional*	*Defines the user level which the system starts in after it has been switched on again. MICRO-EPSILON recommends the selection Professional here.*

6.6.5 Reset Controller

You can reset individual settings to the factory setting in this menu area.

Device settings	*The settings for the following commands are reset to the factory settings: ANALOG RANGE, BAUD RATE, ECHO, KEYLOCK, LED.*
Measurement settings	*Resets the preset to* `Standard matt` *and all parameters, except for interface settings, to the factory setting.*
Reset material database	*All settings for the material table are set to factory setting.*
Reset all	*Resets the device and measurement settings to factory settings.*
Restart controller	*Starts the system with the last settings saved*

6.6.6 Light Source

You can switch the light source for the system on or off. This can be done via software or with the multifunctional input.

6.6.7 Material Table

In this menu area, you can add target materials (layers) to the material table or adjust existing entries. A material is characterized either by three refractive indices or by one refractive index and Abbe number.

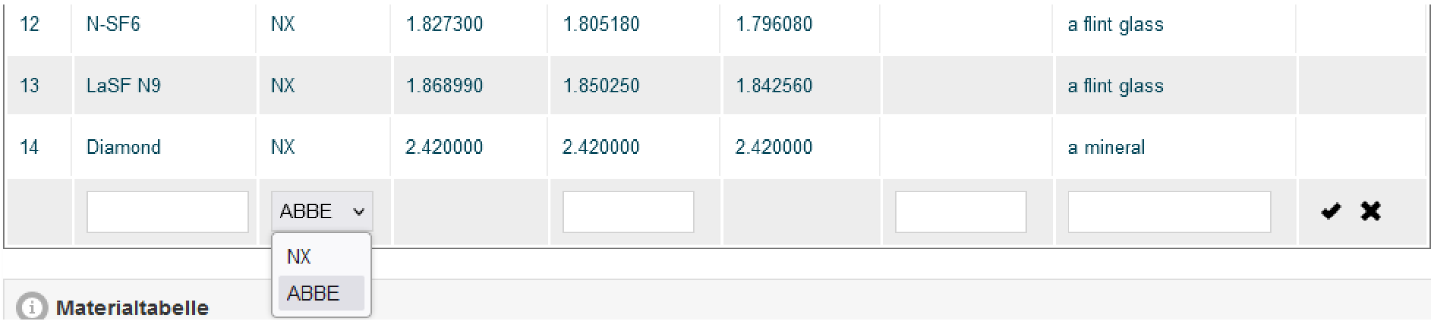


Fig. 74 Mask for supplementing a material

The optical refraction of a material is described using `NX` or `ABBE`:

- `NX` describes the material with the three refractive indices nF, nd and nC,
- `ABBE` describes the material with a refractive index (nd) and an Abbe number (vd).

7. Thickness Measurement, One-Sided, Transparent Target

7.1 Requirement

For a one-sided thickness measurement of a transparent target, the controller evaluates two signals reflected at the surfaces. Based on these two signals, the controller calculates the distances from the surfaces and, from this, derives the thickness.

➡ Align the sensor perpendicularly to the object to be measured. Make sure that the target is approximately in the mid of the measuring range (SMR + 0.5 x MR).

ℹ The light beam must strike the surface of the object at a perpendicular angle. Otherwise, measurements might be inaccurate.

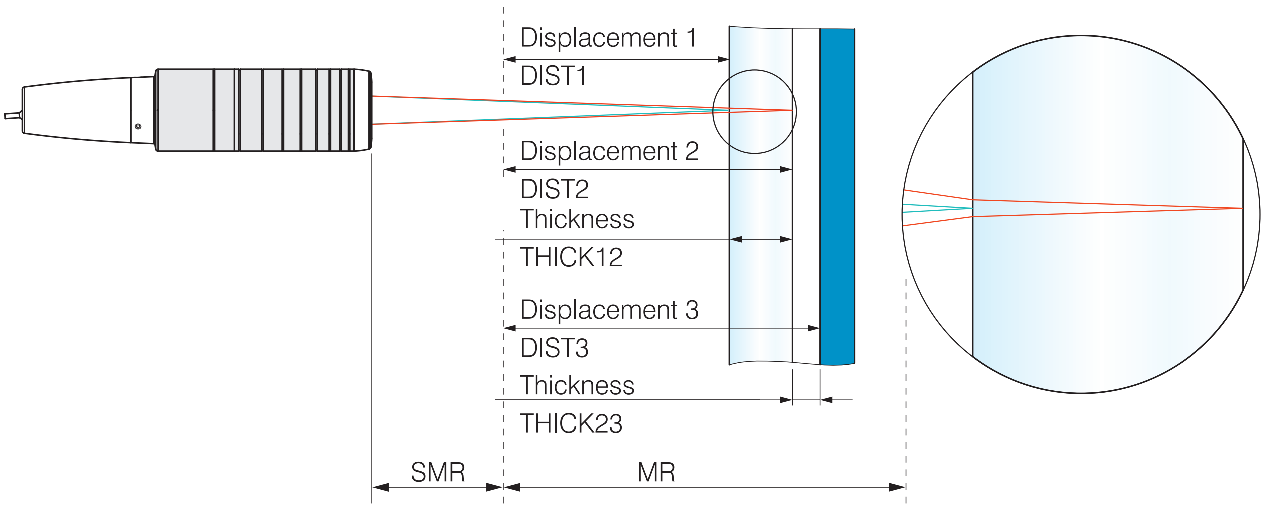


Fig. 75 One-sided thickness measurement on a transparent target

SMR	Start of measuring range
MR	Measuring range
Minimum target thickness	See Technical Data
Maximum target thickness	

7.2 Preset

➡ Switch to the `Home` menu.

➡ Select `One-sided thickness measurement` in the configuration selection.

This presetting prompts the controller to use the first and second peak in the video signal for the thickness calculation.

➡ Switch to the `Settings > Signal processing > calculation` menu and select the program `Thick-ness`.

The thickness program generates a difference from the two signals DIST2 and DIST1.

7.3 Material Selection

Specifying the material is essential for calculating a correct thickness value. To compensate for the spectral change of the index of refraction, at least three refractive indices at different wavelengths or a refractive index and the Abbe number must be known.

➡ Switch to the `Settings > Data recording > Material selection` menu.

➡ Select the material of the target for `Layer 1` and `Layer 2` (if applicable).

7.4 Video Signal

If a surface of the target lies outside the measuring range, the controller will send only one signal for the distance, intensity and center of gravity. This may also occur if a signal is below the detection threshold.

Two boundary surfaces are active when the thickness of a transparent material is measured. As a result, two peaks are visible in the video signal, see Fig. 76.

Even if the detection threshold is just below the saddle between the two peaks, the controller can determine both distances and calculate the thickness from them.

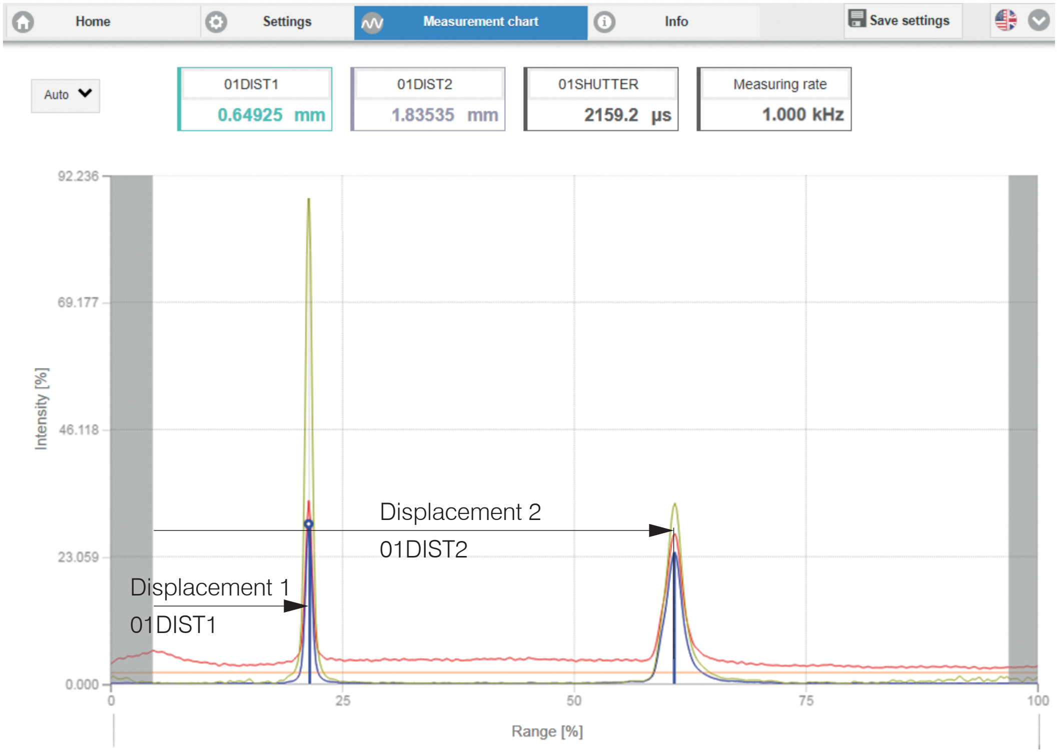


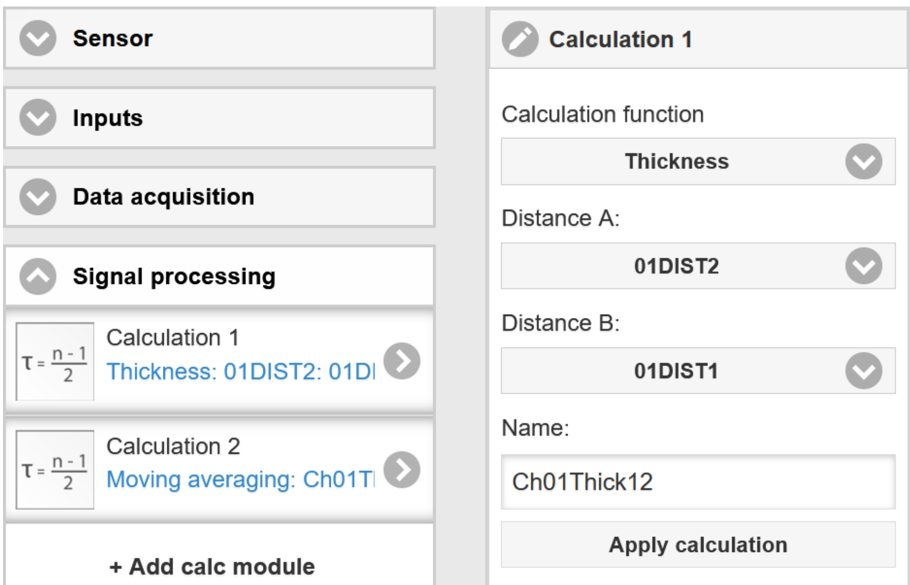
Fig. 76 Video signal web page, `One-sided thickness measurement`

7.5 Signal Processing

The configuration selection `One-sided thickness measurement` also contains the presets for thickness calculation from the two distance signals `Displacement1` and `Displacement2`, see Fig. 76.

In the downstream second calculation block `Calculation 2`, the thickness values undergo a moving averaging with an averaging depth of 16 values.

➡ Adapt the signal processing to your measuring task.



7.6 Measurement Chart

➡ Switch to the `Measurement chart` tab and select `Mess` as the chart type.

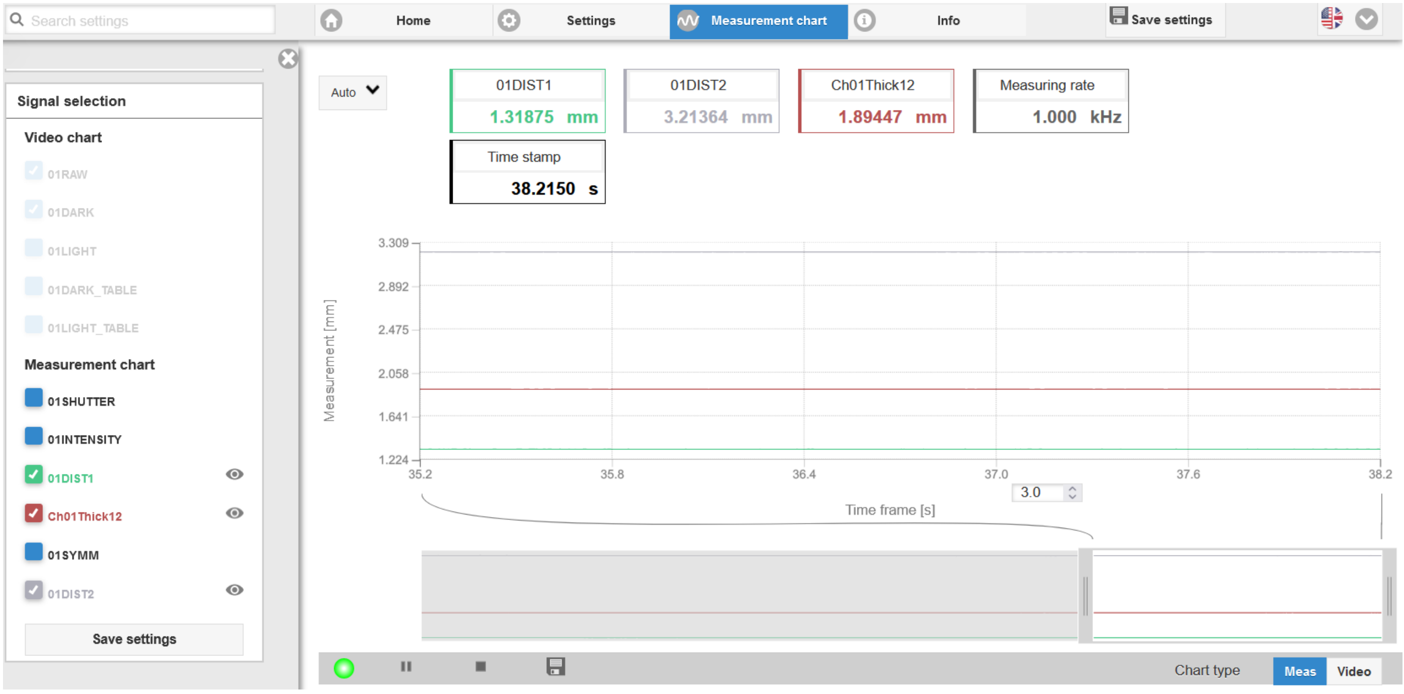


Fig. 77 Measured thickness results based on a one-sided thickness measurement with one sensor

The web page shows the two distances and the thickness (difference between `01DIST2` and `01DIST1`) graphically and numerically. Optionally, the intensities of both peaks (Peak 1 = near, Peak 2 = far) can also be displayed.

8. Error, Repair

8.1 Web Interface Communication

➡ If an error page is displayed in the web browser, please check the following points.

- Check to make sure the controller is connected correctly, see Chap. 4.7.
- Check the IP configuration of PC and controller, find the controller with the `sensorTOOL program`, see Chap. 5.1. If the controller and PC are connected directly, it can take up to two minutes for them to agree on the IP addresses.
- Check proxy settings used. If the controller is connected to the PC via a separate network card, then it will be necessary to disable the use of a proxy server for this connection. Please ask your network manager or administrator about this!

8.2 Changing the Sensor Cable on the Sensors

➡ Loosen the protective sleeve on the sensor. Remove the defective sensor cable.

➡ Feed the new sensor cable through the protective sleeve.

➡ Remove the protective cap on the sensor cable and save it for safe keeping.

➡ Guide the guide lug of the sensor connector into the groove of the port.

➡ Screw the sensor plug and sensor port together.

➡ Screw the protective sleeve back onto the sensor.

➡ Conduct a dark correction, see Chap. 5.10.

8.3 Replacing the Protective Glass on the Sensors

The protective glass must be replaced in case of:

- irreversible contamination,
- scratches.

i The sensor may not be used without a protective glass, as doing so will impair its measuring accuracy.

➡ Loosen the front frame incl. protective glass on the sensor.

➡ Remove the seal and insert the O-ring into the frame groove of the new protective glass.

➡ Screw the new frame incl. protective glass back onto the sensor.

9. Software Support with MEDAQLib

MEDAQLib is a documented driver DLL. This allows you to integrate the confocal measuring system into existing PC software or that of the customer.

Connection options:

- RS422/USB converter (optional accessories) and suitable SC2415-x/OE connection cable,
- Direct Ethernet connection with LAN cable.

No knowledge of the underlying protocol of the respective controller is necessary to be able to contact the controller. The individual commands and parameters for the controller to be addressed are set via an abstract function and converted into the protocol of the controller by the MEDAQLib accordingly.

MEDAQLib

- contains a DLL that can be imported into C, C++, VB, Delphi and many other programs,
- takes care of data conversion for you,
- works regardless of the type of interface used,
- uses the same functions for communication (commands),
- provides a single transmission format for all MICRO-EPSILON sensors.

For C/C++ programmers, an additional header file and a library file are integrated into MEDAQLib.

You can find the current driver routine including documents at:

www.micro-epsilon.com/download
www.micro-epsilon.com/link/software/medaqlib

10. 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/legal-details/. For translations into other languages, the German version shall prevail.

11. Service, Repair

If the measuring system is defective:

- If possible, save the current sensor settings in a parameter set, see Chap. 5.9 to reload them into the controller 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 with cables to:

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

Tel. +49 (0) 8542 / 168-0
Fax +49 (0) 8542 / 168-90

info@micro-epsilon.com
www.micro-epsilon.com

12. Decommissioning, Disposal

To prevent environmentally harmful substances from being released and to ensure the reuse of valuable raw materials, please note the following rules and obligations:

- All cables must be removed from the sensor and/or controller.
- The sensor and/or controller, its components and the accessories, as well as the packaging materials, are to be disposed of according to the country-specific waste treatment and disposal regulations for the respective area of use.
- You are obligated to observe all relevant national laws and provisions.

The following (disposal) instructions apply in Germany / the EU:

- old devices labeled with a crossed-out garbage can must not be disposed of in normal waste (e.g. garbage can or yellow bin) and must be disposed of separately. This prevents hazards to the environment due to improper disposal and proper further use of the old devices is ensured.

- A list of national legislation and contacts in 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 have the opportunity to learn about the respective national collection and return points.
- Old devices can also be sent back to MICRO-EPSILON for disposal, to the address provided in the Legal Notice at https://www.micro-epsilon.com/legal-details/ .
- Please note that you yourself are responsible for deleting the measurement-specific and personal data from the old devices being disposed of.
- We are registered as a manufacturer of electrical and/or electronic devices under registration number WEEE-Reg.-Nr. DE28605721 with Stiftung Elektro-Altgeräte Register, Nordostpark 72, 90411 Nuremberg.

Appendix

A 1 Optional accessories, services

A 1.1 Optional Accessories

Cable C2401 with FC/APC and E2000/APC connector

C2401-x	Optical fiber (3 m, 5 m, 10 m, customer-specific length up to 50 m)
C2401/PT-x	Optical fiber with protective sleeve for mechanical strain (3 m, 5 m, 10 m, customer-specific length up to 50 m)
C2401-x(01)	Optical fiber core diameter 26 µm (3 m, 5 m, 15 m)
C2401-x(10)	Optical fiber in drag chain-compatible design (3 m, 5 m, 10 m)

Mounting adapter

MA2400-27	Mounting adapter for IFS2405-0,3 / IFS2405-1 / IFS2406-3 / IFS2406-10 sensors
MA2402-4	Mounting adapter for IFS2402-x sensors
MA2403-8	Mounting adapter for IFS2403-x sensors
MA2404-12	Mounting adapter for IFS2404-x / IFS2407-0,1 / IFS2407-0,8 sensors
MA2405-34	Mounting adapter for IFS2405-3 sensor
MA2405-40	Mounting adapter for IFS2405-6 / IFS2405/90-6 sensors
MA2405-54	Mounting adapter for IFS2405-10 / IFS2407-3 sensors
MA2405-62	Mounting adapter for IFS2405-28/ IFS2405-30 sensors
MA2406-20	Mounting adapter for IFS2406-2,5 sensor
MA2407-65	Mounting adapter for IFS2407-1,5 sensor
JMA-xx	Adjustable mounting adapter, see Chap. A 3

Other accessories

SC2415-x/OE	Connection cable with 17-pole M12 socket and open ends for analog output, digital I/O and encoder; drag chain-compatible, cable length x = 3 m, 6 m, 9 m or 15 m
IF2001/USB	Converter from RS422 to USB, type: IF2001/USB, suitable for SC2415-x/OE cable, including driver, Connections: 1x 10-pin socket strip (cable clamp), type: Würth 691361100010; 1x 6-pin socket strip (cable clamp), type: Würth 691361100006
SC2415-x/IF2008ETH	Interface cable for interface IF2008/ETH, length 3 m
IF2008/ETH	8-fold RS422/Ethernet converter with industrial M12 plug/socket to connect up to 8 IFC2411/2416 controllers
SC2415-x/IF2008	Interface cable for interface IF2008/ETH or IF2004/USB, length 3 m, 6 m, 9 m or 15 m
IF2008/PCIE	Interface card IF2008/PCIE to capture four digital sensor signals synchronously, confocalDT 2411/2416 series and two encoders. In conjunction with IF2008E a total of six digital signals, two encoders, two analog signals and eight I/O signals can be captured synchronously.
PS2020	Power supply for DIN rail installation, input 230 VAC, output 24 VDC/2.5 A

Vacuum feedthrough

C2402/Vac/KF16	Vacuum feedthrough for optical fiber, 1 channel, vacuum-side FC/APC, non-vacuum-side E2000/APC, clamping flange type KF 16
C2405/Vac/1/KF16	Vacuum feedthrough on both sides FC/APC socket, 1 channel, clamping flange type KF 16
C2405/Vac/1/CF16	Vacuum feedthrough on both sides FC/APC socket, 1 channel, flange type CF 16
C2405/Vac/6/CF63	Vacuum feedthrough for optical fiber on both sides FC/APC socket, 6 channels, flange type CF 63

A 1.2 Services

- confocalDT measuring system linearity check and adjustment
- confocalDT measuring system calibration

A 2 Factory Settings

Number of Peaks	1 measured value, highest peak
Region of interest	Range start corresponds to 0 % Range end corresponds to 100 %
Exposure mode	Measurement mode
User group	Professional, password “000”
Data reduction	Inactive
Detection Threshold	2 %
Error handling	Error output, no measured value
Measuring program	Distance measurement, “Standard matt”
Measuring Rate	1 kHz
Peak modulation	50 %

RS422	921.6 kBps
Interface	Ethernet
Signal Processing	01DIST1, moving averaging, 16 values
Synchronization	no synchronization
Key function	Change operating mode, dark correction, factory setting
Key Lock	Inactive
Trigger mode	No trigger

A 3 Adjustable Mounting Adapter JMA-xx

A 3.1 Functions

- Supports optimal sensor alignment for best possible measurement results
- Manual adjustment mechanism for easy and fast adjustment
  - Shift in X/Y: ±2 mm
  - Tilt angle: ±4°
- High resistance to shocks and vibrations due to radial clamping allows integration into machines
- Compatible with numerous confocalDT and interferoMETER sensor models

A 3.2 Sensor Mounting, Compatibility

Radial clamping for sensors with

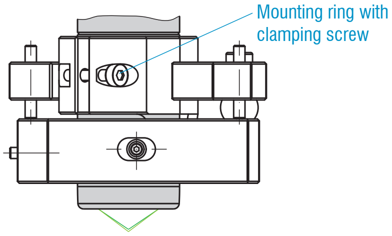
ø 8 mm	ø 12 mm	ø 20 mm	ø 27 mm
Reducing sleeve			
Adapter D27-D8	Adapter D27-D12	Adapter D27-D20	
confocalDT: Series IFS2403	confocalDT: IFS2404-2 IFS2407-0,1 IFS2407-0,8	confocalDT: IFS2406-2,5/VAC	confocalDT: IFS2405-0,3 IFS2404-1 IFS2405-1 IFS2404-3 IFS2406-3 IFS2404-6 IFS2406-10

A 3.3 Mounting

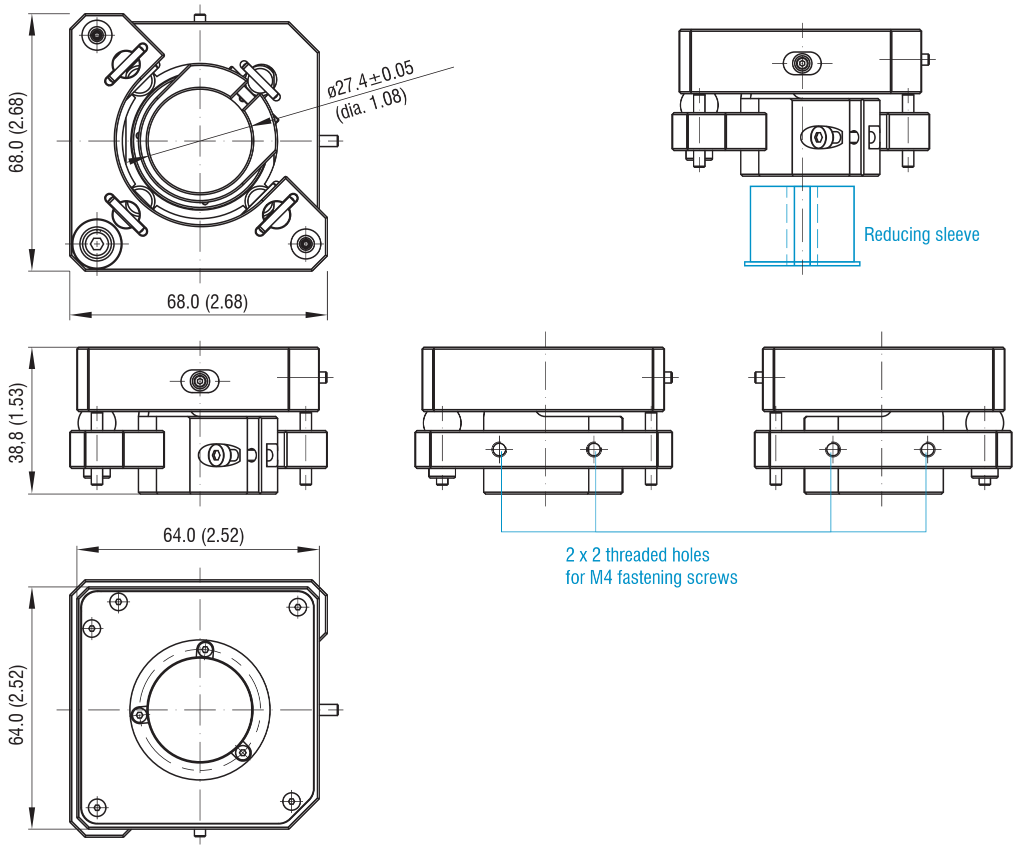
➡ Mount the sensor in the mounting ring, see figure.

➡ Use reducing sleeves for sensors with an outer diameter of less than 27 mm.

➡ Mount the mounting adapter with screws type M4, see dimensional drawing.



A 3.4 Dimensional Drawing of Mounting Adapter



A 3.5 Perpendicular Alignment of Sensor

➡ With the light source switched on, align the sensor with the measuring object.

Horizontal shift ±2 mm

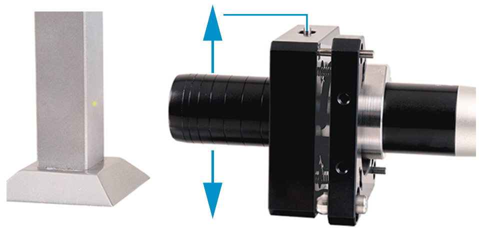
Shift to the left:

➡ Turn the hexagon socket screw clockwise

Shift to the right:

➡ Turn the hexagon socket screw counterclock-wise

Vertical shift ±2 mm



Shift downwards:

➡ Turn the hexagon socket screw clockwise

Shift upwards:

➡ Turn the hexagon socket screw counterclock-wise

Horizontal tilt angle ±4°

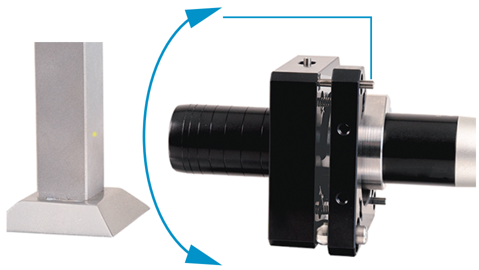
Tilt to the left:

➡ Turn the hexagon socket screw clockwise

Tilt to the right:

➡ Turn the hexagon socket screw counterclock-wise

Vertical tilt angle ±4°



Shift downwards:

➡ Turn the hexagon socket screw clockwise

Shift upwards:

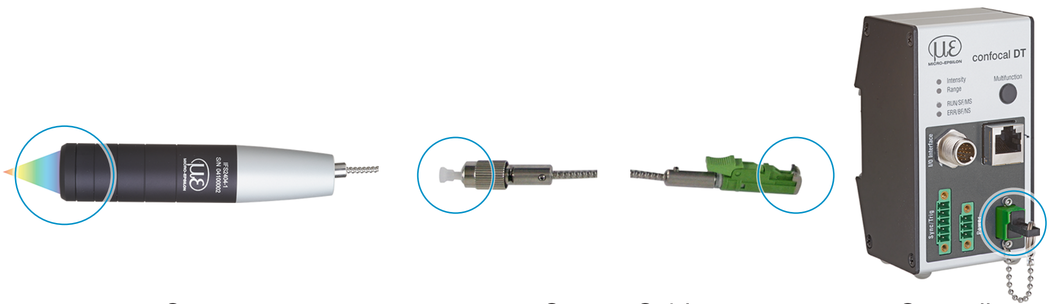
➡ Turn the hexagon socket screw counterclock-wise

A 4 Cleaning Optical Components

A 4.1 Contamination

Contamination of optical surfaces and components can increase the dark value and affect sensitivity and accuracy. To prevent this, it is necessary to clean the optical components and record the dark value. “Dark value” refers to the interfering reflections at boundary surfaces along the optical signal path. At each boundary surface or material transition, the light waves are reflected to a certain extent at the transition and travel back in the fiber optics. The interfering signal overlaps with the useful signal and forms a kind of signal noise.

If the interference signal is sufficiently high and the useful signal is relatively weak, the useful signal can no longer be clearly identified. This may cause the controller to confuse a dark value peak with the measurement signal. Thus the calculated distance of the measuring object does not match the actual one.

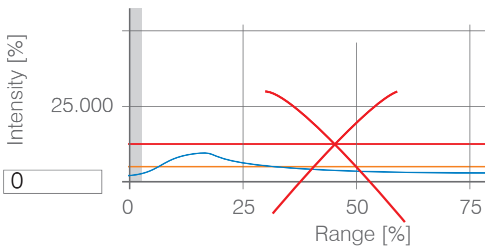


Sensor | Sensor Cable | Controller

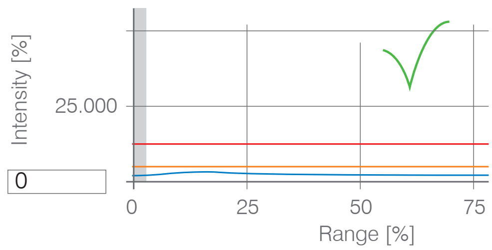
Protective glass | FC connector | E2000 connector

Fig. 78 Optical boundary surfaces of a confocal measuring system

➡ Conduct a dark correction, see Chap. 5.10.



Video signal before dark correction (high dark value, blue line)



Video signal after dark correction

If the video signal corresponds to the condition before the dark correction, you must clean the optical boundary surfaces within the measuring system. Clean the optical surfaces one by one to find the dirty component. You can observe how cleaning improves the result by watching the dark signal of the video signal.

➡ Continue with the section `Protective Glass of Sensor`.

i Check and clean the protective glass of the sensor at regular intervals depending on the operating conditions. Clean the system starting from the controller to the sensor. Always clean both components of a matched pair, i.e. plug and socket.

A 4.2 Tools and Cleaning Agents

One-Click™ Cleaner	Isopropyl alcohol	Q-Tip, suitable for clean rooms	Pressurized gas, dry and oil-free
			
For FC or E2000 type plug or socket	For the protective glass of the sensor	Use with isopropyl alcohol for protective glass of the sensor	Removes loose particles

A 4.3 Sensor Protective Glass

Loose particles

- Blow off loose particles with dry, oil-free pressurized air.

Stuck particles

- Clean the protective glass with a clean, soft, lint-free cloth or lens cleaning paper and pure alcohol (isopropyl alcohol).

For sensors with a small protective glass, e.g., the IFS2404-2(001) series:

- Soak a Q-Tip in isopropyl alcohol. Slowly rub the Q-Tip with a circular motion on the protective glass.

Fig. 79 Cross-section of protective glass

- Conduct a dark correction.

If the video signal corresponds to the condition before the dark correction, you must clean the boundary surfaces within the measuring system.

- Continue with the section `Interface between Controller and Sensor Cable`.

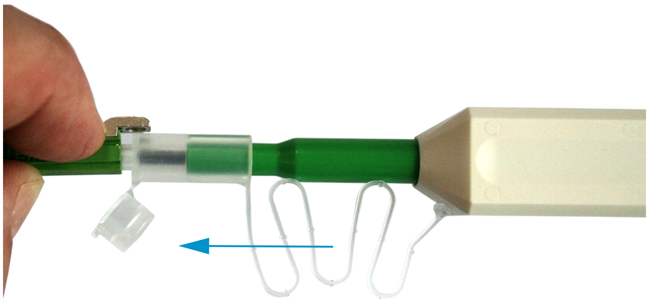
A 4.4 Interface between Controller and Sensor Cable

- Disconnect the sensor cable (fiber optic cable) from the controller.
- Remove the protective cap of the One-Click™ cleaner.
- Put the One-Click™ cleaner into the fiber optic connector of the controller, see figure.
- Press the outer sleeve of the One-Click™ cleaner onto the fiber optic connector until a click noise signalizes the end of cleaning.

Fig. 80 One-Click™ Cleaner *for cleaning E2000 optical fiber transitions*

- Plug the protective front cap on the controller into the optical fiber connection.

- Remove the front protective cap of the One-Click™ cleaner.
- Put the One-Click™ cleaner into the optical fiber, see figure.
- Press the outer sleeve of the One-Click™ cleaner onto the fiber optic connector until a click noise signalizes the end of cleaning.



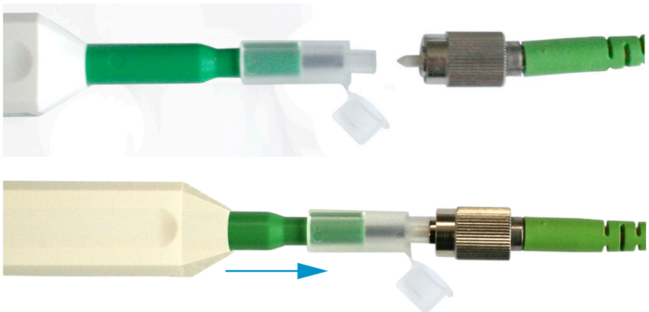
- Plug the sensor cable into the controller.
- Conduct a dark correction.

If the video signal corresponds to the condition before the dark correction, you must clean the boundary surfaces within the measuring system.

- Continue with the section `Interface between Sensor Cable and Sensor`.

A 4.5 Interface between Sensor Cable and Sensor

- Remove the sensor cable (fiber optic cable) from the sensor.
- Remove the front protective cap of the One-Click™ cleaner.
- Put the One-Click™ cleaner into the optical fiber, see figure.
- Press the outer sleeve of the One-Click™ cleaner onto the fiber optic connector until a click noise signalizes the end of cleaning.



- Plug a protective cap onto the optical fiber.

Sensor with optical fiber in the sensor:

- Remove the protective cap of the One-Click™ cleaner.
- Put the One-Click™ cleaner into the sensor, see figure.
- Press the outer sleeve of the One-Click™ cleaner onto the sensor until a click noise signalizes the end of cleaning.

- Put the sensor cable and sensor together.
- Conduct a dark correction.

If the video signal corresponds to the condition before the dark correction, you must clean the boundary surfaces within the measuring system.

- Continue with the section `Interface between Controller and Sensor Cable`.

A 4.6 Preventive Protection

Sensors and controllers of a confocal chromatic sensor system are supplied with protective caps. This prevents dust or similar contaminants from being deposited at the optical boundary surfaces.

- Cover all optical fiber connections immediately when replacing sensors or disconnecting a sensor cable from the controller.

A 5 ASCII Communication with Controller

A 5.1 General

The ASCII commands can be sent to the controller via the RS422 interface or Ethernet (Port 23). All commands, inputs and error reports are in English. A command always consists of the command name and zero or several parameters that are separated with a space and end in LF. If spaces are used in parameters, the parameter must be placed in quotation marks, e.g. “Password with space”.

Example: Switching on output via RS422

OUTPUT RS422 ↵

Note: ↵ Must contain LF, but can also be CR LF.

Explanation: LF Line feed (hex 0A)

CR Carriage return (hex 0D)

↵ Enter (depending on system, hex 0A or hex 0D0A)

The currently set parameter value is reset if a command is invoked without parameters.

The output format is:

<Command name> <Parameter1> [<Parameter2> […]]

The response can be used again without changes as a command for setting the password. Optional parameters are only returned as well if this is necessary.

After a command is processed, a line break and a prompt (“->”) is always returned. In the event of an error, an error message beginning withExx, where xx stands for a unique error number, comes before the prompt. Moreover, instead of error messages, warning messages (“Wxx”) may be output. Warnings are structured like error messages, such as “If Xenon lamp is too hot...”. Warnings do not prevent commands from being executed.

A 5.2 Commands Overview

Group	Chapter	Command	Brief information
General			
	Chap. A 5.3.1.1	HELP	Help
	Chap. A 5.3.2.2	GETINFO	Controller information
	Chap. A 5.3.1.3	ECHO	Reply type
	Chap. A 5.3.1.4	PRINT	Parameter overview
	Chap. A 5.3.1.5	SYNC	Synchronization
	Chap. A 5.3.1.6	TERMINATION	Termination resistor
	Chap. A 5.3.1.7	RESET	Boot sensor
	Chap. A 5.3.1.8	RESETCNT	Reset counter
User level			
	Chap. A 5.3.2.1	LOGIN	Change user level
	Chap. A 5.3.2.2	LOGOUT	Change to user level User
	Chap. A 5.3.2.3	GETUSERLEVEL	User level query
	Chap. A 5.3.2.4	STDUSER	Set standard user
	Chap. A 5.3.2.5	PASSWD	Change password
Inputs			
	Chap. A 5.3.3	MFILEVEL	Input level multifunction inputs
Sensor			
	Chap. A 5.3.4.1	SENSORTABLE	Display available sensors
	Chap. A 5.3.4.2	SENSORINFO	Information on sensor
	Chap. A 5.3.4.3	SENSORHEAD	Select aktive sensor
	Chap. A 5.3.4.4	DARKCORR	Start dark correction
	Chap. A 5.3.4.5	LED	LED on/off
	Chap. A 5.3.4.6	LEDSOURCE	Control input measurement light source

Triggering			
	Chap. A 5.3.5.1	TRIGGERSOURCE	Trigger source
	Chap. A 5.3.5.2	TRIGGERAT	Effect of trigger input
	Chap. A 5.3.5.3	TRIGGERMODE	Trigger type
	Chap. A 5.3.5.4	TRIGGERLEVEL	Active level of trigger input
	Chap. A 5.3.5.5	TRIGGERSW	Generates a software trigger pulse
	Chap. A 5.3.5.6	TRIGGERCOUNT	Number of measured values to be specified
	Chap. A 5.3.5.7	TRIGGERENCSTEPSIZE	Step Size Encoder Triggering
	Chap. A 5.3.5.8	TRIGGERENCMIN	Minimum Encoder Triggering
	Chap. A 5.3.5.9	TRIGGERENCMAX	Maximum Encoder Triggering
Encoder			
	Chap. A 5.3.6.1	META_ENCODERCOUNT	Number of Available Encoders
	Chap. A 5.3.6.2	ENCINTERPOL1	Setting Interpolation Depth
	Chap. A 5.3.6.3	ENCREF1	Setting the Reference Track
	Chap. A 5.3.6.4	ENCVALUE1	Setting Encoder Value
	Chap. A 5.3.6.5	ENCSET1	Setting Encoder
	Chap. A 5.3.6.6	ENCRESET1	Reset Encoder Value
	Chap. A 5.3.6.7	ENCMAX1	Setting Maximum Encoder Value
Interface RS422			
	Chap. A 5.3.7	BAUDRATE	Setting RS422
Parameter Management, Load/Save Settings			
	Chap. A 5.3.8.1	BASICSETTINGS	Load Connection Settings
	Chap. A 5.3.8.2	CHANGESETTINGS	Show Changed Parameters
	Chap. A 5.3.8.3	EXPORT	Export Parameter Sets
	Chap. A 5.3.8.4	IMPORT	Import Parameter Sets
	Chap. A 5.3.8.5	SETDEFAULT	Set Factory Settings
	Chap. A 5.3.8.6	MEASSETTINGS	Edit Measurement Settings
Measurement			
	Chap. A 5.3.9.1	PEAKCOUNT	Number of Measurement Peaks
	Chap. A 5.3.9.2	MEASPEAK	Peak selection
	Chap. A 5.3.9.3	REFRACCORR	Refractivity Correction
	Chap. A 5.3.9.4	SHUTTERMODE	Exposure mode
	Chap. A 5.3.9.5	MEASRATE	Measuring frequency
	Chap. A 5.3.9.6	SHUTTER	Exposure time
	Chap. A 5.3.9.7	ROI	Range of interest
	Chap. A 5.3.9.8	MIN_THRESHOLD	Minimum Threshold Peak Detection
	Chap. A 5.3.9.9	PEAK_MODULATION	Modulation of Peaks
	see A 5.3.9.10	PEAK_THRESHOLD	Peak minimum threshold
Material database			
	Chap. A 5.3.10.1	MATERIALTABLE	Material table
	Chap. A 5.3.10.2	MATERIAL	Select material
	Chap. A 5.3.10.3	MATERIALINFO	Show Material Property
	Chap. A 5.3.10.4	META_MATERIAL	Existing Materials, Material Names
	Chap. A 5.3.10.5	META_MATERIAL_PROTECTED	Protected Materials
	Chap. A 5.3.10.6	MATERIALEDIT	Edit Material Table
	Chap. A 5.3.10.7	MATERIALDELETE	Delete material
	Chap. A 5.3.10.8	MATERIALADD	Add Material

Edit measured value			
	Chap. A 5.3.11.1	STATISTIC	Selection of Signals for Statistics
	Chap. A 5.3.11.2	META_STATISTIC	List of Possible Statistics Signals
	Chap. A 5.3.11.3	STATISTICSIGNAL	Selection of Statistics signal
	Chap. A 5.3.11.4	META_STATISTICSIGNAL	List of Possible Statistics Signals to Select
	Chap. A 5.3.11.5	META_MASTERSIGNAL	List of Possible Signals to be Parameterized
	Chap. A 5.3.11.6	MASTERSIGNAL	Parameterization of Master Signals
	Chap. A 5.3.11.7	META_MASTER	List of Possible Signals for Mastering
	Chap. A 5.3.11.8	MASTER	Trigger Mastering
	Chap. A 5.3.11.9	MASTERSIGNALSELECT	Determine Signal for Mastering with External Source
	Chap. A 5.3.11.10	MASTERSOURCE	Select External Source for Mastering
	Chap. A 5.3.11.11	COMP	Calculation in Channel
	Chap. A 5.3.11.12	META_COMP	List of Possible Calculation Signals
	Chap. A 5.3.11.13	SYSSIGNALRANGE	Two-Point Scaling Data Outputs
Data Output			
	Chap. A 5.3.12.1	OUTPUT	Digital Output Selection
	Chap. A 5.3.12.2	OUTREDUCEDEVICE	Output Data Rate
	Chap. A 5.3.12.3	OUTREDUCECOUNT	Reduction Counter
	Chap. A 5.3.12.4	OUTHOLD	Error Handling
	see A 5.3.12.5	MEASCNT_ETH	Ethernet frame counter
Selection of Measured Values to be Output via Interfaces			
	Chap. A 5.3.13.2	OUT_RS422	Data Selection for RS422
	Chap. A 5.3.13.3	META_OUT_RS422	List of Possible Signals RS422
	Chap. A 5.3.13.4	GETOUTINFO_RS422	List of Selected Signals, Sequence via Rs422
	Chap. A 5.3.13.5	OUT_ETH	Data Selection for Ethernet
	Chap. A 5.3.13.6	META_OUT_ETH	List of Possible Signals Ethernet
	Chap. A 5.3.13.7	GETOUTINFO_ETH	List of Selected Signals, Sequence via Ethernet
Switching Output, possible for IFC2416			
	Chap. A 5.3.14.2	ERROROUT1	Selection of Error Signal for Output
	Chap. A 5.3.14.3	META_ERRORLIMITSIGNAL1	List of Possible Signals for Error Output
	Chap. A 5.3.14.4	ERRORLIMITSIGNAL1	Set Signal to be Evaluated
	Chap. A 5.3.14.5	ERRORLIMITCOMPARETO1	Set Limit Values
	Chap. A 5.3.14.6	ERRORLIMITVALUES1	Set Value
	Chap. A 5.3.14.7	ERRORLEVELOUT1	Switching Behavior of Switching Output
	Chap. A 5.3.14.8	ERRORHYSTERESIS1	Switching Hysteresis of Switching Output
Analog Output			
	Chap. A 5.3.15.1	ANALOGOUT	Data Selection for Analog Output
	Chap. A 5.3.15.2	META_ANALOGOUT	List of Possible Signals for Analog Output
	Chap. A 5.3.15.3	ANALOGRANGE	Set Current/Voltage Range of Digital-to-Analog Converter (DAC)
	Chap. A 5.3.15.4	ANALOGSCALEMODE	Set Scaling for DAC
	Chap. A 5.3.15.5	ANALOGSCALERANGE	Set Scaling Range
System Settings for Key Functions			
	Chap. A 5.3.16.1	KEYLOCK	Selection of the Key Lock
	Chap. A 5.3.16.2	LANGUAGE	Language Webinterface
	Chap. A 5.3.16.3	IPCONFIG	IP-Address Ethernet
	Chap. A 5.3.16.4	MEASTRANSFER	Ethernet measured value transmission
	Chap. A 5.3.16.5	TCPKEEPALIVE	Keepalive Signal

A 5.3 General Commands

A 5.3.1 General

A 5.3.1.1 Help

```
HELP [<Command>]
```

Output help for each command. If no command is given, a general help is output.

A 5.3.1.2 Controller Information

```
GETINFO
```

Request sensor information. Output see example below:

```
->GETINFO
Name:            IFD2416
Serial:          12345678
Option:          000
Article:         1234567
MAC address:     00-0C-12-01-E2-0C
Version:         004,004
Hardware-rev:    01
Boot version:    001,018
BuildID:         57
Output variant:  Ethernet
->
```

Name: Model name of controller / controller series

Serial: Controller serial number

Option: Controller option number

Article: Controller article number

MAC address: Address of network adapter

Version: Version of software booted

Hardware-rev: Hardware revision used

Boot version: Bootloader version

BuildID: Identification number for software generated

A 5.3.1.3 Reply type

```
ECHO ON | OFF
```

The reply type describes the structure of a command reply.

ECHO ON: The command name and the command reply or an error message is output.

ECHO OFF: The command name and the command reply or an error message is output.

A 5.3.1.4 Parameter Overview

```
PRINT [ALL]
```

no parameters: This command outputs a list of all configuration parameters and their values.

- ALL : This command outputs a list of all configuration parameters and their values, such as sensor table or GETINFO, from

A 5.3.1.5 Synchronization

```
SYNC [NONE | MASTER | SLAVE | SLAVE_MFI1]
```

Set synchronization type:

- NONE: No synchronization
- MASTER: Controller is master, i.e., it outputs synchronization pulses at the Sync output
- SLAVE: Controller is slave and waits for synchronization pulses, e.g., from the Sync input.
- SLAVE_MFI1: Controller is slave and waits for synchronization pulses e.g. from an external source at the MFI1 input.

A 5.3.1.6 Termination Resistor at Sync

```
TERMINATION [OFF | ON]
```

The termination resistor 120 Ohm at the Sync/Trig synchronization input is switched on or off. The termination resistor prevents reflections on the Sync line.

A 5.3.1.7 Boot Sensor

```
RESET
```

The controller is restarted.

A 5.3.1.8 Reset Counter

```
RESETCNT (TIMESTAMP|MEASCNT) {TIMESTAMP|MEASCNT}
```

The internal counters are reset.

- TIMESTAMP: resets the timestamp
- MEASCNT: resets the measured value counter

A 5.3.2 User level

A 5.3.2.1 Change User Level

```
LOGIN <Password>
```

Enter the password to access another user level. There are the following user levels:

- USER: Read access to all elements + use of web diagrams
- PROFESSIONAL: Read/write access to all elements

A 5.3.2.2 Switch to User Level

```
LOGOUT
```

Set user level to USER.

A 5.3.2.3 User Level Query

```
GETUSERLEVEL
```

Queries the current user level.

A 5.3.2.4 Set Standard User

```
STDUSER [USER|PROFESSIONAL]
```

Sets the standard user who is logged in after the system starts or reset.

A 5.3.2.5 Change Password

```
PASSWD <old_password> <new_password> <new_password>
```

Change the password for the PROFESSIONAL user. The factory standard password is “000”.

For this, the old password must be entered and the new password must be entered twice. If the new passwords do not match, an error message will be output. The password function is case-sensitive.

Minimum length: 1 character, Maximum length: 31 characters. The following characters are permitted: a-zA-Z0-9 _(),;.:-_/.

If a password contains spaces, the entire password must be placed inside quotation marks (“password”).

A 5.3.3 Level of Multifunction Inputs

```
MFILEVEL [HTL | TTL]
```

Selection of input level of the multifunction inputs. (MFI).

- HTL: HTL level
- TTL: TTL level

A 5.3.4 Sensor

A 5.3.4.1 Information on Calibration Tables

```
SENSORTABLE
```

```
->SENSOR TABLE
Position       Sensor name,        Measurement range,    Serial number
0,              IFS2404-3,         3.000mm,              05110005
1,              IFS2404-6,         6.000mm,              05120003
2,              IFS2404-2,         2.000mm,              00001335
->
```

Output of all available (taught-in) sensors.

A 5.3.4.2 Sensor Information

```
SENSORINFO
```

Output of information about the sensor (name, measuring range and serial number).

```
->SENSORINFO
Position:                   0
Name:                       BG
Measurement range:          3,000 mm
Serial:                     12345678
->
```

A 5.3.4.3 Aktive Sensor Selection

```
SENSORHEAD [<number>]
```

Select active sensor for a measurement.

A 5.3.4.4 Dark Correction

```
DARKCORR
```

Performing the dark referencing for the current sensor. The dark referencing depends on the sensor and is saved separately for each individual sensor in the controller.

```
DARKCORR_PRINT
```

Lists the values of the dark correction table.

A 5.3.4.5 LED

```
LED OFF | ON
```

Switches the LED of the respective channel on or off.

A 5.3.4.6 Control Input Measurement Light Source

```
LEDSOURCE [SOFTWAREONLY | MFI]
```

- SOFTWAREONLY: The measurement light source can only be controlled by software; via ASCII command LED ON/OFF or web interface
- MFI: Control of the measurement light source via selected multifunction input MFI

A 5.3.5 Triggering

A 5.3.5.1 Select Trigger Source

```
TRIGGERSOURCE [NONE | SYNC | MFI | SOFTWARE | ENCODER1 | ENCODER2 | ENCODER3]
```

- NONE: No trigger source used
- SYNC: Use input `Sync`
- MFI: Use the multifunctional input `MFI`
- SOFTWARE: Triggering is initiated by the command TRIGGERSW.
- ENCODER1: Encoder triggering of encoder 1
- ENCODER2: Encoder triggering of encoder 2, requires TRIGGERCOUNT 2 or higher
- ENCODER3: Encoder triggering of encoder 3, requires TRIGGERCOUNT 3

The IFC2411 controller supports one encoder. The IFC2416 supports up to three encoders.

A 5.3.5.2 Output of Triggered Values, with/without Averaging

```
TRIGGERAT [INPUT | OUTPUT]
```

- INPUT: Triggers measured value acquisition. Values measured immediately before the trigger event are not included in the average value calculation, but older measured values that were output during previous trigger events are included instead.
- OUTPUT: Triggers measured value output. Values measured immediately before the trigger event are included in the average value calculation.

Triggering of data recording is active as a factory setting.

A 5.3.5.3 Trigger Type

```
TRIGGERMODE [EDGE | PULSE]
```

Selection of trigger type.

- PULSE: Level triggering
- EDGE: Edge triggering

A 5.3.5.4 Active Level of Trigger Input

```
TRIGGERLEVEL [HIGH | LOW]
```

- HIGH: Edge triggering: Rising edge, level triggering: High active
- LOW: Edge triggering: Falling edge, level triggering: Low active

A 5.3.5.5 Software Trigger Pulse

```
TRIGGERSW
```

Generates a software trigger pulse when the trigger source is set to software.

A 5.3.5.6 Number of Measured Values to be Output

```
TRIGGERCOUNT [NONE | INFINITE | <n>]
```

- NONE: Stop triggering
- <n>: Number of measured values (1 ... 16382) to be output after a trigger pulse (with edge triggering or software triggering)
- Infinite: Start of an infinite measured value output after a trigger pulse (with edge triggering or software triggering)

A 5.3.5.7 Step Size Encoder Triggering

```
TRIGGERENCSTEPSIZE [value_of_step_size]
```

Sets the number of encoder steps after which a measured value is output each time (min: 0, max: 2^{31}-1). At 0, measured values are continuously output between min and max.

A 5.3.5.8 Minimum Encoder Triggering

```
TRIGGERENCMIN [<value>]
```

Sets the minimum encoder value starting at which triggering takes place (min: 0 max: 2^{32}-1).

A 5.3.5.9 Maximum Encoder Triggering

```
TRIGGERENCMAX [<value>]
```

Sets the maximum encoder value up to which triggering takes place (min: 0 max: 2^{32}-1).

A 5.3.6 Encoder

A 5.3.6.1 Number of Available Encoders

```
META_ENCODERCOUNT
```

Lists the number of available encoders that can be selected with ENCODERCOUNT. The IFC2411 controller supports one encoder. The IFC2416 supports up to three encoders.

A 5.3.6.2 Encoder Interpolation Depth

```
ENCINTERPOL1 [1 | 2 | 3]
ENCINTERPOL2 [1 | 2 | 3]
ENCINTERPOL3 [1 | 2 | 3]
```

Sets the interpolation depth of the respective encoder input.

- 1 - Single interpolation
- 2 - Dual interpolation
- 4 - Quadruple interpolation

A 5.3.6.3 Effect of Reference Track

```
ENCREF1 [NONE | ONE | EVER]
ENCREF2 [NONE | ONE | EVER]
```

Sets the effect of the encoder reference track.

- NONE: Encoder reference marker has no effect.
- ONE: One-time setting (the first time the reference marker is reached, the encoder value, see Chap. A 5.3.6.4 will be adopted).
- EVER: Setting for all markers (every time the reference marker is reached, the encoder value, see Chap. A 5.3.6.4 will be adopted).

A 5.3.6.4 Encoder value

```
ENCVALUE1 [<value>]
ENCVALUE2 [<value>]
ENCVALUE3 [<value>]
```

Indicates the value which the corresponding encoder should be set to when a reference marker is reached (or via software).

The encoder value can be between 0 and 2^{32}-1.

Setting the ENCVALUE automatically resets the algorithm for recognizing the first reference marker, see Chap. A 5.3.6.3.

A 5.3.6.5 Set Encoder Value via Software

```
ENCSET 1 | 2 | 3
```

Set the encoder value via software (only possible with ENCREF NONE, otherwise the command immediately returns without an error message).

A 5.3.6.6 Reset Detection of First Reference Marker

```
ENCRESET 1 | 2
```

Resets the detection of the first reference marker (only possible with ENCREF ONE, otherwise the command immediately returns without an error message).

A 5.3.6.7 Maximum Encoder Value

```
ENCMAX1 <encoder value>
ENCMAX2 <encoder value>
ENCMAX3 <encoder value>
```

Indicates the maximum value of the encoder after which the encoder jumps back to 0. Can be used for rotary encoders without reference track. The maximum value has to be greater than the start value determined by ENCVALUEn.

The encoder value can be between 0 and 2^{32}-1.

A 5.3.7 Setting the RS422 Baud Rate

```
BAUDRATE  [9600|115200|230400|460800|691200|921600|2000000|3000000|4000000]
```

Indicates or sets the baud rate in bps for the RS422 interface.

A 5.3.8 Parameter Management, Load/Save Settings

A 5.3.8.1 Load / Save Connection Settings

```
BASICSETTINGS [READ | STORE]
```

- READ: Reads the connection settings from the controller flash.
- STORE: Saves the current connection settings from the controller RAM to the controller flash.

Device settings can be changed with the following commands: ANALOGRANGE, BAUDRATE, ECHO, ENCODERCOUNT, KEYLOCK, LANGUAGE, LED, LEDSOURCE, and UNIT.

A 5.3.8.2 Show Changed Parameters

```
CHANGESETTINGS
```

Outputs all changes to the measurement settings that were most recently saved using MEASSETTINGS STORE.

A 5.3.8.3 Export Parameter Sets to PC

```
EXPORT (MEASSETTINGS <SetupName>) | BASICSETTINGS | MEASSETTINGS_ALL | MATERIALTABLE |
ALL
```

Saves parameters in an external device, e.g. PC.

The export file is formatted as readable JavaScript Object Notation, or JSON for short.

- MEASSETTINGS <SetupName>: Exports the specified measurement settings. Nothing is deleted before importing.
- BASICSETTINGS: Export the currently saved basic settings. The basic settings are deleted before importing.
- MEASSETTINGS_ALL: Export all saved measurement settings, including the initial setting. All existing measurement settings are deleted before importing.
- MATERIALTABLE: Exports the saved material table. The existing material table is deleted before importing.
- ALL: Complete export of all saved settings (Basic and Meas), the material table and all sensor data saved. Everything is deleted before importing.

A 5.3.8.4 Import Parameter Sets from PC

```
IMPORT [FORCE] [APPLY] <ImportData>
```

Loads parameters from an external device, e.g. PC.

The import file is a JSON file previously saved with export.

- FORCE: Overwrite `measurement settings` with the same name, otherwise an error message is returned if the names are the same. If all
  `measurement settings` or `basic settings` are imported, `Force` must always be specified.
- APPLY : Apply the settings after importing and reading the initial settings.
- ImportData: Data in JSON format

A 5.3.8.5 Factory Settings

```
SETDEFAULT ALL | MEASSETTINGS | BASICSETTINGS | MATERIAL
```

Set the default values (reset to factory settings), delete the corresponding settings in the flash.

- ALL: All setups are deleted and the default parameters are loaded. The current material table is also overwritten by the standard material table.
- MEASSETTINGS: Settings for measurement task.
- BASICSETTINGS: Basic settings such as IP, baud rate, language, unit.
- MATERIAL: Only overwrite the current material table with the standard material table.

A 5.3.8.6 Editing, Storing, Displaying, Deleting Measurement Settings

```
MEASSETTINGS <subcommand> [<name>]
```

Settings for measurement task. Moves application-dependent measurement settings between controller RAM and controller flash. Either the manufacturer-specific presets or the user-defined settings are used. Each preset can be used as a user-defined setting.

Subcommands:

`PRESETMODE <mode>`	Defines the preset dynamics.
`<mode> = NONE|STATIC|BALANCED|DYNAMIC`	With NONE, there is no selection for a preset.
`PRESETLIST`	Lists all existing presets (names): “Name1” “Name2” “…”
`READ <Name>`	Loads a basic setting or measurement setting/preset (specify name) from the controller flash.
`STORE <Name>`	Saves a basic setting or measurement setting in the controller flash. Enter name or it will be saved under the current name.
`DELETE <Name>`	Deletes the named measurement setting from the controller flash.
`RENAME <NameOld> <NameNew> [FORCE]`	Changes the name of a measurement setting in the controller flash. An existing measurement setting can be overwritten with FORCE.
`LIST`	Lists all saved measurement settings (names) “Name1” “Name2” “...”. The order is based on the internal slot numbers, that is, not the order of saving.
`CURRENT`	Outputs the current measurement setting / preset (name)
`INITIAL AUTO`	Loads the last saved setting when the controller is started or the first preset if no setups are present.
`INITIAL <Name>`	Loads a named measurement setting upon starting the controller. Presets cannot be entered.

A 5.3.9 Measurement

A 5.3.9.1 Peak count

PEAKCOUNT [1 | 2] for IFC2411

PEAKCOUNT [<value>] for IFC2416

Indicates or sets the maximum number of peaks to be evaluated.

- For distance measurement <n> = 1
- For thickness measurement <n> = 2
- For multi-layer measurement <value> 1 ... 6

A 5.3.9.2 Peak Selection

MEASPEAK F_L|L_SL|F_S|H_SH

Selection of the peaks used for the measurement

Distance measurement		Thickness measurements	
F_L:	first peak	F_L:	first and last peak
L_SL:	last peak	L_SL:	second-last and last peak
F_S:	first peak	F_S:	first and second peak
H_SH:	highest peak	H_SH:	highest and second highest

A 5.3.9.3 Number of Peaks and Switching Refractivity Correction On/Off

REFRACCORR [on | off]

- On: The refractivity correction is carried out with the set materials, standard setting.
- Off: The refractivity index 1.0 is assumed for all layers.

A 5.3.9.4 Exposure Mode

SHUTTERMODE MEAS|MANUAL|2TIMEALT|2TIMES

- MEAS: Automatic exposure time control with fixed measuring rate, recommended for measurement
- MANUAL: Selectable exposure time and measuring rate.
- 2TIMEALT: Mode with 2 manually set exposure times which are always applied alternately, for 2 peaks of very different height in the thickness measurement. We recommend using this mode in particular if the smaller peak disappears or the larger one is overmodulated.
- 2TIMES: Fastest mode with two manually preset exposure times. The more suitable time is automatically selected. Recommend for distance measurement for rapidly changing surface properties, such as mirrored or anti-glare glass.

A 5.3.9.5 Measuring rate

MEASRATE [<frequency>]

Enter the measuring rate in kHz:
IFC2411: Value range 0.100 … 8,000;
IFC2416: Value range 0.100 … 25,000.

A maximum of three decimal places can be specified, e.g. 0.100 for 0.1 kHz.

A 5.3.9.6 Exposure Time

SHUTTER [<exposure time1> [<exposure time2>]]

Indicates or sets the exposure times for manual and two-time exposure modes.

The minimum step size is 0.1 µs.

Value range <exposure_time_x>: 3.0 .. 10,000.0 [us]

<exposure_time_2> should not be greater than <exposure_time_1>.

A 5.3.9.7 Range of Interest (ROI)

```
ROI [<begin> [<End>]]
```

Indicates or sets the evaluation range for the “Range of interest”. Start and end must be between 0 and 511. The entry is made in the unit pixels. The start value must be less than the end value.

A 5.3.9.8 Minimum Threshold Peak Detection

```
MIN_THRESHOLD <value>
```

Sets the minimum detection threshold. A peak must be above this threshold for it to be recognized as peak.

The entry is made in %.

A 5.3.9.9 Peak Modulation

```
PEAK_MODULATION <value>
```

Specifies the peak modulation through so that peaks running into each other are separated. At 100%, there is no peak separation and at 0% (factory setting), all peaks are separated.

This way, the relevant peak artefacts can be removed or not be considered as individual peaks.

Value range: 0 ... 100.

A 5.3.9.10 Peak Minimum Threshold

PEAK_THRESHOLD <value>

Sets the minimum peak threshold. A peak must be above this threshold for it to be recognized and isolated as a peak value. The entry must be made in %. The PEAK_THRESHOLD value must be less than MIN_THRESHOLD.

Value range: 0.0 ... 100.0.

A 5.3.10 Material Database

A 5.3.10.1 Material Table

```
MATERIALTABLE
```

Output of the material table saved in the controller.

```
->MATERIALTABLE
                                      Refraction index                Abbe number
Item,  Name,          nF at 486nm,  nd at 587nm,  nC at 656nm,      vd           Description
0      Vacuum,        1.000000,     1.000000,     1.000000,         0.000000     Vacuum; air (approximate)
1      Water,         1.337121,     1.333044,     1.331152,         0.000000
1      Ethanol,       1.361400,     1.361400,     1.361400,         0.000000
7      PC,            1.599439,     1.585470,     1.579864,         0.000000     Polycarbonate
8      Quartz glass,  1.463126,     1.458464,     1.456367,         0.000000     Silicon dioxide, fused silica
9      BK7,           1.522380,     1.516800,     1.514320,         0.000000     Crown glass
->
```

A 5.3.10.2 Select Material

```
MATERIAL [<mat1>]
```
for IFC2411

```
MATERIAL [<mat1> [<mat2> [<mat3> [<mat4> [<mat5>]]]]]
```
for IFC2416

Change the material between the distances.

The material name must be entered, including spaces. The command supports case sensitive input, distinguishing between uppercase and lowercase letters. The maximum length of the material name is 30 characters.

A 5.3.10.3 Show Material Property

`MATERIALINFO [<layer>]`

Output of the material properties of the selected layer. Layer 1 is between distance 1 and 2, Layer 2 between distance 2 and 3, etc. If there are no parameters, the information on layer 1 is output.

Example:

```
->MATERIALINFO
Name:                                   BK7
Description:                            Crown glass
Refraction index nF at 486nm:           1.522380
Refraction index nd at 587nm:           1.516800
Refraction index nC at 656nm:           1.514320
Abbe value vd:                          0.000000
->
```

A 5.3.10.4 Existing Material in Controller

`META_MATERIAL`

Lists the material names already saved in the controller.

A 5.3.10.5 Protected Materials in Controller

`META_MATERIAL_PROTECTED`

Displays a list of all material names saved in the controller during calibration. These materials cannot be edited or deleted.

A 5.3.10.6 Edit Material Table

`MATERIALEDIT <name> <description> (NX <nF> <nd> <nC>)|(ABBE <nd> <vd>)`

Edits an existing material. A material is characterized either by three refractive indices or by one refractive index and Abbe number.

- name: Name of the material
- description: Brief description of the material
- nF: Refractivity index nF at 670 nm (1.000000 ... 4.000000)
- nd: Refractivity index nd at 587 nm (1.000000 ... 4.000000)
- nC: Refractivity index nC at 656 nm (1.000000 ... 4.000000)
- vd: Abbe value (10.000000 ... 100.000000)

If the material name has already been assigned, this material will be edited. Otherwise, a new material will be created.

There is a maximum of 20 materials.

A 5.3.10.7 Delete a Material

`MATERIALDELETE <name>`

Deletes a material.

- name: Name of the material (length: max. 30 characters)

A 5.3.10.8 Add Material

`MATERIALADD <Name> <Description> (NX <nF> <nd> <nC>)|(ABBE <nd> <vd>)`

Adds a material to the material table. A material is characterized either by three refractive indices or by one refractive index and Abbe number.

- Name: Name of the material
- Description: Brief description of the material
- nF: Refractivity index nF at 670 nm (1.000000 ... 4.000000)
- nd: Refractivity index nd at 587 nm (1.000000 ... 4.000000)
- nC: Refractivity index nC at 656 nm (1.000000 ... 4.000000)
- vd: Abbe value (10.000000 ... 100.000000)

A 5.3.11 Edit measured value

A 5.3.11.1 Statistical Calculations

```
STATISTIC ALL|<signal> RESET
```

Resets individual statistics.

- <signal>_MIN
- <signal>_MAX
- <signal>_PEAK
- signal: A measurement data signal; see META_STATISTIC

A 5.3.11.2 List of Statistics Signals

```
META_STATISTIC
```

Provides a list of the active statistics signals, that can be evaluated with STATISTIC.
These signals were defined under `STATISTICSIGNAL`.

A 5.3.11.3 Selection of Statistics Signal

```
STATISTICSIGNAL [<signal>]
```

```
STATISTICSIGNAL <signal> NONE|INFINITE|<depth>
```

The statistics are created for the selected signal. A list of possible signals can be found by using the command `META_STATISTICSIGNAL`.

New signals will be created, which can then be output via the interfaces.

- <signal>_MIN --> Minimum signal
- <signal>_MAX --> Maximum signal
- <signal>_PEAK --> <signal>_max - <signal>_min

The `INFINITE` option can be selected instead of <depth>; the new signals include all values of the relevant <signal>.

The `NONE` option is used to delete a configured statistics signal.

The `STATISTIC` and `RESETSTATISTIC` commands can be used to restart a calculation.

The `META_STATISTICSIGNAL` command shows all the possible signals that are available for a statistical calculation.

Value range <depth>: 2|4|8|...|4096|8192

A 5.3.11.4 List of Possible Statistics Signals to Select

```
META_STATISTICSIGNAL
```

Lists all possible signals that can be included in the statistics.

A 5.3.11.5 List of Possible Signals to be Parameterized

```
META_MASTERSIGNAL
```

Lists all possible signals that can be used for mastering.

A 5.3.11.6 Parameterization of Master Signals

```
MASTERSIGNAL [<signal>]
```

```
MASTERSIGNAL <signal> <master value>
```

```
MASTERSIGNAL <signal> NONE
```

Defines the signal to be mastered. The parameter `NONE` resets the signal. The function itself is triggered with MASTER.

- <signal>: select a specific measured or calculated signal which the master value is to be set to; see META_MASTER-SIGNAL
- <master value> master value in mm, value range: -2147.0 ... 2147.0

A 5.3.11.7 List of Possible Signals for Mastering

```
META_MASTER
```

Lists all defined master signals from the `MASTERSIGNAL` command. These can be used with the command `MASTER`.

A 5.3.11.8 Mastering / Zeroing

```
MASTER [<signal>]
MASTER [ALL|<signal> [SET|RESET]]
```

The `MASTER` command is not channel-specific. There are up to 10 master signals in the controller. These 10 signals can be applied to any internally determined value, including calculated values.

This command sets or resets the mastering for the corresponding signal.

- ALL: use all signals for mastering
- <signal>: use a specific measured or calculated signal for mastering
- SET|RESET: Start or end function

If the master value is 0, the mastering function has the same functionality as zeroing.

A 5.3.11.9 Signal for Mastering with External Source

Select the measured or calculated signal that can be mastered with the multifunction input or with an external source. META_MASTER provides a list of all defined master signals. The signals are configured using MASTERSIGNAL.

```
MASTERSIGNALSELECT [ALL | NONE | <signal1> [ | <signal2> [...]]]
```

- ALL: All configured signals are mastered with the selected input source.
- NONE: no mastering.
- signal: Signal is mastered with external source

A 5.3.11.10 Mastering with External Source

```
MASTERSOURCE [NONE|MFI1]
```

Select the input with which a mastering/zeroing is to be triggered.

- NONE: No port selected. (Controlling by commands is possible.)
- MFI1: Use MFI1-port to control the mastering function.

A 5.3.11.11 Example of Mastering

For the example, the preset option `Standard matt "Opposite thickness measurement"` was selected in the controller; execution of the commands with the Tera Term program, no variables are defined.

->o 169.254.168.150	

->META_MASTERSIGNAL META_MASTERSIGNAL 01DIST1 01DIST1 FOIL	// List all variables that can be mastered to
->META_MASTER META_MASTER NONE	// List all variables that have been assigned a master value
->MASTERSIGNAL 01DIST1 1.0 ->MASTERSIGNAL FOIL 2.1	// Set variable 01DIST1 to the value 1.0 // Set variable FOIL to the value 2.1
->META_MASTER META_MASTER 01DIST1 FOIL	// List all variables that have been assigned a master value; the variable 01DIST1 has now been assigned
->MASTER ALL MASTER 01DIST1 INACTIVE MASTER FOIL INACTIVE MASTER NONE ... MASTER NONE MASTER NONE	// List all 10 possible variables and show their status 01DIST1 0.89077 mm · 01DIST2 2.12215 mm · Foil 1.23137 mm · Measuring rate 1.800 kHz
->MASTER ALL SET	// Triggers a master measurement for all assigned variables 01DIST1 1.00314 mm · 01DIST2 2.12511 mm · Foil 2.10092 mm · Measuring rate 1.800 kHz
->MASTER 01DIST1 RESET	// the offset (master value) is undone for the variable 01DIST1 01DIST1 0.89105 mm · 01DIST2 2.12485 mm · Foil 2.10154 mm · Measuring rate 1.800 kHz
->MASTER ALL MASTER 01DIST1 INACTIVE MASTER FOIL ACTIVE MASTER NONE ... MASTER NONE MASTER NONE	
->MASTER FOIL RESET	// the offset (master value) is undone for the variable FOIL 01DIST1 0.89087 mm · 01DIST2 2.12048 mm · Foil 1.23745 mm · Measuring rate 1.800 kHz
->MASTERSIGNAL 01DIST1 NONE ->MASTERSIGNAL FOIL NONE	// The variable 01DIST1 is deleted // The variable FOIL is deleted
->MASTER ALL MASTER NONE ... MASTER NONE	// no variable which a master measurement could be applied to is present

A 5.3.11.12 Calculation in channel

```
COMP [<channel> [<id>]]
COMP <channel> <id> MEDIAN <signal> <median data count>
COMP <channel> <id> MOVING <signal> <moving data count>
COMP <channel> <id> RECURSIVE <signal> <recursive data count>
COMP <channel> <id> CALC <factor1> <signal> <factor2> <signal> <offset> <name>
COMP <channel> <id> THICKNESS <signal> <signal> <name>
COMP <channel> <id> COPY <signal> <name>
COMP <channel> <id> NONE
```

This command defines all controller-specific calculations.

- <id> 1...10 — *Calculation block number*
- <signal> — *Measuring signal; you can query the available signals with the command META_COMP*
- <median data count> 3|5|7|9 — *Averaging depth median*
- <moving data count> 2|4|8|16|32|64|128|256|512|1024|2048|4096 — *Averaging depth moving average*
- <recursive data count> 2 ... 32000 — *Averaging depth recursive average*
- <factor1>, <factor2> -32768.0 … 32767.0 — *Multiplication factor*
- <offset> -2147.0 ... 2147.0 — *Correction value in mm*
- <name> — *Name of calculation block; length min. 2 characters, max. 15 characters. Permitted characters a-zA-Z0-9, the name must start with a letter.*

  Command names such as STATISTIC, MASTER, CALC, NONE, ALL are not permitted.

You can use the COMP command to create new calculation blocks, modify or delete calculation blocks.

Functions:

- MEDIAN, MOVING and RECURSIVE: Averaging functions
- CALC: Calculation function according to formula
  (<factor1> * <signal>) + (<factor2> * <signal>) + <offset>
- Thickness: Thickness calculation according to the formula <signal B>) - <signal A> under the condition that signal B is larger than signal A
- COPY: Duplicates a signal; the effect can also be achieved with the command CALC, e.g. with (1 * <signal>) + (0 * <signal>) + 0
- NONE: deletes a calculation block

A 5.3.11.13 List of Possible Calculation Signals

```
META_COMP [CH01 <id>]
```

Lists all possible signals that can be used in the calculation.

A 5.3.11.14 Two-Point Scaling Data Outputs

```
SYSSIGNALRANGE [<start of range> [<end of range>]]
```

The values determined from the calculation can be greater than the values that the controller can display. This command is used to define the value range in millimeters and apply it to both RS422 and the analog output; see ANALOGSCALEMODE STANDARD.

Value range: 0 to 10 mm.

- start_of_range: -21.47 .. <end_of_range>
- end_of_range: <start_of_range> .. 21.47

A 5.3.12 Data Output

A 5.3.12.1 Digital Output Selection

```
OUTPUT [NONE|(RS422 | Ethernet | ANALOG | ERROROUT)]
```

- NONE: No output of measured values
- RS422: Output of measured values via RS422
- Ethernet: Output of measured values via Ethernet.
- ANALOG: Output of measured values via analog output
- ERROROUT: Error or status information via the error outputs

Command starts the output of measured values. The connection to the measured value server can already exist or can now be established.

A 5.3.12.2 Output Data Rate

```
OUTREDUCEDEVICE [NONE|([RS422] | [ANALOG] | [Ethernet])]
```

Reduction of output of measured values via specified interfaces.

- NONE: No reduction of output of measured values
- RS422: Reduction of output of measured values via RS422
- ANALOG: Reduction of output of measured values via analog interface
- Ethernet: Reduction of output of measured values via Ethernet

A 5.3.12.3 Reduction Counter for Output of measured values

```
OUTREDUCECOUNT <n>
```

Reduction counter for output of measured values.

Only each nth measured value is output. The other measured values are rejected.

- Number n: 1...3000000 (1 means all frames)

A 5.3.12.4 Error Handling

```
OUTHOLD [NONE|INFINITE|<n>]
```

Sets the measured value output behavior in the event of an error.

- NONE: Last measured value not held; error value output
- INFINITE: Last measured value held indefinitely
- Number n: Holds the last measured value over the specified number of measurement cycles with errors and then outputs the error value

Value range for Number n: 1 ... 1024

A 5.3.12.5 Ethernet Frame Counter

```
MEASCNT_ETH [0 | <count>]
```

Indicates or sets the maximum frame count per packet.

0: Automatic assignment of the frame count per packet

<count>: Maximum number of frames per packet, value range 0 ... 350

A 5.3.13 Selection of Measured Values to be Output

A 5.3.13.1 General

Setting the values to be output via the RS422 and Ethernet interface.

A limitation of the data volume via the RS422 depends on the measuring frequency and the baud rate.

In multi-layer measurement mode, any desired distances and differences can be selected for output.

A 5.3.13.2 Data Selection for RS422

```
OUT_RS422 [<signal1>] [<signal2>] ... [<signalN>]
```

Describes which data is output via this interface.

A 5.3.13.3 List of Possible Signals for RS422

```
META_OUT_RS422
```

List of possible data for the RS422 output.

A 5.3.13.4 List of Selected Signals, Sequence via RS422

```
GETOUTINFO_RS422
```

Returns the order of the signals via this interface.

A 5.3.13.5 Data Selection for Ethernet

```
OUT_ETH [<signal1>] [<signal2>] ... [<signalN>]
```

Describes which data is output via this interface.

A 5.3.13.6 List of Possible Signals for Ethernet

```
META_OUT_ETH [MEAS|VIDEO|CALC]
```

List of possible data for the Ethernet output.

The MEAS, VIDEO, or CALC options can be used to restrict the search to the selected type.

A 5.3.13.7 List of Selected Signals, Sequence via Ethernet

```
GETOUTINFO_ETH
```

Returns the order of the signals via this interface.

A 5.3.14 Switching Outputs

A 5.3.14.1 General

Commands are valid for the IFC2416.

A 5.3.14.2 Error - Switching Outputs

```
ERROROUT1 [01ER1|01ER2|01ER12|ERRORLIMIT]
```

Setting the error switching outputs.

- 01ER1: Switching output is switched in the event of an intensity error
- 01ER2: Switching output is switched in the event of a measuring range error
- 01ER12: Switching output is switched in the event of an intensity error or a measuring range error
- ERRORLIMIT: Switching output is switched when the measured value is outside the limit values; the basis is formed by the settings for ERRORLIMITSIGNAL1, ERRORLIMITCOMPARETO1 and ERRORLIMITVALUES1.

A 5.3.14.3 List of Possible Signals for Error Output

```
META_ERRORLIMITSIGNAL1
```

List of all signals that are possible for the ERRORLIMITSIGNAL1 command.

A 5.3.14.4 Set Signal to be Evaluated

```
ERRORLIMITSIGNAL1 [<signal>]
```

Selection of the signal to be used for the limit value analysis.

A 5.3.14.5 Set Limit Values

```
ERRORLIMITCOMPARETO1 [LOWER | UPPER |BOTH]
```

Specifies whether the output should activate upon

- LOWER --> undershot
- UPPER --> exceeded
- BOTH --> undershot or exceeded

A 5.3.14.6 Set Value

```
ERRORLIMITVALUES1 [<lower limit [mm]> <upper limit [mm]>]
```

Sets the values for Lower and Upper limit values.

- <lower limit [mm]> = -2147.0 ... 2147.0
- <upper limit [mm]> = -2147.0 ... 2147.0

A 5.3.14.7 Switching Behavior of Error Outputs

```
ERRORLEVELOUT1 [PNP|NPN|PUSHPULL|PUSHPULLNEG]
```

Switching behavior of error output Error 1.

- PNP: Switching output is High in the case of an error and open without error
- NPN: Switching output is Low in the case of an error and open without error
- PUSHPULL: Switching output is High in the case of an error and Low without error
- PUSHPULLNEG: Switching output is Low in the case of an error and High without error

A 5.3.14.8 Switching Hysteresis of Error Outputs

```
ERRORHYSTERESIS1 <hysteresis [mm]>
```

Sets the hysteresis for the switching outputs, see also function ERRORLIMIT.

- <hysteresis [mm]> = (0 ... 2) * measurement range [mm]

A 5.3.15 Analog Output

A 5.3.15.1 Data Selection

```
ANALOGOUT [<signal>]
```

Selection of the signal to be output via the analog output. The signal is specified as a parameter. A list with the possible signals can be shown with META_ANALOGOUT.

A 5.3.15.2 List of Possible Signals for Analog Output

```
META_ANALOGOUT
```

Lists all signals that can be connected to the analog output.

A 5.3.15.3 Output Range

```
ANALOGRANGE 0-5V | 0-10V | 4-20mA
```

- 0-5 V: The analog output puts out a voltage of 0 to 5 volts.
- 0-10 V: The analog output puts out a voltage of 0 to 10 volts.
- 4-20mA: The analog output puts out a current of 4 to 20 milliamperes.

A 5.3.15.4 Set Scaling for DAC

```
ANALOGSCALEMODE [STANDARD | TWOPOINT]
```

Sets or indicates the scaling of the analog output.

- STANDARD --> Measuring range is scaled via the output
- TWOPOINT --> Two-point scaling

The standard scaling is configured for distances -MB/2 to MB/2 and for thickness measurement from 0 to 2 MB (MB=measuring range).

Two-point scaling: Scaling of measured values defined with ANALOGSCALERANGE.

A 5.3.15.5 Set Scaling Range

```
ANALOGSCALERANGE <limit 1> <limit 2>
```

Two-point scaling requires the start and end of the range to be entered in millimeters.

- <limit 1> = (-2147.0 ... 2147.0) [mm], and different from <limit 2>.
- <limit 2> = (-2147.0 ... 2147.0) [mm], and different from <limit 1>.

The values cannot be identical.

A 5.3.16 System Settings

A 5.3.16.1 Key Lock

```
KEYLOCK [NONE | ACTIVE | (AUTO [<timeout period>]]
```

Selection of the key lock.

- NONE: Key always functions; no key lock
- ACTIVE: Key lock activates immediately upon restart
- AUTO: Key lock is only activated `<timeout period>` minutes after restart, value range 1 ... 60 min

A 5.3.16.2 Language Webinterface

```
LANGUAGE DE | EN | CN | KR | JP
```

A 5.3.16.3 IP-Address

```
IPCONFIG DHCP|(STATIC [<IPaddress> [<netmask> [<gateway>]]])
```

Ethernet Settings

- DHCP: IP address and gateway are automatically set via DHCP. If no DHCP server is available, the controller attempts to obtain a link-local address.
- STATIC: Specify IP address, network mask, and gateway in the format ddd.ddd.ddd.ddd

A 5.3.16.4 Protocol for Ethernet Measured Value Transmission

```
MEASTRANSFER NONE
MEASTRANSFER SERVER/TCP [<port>]
MEASTRANSFER CLIENT/TCP [<IP> [<port>]]
MEASTRANSFER CLIENT/UDP [<IP> [<port>]]
```

Indicates or configures the Ethernet connection for exchanging measured values.

- NONE: No Ethernet connection
- SERVER/TCP: Controller contains a TCP/IP server
- CLIENT/TCP: Controller functions as a TCP/IP network client
- CLIENT/UDP: Controller functions as a UDP/IP client
- IP: IP address of network server
- Port: Communication port (1024 ... 65535), factory setting is 1024

A 5.3.16.5 Keepalive Signal

```
TCPKEEPALIVE [ON|OFF]
```

Setting is used for new TCP connections; existing connections remain unaffected.

- ON: Send keep-alive signal
- OFF: Suppress keep-alive signal

A 5.4 Measured Value Format, Structure

The structure of measured value frames depends on the selection of the measured values or on the selection of a preset. In the following overview, you will find a summary of commands which you can use to query the available measured values via RS422 and Ethernet.

Chap. A 5.3.13.2	OUT_RS422	Chap. A 5.3.13.5	OUT_ETH	Data selection for RS422, Ethernet
Chap. A 5.3.13.3	META_OUT_RS422	Chap. A 5.3.13.6	META_OUT_ETH	List of Possible Signals RS422, Ethernet
Chap. A 5.3.13.4	GETOUTINFO_RS422	Chap. A 5.3.13.7	GETOUTINFO_ETH	List of Selected Signals; Sequence via RS422, Ethernet

Example for the structure of a data block, query via Tera Term for RS422:

Preset `Standard matt`	Preset `One-sided thickness measurement`
->META_OUT_RS422 META_OUT_RS422 01RAW 01DARK 01LIGHT 01SHUTTER 01ENCODER1 01INTENSITY 01SYMM 01DIST1 MEASRATE TIMESTAMP TIMESTAMP_HIGH TIMESTAMP_LOW COUNTER 01DIST1_MIN 01DIST1_PEAK 01DIST1_MAX ->	->META_OUT_RS422 META_OUT_RS422 01RAW 01DARK 01LIGHT 01SHUTTER 01ENCODER1 01INTENSITY 01SYMM 01DIST1 01DIST2 01DIST3 MEASRATE TIMESTAMP TIMESTAMP_HIGH TIMESTAMP_LOW COUNTER Ch01Thick12 Ch01Thick12_MIN Ch01Thick12_PEAK Ch01Thick12_MAX ->
->GETOUTINFO_RS422 GETOUTINFO_RS422 01SHUTTER 01INTENSITY1 01DIST1 ->	->GETOUTINFO_RS422 GETOUTINFO_RS422 01SHUTTER 01INTENSITY1 01DIST1 01INTENSITY2 01DIST2 Ch01Thick12 ->

A measured value frame is built dynamically, i.e., values not selected are not transmitted.

A 5.5 Warning and Error Messages

E200 I/O operation failed

E202 Access denied

E204 Received unsupported character

E205 Unexpected quotation mark

E210 Unknown command

E212 Command not available in current context

E214 Entered command is too long to be processed

E230 Unknown parameter

E231 Empty parameters are not allowed

E232 Wrong parameter count

E233 Command has too many parameters

E234 Wrong or unknown parameter type

E236 Value is out of range or the format is invalid

E262 Active signal transfer, please stop before

E270 No signals selected

E272 Invalid combination of signal parameters, please check measure mode and signal selection

E276 Given signal is not selected for output

E277 One or more values were unavailable. Please check output signal selection

E281 Not enough memory available

E282 Unknown output signal

E283 Output signal is unavailable with the current configuration

E284 No configuration entry was found for the given signal

E285 Name is too long

E286 Names must begin with an alphabetic character, and be 2 to 15 characters long. Permitted characters are: a-zA-Z0-9_

E320 Wrong info-data of the update

E321 Update file is too large

E322 Error during data transmission of the update

E323 Timeout during the update

E324 File is not valid for this sensor

E325 Invalid file type

E327 Invalid checksum

E331 Validation of import file failed

E332 Error during import

E333 No overwrite during import allowed

E340 Too many output values for RS422 selected

E350 The new passwords are not identical

E351 No password given

E360 Name already exists or not allowed

E361 Name begins or ends with spaces or is empty

E362 Storage region is full

E363 Setting name not found

E364 Setting is invalid

E500 Material table is empty

E502 Material table is full

E504 Material name not found

E600 ROI begin must be less than ROI end

E602 Master value is out of range

E603 One or more values were out of range

E610 Encoder: minimum is greater than maximum

E611 Encoder‘s start value must be less than the maximum value

E615 Synchronization as slave and triggering at level or edge are not possible at the same time

E616 Software triggering is not active

E618 Sensor head not available

E621 The entry already exists

E622 The requested dataset/table doesn‘t exist.

E623 Not available in EtherCAT mode

E624 Not allowed when EtherCAT SYNC0 synchronization is active

W505 Refractivity correction deactivated, vacuum is used as material

W526 Output signal selection modified by the system

W528 The shutter time has been changed to match the measurement rate and the system requirements.

W530 The IP settings has been changed.

A 6 Tera Term

A 6.1 General

The Tera Term service allows you to communicate with the IFC241x from your PC. To communicate with Tera Term, you will need

- a connection between the IFC241x and your PC,
  - Ethernet
  - RS442 communication
- the ASCII commands, see Chap. A 5.

A 6.2 Establishing the Connection

➡ Start the program `Tera Term.exe` via Start > Run.

➡ Establish connection using 192.254.168.150 or the IP address of the controller.

➡ Define terminal setup, e.g., local echo for commands.

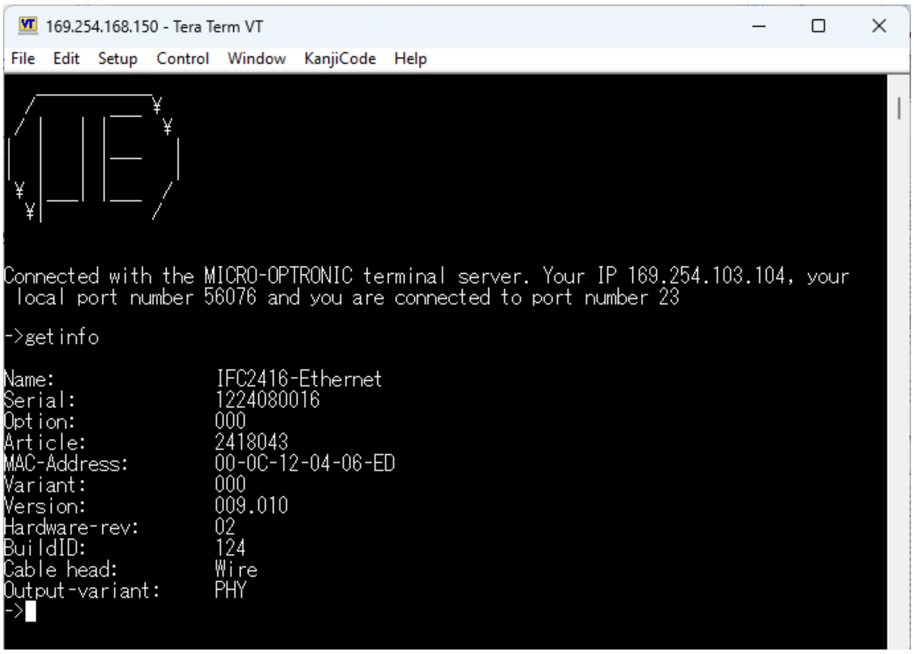


Fig. 81 Tera Term start screen of IFC2416

A command always consists of the command name(s) plus several parameters separated by spaces. The currently set parameter value is reset if a command is invoked without parameters.

The output format is:

<Command name> <Parameter1> [<Parameter2> […]]

The returned command can be used again without changes for setting the password. After a command is processed, a line break and a prompt ("->") is always returned. In the event of an error, an error message beginning with `Exx`, where xx stands for a unique error number, comes before the prompt.

i If no connection is successfully established after the IP address is sent, send a `c` to close the connection. Now send the command `o 192.254.168.150` again to establish the connection.

A 6.3 Help on a Command

Tera Term can output information about a command. For this, enter the sequence “HELP <command name>”.

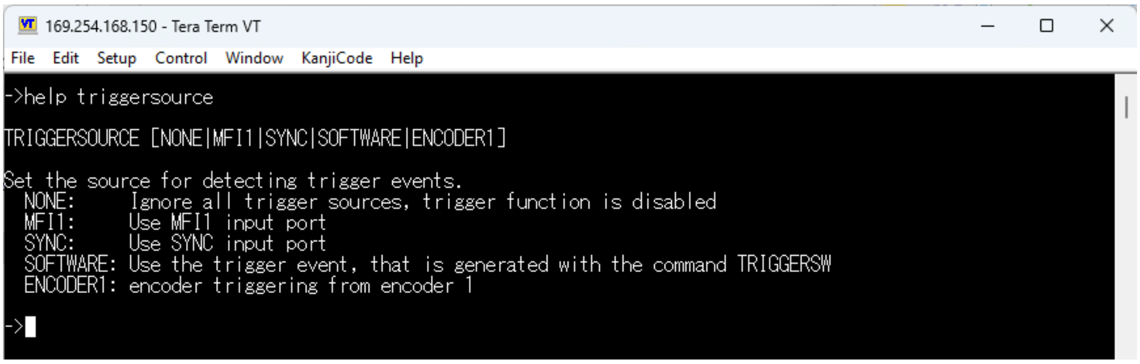


Fig. 82 Access the information about the TRIGGERSOURCE command

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X9751458.03-A012065MSC