MICRO-EPSILON

Operating Instructions

confocalDT 2451/2461/2471

IFC2451
IFC2451MP
IFC2461
IFC2461MP
IFC2471
IFC2471MP
IFC2471LED
IFC2471MP LED
IFX2471

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IFS2407/90-0,3
IFS2407-0,8
IFS2407-3

Confocal chromatic distance and thickness measurement

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confocalDT 2471
confocalDT 2461

confocalDT 2451

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Contents

1. Safety

System operation assumes knowledge of the operating instructions.

1.1 Symbols Used

The following symbols are used in these operating instructions:

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

1.2 Warnings

CAUTION

Do not open the external Xenon light source IFX2471.

> Risk of burns; high voltage

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 and the light source

NOTICE

The supply voltage must not exceed the specified limits.

> Damage to or destruction of the controller or the light source

Avoid shocks and impacts to the controller, the sensor and the external light source.

> Damage to or destruction of the components

Do not allow optical fibers to twist or bend tightly.

> Damage to or destruction of the optical fibers; failure of the measurement device

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

> Incorrect measurement

> Failure of the measuring device

Do not cover the ventilation slots on the top and bottom of the external light source.

> Damage to external light source, or light source switches off automatically

Protect the cables against damage.

> Failure of the measuring device

1.3 Notes on CE Marking

The following apply to the confocalDT 2451/2461/2471 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 measuring system is designed for use in industrial and residential applications.

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

1.4 Intended Use

- The confocalDT 2451/2461/2471 is designed for use in industrial and residential applications. It is used for
  - measuring displacement, distance, profile, thickness and surface inspection
  - monitoring quality and checking dimensions
- The system must only be operated within the limits specified in the technical data, see 2.6.
- The system must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the controller.
- Take additional precautions for safety and damage prevention in case of safety-related applications.

1.5 Proper Environment

- Protection class sensor: IP40 ... IP 65, see 2.6
- Protection class controller: IP40
- Protection class external light source: IP40

Optical inputs are excluded from protection class. Contamination leads to impairment or failure of the function.

- Temperature range
  - Operation:
    - Sensor: +5 ... +70 °C (+41 ... +158 °F)
    - Controller: +5 ... +50 °C (+41 ... +122 °F)
    - External light source: +5 ... +40 °C (+41 ... +104 °F)
  - Storage: -20 ... +70 °C (-4 ... +158 °F)
- Humidity: 5 ... 95 % (non-condensing)
- Ambient pressure: Atmospheric pressure
- EMC: According to EN 61000-6-3 / EN 61326-1 (Class B) and EN 61 000-6-2 / EN 61326-1

2. Functional Principle, Technical Data

2.1 Short Description

The confocalDT 2451/2461/2471LED measuring system includes

- one sensor,
- one controller IFC2451, IFC2461 or IFC2471LED
- one optical fiber (optic cable).

The confocalDT 2471 measuring system includes

- one sensor,
- one controller (IFC2471) for the external light source,
- one Xenon light source (IFX2471),
- two optical fibers (optic cable).

The external light source IFX2471 is required to operate the controller IFC2471 at high measuring rates. The controller IFC2451, IFC2461 and IFC2471LED comes with an integrated white light LED as an internal light source.

The sensor is completely passive as it contains no heat sources or moving parts. This prevents any heat-related expansion, and ensures high precision of the measuring system.

The external light source feeds the sensor through the controller. The controller uses a spectrometer to convert any light signals that it receives from the sensor. It then calculates distance values using the integrated signal processor (CPU) and transfers the data via its interfaces or analog outputs.

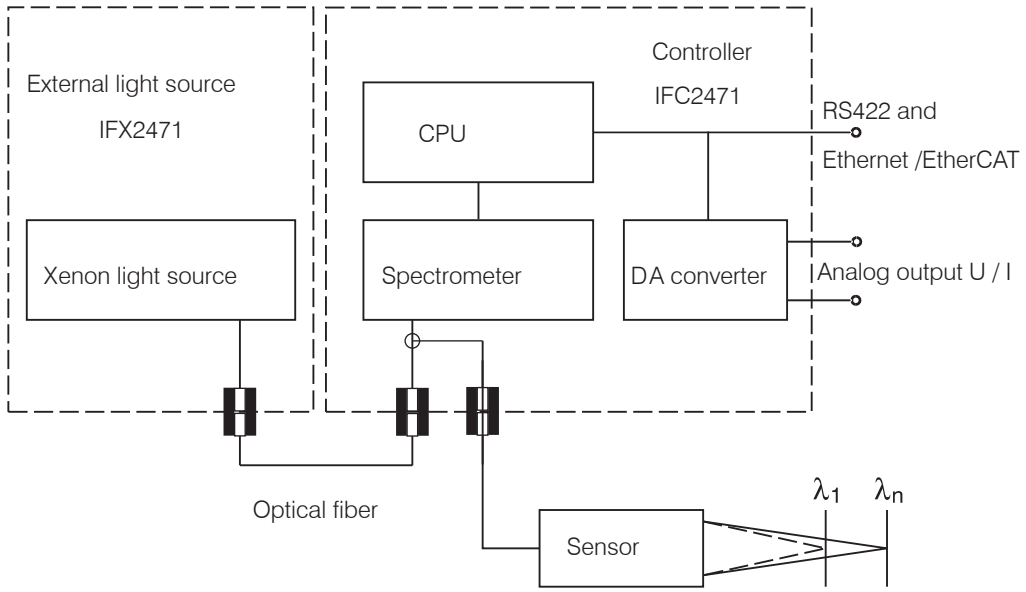


Fig. 1 Block diagram confocalDT 2471

2.2 Measuring Principle

The sensor projects polychromatic light (white light) to the target surface. The sensor lenses are designed to use controlled chromatic aberration to focus each light wavelength at a specific distance. In reverse, the sensor will then receive the light that is reflected from the target surface and transfer it to the controller. This is followed by the spectral analysis, and then the data stored in the controller are used to calculate the distances.

i Sensor and controller are one unit, as the sensor's linearization table is stored in the controller.

This unique measuring system allows for highly precise measurement of applications. It is possible to measure both diffuse and reflecting surfaces. For transparent layered materials, thickness measurements can be conducted in addition to distance measurements. Shadowing is avoided because sender and receiver are aligned along one axis.

The excellent resolution and the small beam spot diameter make it possible to measure surface structures. However, measurement deviations may occur if the structure is of a similar size to the beam spot diameter or if the maximum tilt angle is exceeded (for example, with groove edges).

2.3 Glossary

SMR Start of measuring range. Minimum distance between sensor surface and target

MMR Mid of measuring range

EMR End of measuring range (start of measuring range + measuring range)
Maximum distance between sensor face and target

MR Measuring range

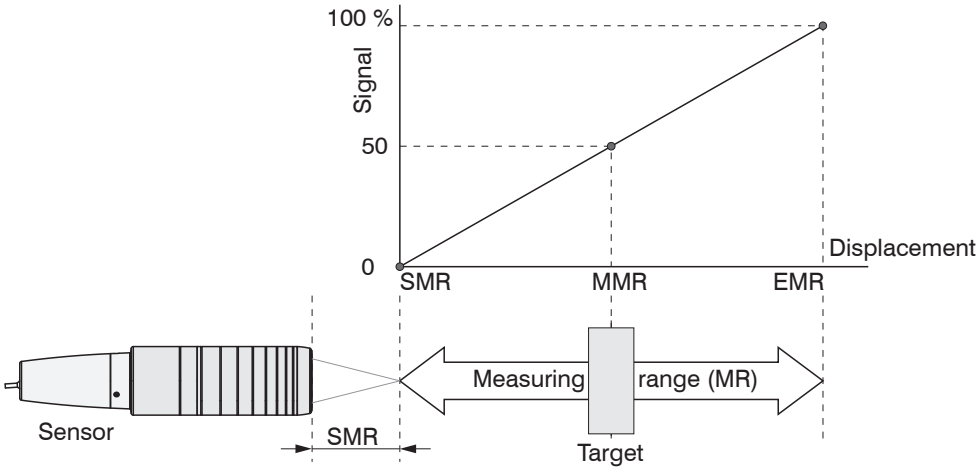


Fig. 2 Measuring range and output signal at the controller

2.4 Operating Modes

- Distance measurement for reflecting (mirroring and diffuse) surfaces,
- thickness measurement of transparent objects

covering ranges between just a few tenths of a micrometer to several millimetres.

2.5 Sensors

The controller can be operated with up to 20 different sensors. The required calibration tables are stored within the controller.

The sensor is a passive element in the measuring system: it contains neither moving nor heat-generating parts which might affect measuring accuracy due to thermal expansion in the sensor.

i Protect the ends of the sensor cables (optical fibers) and the sensor lens from dirt and contamination.

2.6 Technical Data

Model IFS		2402-0,4	IFS2402-0,5	2402-1,5	2402-4	2402-10	2402/90-1,5	2402/90-4	2402/90-10
Measuring range		0.4 mm	0.5 mm	1.5 mm	3.5 mm	6.5 mm	1.5 mm	2.5 mm	6.5 mm
Start of measuring range	approx.	1.5 mm	1.7 mm	0.9 mm	1.9 mm	2.5 mm	2.5 mm [1]	2.5 mm [1]	3.5 mm [1]
Resolution	static [2]	16 nm	16 nm	60 nm	100 nm	200 nm	60 nm	100 nm	200 nm
	dynamic [3]	48 nm	48 nm	192 nm	480 nm	960 nm	192 nm	480 nm	960 nm
Linearity [4]	Displacement and distance	< ±0.3 µm	< ±0.2 µm	< ±1.2 µm	< ±3 µm	< ±13 µm	< ±1.2 µm	< ±3 µm	< ±13 µm
Light spot diameter		10 µm	10 µm	20 µm	20 µm	100 µm	20 µm	20µm	100 µm
Max. tilt angle [5]		±8°	±18°	±5°	±3°	±1.5°	±5°	±3°	±1.5°
Numerical aperture		0.25	0.40	0.20	0.10	0.10	0.20	0.10	0.10
Connection		integrated optical fiber 2 m with E2000/APC connector; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm							
Installation		Clamping, mounting adapter (see accessories)							
Temperature range	Storage	-20… +70 °C (-4 ... +158 °F)							
	Operation	+5 … +70 °C (+41 ... +158 °F)							
Shock (DIN-EN 60068-2-27)		15 g / 6 ms in XY axis, 1000 shocks each							
Vibration (DIN-EN 60068-2-6)		2 g / 20 Hz … 500 Hz in XY axis, 10 cycles each							
Protection class (DIN-EN 60529)		IP64 (front operated)					IP40		
Material		Stainless steel housing, glass lenses							
Weight		approx. 186 g (incl. optical fiber)							

Model IFS		2403-0,4	2403-1,5	2403-4	2403-10	2403/90-1,5	2403/90-4	2403/90-10
Measuring range		0.4 mm	1.5 mm	4 mm	10 mm	1.5 mm	4 mm	10 mm
Start of measuring range	approx.	2.5 mm	8.0 mm	14.7 mm	11 mm	4.9 mm [1]	12 mm [1]	8.6 mm [1]
Resolution	static [2]	16 nm	60 nm	100 nm	250 nm	60 nm	100 nm	250 nm
	dynamic [3]	47 nm	186 nm	460 nm	1250 nm	186 nm	460 nm	1250 nm
Linearity [4]	Displacement and distance	< ±0.3 µm	< ±1.2 µm	< ±3 µm	< ±20 µm	< ±1.2 µm	< ±3 µm	< ±20 µm
	Thickness	< ±0.6 µm	< ±2.4 µm	< ±6 µm	< ±40 µm	< ±2.4 µm	< ±6 µm	< ±40 µm
Light spot diameter		9 µm	15 µm	28 µm	56 µm	15 µm	28 µm	56 µm
Max. tilt angle [5]		±20°	±16°	±6°	±6°	±16°	±6°	±6°
Numerical aperture		0.5	0.3	0.15	0.15	0.3	0.15	0.15
Min. target thickness [6]		0.06 mm	0.23 mm	0.6 mm	1.5 mm	0.23 mm	0.6 mm	1.5 mm
Connection		integrated optical fiber 2 m with E2000/APC connector; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm						
Installation		Clamping, mounting adapter (see accessories)						
Temperature range	Storage	-20 … +70 °C (-4 ... +158 °F)						
	Operation	+5 … +70 °C (+41 ... +158 °F)						
Shock (DIN-EN 60068-2-27)		15 g / 6 ms in XY in XY axis, 1000 shocks each						
Vibration (DIN-EN 60068-2-6)		2 g / 20 Hz … 500 Hz in XY axis, 10 cycles each						
Protection class (DIN-EN 60529)		IP64 (front operated)				IP40		
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, near to the midrange 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 tilt angle that produces a usable signal on reflecting surfaces. The accuracy decreases when approaching the limit values.

6) Glass with refractive index n = 1.5 in midrange

Model	IFS	2404-2	2404/90-2	2404-2(001)	2404/90-2(001)
Measuring range		2 mm	2 mm	2 mm	2 mm
Start of measuring range	approx.	14 mm	9.6 mm [1]	14 mm	9.6 mm [1]
Resolution	static [2]	40 nm	40 nm	40 nm	40 nm
	dynamic [3]	125 nm	125 nm	125 nm	125 nm
Linearity [4]	Displacement and distance	< ±1 µm	< ±1 µm	< ±1 µm	< ±1 µm
	Thickness	< ±2 µm	< ±2 µm	< ±2 µm	< ±2 µm
Light spot diameter		10 µm	10 µm	10 µm	10 µm
Max. tilt angle [5]		±12°	±12°	±12°	±12°
Numerical aperture		0.25	0.25	0.25	0.25
Min. target thickness [6]		0.1 mm	0.1 mm	0.1 mm	0.1 mm
Connection		pluggable optical fiber via FC socket, type C2404-x; standard length 2 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm		pluggable optical fiber via FC socket, standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm	
Installation		Clamping, mounting adapter (see accessories)			
Temperature range	Storage	-20 … +70 °C (-4 ... +158 °F)			
	Operation	+5 … +70 °C (+41 ... +158 °F)			
Shock (DIN-EN 60068-2-27)		15 g / 6 ms in XY axis, 1000 shocks each			
Vibration (DIN-EN 60068-2-6)		2 g / 20 Hz … 500 Hz in XY axis, 10 cycles each			
Protection class (DIN-EN 60529)		IP65 (front operated)			
Material		Stainless steel housing, glass lenses			
Weight		approx. 20 g	approx. 30 g	approx. 40 g	approx. 50 g

Model		2405-0,3	2405-1	2405-3	2405-6	2405/90-6	2405-10	2405-28	2405-30
Measuring range		0.3 mm	1 mm	3 mm	6 mm	6 mm	10 mm	28 mm	30 mm
Start of measuring range	approx.	6 mm	10 mm	20 mm	63 mm	41 mm [1]	50 mm	220 mm	100 mm
Resolution	static [2]	4 nm	28 nm	60 nm	18 nm	18 nm	60 nm	250 nm	300 nm
	dynamic [3]	20 nm	52 nm	126 nm	93 nm	93 nm	386 nm	1420 nm	1040 nm
Linearity [4]	Displacement and distance	< ±0.15 µm	< ±0.25 µm	< ±0.75 µm	< ±1.5 µm	< ±1.5 µm	< ±2.5 µm	< ±7.0 µm	< ±7.5 µm
	Thickness	< ±0.3 µm	< ±0.5 µm	< ±1.5 µm	< ±3 µm	< ±3 µm	< ±5 µm	< ±14 µm	< ±15 µm
Light spot diameter		6 µm	8 µm	9 µm	31 µm	31 µm	16 µm	60 µm	50 µm
Max. tilt angle [5]		±34°	±30°	±24°	±10°	±10°	±17°	±5°	±9°
Numerical aperture		0.6	0.55	0.45	0.22	0.22	0.3	0.1	0.2
Min. target thickness [6]		0.015 mm	0.05 mm	0.15 mm	0.3 mm	0.3 mm	0.5 mm	2.2 mm	1.5 mm
Connection		pluggable optical fiber via FC socket; standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm							
Installation		Clamping, mounting adapter (see accessories)							
Temperature range	Storage	-20 … +70 °C (-4 ... +158 °F)							
	Operation	+5 … +70 °C (+41 ... +158 °F)							
Shock (DIN-EN 60068-2-27)		15 g / 6 ms in XY axis, 1000 shocks each							
Vibration (DIN-EN 60068-2-6)		2 g / 20 Hz … 500 Hz in XY axis, 10 cycles each							
Protection class (DIN-EN 60529)		IP64 (front operated)							
Material		Aluminum housing, glass lenses							
Weight	approx.	140 g	125 g	225 g	217 g		500 g	750 g	730 g

1) Start of measuring range measured from sensor axis.

2) Average from 512 values at 1 kHz, near to the midrange 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 objects.

5) Maximum sensor tilt angle that produces a usable signal on reflecting surfaces. The accuracy decreases when approaching the limit values.

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

Model IFS		2406-2,5/VAC(003)	2406/90-2,5/VAC(001)	2406-3	2406-10	2406-3/VAC(001)
Measuring range		2.5 mm		3 mm	10 mm	3 mm
Start of measuring range	approx.	17.2 mm	12.6 mm [1]	75 mm	27 mm	75 mm
Resolution	static [2]	24 nm		50 nm	60 nm	50 nm
	dynamic [3]	106 nm		168 nm	385 nm	168 nm
Linearity [4]	Displacement and distance	< ± 0.75 µm		< ± 1.5 µm	< ± 2.5 µm	< ±1.5 µm
	Thickness	< ± 1.5 µm		< ± 3.0 µm	< ± 5 µm	< ±3.0 µm
Light spot diameter		10 µm		35 µm	15 µm	35 µm
Max. tilt angle [5]		±16°		±6.5°	±13.5°	±6.5°
Numerical aperture		0.3		0.14	0.25	0.14
Min. target thickness [6]		0.125 mm		0.15 mm	0.5 mm	0.15 mm
Connection		pluggable optical fiber via FC socket, type C240x-x (01); standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm				Typ C240x-x/VAC(01); bending radius: static 30 mm, dynamic 40 mm
Installation		Clamping, mounting adapter (see accessories)				
Temperature range	Storage	-20 … +70 °C (-4 ... +158 °F)				
	Operation	+5 … +70 °C (+41 ... +158 °F)				
Shock (DIN-EN 60068-2-27)		15 g / 6 ms in XY axis, 1000 shocks each				
Vibration (DIN-EN 60068-2-6)		2 g / 20 Hz … 500 Hz in XY axis, 10 cycles each				
Protection class (DIN-EN 60529)		IP40 (vacuum compatibale)		IP65 (front operated)		IP40 (vacuum compatibale)
Material		Stainless steel housing, glass lenses		Aluminium, glass lenses		Stainless steel housing (1.4305), glass lenses
Weight		approx. 105 g	approx. 130 g	approx. 99 g	approx. 128 g	approx. 250 g

Model IFS		2407-0,1	2407-0,1(001)	2407-0,8	2407/90-0,3	2407-3
Measuring range		0.1 mm		0.8 mm	0.3 mm	3 mm
Start of measuring range	approx.	1 mm		5.9 mm	5.3 mm	28 mm
Resolution	static [2]	3 nm		24 nm	10 nm	20 nm
	dynamic [2]	6 nm		75 nm	20 nm	58 nm
Linearity [4]	Displacement and distance	< ±0.05 µm		< ±0.2 µm	< ±0.15 µm	< ±0.75 µm
	Thickness	< ±0.1 µm		< ±0.4 µm	< ±0.3 µm	< ±1.5 µm
Light spot diameter		3 µm	4 µm	6 µm	6 µm	9 µm
Max. tilt angle [5]		±48°	±48°	±30°	±27°	±30°
Numerical aperture		0.8	0.7	0.50	0.5	0.53
Min. target thickness [6]		0.005 mm		0.04 mm	0.015 mm	0.15 mm
Connection (pluggable optical fiber via FC socket; length 3 m, extension up to 50 m)		bending radius: static 30 mm, dynamic 40 mm			type C2407-x; bending radius: static 30 mm, dynamic 40 mm	bending radius: static 30 mm, dynamic 40 mm
Installation		Clamping, mounting adapter			Mounting holes (2x M2)	Clamping, mounting adapter
Temperature range	Storage	-20 … +70 °C (-4 ... +158 °F)				
	Operation	+5 … +70 °C (+41 ... +158 °F)				
Shock (DIN-EN 60068-2-27)		15 g / 6 ms in XY axis, 1000 shocks each				
Vibration (DIN-EN 60068-2-6)		2 g / 20 Hz … 500 Hz axis, 10 cycles each				
Protection class (DIN-EN 60529)		IP65 (front operated)				
Material		Stainless steel housing, glass lenses				Aluminium, glass lenses
Weight		approx. 36 g		approx. 40 g	approx. 30 g	approx. 550 g
Features		high numerical aperture	Light-intensive sensor		-	-

Controller		**IFC2451**	**IFC2451MP**	**IFC2461**	**IFC2461MP**	**IFC2471LED**	**IFC2471MP LED**
Multi peak measurement		2 peaks	up to 6 peaks	2 peaks	up to 6 peaks	2 peaks	up to 6 peaks
Light source		internal white LED					
Measuring rate		adjustable 10 / 5 / 2.5 / 1 / 0.3 / 0.2 / 0.1 kHz		adjustable 25 / 10 / 5 / 2.5 / 1 / 0.3 / 0.2 / 0.1 kHz		adjustable 70 / 50 / 25 / 10 / 5 / 2.5 / 1 / 0.1 kHz	
		variable 10 ... 0.1 kHz, step size 100 Hz		variable 25 ... 0.1 kHz, step size 100 Hz		variable 70 ... 0.1 kHz, step size 100 Hz	
Resolution	Ethernet / EtherCAT	1 nm					
	RS422	18 bit					
	Analogue	16 bit					
Storage		up to 20 calibration tables for different sensors, menu selection					
Controller inputs / outputs		sync-in / trigger-in, sync-out error1-out, error2-out encoder (3x A, B, Index) EtherCAT/Ethernet RS422 analogue: current, voltage (16bit D/A converter)					
EtherCAT		EtherCAT Conformance tested		EtherCAT			
Operating elements, controller display		On/Off switch; Button for dark alignment (as well as for reset to factory setting after 10 s) 4x LED for intensity, range, status, supply voltage					
Supply voltage, power consumption		24 VDC ±15 %, ~10 W					
Housing		Aluminium case for DIN rail mounting					
Protection class		IP 40					
Operating temperature		5 °C up to 50 °C					
Storage temperature		-20 °C up to 70 °C					
Safety; EMC Interference emission Interference resistance		CE EN 61 000-6-3 / DIN EN 61326-1 (class B) EN 61 000-6-2 / DIN EN 61326-1					
Shock		15 g, 6 ms					
Vibration		2 g / 10 Hz ... 500 Hz					
Optical fiber cable length	sensor	2 - 50 m					
	connector	E2000					
Cable length (all cables are shielded)	EtherCAT, Ethernet	CAT5E; length < 100 m					
	supply, RS422, sync./error	< 30 m					
	analogue	< 30 m					
	encoder	< 3 m					

Controller		IFC2471	IFC2471MP
Multi peak measurement		2 peaks	up to 6 peaks
Light source		external xenon light source IFX2471	
Measuring rate		adjustable 70 / 50 / 25 / 10 / 5 / 2.5 / 1 / 0.3 kHz variable 70 ... 0.3 kHz, step size 100 Hz	
Resolution	Ethernet / EtherCAT	1 nm	
	RS422	18 bit	
	Analogue	16 bit	
Storage		up to 20 calibration tables for different sensors, menu selection	
Controller inputs / outputs		sync-in / trigger-in, sync-out error1-out, error2-out encoder (3x A, B, Index) EtherCAT/Ethernet RS422 analogue: current, voltage (16bit D/A converter) IFX2471: temperature, light-bulb exchange	
EtherCAT		EtherCAT®	
Operating elements, controller display		On/Off switch; Button for dark alignment (as well as for reset to factory setting after 10 s) 4x LED for intensity, range, status, supply voltage	
Supply voltage, power consumption	controller	24 VDC ±15 %, ~10 W	
	external light source	90 … 265 VAC, ~100 W	
Housing		Aluminium case for DIN rail mounting	
Protection class		IP 40	
Operating temperature	controller	5 °C up to 50 °C	
	external light source	5 °C up to 40 °C	
Storage temperature		-20 °C up to 70 °C	
Safety; EMC		CE	
Interference emission		EN 61 000-6-3 / DIN EN 61326-1 (class B)	
Interference resistance		EN 61 000-6-2 / DIN EN 61326-1	
Shock		15 g, 6 ms	
Vibration		2 g / 10 Hz ... 500 Hz	
Optical fiber cable length	sensor	2 - 50 m	
	xenon light source	1 m	
	connector	E2000	
Cable length (all cables are shielded)	EtherCAT, Ethernet	CAT5E; length < 100 m	
	supply, RS422, sync./error	< 30 m	
	analogue	< 30 m	
	encoder	< 3 m	

3. Delivery

3.1 Unpacking, Included in Delivery

1 Controller	IFC2451/2461/2471
1 Sensor, incl. sensor cable	(optical fiber)
1 RJ patch cable Cat5	2 m
1 Test certificate	

Optional for IFC2471:

1 External light source IFX2471
1 Power supply cable
1 Optical fiber cable for connecting the controller, 1 m
1 Status lead (4-pin)

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

3.2 Storage

Temperature range storage: -20 ... +70 °C (-4 ... +158 °F)

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

4. Assembly

4.1 Controller IFC2451/2461/2471

Place the controller IFC2451/2461/2471 on a level surface, or install it at a location of your choice (e.g. in a switch cabinet) using a DIN EN 60715 mounting rail (DIN rail TS35).

When using a DIN rail, an electrical connection (potential equalisation) is established between the controller case and the rail.

- To remove, push the controller upwards, and pull it forwards.

i When attaching the controller, ensure that no connections, operating or display elements are covered.

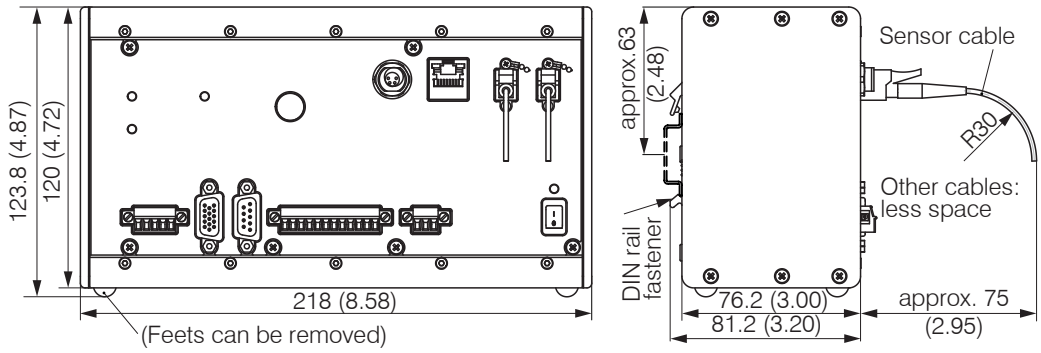


Fig. 3 Dimension drawing of controller IFC2471, dimensions in mm, not to scale

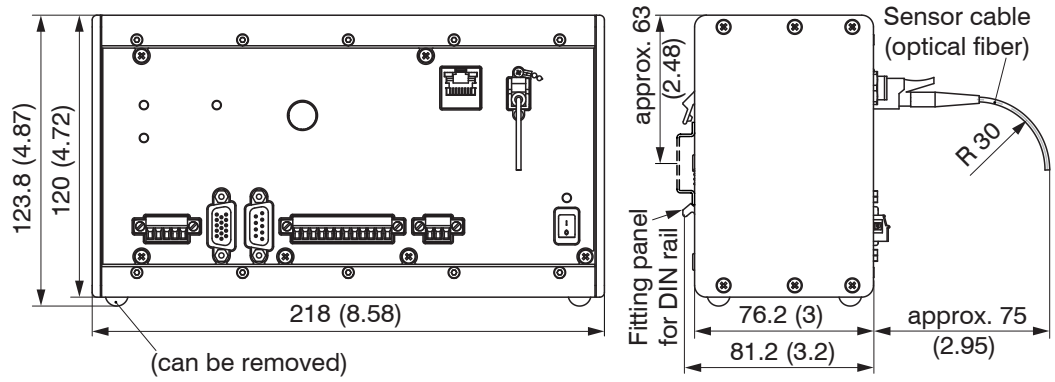


Fig. 4 Dimension drawing of controller IFC2451/2461/2471LED, dimensions in mm, not to scale

4.2 External Light Source IFX2471

Like the controller, the external light source IFX2471, see A 3, may be placed onto an even surface or attached to the rear panel using a DIN rail.

4.3 Controller Operating Elements

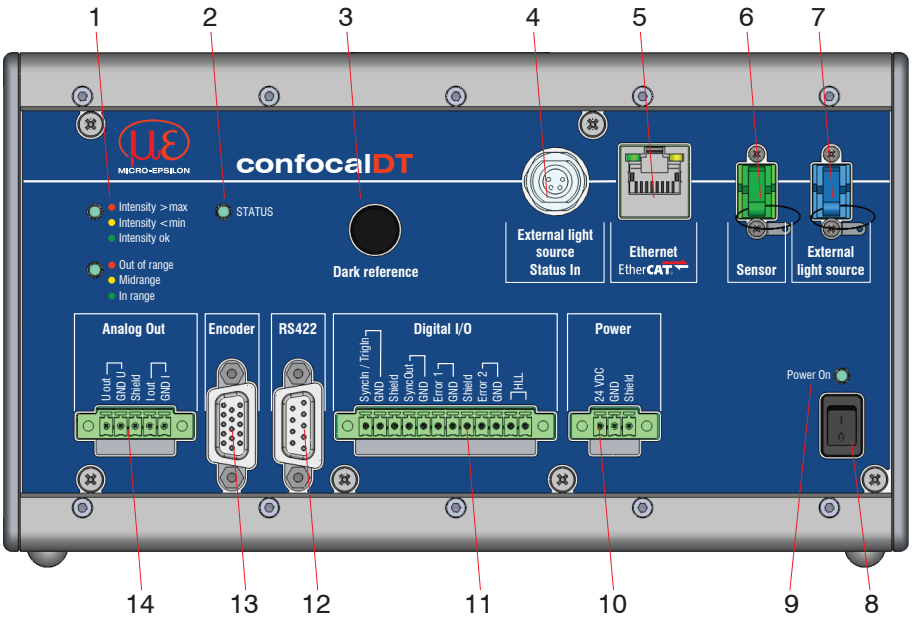


Fig. 5 Front view controller IFC2471 (IFC2451/2461/2471)

1	Intensity, Range LEDs	8	On/off switch
2	Status LED	9	Power On LED
3	Dark reference button [1]	10	Power supply connection
4	Status input for the external light source [2]	11	Digital I/O
5	Ethernet / EtherCAT	12	RS422 connector
6	Sensor connection (optic fibre)	13	Encoder connection
7	External light source [2]	14	Analog out (U / I)

1) Resetting to factory settings: Press the `Dark reference` button for more than 10 sec.
2) There are no external light source connections on the controller IFC2451/2461 and 2471LED (status in, optic fiber).

4.4 Controller LEDs

Power on	Green	Active supply voltage
Status	Off	No errors
	Flashing red	Processing error
	Red	Error during synchronization
		If EtherCAT is active, meaning of the LED is conform with the EtherCAT guidelines.
Intensity 	Flashing red	Dark signal acquisition in progress
	Red	Signal in saturation
	Yellow	Signal too low
	Green	Signal ok
Range 	Flashing red	Dark signal acquisition in progress
	Red	No target object, or target object outside the measuring range
	Yellow	Target object near the midrange
	Green	Target object within the measuring range

Fig. 6 Description of the controller LEDs

4.5 Electrical Controller Connections

4.5.1 Connection Options

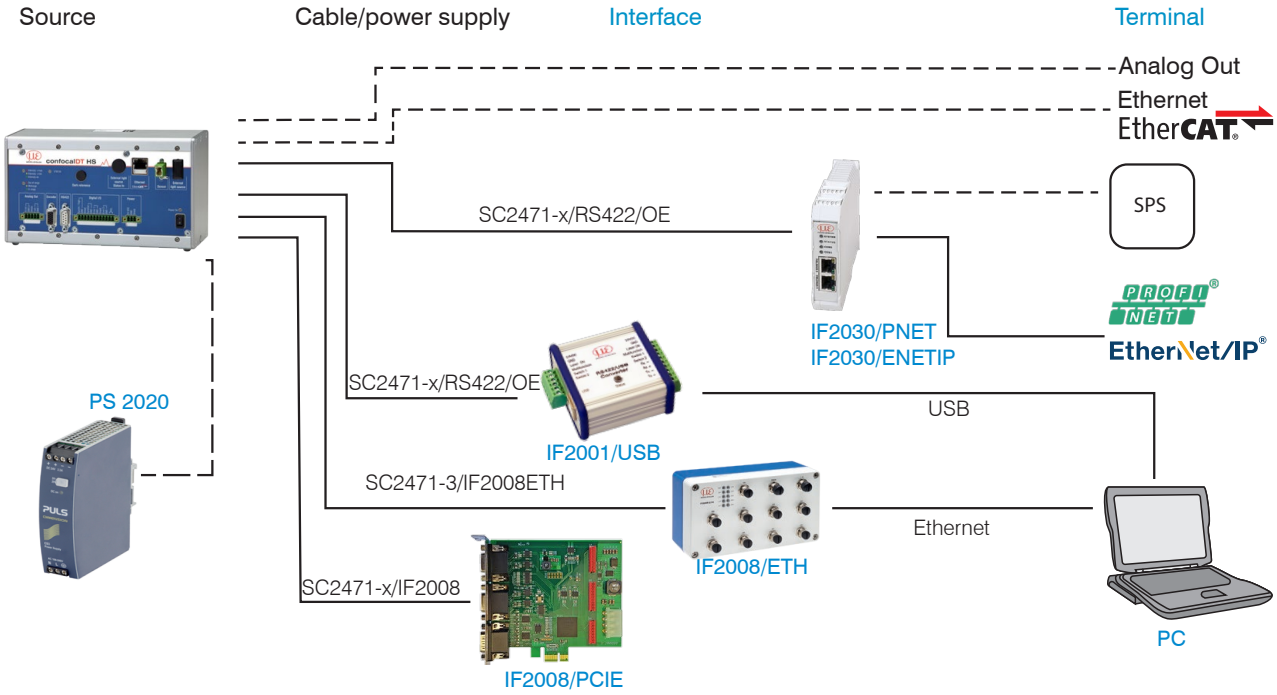


Fig. 7 Connection examples for confocalDT24x1

The different periphery devices, see Fig. 7, can be connected by the illustrated connection cables.

Peripheral	Sensor channels	Power supply converter/modules	Interface
IF2001/USB, RS422-USB converter	1	optional available power supply PS2020	RS422
IF2030/PNET, IF2030/ENETIP	2		
IF2008/ETH	8		
IF2008/PCIE, PCI interface card	5		

4.5.2 Handling of Pluggable Screw Terminals

The controller IFC24x1 has three pluggable screw terminals for supply, digital I/O and analog out, which are included as accessories.

- Remove approx. 7 mm of the connecting wire isolation (0.14 ... 1.5 mm²).
- Connect the connecting wires.

i Use two captive screws to fix the screw terminals.

4.5.3 Supply Voltage (Power)

- 3-pin pluggable screw terminal (24 VDC, GND, Shield),
- 24 VDC ± 15 %, I_{max} <1A
- not electrically isolated, GND is electrically connected to the GND wiring for switching outputs, synchronization and encoder input.

➪ Use a shielded cable of less than 30 m.

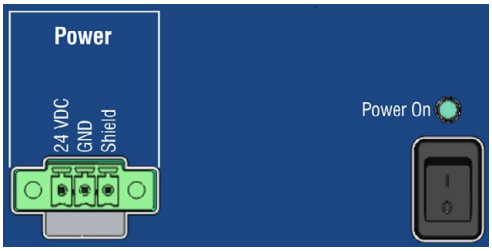


Fig. 8 Supply connection, switch and LED on the controller IFC2451/2461/2471

When the supply voltage has been connected, the `Power On` LED lights up.

4.5.4 RS422

- Differential signals in accordance with EIA-422, electrically isolated from the supply voltage.
- Receiver Rx with a 120 ohm internal terminating resistor.

➪ On the evaluation unit (receiver), terminate the transmitter input (Tx) with 90 ...120 ohm.

➪ Use a shielded twisted cable of less than 30 m.

➪ Connect the earth connections.

i The pin assignment for the 9-pin D-sub connector is not standardized.

Pin	Name	Signal
3	RX -	Receiver -
2	RX +	Receiver +
5	GND422	RS422 ground
9	TX +	Sender +
1	TX -	Sender -
Cover	Shield	Cable shield

Fig. 9 Pin assignment for the 9-pin D-sub connector (RS422)

4.5.5 Ethernet, EtherCAT

Potential isolated RJ45 standard connector for connecting the controller IFC2451/2461/2471

- to an Ethernet network (PC) or
- the EtherCAT bus system (IN-Port).

➪ Use a shielded Ethernet cable (Cat5E, patch cable, 2 m, included in the delivery, overall cable length less than 100 m to connect controller and network.

Both LEDs on the plug-in connector light up to indicate that the connection was successful and is active.

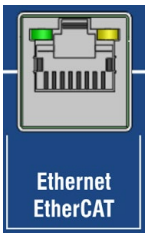


Fig. 10 RJ45 connector for Ethernet, EtherCAT

The measuring device can be configured through the web interface or using ASCII commands (e. g. Telnet), see A 7, or with EtherCAT objects.

4.5.6 Analog Output

The two alternative analog outputs (voltage or current) are connected to the 5-pin screw terminal, and both are electrically isolated from the supply voltage.

Voltage: Pin U_{out} and Pin GND U,

R_i approx. 30 ohm, R_L > 1 kOhm, C_L ≤ 10 nF;

Slew rate (no C_L, R_L ≥ 1 kOhm) ave. 0.5 V/µs

Slew rate (with C_L = 10 nF, R_L ≥ 1 kOhm) ave. 0.4 V/µs

Current: Pin I_{out} and Pin GND I

R_L ≤ 500 ohm, C_L ≤ 10 nF;

Slew rate (no C_L, R_L)= 500 ohm) ave. 1.6 mA/µs

Slew rate (with C_L = 10 nF, R_L = 500 ohm) ave. 0.6 mA/µs

➨ Use a shielded cable of less than 30 m.

Pin 3 (Shield) is connected to the cover.

Alternatively, the following values may be defined for the output range:

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

Current: 4 ... 20 mA.

Only one reading can be produced as voltage or current.

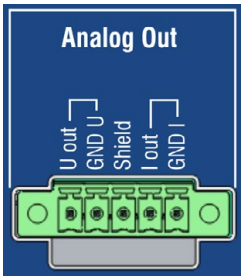


Fig. 11 Analog outputs on the controller

4.5.7 Switching Outputs (Digital I/O)

The two push-pull switching outputs on the 12-pin pluggable screw terminal are not electrically isolated from the supply voltage.

A bridge between the pins (HLL) defines the logic levels for all I/O and Sync/Trig on the screw terminal:

- with bridge: HLL (high logic level)
- open: LLL (low logic level).

Error out 1: error 1 and GND

Error out 2: error 2 and GND

Cable shield: Shield is connected to the cover. Connect the cable shield.

All GND pins are interconnected, and they are connected to the operating voltage ground.

➨ Use a shielded cable of less than 30 m.

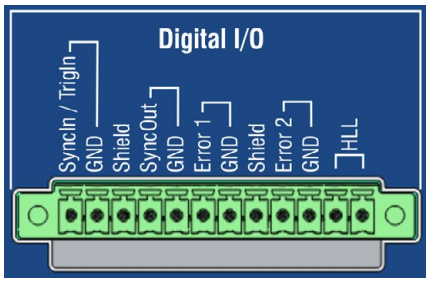


Fig. 12 Digital I/O on the controller

Output level (no load resistance), with a supply voltage of 24VDC	LLL: Low 0.2 … 0.8 V; High 4.5 … 5 V
	HLL: Low 0.2 … 0.8 V; High 23.5 … 24 V
Output resistance	R_i approx. 90 ohm,
Load resistance, saturation voltage	LLL operation: R_L ≥ 100 ohm; $U_{sat\text{-}lo/hi}$ ave. 1.5 V
	HLL operation: R_L ≥ 2 kOhm; $U_{sat\text{-}lo/hi}$ ave. 1.2 V

$U_{sat\text{-}lo/hi}$ saturation voltage (with resistance load R_L) is measured between output and GND, when output = low, or between output and U_B, when output = high.

4.5.8 Synchronization (Inputs/Outputs)

For the pin assignment of the 12-pin pluggable screw terminal, see Fig. 12.

Pin SyncIn/TrigIn: sync or trigger input
Pin GND: ground
Pin Shield: cable shield; shield is connected to the cover
Pin SyncOut: sync output
Pin GND: sync ground

All GND pins are interconnected, and they are connected to the operating voltage ground.

Signal level

SyncOut output level (push-pull, no load resistance), with a supply voltage of 24VDC	LLL: Low 0.2 … 0.8 V; High 4.5 … 5 V
	HLL: Low 0.2 … 0.8 V; High 23.5 … 24 V
Output resistance	R_i approx. 90 ohm,
Load resistance, saturation voltage	LLL operation: $R_L \geq 100$ ohm; $U_{sat\text{-}lo/hi}$ ave. 1.5 V
	HLL operation: $R_L \geq 2$ kOhm; $U_{sat\text{-}lo/hi}$ ave. 1.2 V

SyncIn / TrigIn		
LLL operation [1]	Low 0 V … 0.8 V, High 2 V … 5 V	no bridge between the pins (HLL)
HLL operation	Low 0 V … 4 V, High 11 V … 30 V	bridge between the pins (HLL)
Pulse duration	≥ 5 µs	

Star synchronization:

- Connect the SyncOut output of controller 1 (master) in star configuration with the SyncIn inputs from controller 2 (slave) to Controller n, in order to synchronize two or more controllers, see Fig. 13.

Cascaded synchronization:

- Connect the SyncOut output of controller 1 (master) with the SyncIn inputs of controller 2 (slave 1). Connect the SyncIn inputs of downstream controllers in order to synchronize two or more controllers, see Fig. 13.
- Use a shielded cable. Partial cable length less than 30 m with star synchronization, total cable length less than 30 m with cascaded synchronization. Connect the cable shield to 'Shield'.

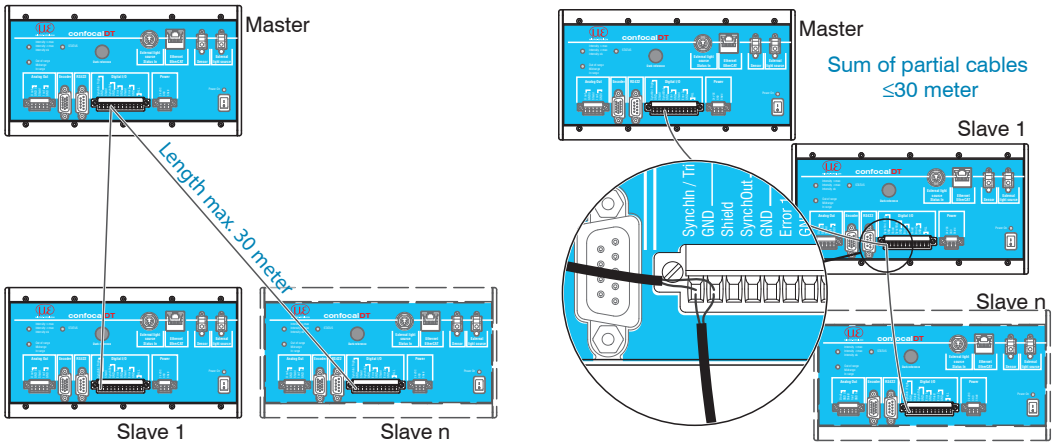


Fig. 13 Synchronization of more controllers, star synchronization (left), cascaded (right)

The number of connectable slaves is limited by the maximum permissible load capacitance CL at the sync output of the master. CL consists of the cable capacity (typ. 0.1 nF / m with twisted wires) and the input capacity of the slaves (Cin typ.1 nF).

CLmax at 100 Hz…10 kHz	80 nF		CLmax at 50 kHz	15 nF
CLmax at 25 kHz	30 nF		CLmax at 70 kHz	10 nF

1) Use the LLL operation if possible to reduce the power dissipation of the driver IC.

Depending on these conditions, the maximum number of controllers to be synchronized or the permitted total cable length can be determined graphically for synchronization, see Fig. 14.

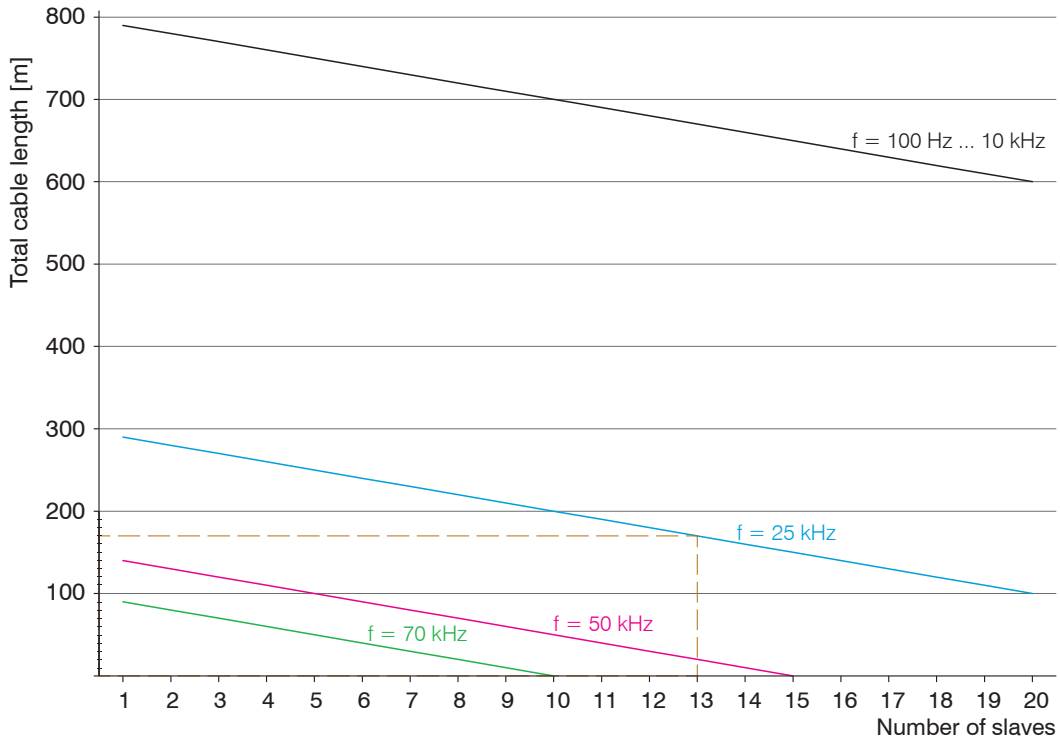


Fig. 14 Influence of the measuring rate on synchronization

Star synchronization	Cascaded synchronization
Example: measuring rate = 25 kHz, number of slaves = 13	
Solution: total cable length = 170 m,	
Partial cable length between master and slaves appr. 13 meter (170 m div. 13 slaves)	Partial cable length between the individual controllers appr. 2.3 meter (30 m div. 13 slaves)

General:

$$N = \frac{CL_{max.}\ [nF] + L\ [m] * 0.1\ [nF/m]}{C_{In}\ [nF]}$$

N	Number of slaves,
$CL_{max.}$	Max. permissible load capacitance,
L	Total cable length,
C_{In}	Input capacity slave (typ. 1 nF)

i If the controller are operated via the EtherCAT interface, then a synchronization even without the sync cable can be realized.

4.5.9 Encoder Inputs

Three encoders can be connected simultaneously and powered with 5V using the 15-pin HD-sub connector.

Each encoder provides A, B and N signals (zero pulse, reference, index).

The maximum pulse frequency is 1 MHz.

Values for A, B, N: TTL level

2.4 V ≤ High ≤ 5 V

0 V ≤ Low ≤ 0.5 V

Reference value: GND

Encoder supply 5 V: 5 V each, max. 150 mA

Fig. 15 15-pin HD connector

Encoder	Pin	Signal	Encoder	Pin	Signal	Encoder	Pin	Signal
1	5	A1	2	4	A2	3	3	A3
	15	B1		14	B2		13	B3
	10	N1		9	N2		8	N3
	1	GND1		6	GND2		11	GND3
	2	5V-1		7	5V-2		12	5V-3
	Cover	Screen		Cover	Screen		Cover	Screen

Fig. 16 Encoder In pin configuration

➡ Use a shielded cable of less than 3 m. Connect the cable shield to the cover.

Connection requirements

The signal refers to ground (GND). Tracks A and B of encoder n are connected to inputs An and Bn, with common ground GNDn. The inputs are not electrically isolated from the supply voltage.

4.5.10 Status Inputs for External Light Sources

The `Lifetime` and `Overheat` error details are transmitted through the status cable (included in the delivery of the external light source IFX2471) from the external light source IFX2471 to the controller IFC2471, see A 3.6.

Use of the status cable is optional, as the status LEDs on the light sources will also indicate the state.

The status signals are used internally to help the controller detect any external light source errors automatically and to issue warnings.

4.6 Sensor Cable, Optical Fiber

Sensor and controller are connected through an optical fiber.

- Do not shorten or lengthen the optical fibers.
- Do not pull or hold the sensor on the optical fiber.
- The optical fibers has a diameter of 50 µm.

Do not soil the connectors, because this would lead to particle deposition in the controller and therefore to strong loss of light. Cleaning of the connectors requires the corresponding know-how and a fiber microscope for control.

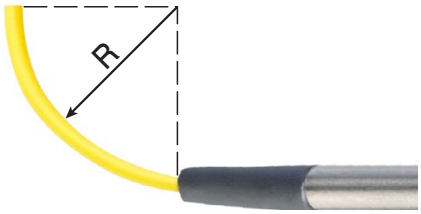
Basic Rules

NOTICE

Avoid

- any contamination of the connector, e. g. dust or finger prints, and frequent connecting and disconnecting
- any mechanical stress of the fiber (kinking, squeezing, pulling, twisting, knotting etc.)
- strong bending of the fiber. as the optical fiber is damaged thereby rapidly and this leads to permanent damage through micro-cracks

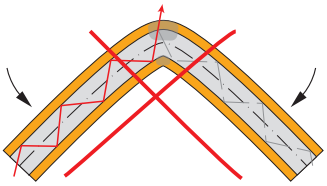
Please never underrun the allowed bending radius.



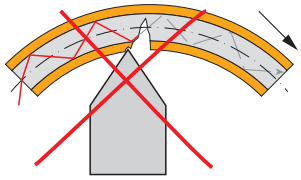
Fixed:
R = 30 mm or more

Flexible:
R = 40 mm or more

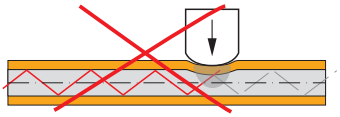
Do not kink the sensor cable.



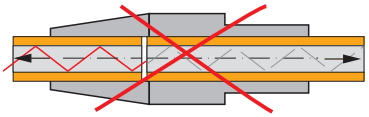
Please do not grind the sensor cable over sharp corners.



Do neither squeeze the sensor cable nor fix it by using cable ties.



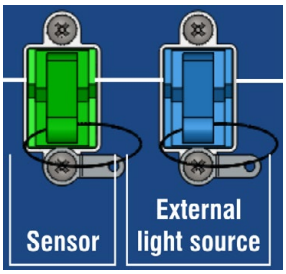
Do not pull the sensor cable.



Miniature sensors IFS2402, hybrid sensors IFS2403
The optical fibers are fixed to the sensor and cannot be replaced. Repairs involve reducing the cable length and a new connector through the manufacturer only.

Standard sensors IFS2405
The sensor cable is connected to the sensor. Sensor cables may be up to 50 m long. Cables for drag chain use and cables with protective metal tubing are available, see A 1. A damaged sensor cable can be replaced, see 7.2.

Connecting the sensor cable to the controller



- Remove the dummy connector from the green `Sensor` optical fiber socket on the controller.
- Plug the sensor cable (green connector, E2000/APC) into the optical fiber socket, and ensure that the sensor connector is aligned correctly.
- Push the sensor connector into the socket until it locks.

Disconnecting the sensor cable from the controller

- Push the sensor connector's release lever down, and pull the sensor connector out of the socket.
- Replace the dummy connector.

Optical fiber for the external light source

Connect the external light source and the controller with an optical fiber (blue connector, E2000/PC).

- Make sure that you connect the optical fiber to the external light source and the controller first, before switching on the external light source.

Step by step installation of the optical fiber for IFX2471

- Connect the optical fiber with the controller, and ensure that the connector is aligned correctly.
- Push the sensor connector into the socket until it locks.

Disconnecting the optical fiber from the controller

- Push the connector's release lever down, and pull the connector out of the socket.

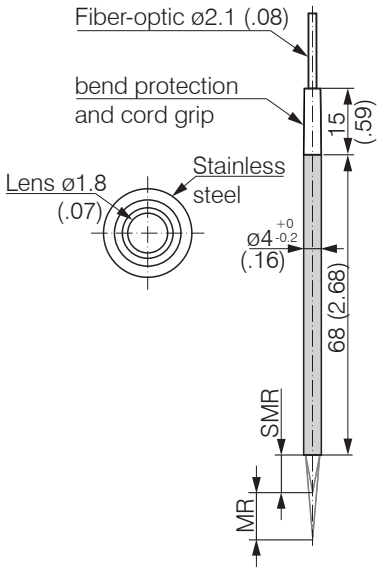
Fig. 17 Connecting the optical fiber to IFX2471

NOTICE

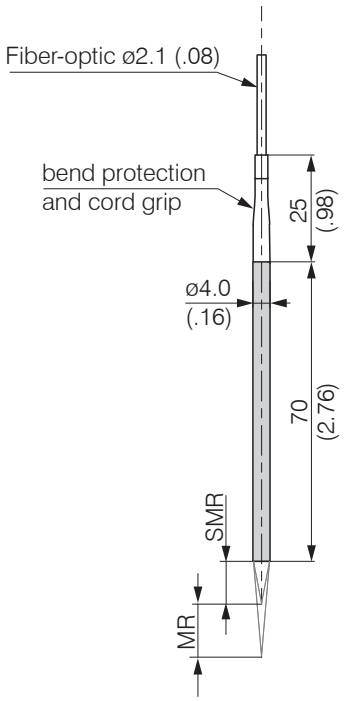
Close the optical inputs and outputs with protective caps when no fiber cable is connected.

4.7 Sensors

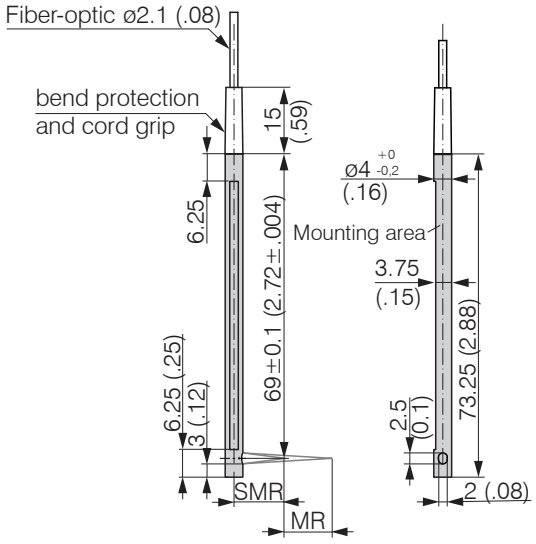
4.7.1 Dimensions IFS2402 Sensors



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



IFS2402-0,5

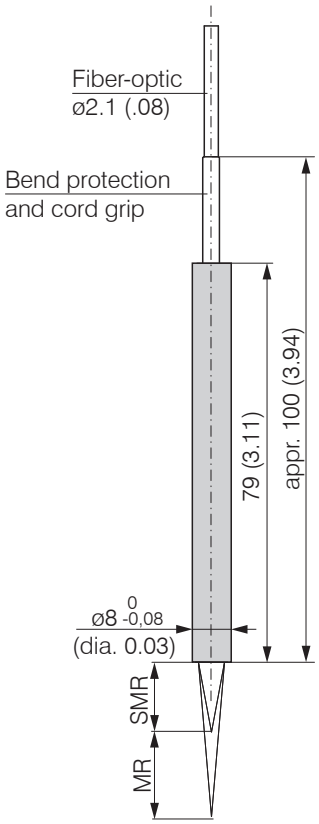


IFS2402/90-1,5/4/10

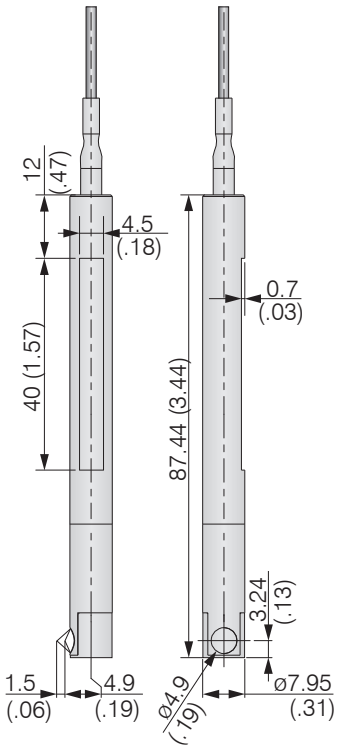
MR = Measuring range
SMR = Start of measuring range

Dimension in mm (Inch)

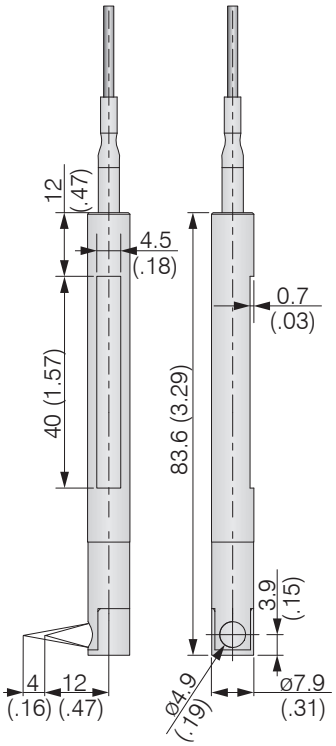
4.7.2 Dimensions IFS2403 Sensors



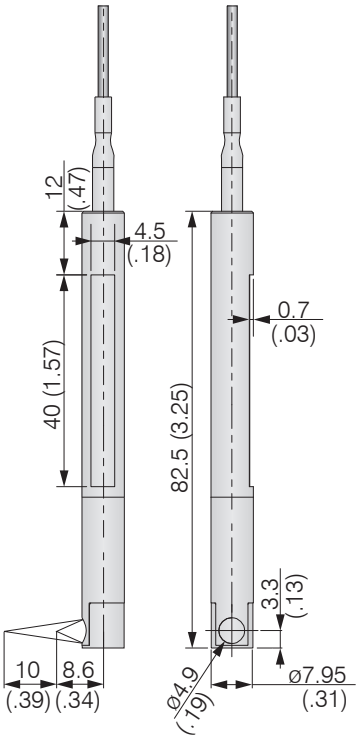
IFS2403 -0,4/1,5/4/10



IFS2403/90-1,5



IFS2403/90-4

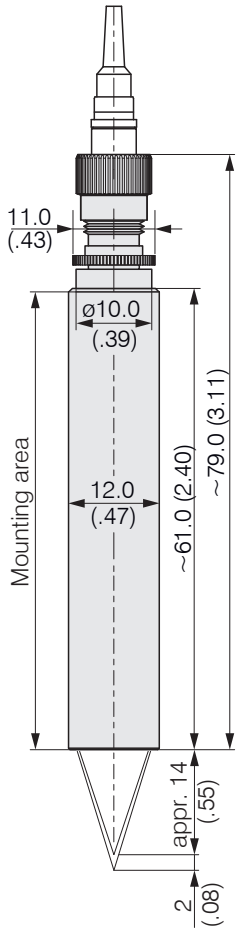


IFS2403/90-10

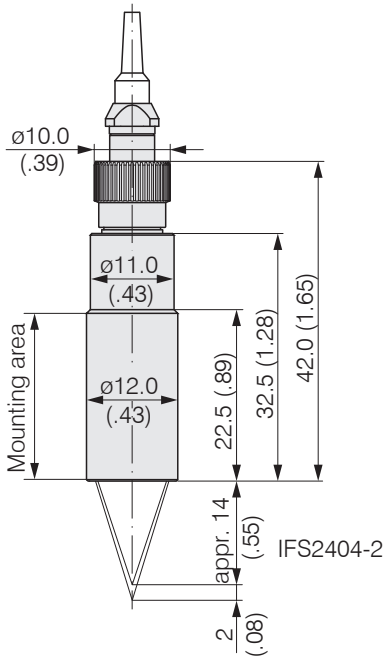
Dimension in mm (Inch)

MR = Measuring range
SMR = Start of measuring range

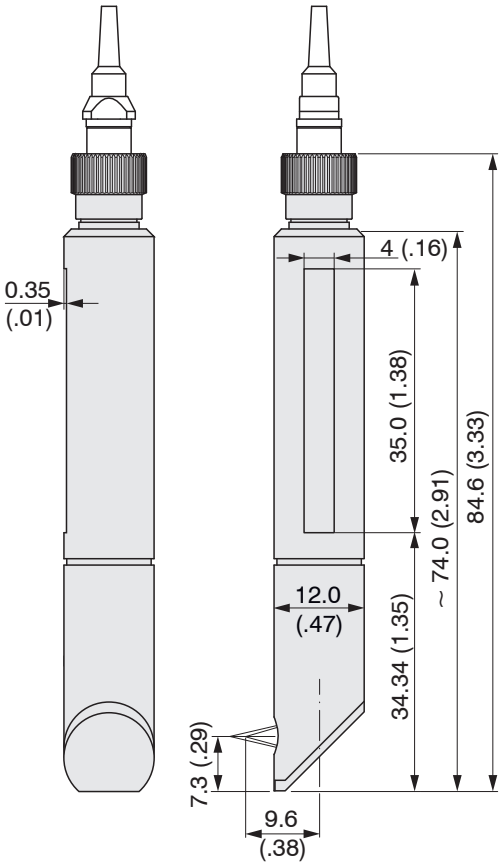
4.7.3 Dimensions IFS2404 Sensors



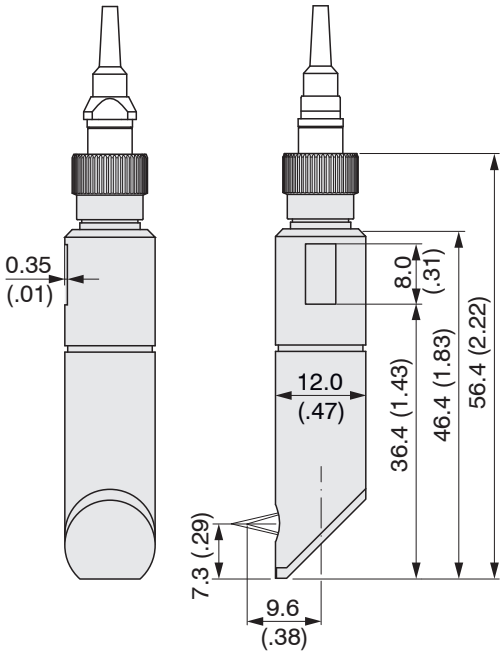
IFS2404-2(001)



IFS2404-2



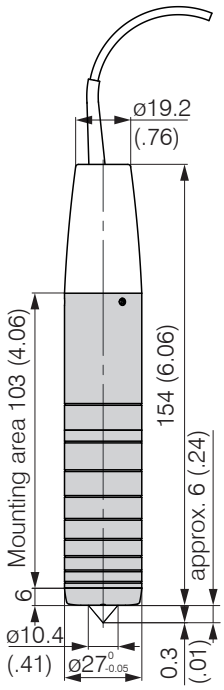
IFS2404/90-2(001)



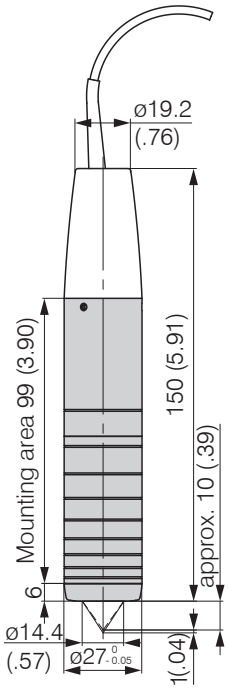
IFS2404/90-2

Dimension in mm (Inch)

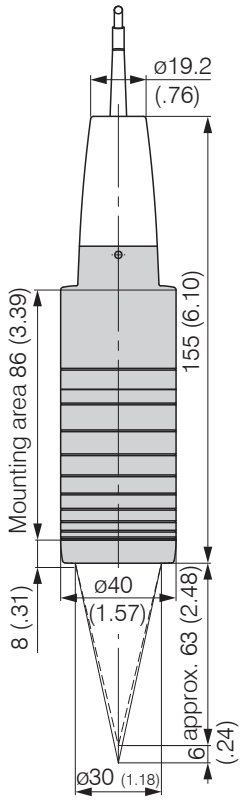
4.7.4 Dimensions IFS2405 Sensors



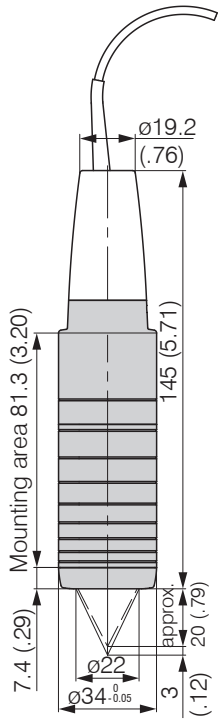
IFS2405-0,3



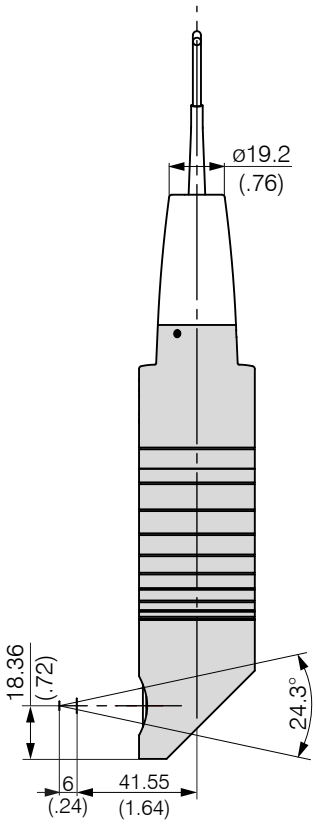
IFS2405-1

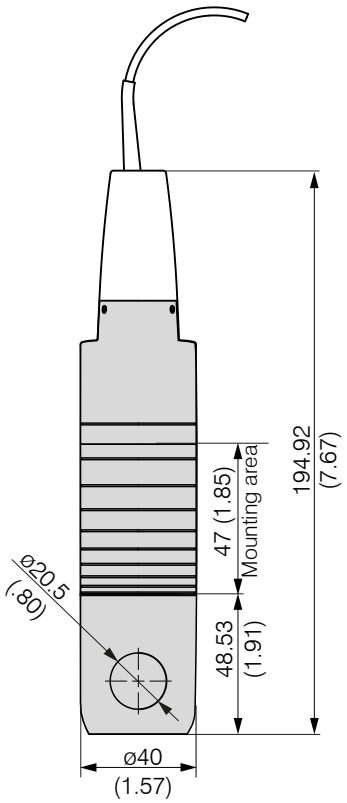


IFS2405-6



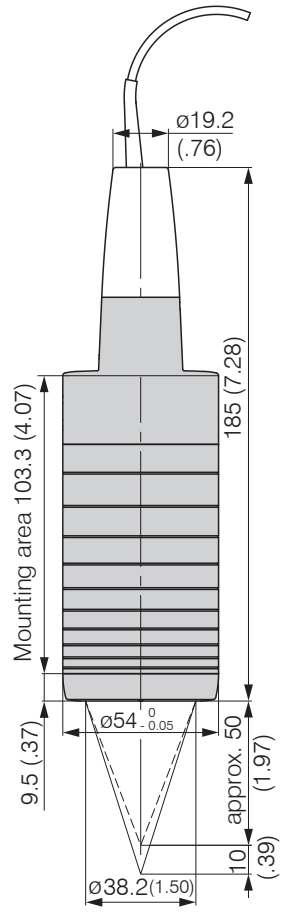
IFS2405-3



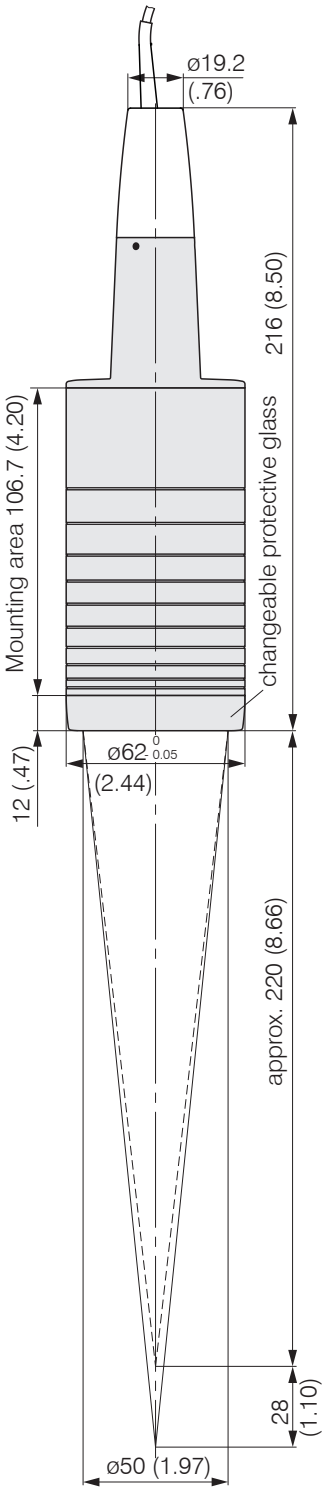


IFS2405/90-6

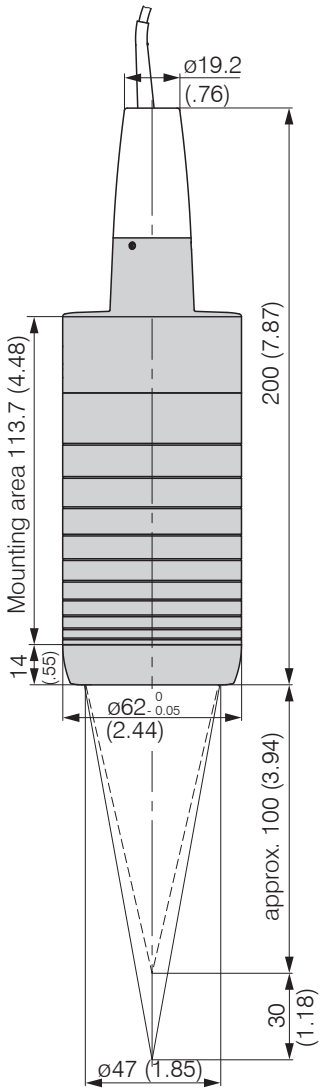
Dimension in mm (Inch)



IFS2405-10



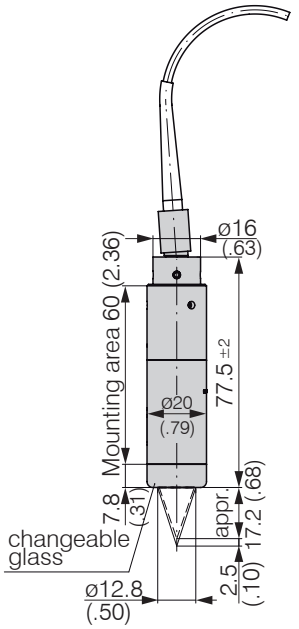
IFS2405-28



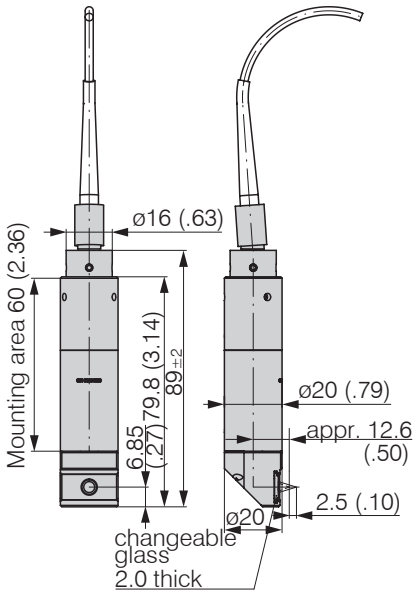
IFS2405-30

Dimension in mm (Inch)

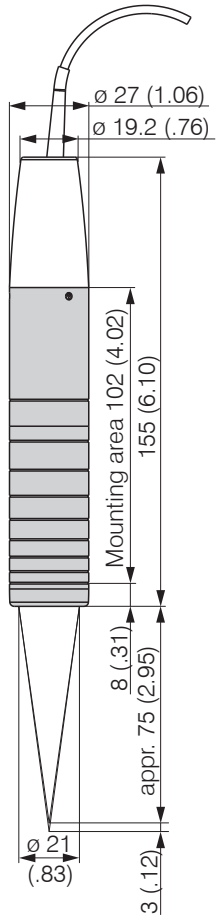
4.7.5 Dimensions IFS2406 Sensors



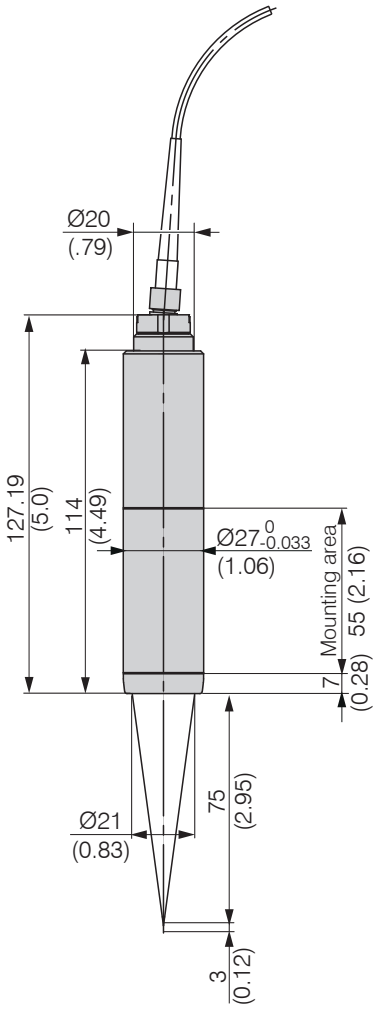
IFS2406-2,5/VAC(003)



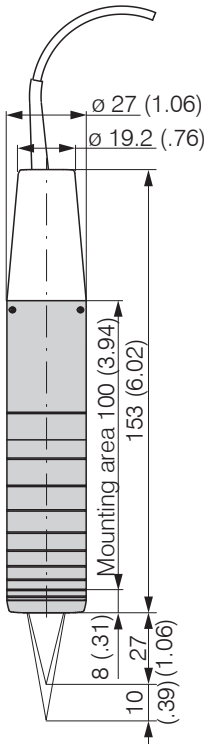
IFS2406/90-2,5/VAC(001)



IFS2406-3



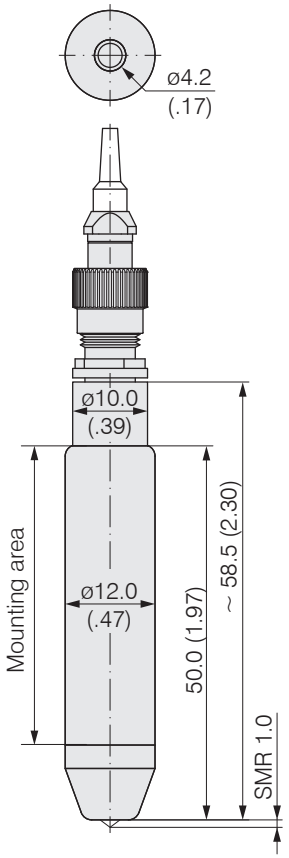
IFS2406-3/VAC(001)



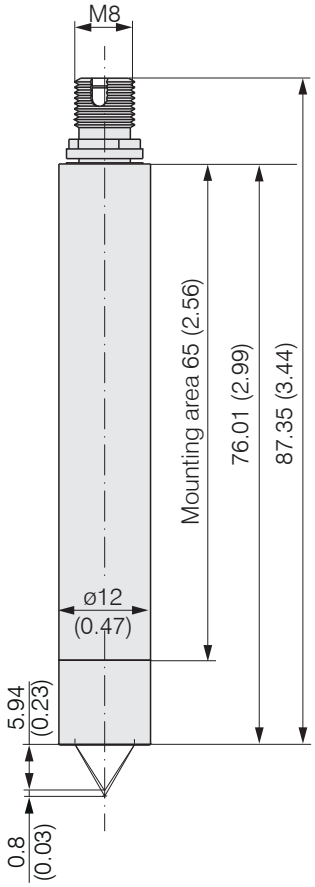
IFS2406-10

Dimension in mm (Inch)

4.7.6 Dimensions IFS2407 Sensors



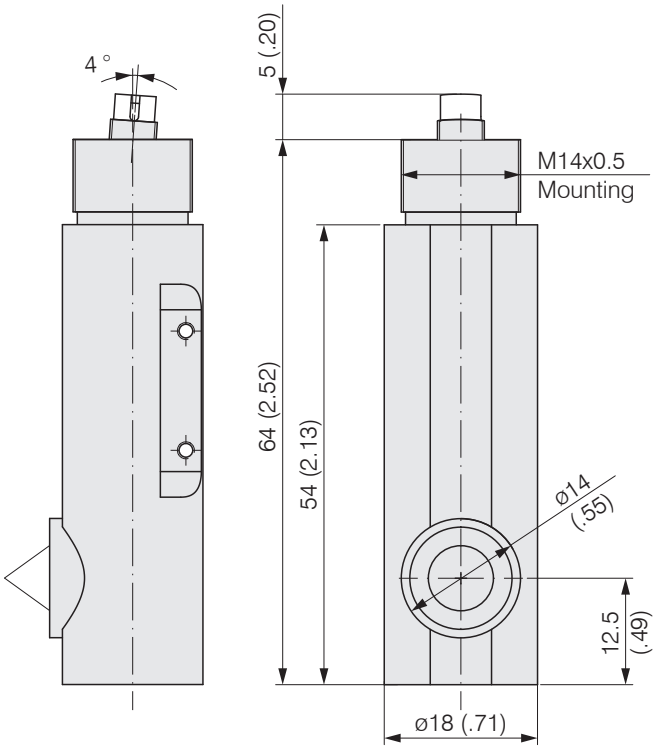
IFS2407-0,1

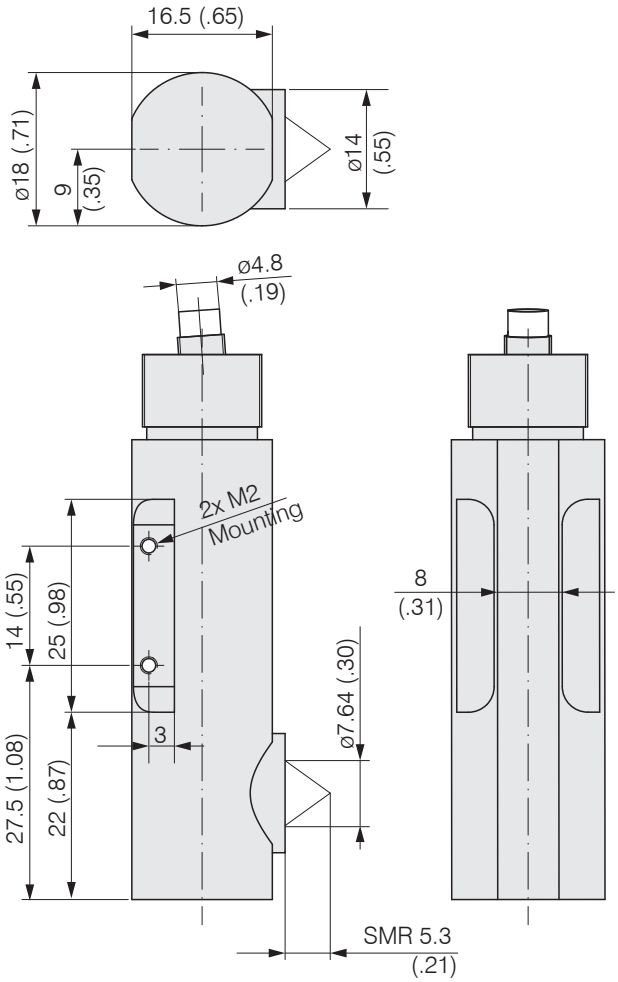


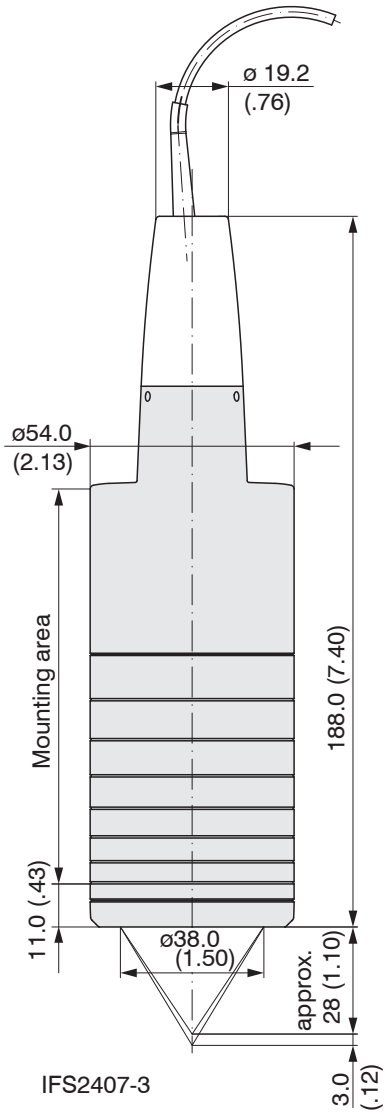
IFS2407-0,8

Dimension in mm (Inch)

IFS2407/90-0,3







Dimension in mm (Inch),
not to scale

4.7.7 Start of Measuring Range

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

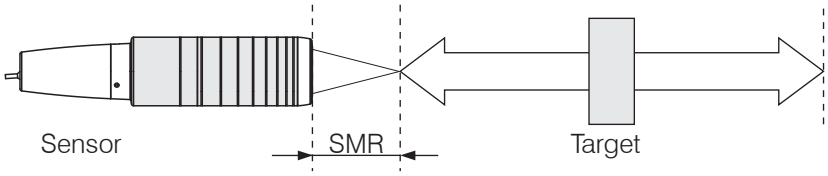


Fig. 18 Start of measuring range (SMR), the smallest distance between the sensor surface and the target.

SMR = Start of measuring range, approximate values

Sensor	SMR
IFS2402-0.4	1.5 mm
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 [1] mm
IFS2403-4	14.7 mm
IFS2403/90-4	12 [1] mm
IFS2403-10	11 mm
IFS2403/90-10	8.6 [1] mm

Sensor	SMR
IFS2404-2	14 mm
IFS2404-2(001)	14 mm
IFS2404/90-2	9.6 mm [1]
IFS2404/90-2(001)	9.6 mm [1]

Sensor	SMR
IFS2405-0,3	6 mm
IFS2405-1	10 mm
IFS2405-3	20 mm
IFS2505-6	63 mm
IFS2405/90-6	41 mm [1]
IFS2405-10	50 mm
IFS2405-28	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

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

1) Start of measuring range measured from sensor axis

4.7.8 Mounting an Installation Bracket

4.7.8.1 General

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

Please ensure careful handling during installation and operation!

Mount the sensors with a 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.

4.7.8.2 IFS2402 Sensors

Use an installation bracket MA2402 to mount IFS 2402 sensors.

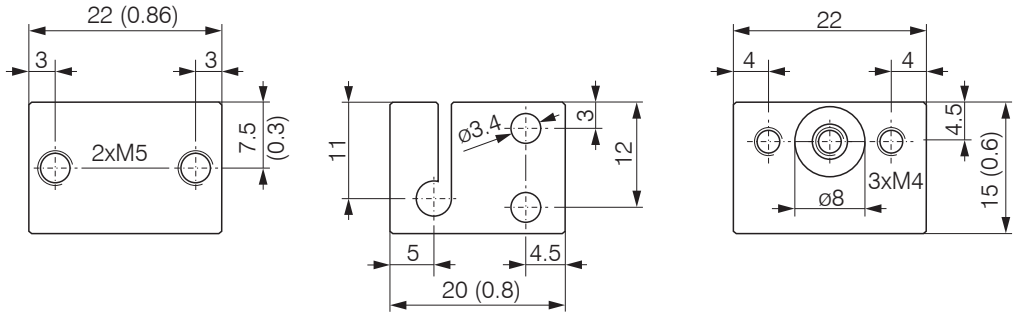


Fig. 19 MA2402-4 installation bracket

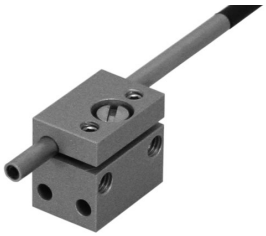


Fig. 20 Outer clamps with MA2402 for IFS2402 sensors

4.7.8.3 IFS2403 Sensors

Use an installation bracket MA2403 to mount IFS 2403 sensors.

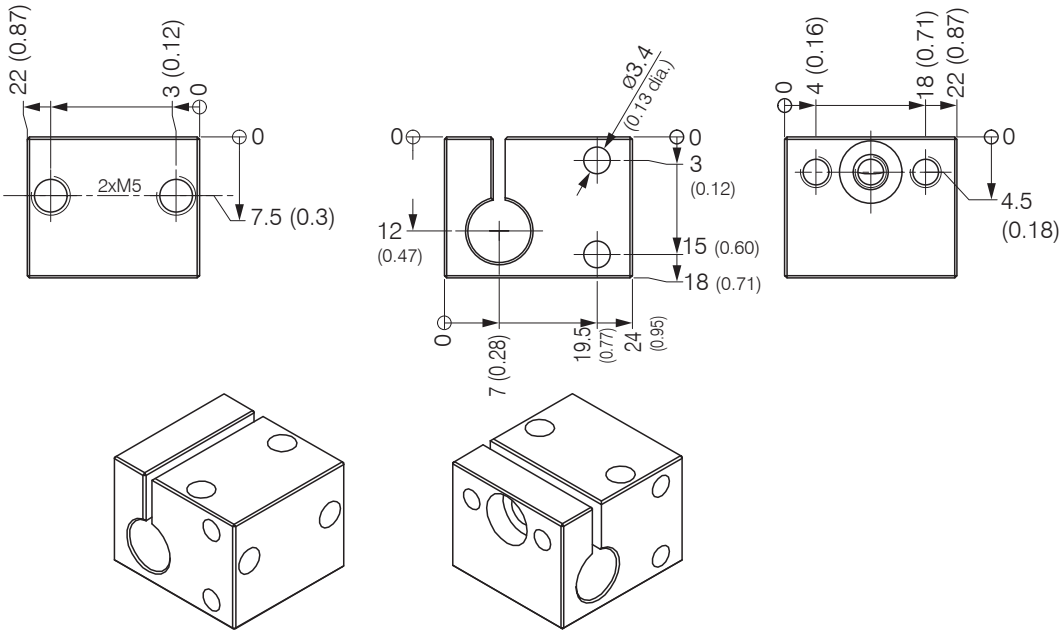
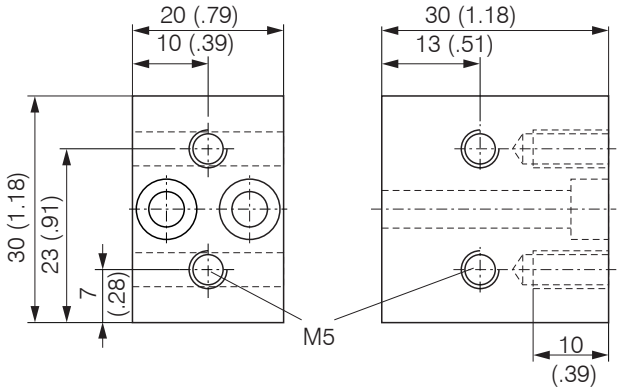


Fig. 21 MA2403 installation bracket

Dimension in mm (Inch)

4.7.8.4 IFS2405, IFS2406 and IFS2407 Sensors

Use an installation bracket MA240x to mount the sensors.



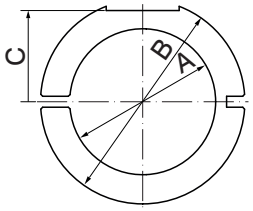
Installation ring		Length A	Length B	Length C	Sensor
MA2400-27		ø27	ø46	19.75	IFS2405-0.3 IFS2405-1 IFS2406-3 IFS2406-10
MA2405-34		ø34	ø50	22	IFS2405-3
MA2405-40		ø40	ø56	25	IFS2405-6
MA2405-54		ø54	ø70	32	IFS2405-10 IFS2407-3
MA2405-62		ø62	ø78	36.5	IFS2405-28 IFS2405-30
MA2406-20		ø20	ø36	14.5	IFS2406-2.5

Fig. 22 MA240x installation block and ring

Fig. 23 Outer clamps with installation bracket MA240x for IFS2405, IFS2406 and IFS2407 sensor, consisting of mounting block and mounting ring

Dimension in mm (Inch)

4.7.8.5 IFS2404 and IFS2407 Sensors

➥ Use an installation bracket MA2404-12 to mount IFS2404-2, IFS2404/90-2, IFS2407-0,1 and IFS2407-0,8 sensors.

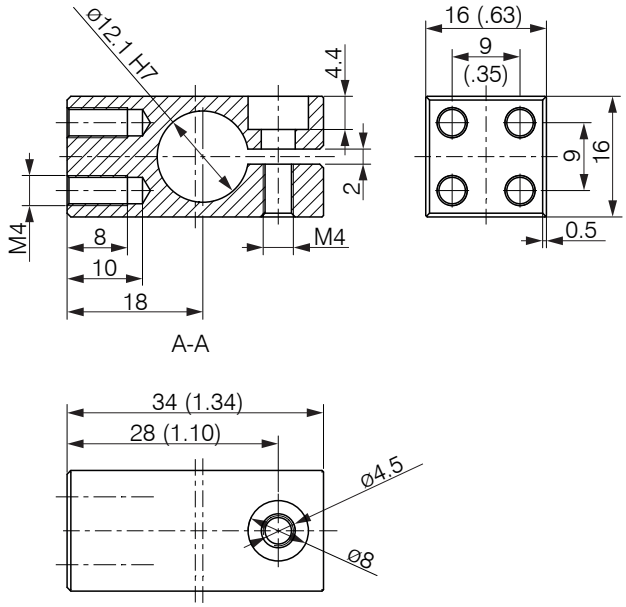


Fig. 24 Outer clamps with installation bracket MA2404-12 for IFS2404-2, IFS2404/90-2, *IFS2407-0,1 and IFS2407-0,8 sensors, dimension in mm (Inch)*

➥ Use the mounting area and two screws M2 or the mounting thread M14x0,5 to mount IFS2407/90 sensors.

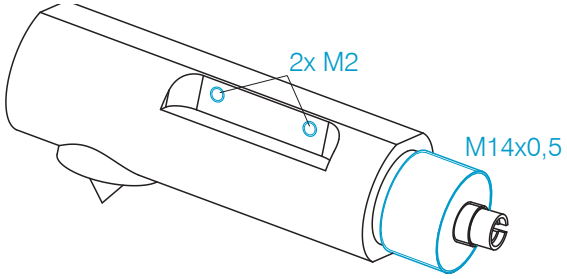


Fig. 25 Mounting for series IFS2407/90-0,3 sensors

4.7.8.6 Adjustable Mounting Adapter JMA-xx

The JMA-xx adjustable mounting adapter is compatible with numerous confocalDT sensor models. You can find more information on these accessories in the Appendix, see A 5.

5. Operation

5.1 Commissioning

- Connect the controller to a voltage supply, see 4.5.3.
- Connect the sensor and the controller with the optical fiber (sensor cable), see 4.6

If you use controller IFC2471 with an IFX2471 external light source, the following applies:

- Connect the controller and the external light source with the optical fiber and the status cable.
- Connect the external light source to the mains power supply.
- Switch on the external light source, then switch on the controller using the `Power` switch.

When the controller has been switched on it initializes. The measuring system is ready after approx. 10 seconds. To ensure precise measurements, let the measuring system warm up for about 60 minutes. The system can be configured through web pages that are integrated into the controller or using commands, see A 7. We recommend configuring the controller through the web pages.

5.2 Operation Using Ethernet

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

5.2.1 Requirements

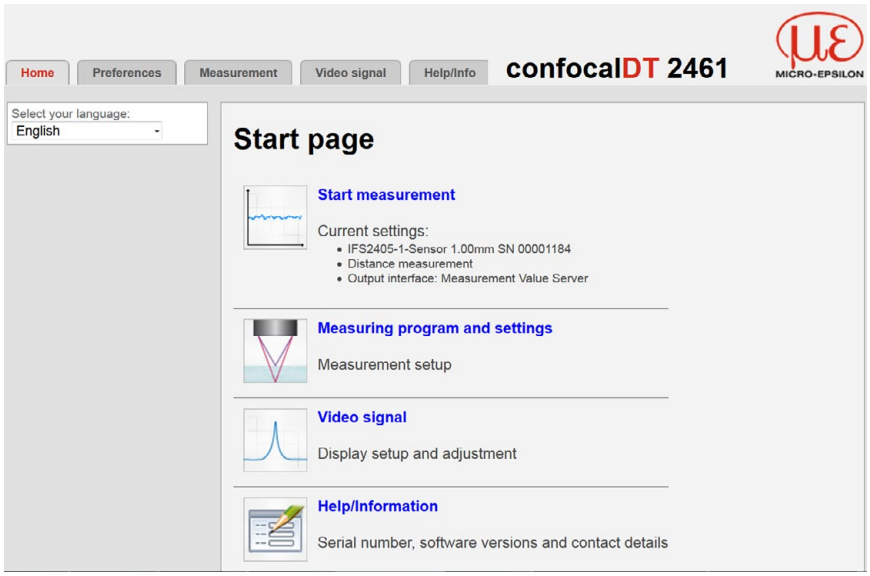
To support a basic first commissioning of the sensor, the sensor is set to a direct connection.

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

i You need a HTML5 browser. Use one of the browsers below:
Internet Explorer 11.0 | Mozilla Firefox 19.0 | Google Chrome 25.0

<table>
<tr><th colspan="2">Direct connection to PC, controller with static IP (Factory setting)</th><th>Network</th></tr>
<tr><th>PC with static IP</th><th>PC with DHCP</th><th>Controller with dynamic IP, PC with DHCP</th></tr>
<tr><td colspan="2">➨ Connect the controller to a switch (intranet). Use a LAN cable with RJ-45 connectors.</td><td>➨ Connect the controller to a switch (intranet). Use a LAN cable with RJ-45 connectors.</td></tr>
<tr><td>➨ Start the sensorTOOL.exe program.</td><td>Wait until Windows has established a network connection (Connection with limited connectivity).
➨ Start the sensorTOOL.exe program.</td><td>➨ Enter the sensor in the DHCP / register the controller in your IT department.
The controller gets assigned an IP address from your DHCP server. You can check this IP address with the sensorTOOL.exe program.
➨ Start the sensorTOOL.exe program.</td></tr>
<tr><td colspan="3">This program is available online at https://www.micro-epsilon.com/download/software/sensorTOOL.exe.</td></tr>
<tr><td>➨ Click the button.
Select the designated controller from the list. In order to change the address settings, click the button <code>Configure sensor IP</code>.
• IP type: static
• IP address: 169.254.168.150 [1]
• Subnet mask: 255.255.0.0
➨ Click the button <code>Apply</code>, to transmit the changes to the controller.
➨ Click the button <code>Open Website</code> to connect the controller with your default browser.
1) Requires that the LAN connection on the PC uses, for example, the following IP address: 169.254.168.1.</td><td>This program is available online at https://www.micro-epsilon.de/download/software/sensorTOOL.exe.
➨ Click the button.
Select the designated controller from the list.
➨ Click the button <code>Open Website</code> to connect the controller with your default browser.</td><td>➨ Click the button.
Select the designated controller from the list.
➨ Click the button <code>Open Website</code>, to connect the controller with your default browser.
Alternatively: If DHCP is used and the DHCP server is linked to the DNS server, access to the controller via a host name of the structure “IFC24x1_SN <serial_number>” is possible (where x = 5 for IFC2451, x = 6 for IFC2461, x = 7 for IFC2471).
➨ Start a web browser on your PC. To achieve a IFC2461 with the serial number “01234567”, type in the address bar on your browser “IFC2461_SN01234567”.</td></tr>
<tr><td colspan="3">Interactive web pages for setting the controller and peripherals are now shown in the web browser.</td></tr>
</table>

5.2.2 Access via Ethernet



Use the upper navigation bar to access additional features (settings, video signal etc.).

All settings on the web page are applied immediately in the controller after pressing the `Submit` button.

Fig. 26 First interactive web page after calling the IP address

Parallel operation with keyboard and web browser is possible; the last setting applies. Do not forget to save your settings.

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

5.2.3 Measured Value Presentation with Ethernet

➪ Start `Measurement` display in the horizontal navigation bar.

Diagram control and display are done in the browser with HTML5 which will continue to run independently from the controller (which will also continue to operate separately).

i By letting the diagram display run in a separate tab or browser window, you avoid having to restart the display every time.

➪ Click the `Start` button to begin displaying measurement results.

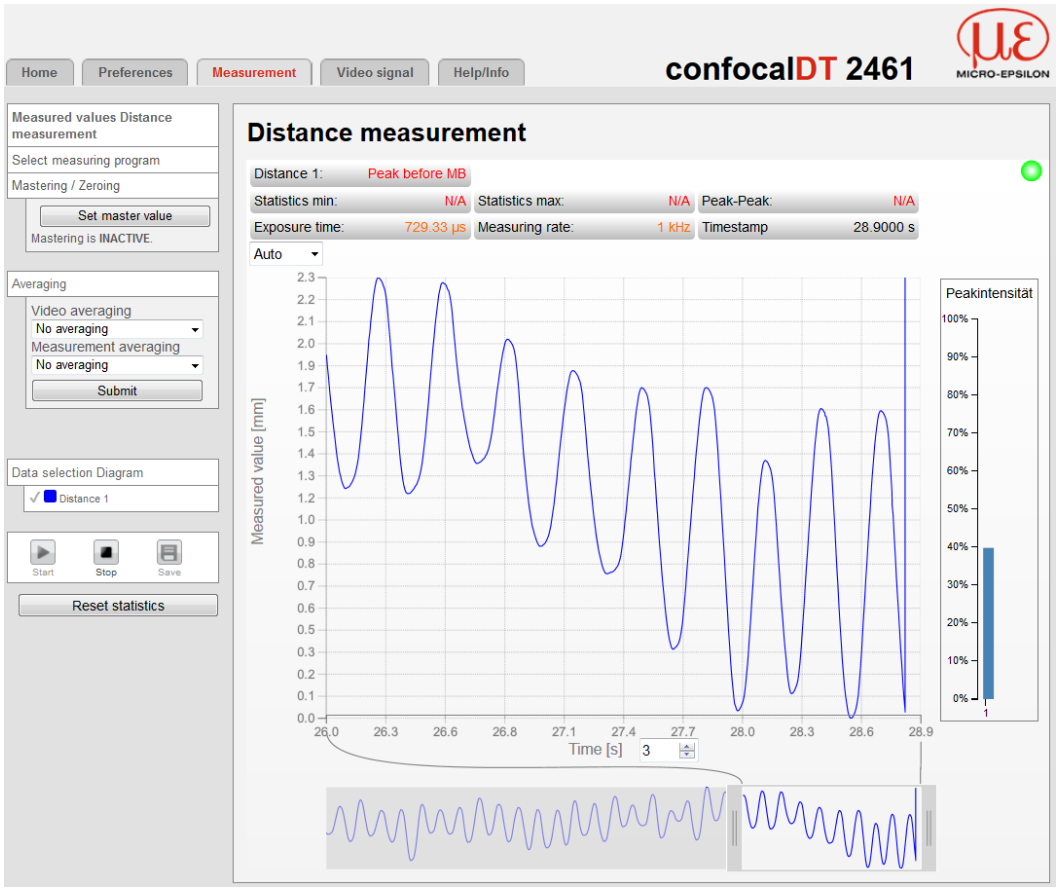


Fig. 27 Displaying measuring results

5.3 User Interface, Basic Preferences

5.3.1 Introduction

The following chapters describe any controller settings that are required to get started and quickly achieve first measuring results.

You can access additional submenus, e.g. for measuring rates and triggers, through the navigation bar on the left side of a web page.

i When programming has been completed, all settings must be permanently stored in a set of parameters to ensure that these settings will be available when the sensor is switched on the next time.

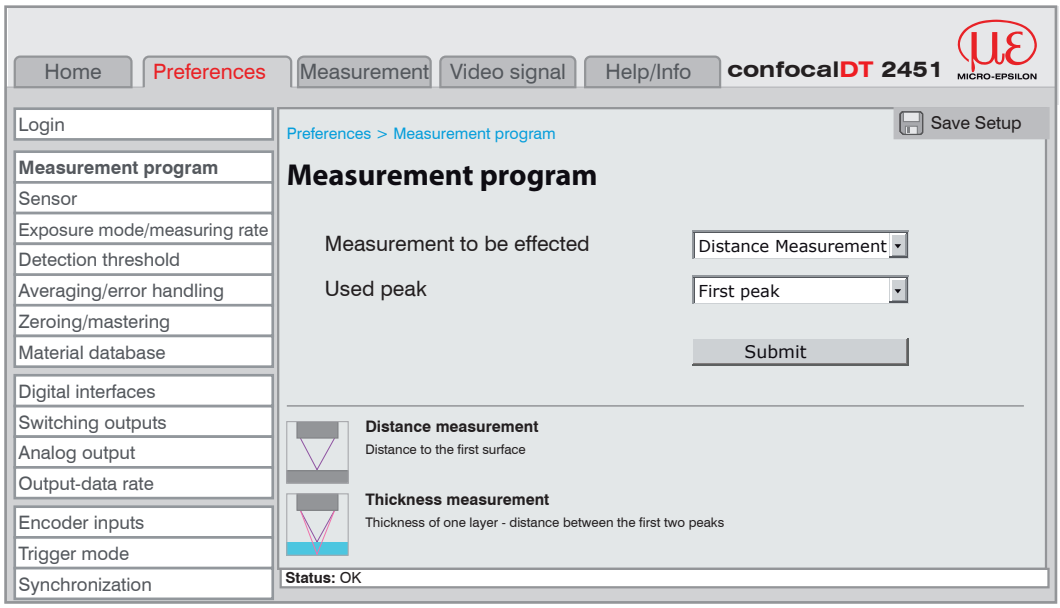
Some parameters are only available in the controller IFC24x1MP. This is characterized by a separate formatting.

Distance measurement	Parameter available with controller IFC24x1 and controller IFC24x1MP
Thickness measurement	
Multilayer measurement	Parameter available with controller IFC24x1MP

For details about other measuring control settings and features, such as setting masters or triggers, see 6.

5.3.2 Measurement Program

➪ Select the desired type of measurement program from the list:



Type of measurement	*Distance*	Used peak	*first / highest / last peak*	*Distance to n-th surface, depends on the selected peak*
	Thickness	Used peak	*first and second / first and last / second to last and last / highest and second highest peak*	*One-sided thickness measurement of transparent materials; the relevant material needs to be selected (refractive index).*
		Selection of material	*Vacuum / water ...*	
	Multilayer measurement			*Selectable distances for up to 6 peaks*
				Use refractive correction: Yes / No
				Material between Peak 1 / 2 ... 6 and Peak 2 / 3 ... 6

i The selected measuring program is used as the standard measuring program on startup.

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

MP Parameter available with controller IFC24x1MP

5.3.3 Material Database

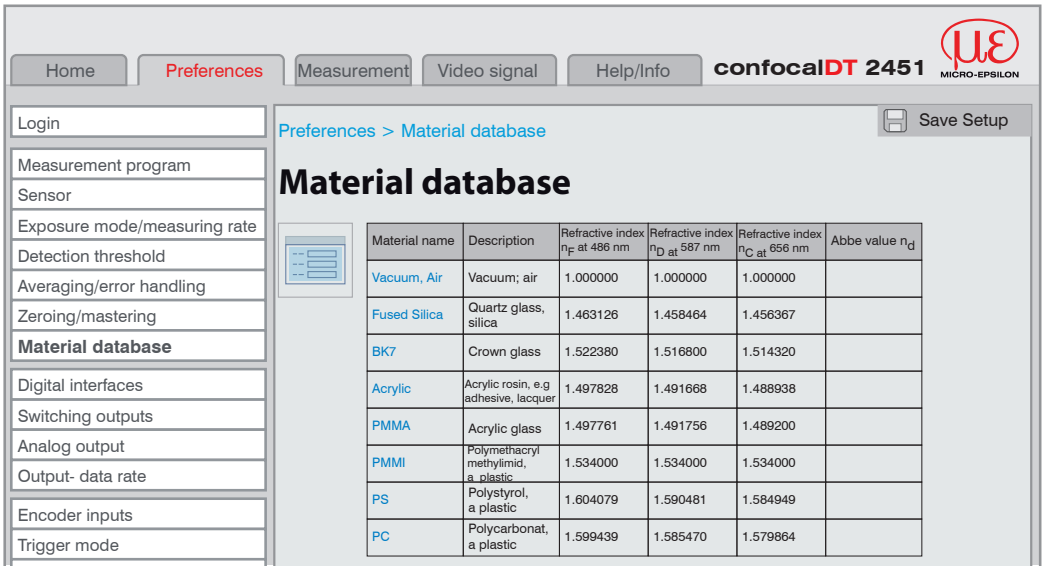
Select Material

One-sided thickness measurements require the refractive index of the transparent material to calculate the actual thickness. For this purpose, different material data are stored in the controller.

You can select the transparent material in the Thickness Measurement program, see 5.3.2.

- Select the transparent material to be used for measuring the thickness.
- Click `Submit` to confirm your selection.

The controller stores a material table that can be modified and added to, see 6.17.

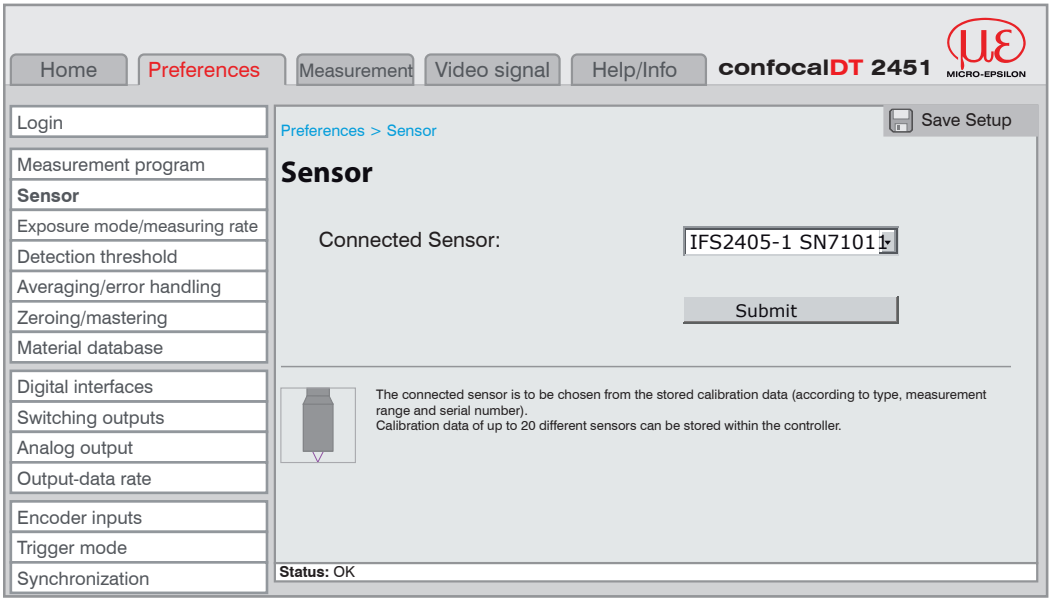


Micro-Epsilon assumes no responsibility for the stored material parameters.

5.3.4 Selecting a Sensor

Controller and sensor(s) are matched at the factory.

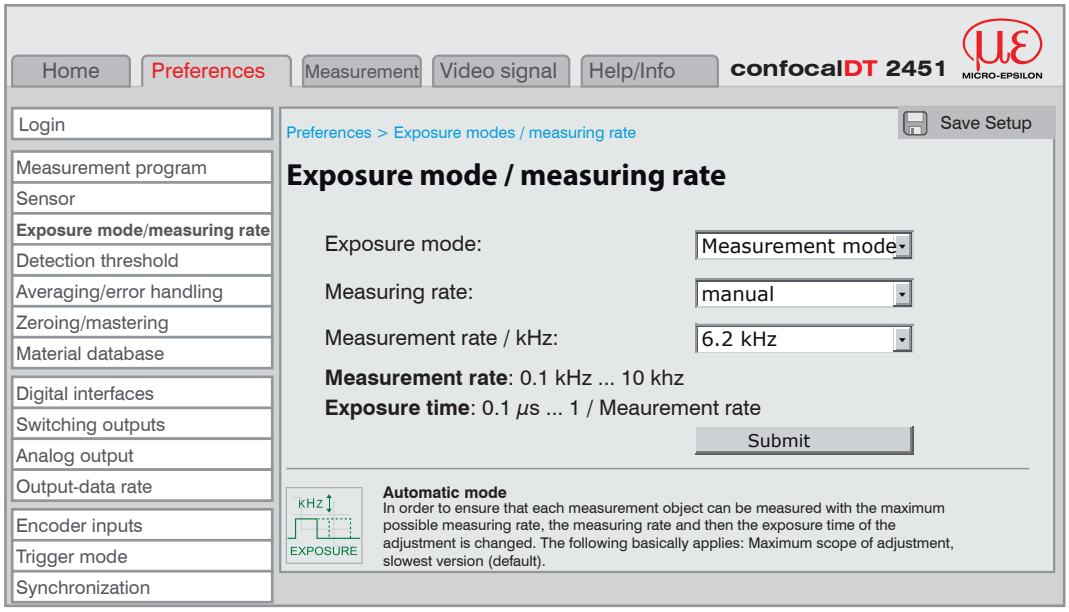
- Select the connected sensor (type, range and serial number) from the list.
- Click `Submit` to confirm your selection.



The calibration data of up to 20 different sensors can be stored in the controller.

5.3.5 Exposure Mode / Measuring Rate

To select the exposure mode click Settings > Exposure mode/Measuring rate.



Exposure mode/ Measuring rate	Exposure mode	*Automatic mode / Measurement mode / Manual mode / Alternating two time mode / Automatic two time mode*
	Measuring rate (IFC2451)	*0.1 / 0.2 / 0.3 / 1 / 2.5 / 5 / 10 kHz / manual*
	Measuring rate (IFC2461)	*0.1 / 0.2 / 0.3 / 1 / 2.5 / 5 / 10 / 25 kHz / manual*
	Measuring rate (IFC2471LED)	*0.1 / 1 / 2.5 / 5 / 10 / 25 / 50 / 70 kHz / manual*
	Measuring rate (IFC2471)	*0.3 / 1 / 2.5 / 5 / 10 / 25 / 50 / 70 kHz / manual*
	Exposure time 1 in µs	*Value (0.1 µs and 10.000 µs IFC2451)*
		Value (0.1 µs and 10.000 µs IFC2461)
		Value (0.1 µs and 3333.3 µs IFC2471/2471LED)
	Exposure time 2 (shorter) in µs	*Value (smaller than Exposure time 1)*

➪ Select the required exposure mode.

`Automatic mode`. Defines the exposure time and automatically sets the relevant measuring rate to ensure that the maximum measuring rate is used for each target. The following principles apply: maximum control range, lowest measuring rate (standard setting). Lasts 1 up to a maximum of 7 measurement cycles (change from no target too good reflective target).

`Measurement mode`. Maintains the required or suitable measuring rate, and adjusts only the exposure time. 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 too good reflective target with 0.1 kHz measuring rate).

`Manual mode`. No automatic adjustments. Set (optimized) values are maintained. This makes sense for fast changes due to targets with identical surfaces moving in and out or for highly dynamic movements (no overshoots). 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.

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

`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 fast changing surface properties, such as mirrored or anti-glare glass.

`Alternating two time mode`. Operating mode with two manually preset exposure times that are 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 overshoots. A possible set video averaging is ignored here.

➨ Select the required measuring rate.

- IFC2471: 0.3 kHz; 1 kHz; 2.5 kHz; 5 kHz; 10 kHz; 25 kHz; 50 kHz and 70 kHz;
- IFC2471LED: 0.1 kHz; 1 kHz; 2.5 kHz; 5 kHz; 10 kHz; 25 kHz; 50 kHz and 70 kHz;
- IFC2461: 0.1 kHz; 0.2 kHz; 0.3 kHz; 1 kHz; 2.5 kHz; 5 kHz, 10 kHz, 25 kHz
- IFC2451: 0.1 kHz; 0.2 kHz; 0.3 kHz; 1 kHz; 2.5 kHz; 5 kHz; 10 kHz.

Select `manual` to set the measuring rate with 100 Hz step size.

The applicable range of values for the current exposure time is displayed underneath the selection list.

➨ Click `Submit` to confirm your selection.

When selecting the measuring rate, take the video signal into consideration, see 5.4.

Step-by-Step procedures:

➨ Place the target in the midrange, see Fig. 28. Keep adjusting the measuring rate until you get a high signal intensity that is not oversaturated.

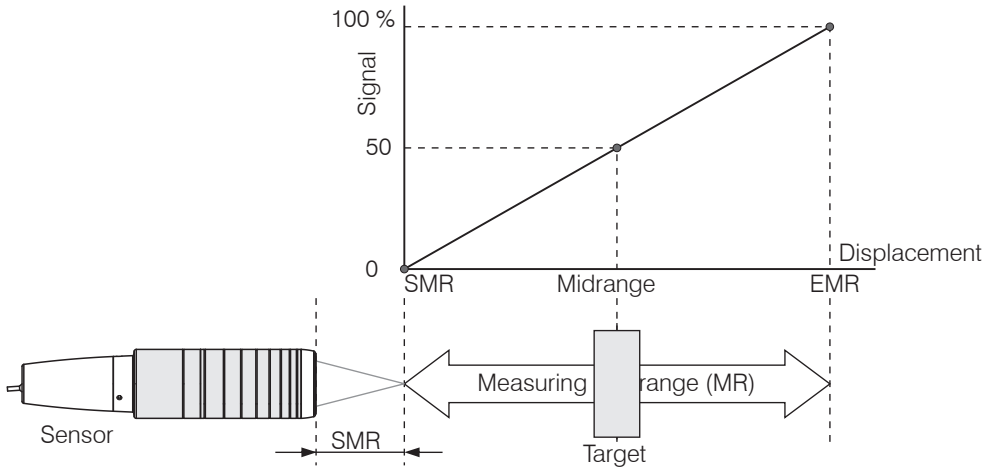


Fig. 28 Defining measuring range and output signal

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

Red	Signal in saturation
Yellow	Signal too low
Green	Signal ok

- If the `Intensity` LED changes to red, reduce exposure time or increase the measuring rate.
- If the `Intensity` LED changes to yellow, increase exposure time or reduce the measuring rate.

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

➨ If necessary, change to `manual mode`.

➨ 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 orange) or saturated (`Intensity` LED is red), the sensor will carry out measurements, but measuring accuracy might not correspond to the specified technical data.

5.4 Video Signal

After launching `Video signal` the following page is displayed. The diagram displayed in the large graph window on the right represents the video signal and the receiving row in different states of post processing.

The video signal displayed in the graph window displays the spectral distribution of the pixels in the receiving row. 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 web page is loaded.

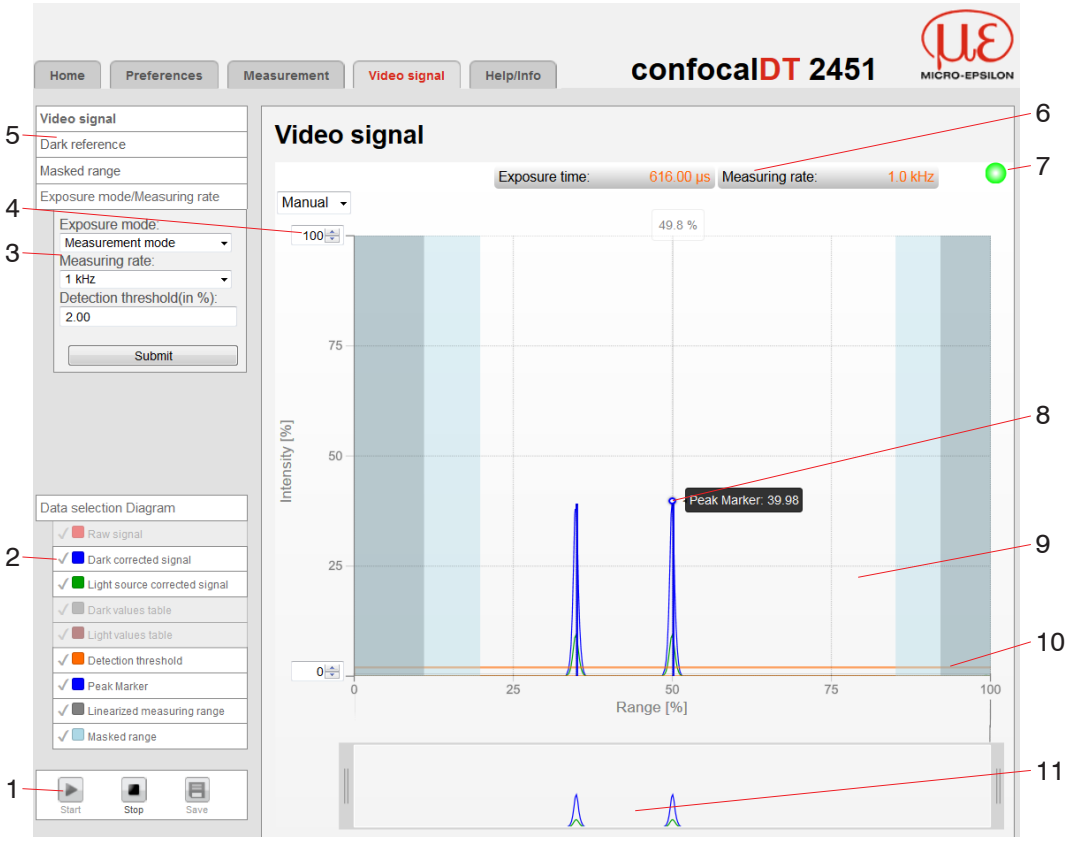


Fig. 29 `Video signal` *web page*

The `Video signal` web page includes the following features:

1 After clicking `Stop` data selection and zooming is still possible. Use the button `Save` to open the Windows dialog box for selecting the file name and location of video signals or correction tables in order to save them as CSV file that contains all pixels. Their (selected) intensities are output in % and further parameters.

2 In the window on the left, the video graph can be enabled or disabled both during and after measuring. Inactive graphs are grey. Click on the check mark to add them. If you want to have displayed one single signal, click on its name.

- Raw signal (uncorrected CCD signal, red)
- Dark corrected signal (raw signal minus dark level table, blue)
- Light source corrected signal (signal which is corrected with the dark signal and the light source table, green),
- Dark value table (table generated in response to dark referencing, grey)
- Light value table (table generated in response to light referencing, brown)
- Recognition threshold , changeable (horizontal orange line)
- Peak marking (vertical blue line), corresponds to the evaluated measured value
- Linearized measuring range (limited by grey hatching), not changeable
- Masked range (limited by pale blue hatching), changeable

3 In the window on the left you can quickly adjust exposure mode, measuring rate and recognition threshold (in %). Click `Submit` to accept the new values.

4 `Auto` (= automatic scaling) or `Manual` (= manual setting) allow for scaling the intensity axis (Y axis) of the graph.

5 From the `Video signal` page, you can launch the `Dark reference` and `Masked range` directly, see 5.7.

6 In addition, the current exposure time values and the selected measuring rate are displayed above the graph.

7 Status Display

- Green: OK; data transfer is active
- Yellow: data transfer is stopped
- Red: sensor connection is disturbed

8 Mouseover feature. When moving the mouse over the graph, curve points or peak markings are highlighted with a circle symbol while the corresponding intensity is displayed. The corresponding x position is displayed in % above the graph window.

9 The linearized range is in the diagram between the grey hatchings and can not be changed. Only peaks of which the centers are in this range can be evaluated. The masked range may be limited if needed. Then an additional pale blue hatching limits the range on the right and on the left side. The peaks remaining in the resulting range are used for evaluation.

10 The recognition threshold, based on the dark corrected signal, is a horizontal straight line that corresponds to the preset value. It needs to be just high enough that no undesired video signal peak is included in the measurement. An acceptable signal-to-noise ratio requires the threshold to be as low as possible. The recognition threshold should not be changed if possible.

11 X axis scaling: The diagram displayed above is zoomable with both sliders on the right and on the left side in the lower total signal. Move it sideways also with the mouse in the center of the zoom window (cross arrow).

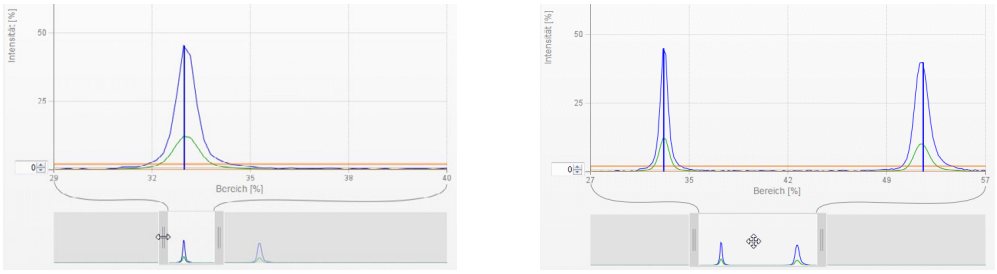
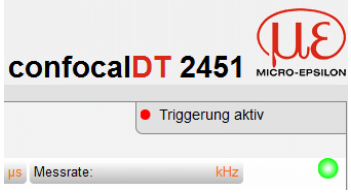


Fig. 30 Slider zoom: one-sided (left) and dragging with cross arrow (right)

In the state of active triggering, see figure, a trigger impulse is required that sets off the video signal. This indicates the display at the top right in the window. The status display may nevertheless be green. Exposure time and measuring rate are not displayed. Recommendation: switch off triggering while the video signal is displayed.



5.5 Dark Reference

This adjustment must be carried out after every sensor change. Dark referencing is sensor-dependent and is stored separately in the controller for each sensor. Therefore, you need to connect the required sensor and select Settings menu > Sensor, before you start dark referencing.

The controller requires a warm-up time of approx. 30 minutes before capturing dark signals.

Step-by-Step procedures:

➪ Remove the target from the measuring range, or cover the sensor surface with a piece of dark paper.

i For dark referencing, no object must be within the measuring range, and no ambient or external light must reach the sensor.

➪ On the controller, press the `Dark reference` button [1], or click the `Start dark reference` button on the `Dark reference` web page.

The `Intensity` and `Range` LEDs will start flashing, and the sensor captures the current dark signal for about 20 seconds.

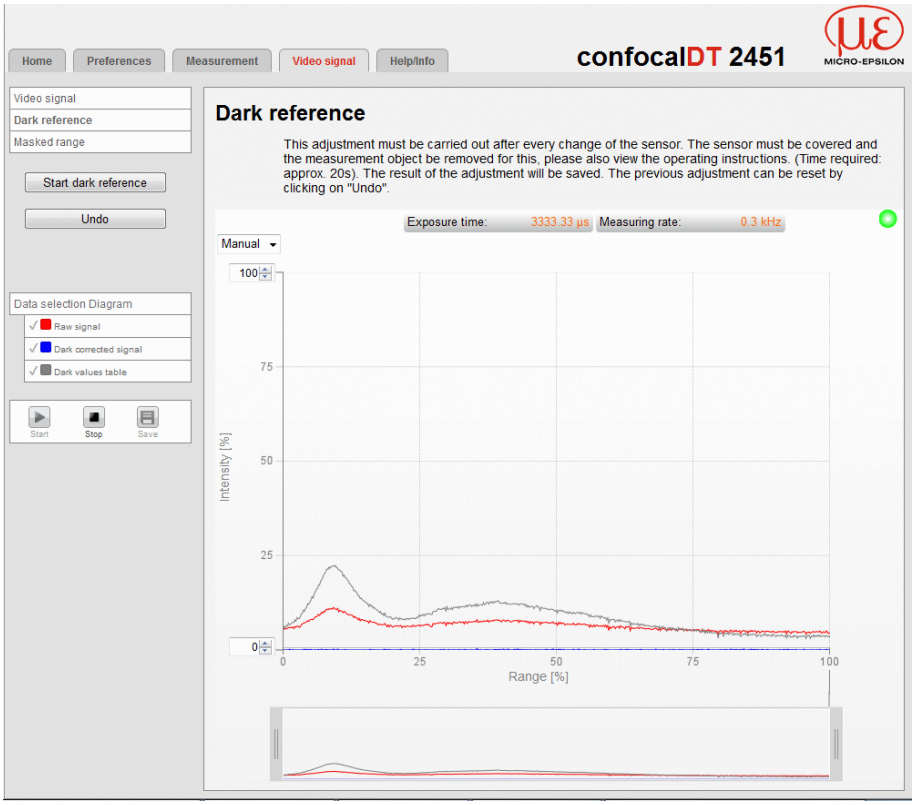


Fig. 31 `Dark reference` *video signal (example: IFC2451 with LED light source)*

After the dark referencing the dark corrected signal is characterized by an almost smooth waveform directly to the X-axis.

➪ Remove the paper cover from the sensor. The sensor can now be used as normal.

i Click `Undo` to reset the previous adjustment. You need to repeat dark referencing after replacing the lamp in the external light source. And for controller IFC2451, IFC2461 and IFC2471LED with an internal LED light source you will also need to carry out dark referencing at regular intervals.

The current brightness value (as the quotient of the sum of all intensities and the current exposure time), is determined with each new darkness correction. If a major change in the previously stored value is detected, this can be interpreted as the degree of contamination, and a warning is given.

You can also ignore this message. However, you should note the current exposure

1) After more than 10 seconds, the factory settings will load!

time in the case of time-critical measurements. Then gently clean the face of the sensor cable's E2000 connector. Only use pure alcohol and fresh lens cleaning tissue to do this. Then repeat the darkness correction. If nothing changes, the sensor cable can also have become damaged or the fibre connector lying in the controller may become soiled.

Change the sensor cable or submit the whole system for checking.

You can adjust the warning threshold if necessary in the event of contamination by an ASCII command (permissible deviation in %); the factory setting is 50 %, see A 7.3.3.5.

The warning threshold is stored specific to the setup.

5.6 Measurements and Web Page Display

5.6.1 Distance Measurements

- Align the sensor vertically to the target object.
- Then, move the sensor (or the target) closer, until you more or less reach the start of measuring range for your sensor.

Once the object is within the sensor's measuring range, the `Range` LED (green or yellow) on the front of the controller will light up. Or, observe the video signal.

Name	State	Description
LED 1 Intensity	Red	Intensity too high, first peak in saturation
	Yellow	Intensity too low, first peak below recognition threshold or no peak above the recognition threshold
	Green	Signal ok
LED 2 Range	Red	No peak within the linearized (or masked) range
	Yellow	Peak in the midrange (47.5 … 52.5 %)
	Green	OK, at least one peak within the linearized (or masked) range
Error 1	Intensity = 1	Intensity too high or too low (warning, if intensity is saturated or below recognition threshold)
Error 2	Out of range = 1	No peak within the linearized range

Fig. 32 Description of LEDs and error signals for distance measurements

After launching `Measurement` the following web page is displayed. The diagram starts automatically when the web page is reloaded. The diagram in the large window to the right displays the value-time graph.

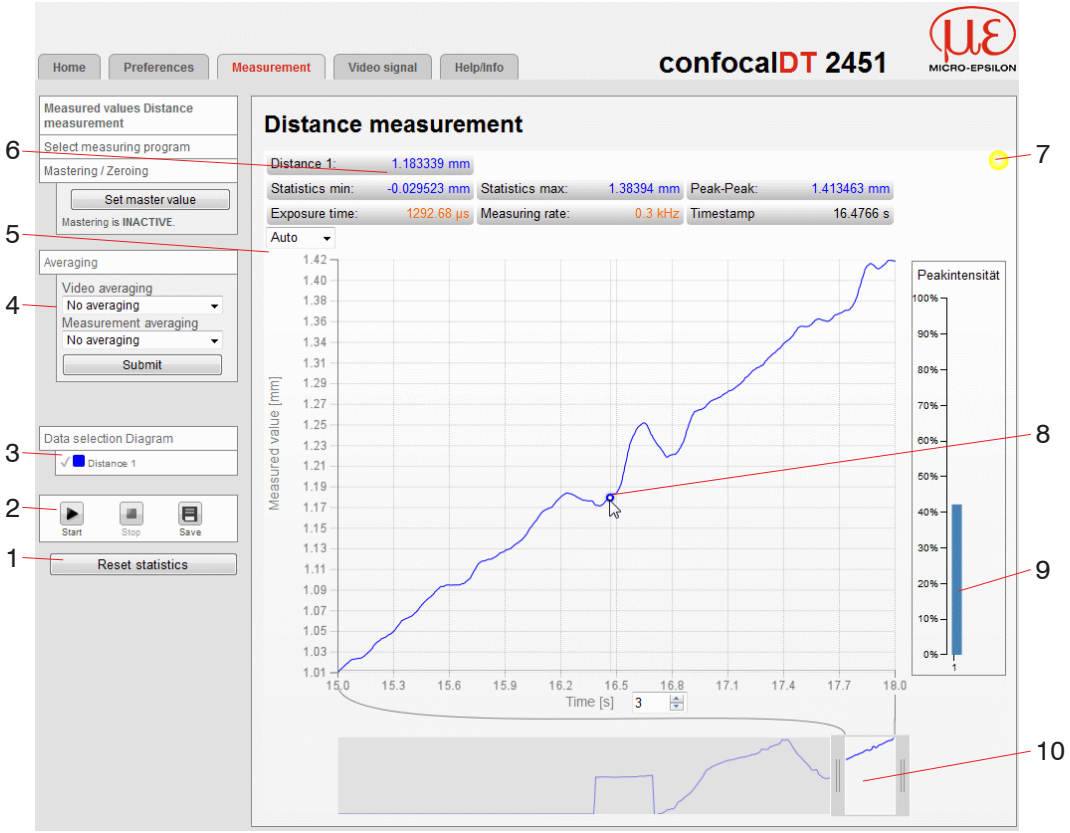


Fig. 33 `Measurement` *web page (distance measurement)*

1 By clicking on the button `Resets statistics`, the statistical values can be reloaded during the measurement. In stop mode, the statistical values calculated at this moment are displayed.

2 The diagram is ended by clicking `Stop`; data selection and zooming is still possible. Clicking on `Save` opens the Windows dialog box for selecting a location and file name in order to save the last 10,000 values in a CSV file (separated by semicolons).

3 Diagram Data Selection

- Distance 1
- Etc. (for thickness and multi-layer measurements)
  Inactive graphs are grey. Click on the check mark to add them. If you want to have displayed one single signal, click on its name.

4 In the left window, you can define settings for averaging readings. If the settings were defined in a different tab or window, you will then need to re-load the `Measurement` page to apply the settings.

5 `Auto` (= automatic scaling) or `Manual` (= manual setting) allow for scaling the intensity axis (Y axis) of the graph.

6 In addition, the values of distance, statistics, the current measuring rate, exposure time and time stamp are displayed in the text boxes above the graph. Errors are displayed as well.

7 Status Display

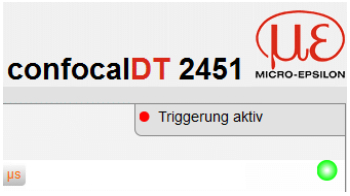
- Green: OK; data transfer is active
- Yellow: data transfer is stopped
- Red: sensor connection is disturbed

8 Mouseover feature. When moving the mouse over the graph, curve points or peak markings are highlighted with a circle symbol while the corresponding values are displayed in the text boxes above the graph. The intensity bars are updated as well.

9 The peak intensity is displayed in form of bar graph.

10 X axis scaling: The total signal is zoomable with the slider on the left side during running measurement. The time range can be defined in the input field below the time axis. Once the diagram is stopped, you can use the right slider as well. The You may also move the zoom window sideways with the mouse in the center of the zoom window (cross arrow).

i In the state of active triggering, see figure, a trigger impulse is required that sets off the video signal. This indicates the display at the top right in the window. The status display may nevertheless be green.



5.6.2 Thickness Measurement of Transparent Objects

In Thickness Measurement mode, the controller evaluates two signals that reflect from the surface. The controller uses the two signals to calculate surface distances and thickness.

➨ Align the sensor vertically to the target object. Ensure that the target is located near the midrange (= SMR + 0.5 x MR).

i The light beam must meet the target surface at a right angle to avoid inaccurate measurements.

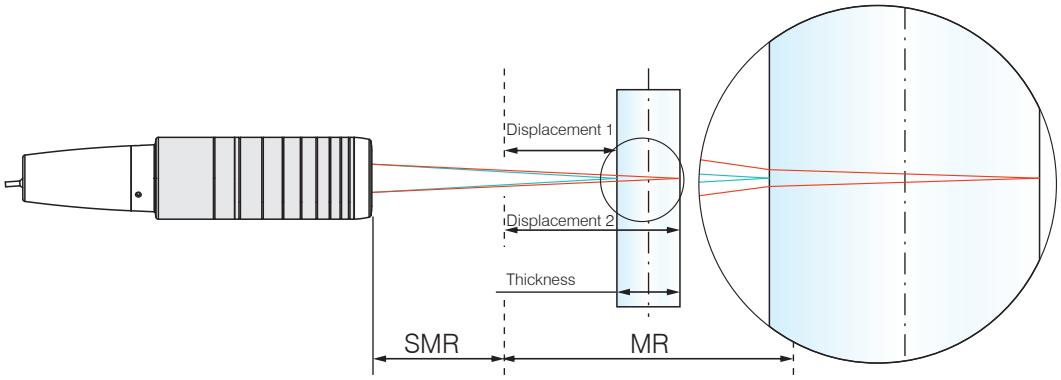


Fig. 34 One-sided thickness measurement for a transparent object

SMR	Start of measuring range
MR	Measuring range
Minimum target thickness	IFS2403 (hybrid sensor) approx. 15 % of the measuring range IFS2405 (standard sensor) approx. 5 % of the measuring range, see 2.6.
Maximum target thickness	Sensor measuring range x refraction index for the target

The `Range` LED on the front of the controller lights up as soon as the two object surfaces are within the sensor's measuring range.

Name	State	Description
LED 1 Intensity	Red	Intensity of at least one of the first two peaks in saturation
	Yellow	Intensity too low, one or both peaks below recognition threshold
	Green	Signal ok
LED 2 Range	Red	Focus of none (or only one) of the peaks within the linearized or masked range
	Yellow	Average value from first and second peak in the midrange (47.5 … 52.5 %)
	Green	OK, focus of at least two peaks within the linearized or masked range
Error 1	Intensity = 1	Warning, if the intensity of at least one of the first two peaks is saturated or below recognition threshold
Error 2	Out of range = 1	Focus of none (or only one) of the peaks within the linearized range

Fig. 35 Description of LEDs and error signals for thickness measurements

Thickness can only be calculated correctly if the material has been specified. To balance the spectral adjustment of the refractive index, a minimum of three refractive index numbers for different wavelengths or one refractive index plus the Abbe number are required. If a target surface is outside the measuring range, the controller provides only one signal for distance, intensity and focus. This might also happen, if one signal is below the recognition threshold.

When measuring the thickness of a transparent material, two boundary areas are active. This means, that two peaks are displayed in the video signal, see Fig. 36.

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

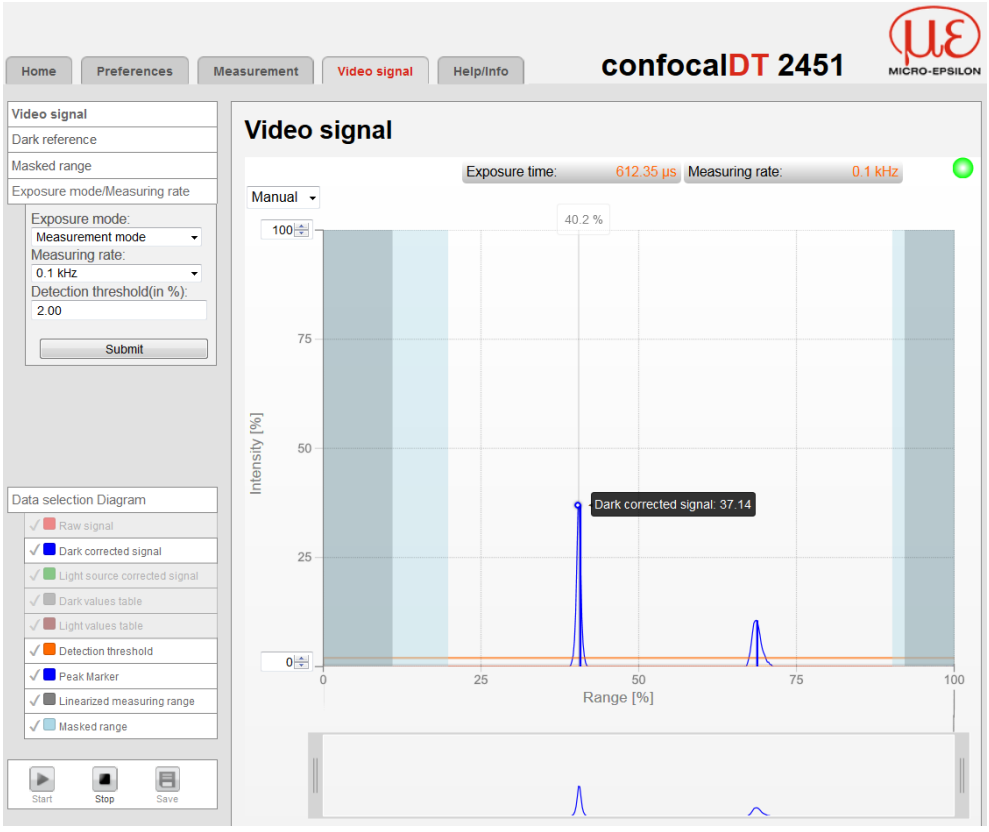


Fig. 36 `Video signal` web page (thickness measurement)

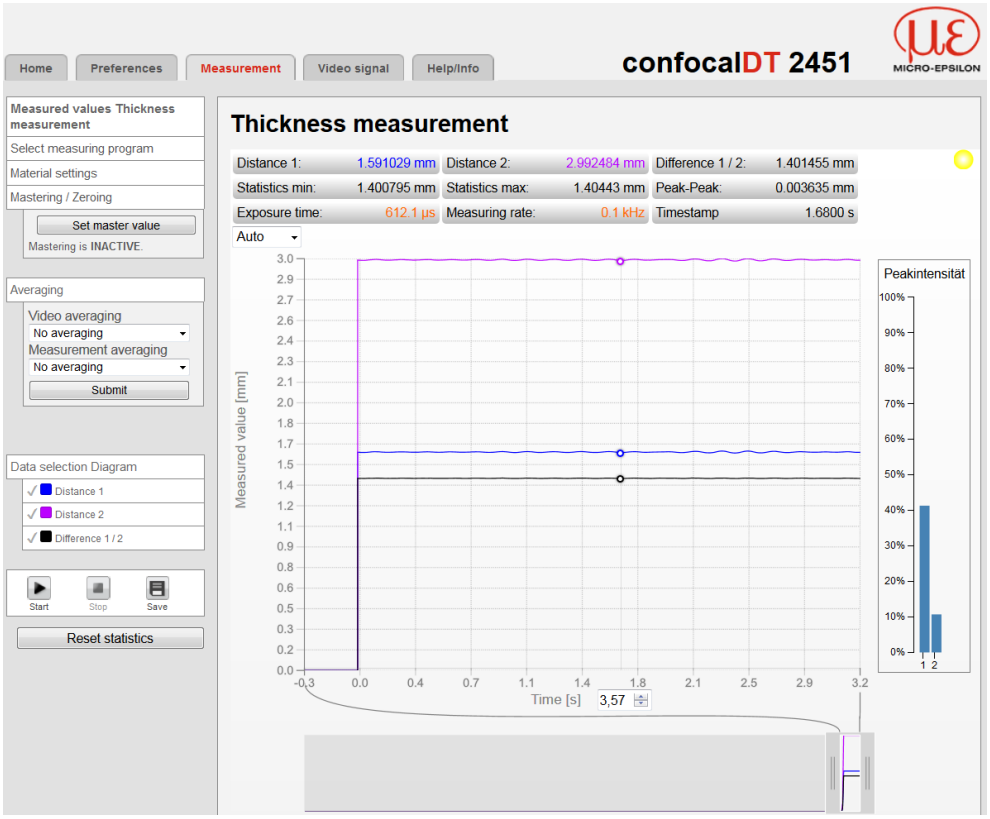
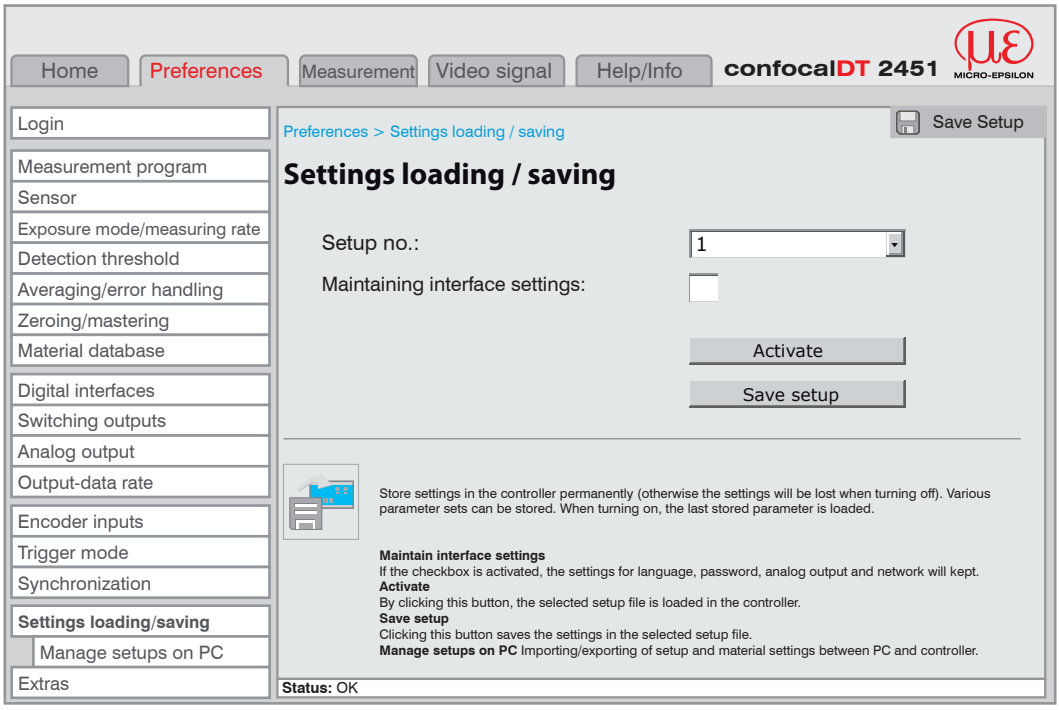


Fig. 37 `Measurement` *web page (thickness measurement)*

The `Measurement` web page visually and numerically displays both distances and the thickness (difference 1/2), intensity is displayed for both peaks (peak 1 = close, peak 2 = far), see Fig. 37. Statistic values relate to thickness. All other settings and features are identical with those for distance measurements, see 5.6.1.

5.7 Load / Save Settings in the Controller

In this menu you can save current device settings to the controller and recall stored settings. You can permanently store eight different parameter sets in the controller.



5.7.1 Saving Settings in the Controller

Current settings are stored in the controller using the selected parameter set number. We recommend saving settings after programming the controller, as the settings will be lost when the controller is switched off.

How to save settings:

- Select the required setup no. of parameters.
- Click the `Save setup` button.

The current settings will be available after the controller has been switched off and on.

For a fast saving to the last saved setup use the `Save setup` button in every preferences page.

i Switching on the controller loads the set of parameters that was last stored in the controller.

5.7.2 Loading from the Controller

The settings that are stored for the selected parameter setup number in the controller are enabled.

How to load settings:

- Select the required setup no. of parameters.

The measurement settings contain measuring properties, such as signal selection, measuring rate and filter settings.

Only maintain interface settings, if the controller is used with the same network and RS422 baud rate.

- Select the `Maintaining interface settings` checkbox if desired.
- Click the `Activate` button.

The controller uses the settings from the selected parameter set.

6. Advanced Settings

6.1 Login, Switching User Level

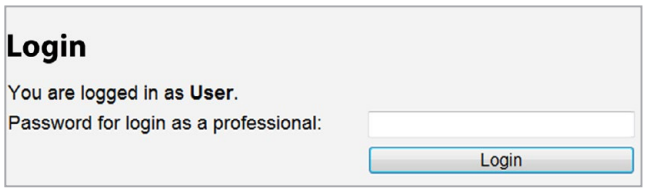
Assigning passwords prevents unauthorized changes to controller settings.
Password protection is not enabled as a factory setting. The sensor works on the `User` level. After the controller has been configured, you should enable password protection.
The standard password for the User level is `000`.

i A software update will not change the standard password or a custom password. The user level password is setup-independent, and is not loaded or stored during setup.

User can do the following:

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

Fig. 38 Permissions within the user *hierarchy*



Enter the standard password `000` or a custom password into the `Password` box, and click `Login` to confirm.

To change to user mode, click the `Logoff` button.

Fig. 39 Changing to professional level

In `User` mode, you can use the change password features to assign a custom password.

Password	*Value*	*All passwords are case-sensitive. Numbers are allowed, but special characters are not permitted.*
User level at restart	*User / Professional*	*Defines the* user *level that is enabled when the sensor starts the next time. MICRO-EPSILON recommend to select Professional level.*

i When an professional restores the factory settings (Settings `menu` > `Tools` > `Factory Settings`), the Professional level password is reset to `000`.

6.2 Detection Threshold

The detection threshold (in %, relates to the signal after dark correction) defines the minimum intensity for including a video signal peak in the measurement. Therefore, the video graph must be taken into consideration when defining the threshold.

Peak detection threshold	*Value*	*Value in %, factory setting: 1%*

Defining the peak detection threshold

- For very weak signals (e.g. typical for extremely high measuring rates), choose a low detection threshold, as only signal parts above this threshold will be included in measurements.
- For thickness measurements, you may increase the detection threshold, if video signal peaks merge. In general, set the threshold high enough to avoid that any interfering video signal peaks are detected.

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

➨ Click `Submit` to confirm selection of the recognition threshold.

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

6.3 Averaging, Error Handling, Spike Correction, Statistics

6.3.1 Notes on Averaging

Video averaging	*no averaging / recursive 2 / 4 / 8 moving 2 / 4 / 3 median 3*			*Video averaging is carried out before measuring distances or thickness. Recommended for very small peaks.*
Measured value averaging	*no averaging*			*Specify the type of averaging. N defines how many sequential measurements the controller will use for averaging, before issuing the next reading. Averaging does not affect the measurement frequency.*
	moving N values	2 / 4 / 8 ... 1024	*Value*	
	recursive N values	2 ... 32768	*Value*	
	median N values	3 / 5 / 7 / 9	*Value*	
Error handling	*Error output, no measurement output*			*Sensor displays an error number.*
	Hold last value	0 ... 1024	*Value*	*If no valid reading can be obtained, the last valid value can be hold for a certain period of time, and will be issued repeatedly. If the reading is 0, the last valid value is hold permanently.*
Spike correction	*No*			
	Yes	Evaluation length 1 - 10	*Value*	*This filter removes individual very high spikes from a relatively constant course of measurement value.*
		Max. tolerance range (mm) 0 - 100	*Value*	*Smaller spikes are preserved.*
		Number of corrected value 1 - 100	*Value*	
Statistics	*2 / 4 / 8 / 16 ... 16384 / all measured values*			*The statistical values Minimum, Maximum and Peak-to-Peak are calculated and output from a predefined number of measuring values.*
Signal for statistics calculation	*Distance 1 ... 6 / Difference 1 - 2 up 5 - 6*			*For multilayer measurement program the signal is selectable and will if not already done, added to the output via Ethernet automatically.*

Averaging can be performed in two different signal processing areas.

- Video signal averaging
- Measurement averaging

It is recommended to use averaging for statistical measurements or slowly changing readings. Averaging reduces noise and suppresses distortions in readings.

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

MP Parameter available with controller IFC24x1MP

Processing sequence:

1. Video averaging
2. Unlinearized distances
3. Linearizing the distances
4. Refractive index correction of the distances
5. Troubleshooting when there is no valid measured value
6. Spike correction of the distances
7. Difference generation for thicknesses
8. Measured value averaging
9. Statistics

6.3.2 Video Averaging

The following video graphs can be averaged successively and pixel by pixel in the sensor. In the web browser, under `Video signal`, you can see the effect of the various settings.

Video averaging is especially recommended for very small video signal peaks to help reduce the threshold and to achieve a greater number of valid readings.

The video averaging must be ignored in the two times alternating exposure mode.

6.3.3 Measurement Averaging

Measurement averaging is performed after measurement 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 stored in the controller to ensure they are hold after it is switched off.

Controller IFC24x1 is delivered with “moving average, averaging value = 1” as factory settings, ie. averaging is not enabled by default.

Moving average

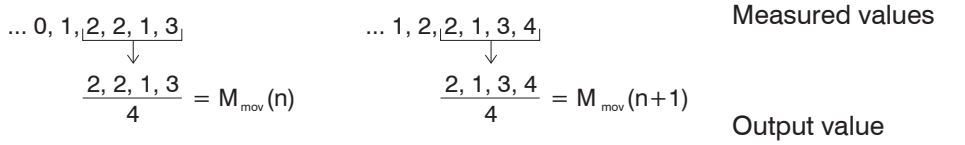
The definable number N for successive measurements (window width) is used to calculate the arithmetic average M_{mov} according to the following formula:

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

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 response times for measurement jumps.

Example: N = 4



Moving average in the controller IFC24x1 allows only potentials of 2 for N. The highest averaging value is 1024.

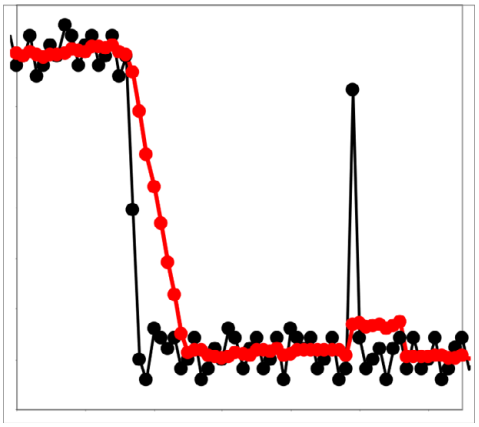


Fig. 40 Moving average, N = 8

Application tips

- Smooths measured values
- The effect can be finely controlled in comparison with the recursive averaging
- With uniform noise of the measured values without spikes
- At a slightly rough surface, in which the roughness should be eliminated
- Also suitable for measured value jumps at relatively low settling time

Recursive average

Formula:

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

MV = measured value

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

n = measurement index

M_{rec} = average value 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 behaviour.

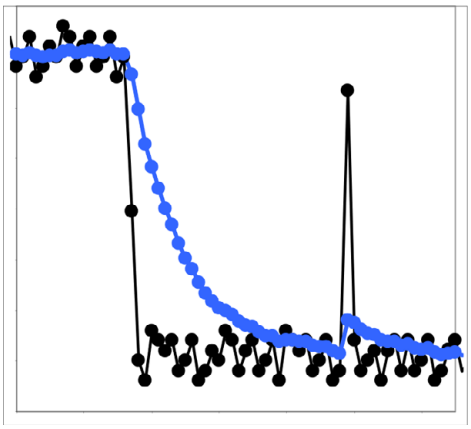


Fig. 41 Recursive Average, N = 8

Application tips

- Permits a high degree of smoothing of the measurement values. However, it requires extremely long transient recovery times for measured value jumps (low-pass behaviour)
- Permits a high degree of smoothing for noise without strong spikes
- For static measurements, to smooth signal noise
- For dynamic measurements on rough surfaces, to eleminate the roughness, e. g. roughness of paper
- For the elimination of structures, e. g. parts with uniform grooves, knurled rotary parts or roughly milled parts
- Unsuitable for highly dynamic measurements

Median

A median value is formed from a preselected number of measurements.

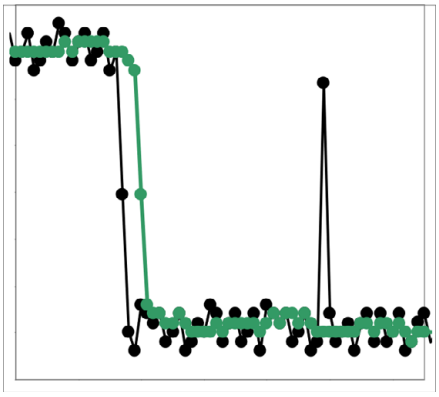
When creating a median value for controller IFC24x1, incoming readings are sorted after each measurement. Then, the average value is provided as the median value.

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. 42 Median, N = 7

Application tips

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

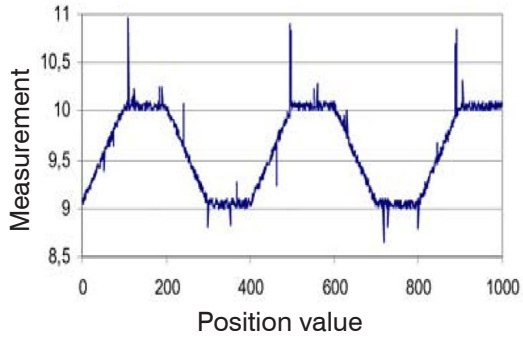


Fig. 43 Original profile

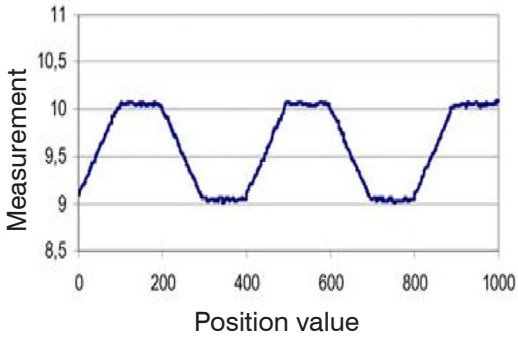


Fig. 44 Profile with Median, N = 9

6.3.4 Error Handling (Hold Last Value)

If no valid reading can be obtained, an error is issued. Should this be a problem for processing, the last valid value can be hold for a certain period of time, and will be issued repeatedly.
Between 1 and 1024 values can be hold.
If the number is 0, the last value is hold until a new, valid reading is obtained.

6.3.5 Spike Correction

This special form of filtering is used to remove very high spikes from a relatively constant course of measurement values, though while retaining any smaller spikes. A median would remove all the spikes.

The assessment of whether a measurement is a spike (outlier) is based on the mean of a particular number of previous valid readings. The permissible deviation from the next value is calculated using the tolerance range. If the new measured value deviates too much, it will be corrected to the previous value. A maximum number of consecutive measured values to be corrected must also be stated.

Attention: In the event of several consecutive spikes (outliers), the previous corrected value is used in the correction of the following measured value. Use this function only in appropriate applications. Improper use can lead to a distortion of the measured value sequence! Check the possible impact of a changed measured value sequence on the measuring environment and subsequent controllers/systems.

This function acts the same way on all output distances; the differences (thicknesses) are calculated on the basis of the corrected distances.

x Evaluation length. Number of previous measured values to be assessed (max. 10).

y Max. tolerance range (mm); the spike (outlier) correction comes into play when the value is not met or is exceeded

z Number of corrected value (max. 100)

Example: x = 3 / y = 0.05 / z = 1

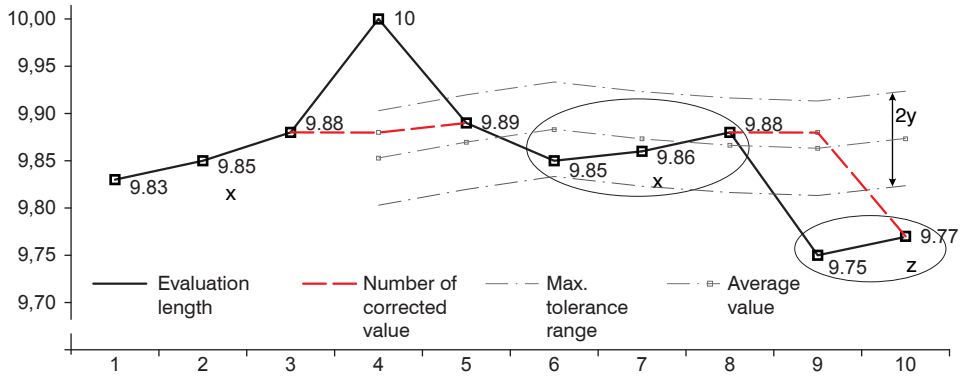


Fig. 45 Correction of measuring values

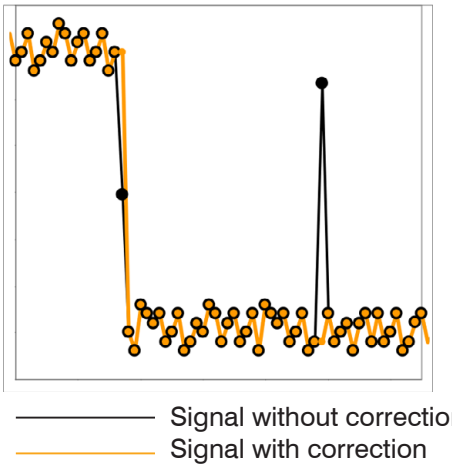


Fig. 46 Different signals

Application tips

- Eliminating spikes with an adjustable threshold
- For highly dynamic data acquisition of fast moving objects
- With measurement jumps suitable, especially those with interfering peaks
- With edge jumps and with some bent edge transitions
- Execution is done before other averages take place

6.3.6 Statistics

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

MIN	Minimum
MAX	Maximum
PEAK-PEAK	Peak-to-peak value (time span)

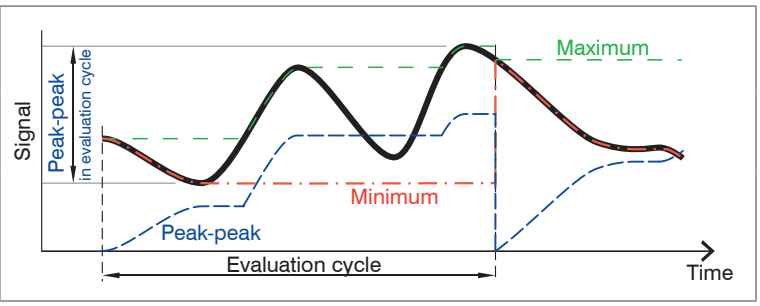


Fig. 47 Evaluation cycle of statistical values

Statistical values are calculated from measurements within an evaluation cycle. The number of measurements used for calculation can be between 2 and 16384 (potential of 2), or include all measurements.

Use the `Statistics reset` button or the RESET STATISTICS command to start a new evaluation cycle (storage period). When a new cycle starts, previous statistical values are deleted.

Statistical values are displayed in the web interface (`Measurement` section) or issued via the interfaces.

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

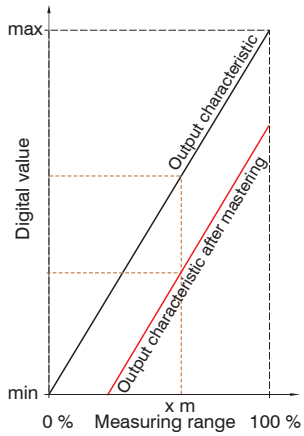
6.4 Zeroing, Mastering

Use zeroing and setting masters to define a target 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 planeness measurements. When measuring the thickness of a transparent target using controller IFC24x1, 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: – 2 x measuring range to + 2 x measuring range*

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 target value.

The `master value` is the reading that is issued as result of measuring a master object. Zeroing is when you set a master with 0 (zero) as the master value.



When setting a master, the sensor 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).

Setting masters/Zeroing – Step-by-Step:

- Place target and sensor into their required positions.
- Define the `Master value` (web interface/ASCII).

After setting the master, the sensor 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. 48 Moving the characteristic when mastering

i `Mastering` or `zeroing` requires a target object to be present in the measuring range and affects both analog and digital outputs.

6.5 Digital Interfaces

Digital interface selection	*Output in the web diagram / Ethernet measurement transfer / RS422 / EtherCAT*	*Defines which interface is used for data output. No parallel data output via multiple channels.*	
Data selection	*Distance 1, 2 / Distance 3 ... 6 / Difference 1 - 2 / Difference 1 - 3 up 5 - 6 / Statistics Min / Statistics Max / Statistics Peak-Peak / Exposure time / Intensity of the (all) distance value(s) / Encoder 1 / Encoder 2 / Encoder 3 / Error status / Measured value counter/ Time stamp /Trigger time difference*	*Select the relevant check boxes to choose which data are used for transmission. The data are issued one after the other in a defined sequence. RS422 allows transmission of no more than 32 records.*	
Ethernet settings	IP settings for controller	*Static IP address / DHCP*	*Values for IP address / gateway / subnet mask. Only for static IP addresses.*
	Ethernet measured value transfer settings	*Server / Client*	*Values for port and IP address*
			TCP/IP / UDP/IP
Settings RS422	Baud rate	*9.6 / 115.2 / 230.4 / 460.8 / 691.2 / 921.6 / 1500 / 2000 / 3500 / 4000 kBps*	
Ethernet/ EtherCAT	Operating mode after start	*Ethernet / EtherCAT*	

6.5.1 Selecting a Digital Interface

Controller IFC24x1 has three digital interfaces that can be used as an alternative data output in conjunction with parameterization.

- Ethernet: allows fast data transfer, but provides no real-time capabilities (packet-based data transfer). Both measurement and video data can be transferred. Use to capture measurements without any direct process control, for subsequent analysis. Parameterization is provided through the web interface or ASCII commands.
- RS422: provides a real-time capable interface with a lower data rate.
- EtherCAT: allows a fast data transfer in real-time capability. Requires the software TwinCAT (Beckhoff) on PC. The configuration is done exclusively through Service Data Objects. The web interface can not be used simultaneously.

The HyperTerminal® application provides an interface for serial communication with the controller using RS422, and Telnet® is used for Ethernet connections. Use the program “TwinCAT” for EtherCAT.

6.5.2 RS422 Interface

The RS422 interface has a maximum baud rate of 4000 kBaud. As a factory setting, the baud rate is set to 115.2 kBaud. 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, 1 stop bit (8N1) Selectable baud rate.

The RS422 interface can transfer 18 bits per output value. In addition, up to 32 output values can be transmitted simultaneously.

The maximum number of measured values that can be transferred for each measuring point depends on the controller measuring rate and the selected RS422 interface transmission rate. Where possible, use the maximum available transmission rate (baud rate), see A 7.5.2.

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

MP Parameter available with controller IFC24x1MP

6.5.3 Ethernet

When using a static IP address, you need to specify values for IP address, gateway and subnet mask. This is not necessary when using DHCP.

The controller is preset to acquire the IP address through DHCP, and it supports link/local operation.

The controller transmits the Ethernet packets at a transmission rate of 10 MBit/s or 100 MBit/s. The transfer rate is selected automatically depending on the connected network or PC.

Any output values and additional information to be transmitted that are logged at one point in time are combined to form a value frame. Multiple value frames are combined as one measurement block. A header is added to the start of each measurement value packet.

When transmitting measurement data, the controller sends each measurement value (measured value block) to the connected remote station after successful connection establishment. No explicit request is required.

If any changes are made to the transmitted data or the frame rate, a new header will be sent automatically. Distance and thickness values are transmitted as 32 bit signed integer with 1 nm resolution.

Video signals are transmitted the same way as measurement data are sent to a measurement server via Ethernet with one exception: only one video signal per measurement block is transmitted, and each video signal must be requested individually.

This measured value block can also consist of several Ethernet packets depending on the size of the video signal.

6.5.4 EtherCAT

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

Service Data Objects SDO: All parameters of the controller can thus be read or modified, all measured values and also the dark-corrected video signal can be polled individually.

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

Distance and thickness values are transmitted as 32 bit signed integer with 1 nm resolution.

You will find further information in the appendix, see A 8.

You can not change directly to the EtherCAT interface through the web interface. Restart your controller to do this. The web site is no longer available.

You will find further instructions how to change from EtherCAT interface back to Ethernet in the appendix, see A 8.2.2.

6.6 Switching Outputs

Assignment of the switch outputs (digital I/O)	*Switching output “Error 1”* *Switching output “Error 2”*	*Error intensity (F1) / Outside of measuring range (F2) / F1 or F2 / Lower limit value (Gr1) / Upper limit value (Gr2) / Gr1 or Gr2 / No output*
Limit value settings	Lower limit value (in mm)	*Value*
	Upper limit value (in mm)	*Value*
	Measurement value that belongs to limit values	*Distance 1, 2 / Distance 3 ... 6 / Difference 1 - 2 / Difference 1 - 3 up 5 - 6*
Switch threshold of the error outputs	*High active / low active*	

6.6.1 Assignment of the Switch Outputs (digital I/O)

Switching outputs “Error 1” and “Error 2” of the “Digital I/O” terminal block can be individually assigned to different errors and thresholds.

Per default, “Error 1” is assigned to intensity errors (F1, peak too high or too low), and “Error 2” corresponds to the signal being outside the measuring range (F2).

6.6.2 Limit Value Settings

You can also use the “Error 1” and “Error 2” switching outputs to monitor threshold values. In this case, enter lower and upper limit values (in mm).

6.6.3 Switch Threshold of the Error Outputs

The switching logic for errors or out-of-range results can be set to `high active` or `low active`.

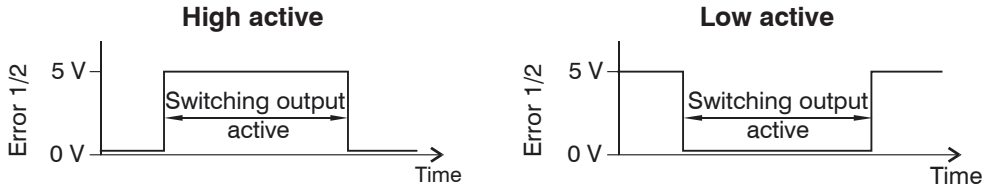


Fig. 49 Behavior of the binary outputs Error 1 and Error 2

Selecting the switching logic is different from selecting a level by using a screw terminal bridge on the front of the controller, see 4.5.7.

You can set the screw terminal voltage level to 5 V or 24 V.

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

MP Parameter available with controller IFC24x1MP

6.7 Analog Output

Analog outputs can either be used for distance or thickness measurements. Only one type of measurement can be transmitted at any given time. The analog output has a resolution of 16 bit.

Output signal	*Distance 1, 2* / *Distance 3 ... 6* / *Difference 1 - 2* / *Difference 1 - 3 up 5 - 6*	*With the distance measurement program only Distance 1 can be measured*	
Output range	*4 ... 20mA* / *0 ... 5V* / *0 ... 10V* / *-5 ... 5V* / *-10 ... 10V* / *inactive*	*Either the voltage or the current output on the controller can be used at any given time.*	
Scaling	*Standard scaling*	*Distance measurements: scaled to 0 ... measuring range Thickness measurements: scaled to 0 ... 2 * measuring range*	
	Two-point scaling	Start of range (in mm):	*Value*
		End of range (in mm):	*Value*

Output value scaling depends on which measuring program was selected for the relevant output range:

- for distance measurements: 0 ... measuring range
- for thickness measurements: 0 ... 2 * measuring range

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 to use zeroing or mastering.

Two-point scaling enables the user to specify separate start and end values (in millimetre) for the sensor's measuring range. The available output range of the analog output is then spread between the minimum and maximum values. This allows for decreasing analog characteristics, see Fig. 50.

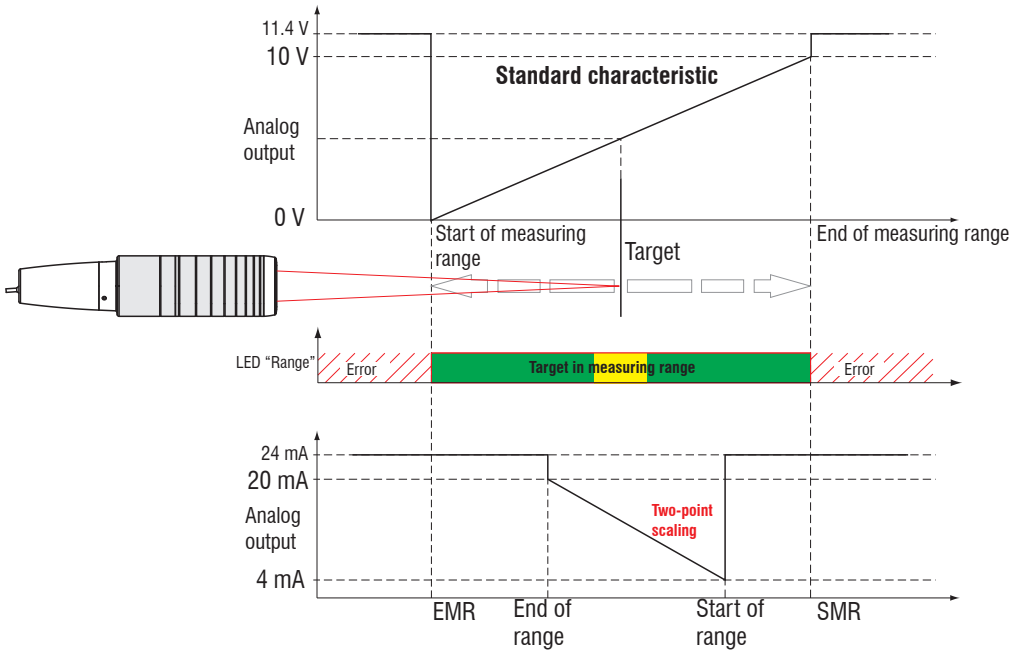


Fig. 50 Scaling the analog signal

6.8 Output Data Rate

Measured value	*Value*	*Only every n-th value is used (n = 1, 2 ... 1000). All other measured values are discarded.*
Reducing interfaces	Analog / RS422 / Ethernet	*Select the relevant check boxes to choose which interfaces are used for data reductions.*

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

MP Parameter available with controller IFC24x1MP

6.9 Encoder Inputs

A maximum of three encoder values can be assigned to the measured data. They will then be issued and used as trigger conditions. This exact assignment to the measured values is ensured by the fact that exactly the encoder values are output that are exist in half of the exposure time of the measured value (the exposure time may vary due to the control). Tracks A and B make it possible to detect directions. Each of the three encoders can be configured separately. The encoder socket configuration, see 4.5.9.

Encoder 1 / 2 / 3	Interpolation	*single / double / quadruple resolution*
	Effect on reference track	*no effect / set on first track /set with every track*
	Set on value	*Value*
	Maximum value	*Value*

6.9.1 Interpolation

The counter reading increases or decreases with each interpolated pulse flank.

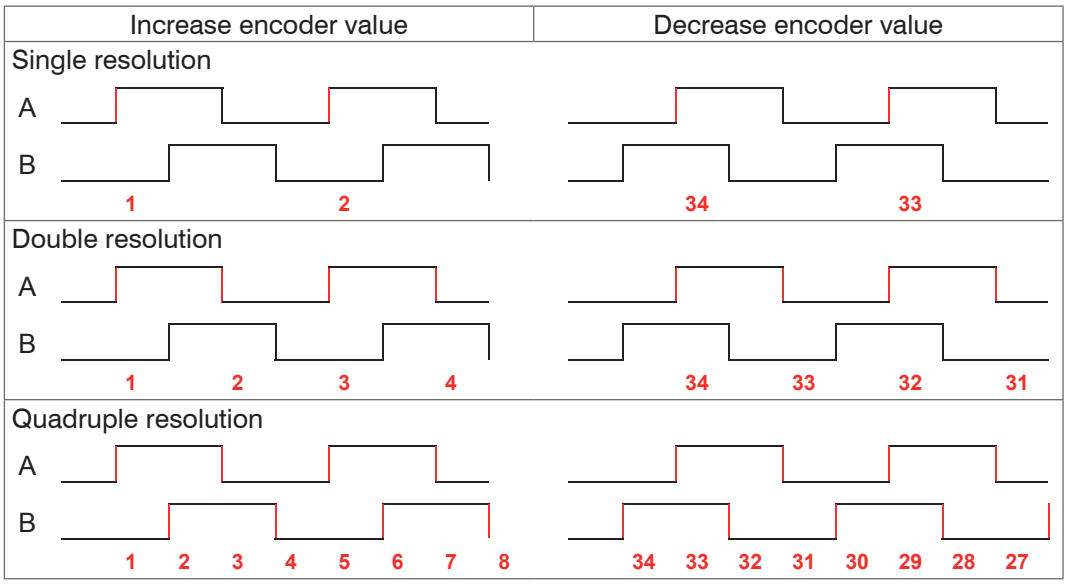


Fig. 51 Pulse sequence encoder signals

6.9.2 Effect on the Reference Track

`No effect`. The encoder counter continues to count; the signal is reset when the controller is switched on or if you click on `Set on value`.

`To set on first track`. Sets the encoder counter to the defined value, if it reaches the first reference mark. It is the first mark after turning on the controller. Without turning off only after pressing the button `Use next mark`.

`To set with every track`. Resets the encoder counter to its starting value at all marker positions or when reaching a marker for a second time (e.g. with traversing movements).

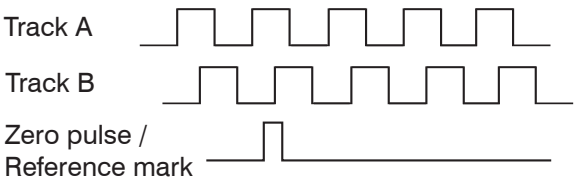


Fig. 52 Reference signal of an encoder

6.9.3 Set on Value

The encoder are set to this value each time the controller is switched on, also at the reference marks (if used).

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

6.9.4 Maximum Value

If the encoder exceeds the maximum value, the counter is reset to zero. Examples include rotary pulse indicators without a zero-signal (reference track). The maximum counter reading before a reset is 4,294,967,295 (2 ^ 32-1). It can be limited to smaller values.

6.10 Trigger Mode

Value input and output on the confocalDT 2451/2461/2471 can be controlled through external electrical trigger signals or commands. Both analog and digital outputs are affected. The measured value to the trigger point is output delayed, see 6.19.

- Triggering does not affect preset measuring rates.
- The Sync input is used as external trigger input.
- Factory settings: no triggering, the controller starts transmitting data as soon as it is switched on.
- “Sync in” pulse duration is 5 µs or more.

Level triggering	Measurement value input Measurement value output	Level low / level high	
Edge triggering	Measurement value input Measurement value output	Start of measured value output	Falling edge / increasing edge
		Number of measured values	*Value*
Software triggering	Measurement value input Measurement value output	Number of measured values	*Value*
Encoder triggering	Measurement value input Measurement value output	Triggering by	Encoder 1 / Encoder 2 / Encoder 3
		Step size	*Value [1 ... 2 31]*
		Lower limit	*Value*
		Upper limit	*Value [1 ... 2 32]*
No triggering		*continuous value output*	

`Level triggering`. Continuous value input/output for as long as the selected level is active. After that the controller stops the input/output of the values. Pulse duration must last for at least one cycle. The subsequent pause must also last for at least one cycle.

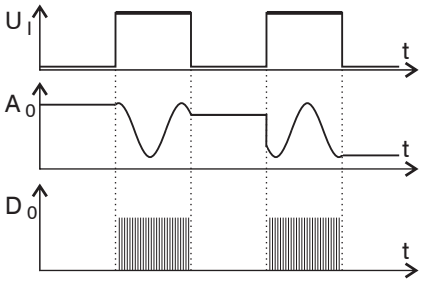


Fig. 53 Active high level trigger (U_I), relevant analog signal (A_0) and digital signal (D_0)

`Edge triggering`. Starts value input/output as soon as the selected edge is active to the trigger input. If trigger conditions are met, the controller outputs a defined number of measurements. Value range between 1 and 16383. After completion of data output the analog output remains standing at the last value (Sample & Hold).The duration of the pulse must be at least 5 µs.

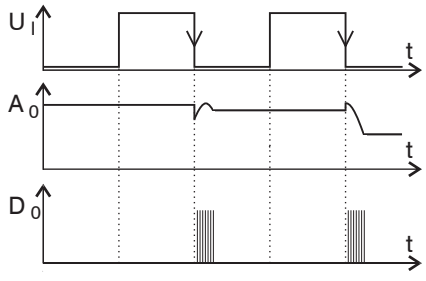


Fig. 54 Falling edge trigger (U_I), relevant analog signal (A_0) and digital signal (D_0)

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

`Software triggering`. Starts outputting values as soon as a software command (instead of the trigger input) or the `Initiate trigger` button is activated. The point in time is not defined as accurately. If trigger conditions are met, the controller outputs a defined number of measurements. Value range between 1 and 16383. Value output can be stopped with a command, see A 7.

`Encoder triggering`. One of the three encoder inputs can be used as trigger signal. If trigger conditions are met, the controller outputs values and then waits for subsequent trigger signals.

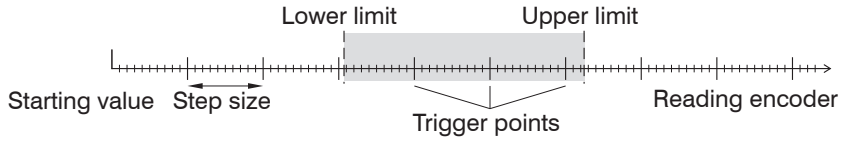


Fig. 55 Definition of terms for encoder triggering

Within the step size there are no readings. Keep this, if measurement averaging is used.

6.10.1 Triggering the Measured Value Recording

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

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

6.10.2 Triggering the Measurement Value Output

The calculation of the measured values is performed continuously and independently of the trigger event. A trigger event only triggers the output of the values via a digital or analog interface.

Thus values measured immediately before the trigger event are used when calculating means (averages) or statistics.

The triggering of the measured value recording and output have the same timing.

6.10.3 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.

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.

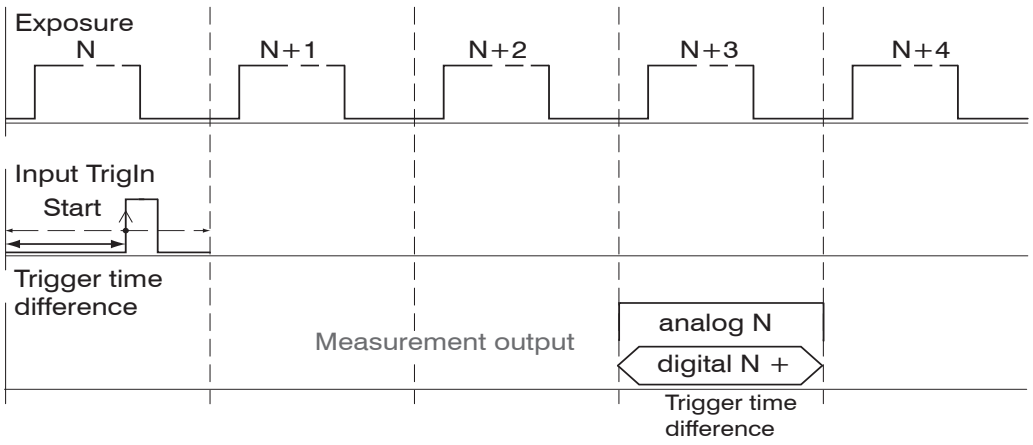


Fig. 56 Definition of the trigger time difference

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

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.

6.11 Synchronization

If several sensors measure the same target synchronously, the controllers may be synchronized with each other. The sync output of the first controller `IFD24x1 Master` is connected to the sync inputs of the further controllers, see 4.5.8. Notice the controller timing, see 6.19.

IFD24x1 Master	*First controller in the measuring chain; synchronizes any subsequent controllers.*
Slave on IFD24xx Master	*Controller operates in dependence on the first controller.*
Slave on external master	*External synchronization. Sync In at the controller is used by an external synchronization source, such as a frequency generator. Min. 0.1...10 kHz (IFC2451), 0,1...25 kHz (IFC2461), 0.1...70 kHz (IFC2471LED) or 0.3...70 kHz (IFC2471). It is also possible to simultaneously synchronized multiple controllers externally.*

If the controllers are operated via an EtherCAT interface, then a synchronization can be realized without a synchronization cable, see A 8.5.

6.12 Manage Setups on PC

Use this menu to save a backup copy of the controller data to a PC or to restore backed up setup files to the controller. You can also use this feature to configure an additional controller.

Save the controller settings, before exporting or importing data, see 5.7.

Data selection for transmission	*Setup / material database*	*Depending on the selected measurement and interface settings, a parameter set contains all controller parameters except for the material database.*
Setup no.	*1 / 2 / 3 ... 8*	*You can permanently store eight different parameter sets in the controller.*
Maintaining interface settings	*Check box*	*Interface settings include network properties, such as the baud rate for the RS422 interface.*
Select setup	*Value*	*File location (path).*

Step by Step:

- Select the data to be transmitted.
- Define a setup number.
- Select whether the interface settings are affected.

Exporting data:

- Click the `Export setup` button.

The Windows dialog box for saving a file opens.

- Enter the file name for the parameter set file (*.meo), and click `OK`.

Any currently selected files will be backed up to the PC.

Importing data:

- Click the `Browse` button.

The Windows dialog box for selecting a file opens.

- Click the `Import setup` button.

The PC starts transferring the file to the controller.

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

6.13 Extras

Language/Sprache		*Deutsch / English*	*Language of the interactive web pages.*
Factory settings	Only reset current setup	*Check box*	*Enables the user to replace the currently used setup only.*
	Maintain interface settings	*Check box*	*Allows to retain all Ethernet and RS422 interface settings without any changes.*

Interface settings are hold when the controller is set to keep current Ethernet and RS422 interface settings.

6.14 Masking the Evaluation Range

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. The measuring range can be reduced thereby.

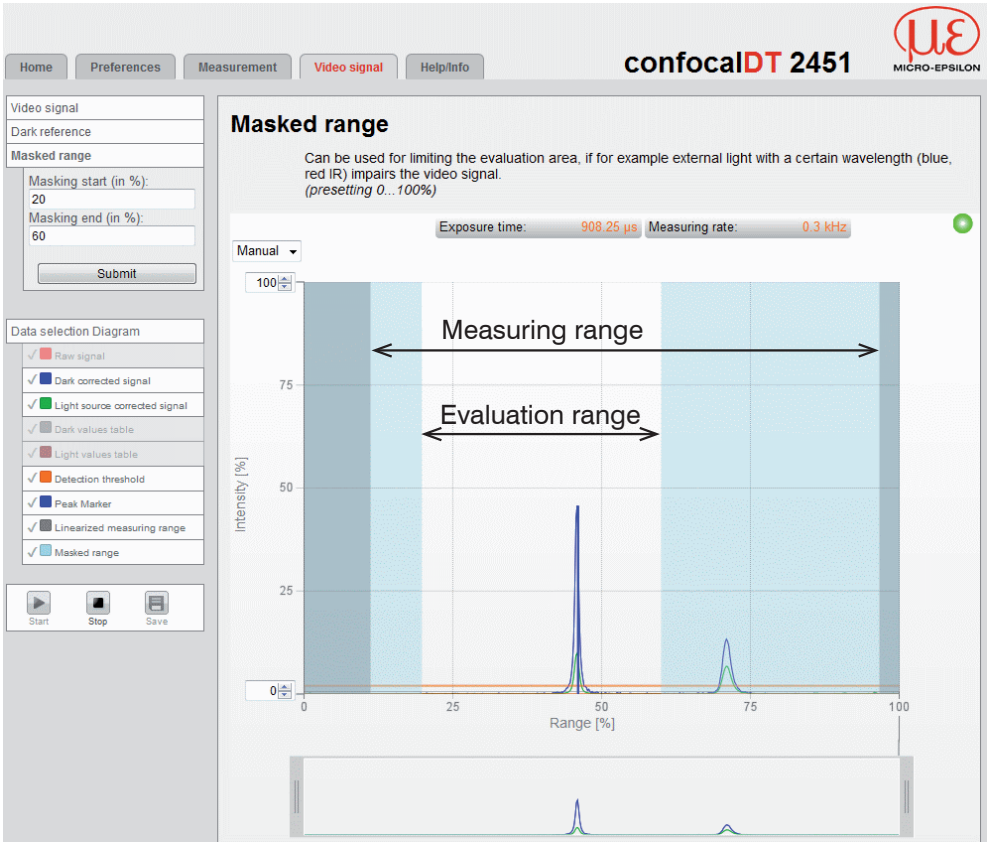


Fig. 57 Limiting the video signal

Fields with a grey background require a selection.

Value Fields with a dark border require the specification of a value.

6.15 Light Source Reference

A light source reference is performed at the manufacturer's premises (prior to delivery). It also needs to be carried out after changing a Xenon light source (controller IFC2471), see A 3, or the LED light source (controller IFC2451, IFC2461 and IFC2471LED).

Step by step:

- Connect the controller with the Xenon light source (using controller IFC2471). Let both devices warm up for approx. 30 minutes.
- Do not connect any sensors. You may need to disconnect the sensor cable from the sensor.
- Perform a dark reference without a sensor, see 5.5. On the controller, press the `Dark reference` button [1], or click the `Start dark reference` button on the web interface (Video signal menu > Dark reference).
- Connect the reflector to the sensor female connection. The reflector is either supplied as part of the Xenon lamp module package, or is sold as optional accessory.
- Perform the light reference. Click the `Start light source reference` button in the web interface (Video signal menu > Light reference). This may take up to 10 seconds. The result is stored.
- Remove the reflector.
- Observe the video signal, see Fig. 58.
- Perform a dark reference with a sensor, see 5.5.

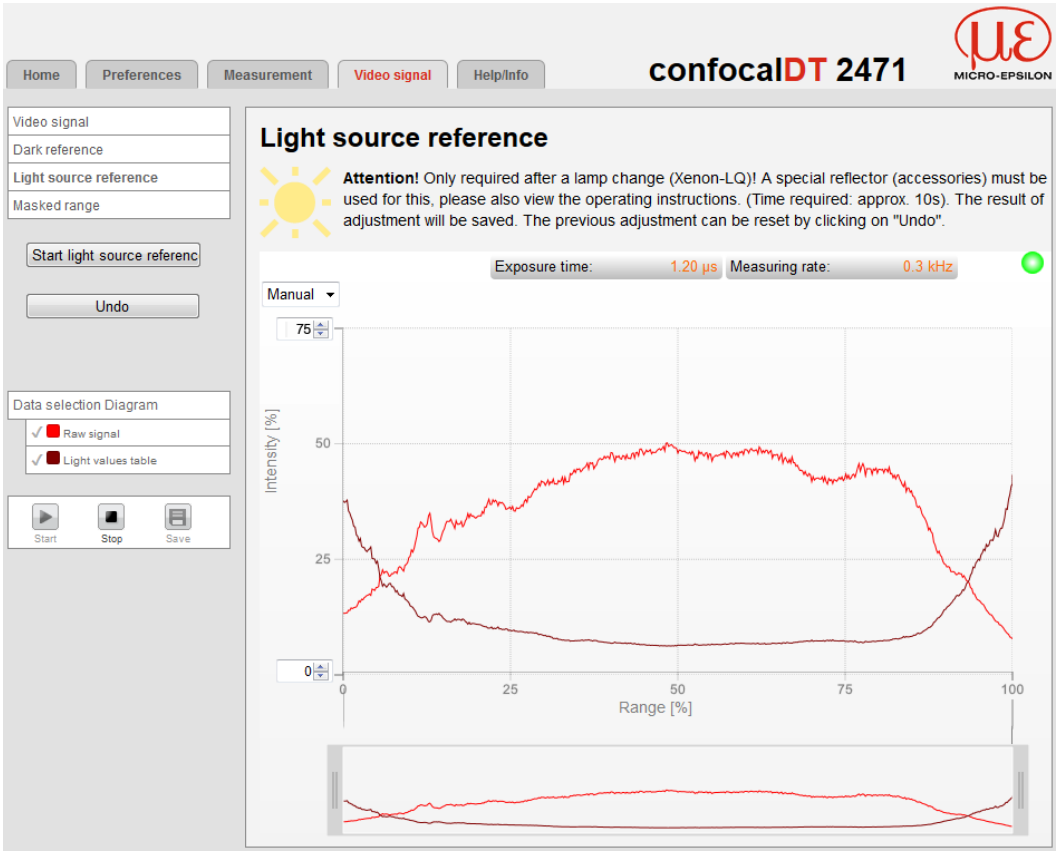


Fig. 58 `Light reference` *video signal ,example: IFC2471 with xenon light source*

Click `Undo` to reset the previous adjustment.

6.16 Help/Info

This page contains information such as the controller's serial and version numbers, stored calibration tables and an address block.

The `Save diagnostic file` function writes the current controller settings and a list of the calibrated sensors in an ASCII file.

1) After more than 10 seconds, the factory settings will load!

6.17 Edit Material Data Bank

6.17.1 Create Known Material

Use the `Add material` button to add values to or delete values from the controller material database. Adding new material requires either the refractive index and the Abbe number vd or three refractive index numbers for wavelengths (even if they more or less coincide).

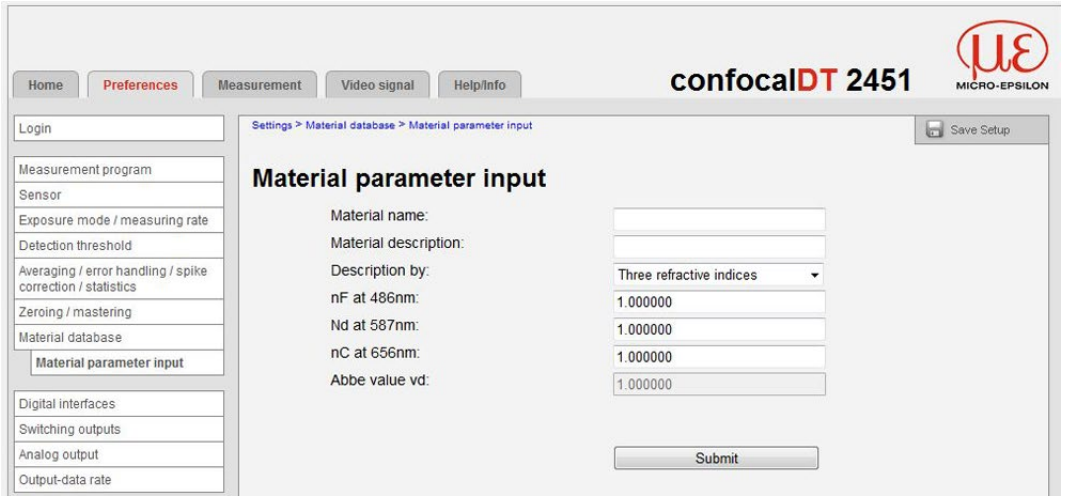


Fig. 59 Input mask for material-specific refractive indices

6.17.2 Create Unknown Material

i Before you can determine the refractive indices of material with unknown object properties, the exact thickness of the material must be known. The pattern should as far as possible not much thicker than the minimum measurable thickness of the sensor type, i.e. approximately 10 ... 20 % of the measuring range, and exactly coplanar.

- Confirm the button `Add material` in menu `Material data base`.
- Duplicate the refractive indices of the material BK7 e.g. in a transparent measuring object as a first approximation.

The more similar the refractive indices of the unknown object and the starting material, the faster and more accurately you determine the refractive indices.

The three refractive indices at different wave lengths are needed for the new material.

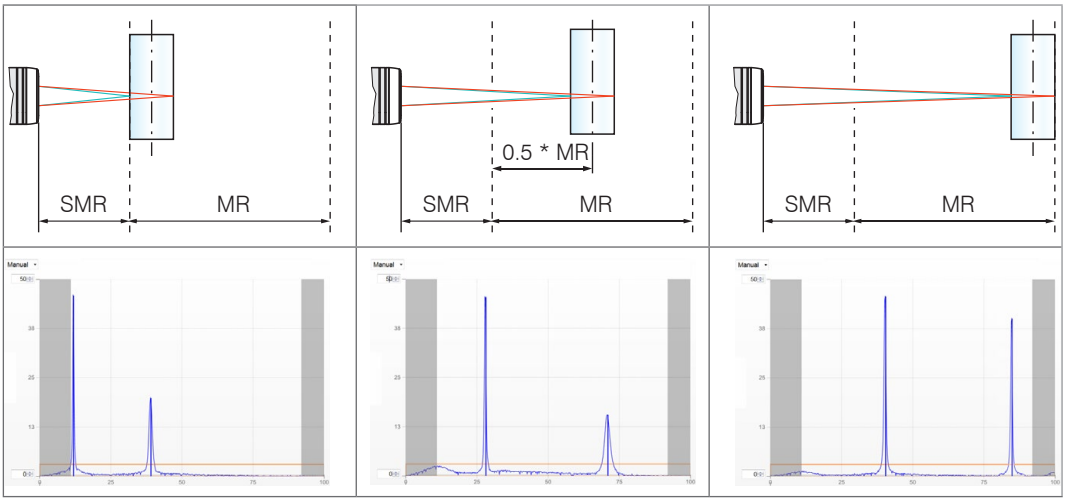


Fig. 60 Video signal at start of measuring range (SMR), midrange (MMR) and end of measuring range (EMR) for determination of refractive indices

- Move the measuring object with the front edge to start of measuring range, see Fig. 60.
- Change to `Measurement` tab and note the current thickness value.
- Move the measuring object to midrange and note the current thickness value at midrange.

- Move the measuring object with the rear edge to start of measuring range and note the current thickness value at end of measuring range.
- Calculate the respective refractive indices using the following formula, the nominal thickness and the three measured thicknesses.

$n_{new,MBx} = \frac{n_{1,MBx} * D_{NOM}}{D_{ACT,MBx}}$	$n_{new,MBx}$	Refractive index, new material at SMR, MMR and EMR
	$n_{1,MBx}$	Refractive index, raw material at SMR, MMR and EMR
	D_{Nom}	Nominal thickness (exact thickness of the used measuring object)
	$D_{ACT\ MBx}$	Actual thickness (the thickness of measuring object displayed by measurement system) at SMR, MMR and EMR

Fig. 61 Formula for determination of the refractive indices

- Change to the `Material database` menu and replace the refractive indices by the calculated values. The refractive indices for start of measuring range, midrange and end of measuring range correspond the 3 refractive indices nF, nd and nC in a rough approximation.
- Change to the `Measurement` tab and check the thickness values for start of measuring range, midrange and end of measuring range.
- Repeat steps to increase the accuracy of the refractive indices.

6.18 Different Peak Selection in the Thickness Measurement Program

This function is used, if a material generates peaks in front of or between the applied peaks caused by thin layers on the measurement object. This function should be used with care and exclusively by product specialists.

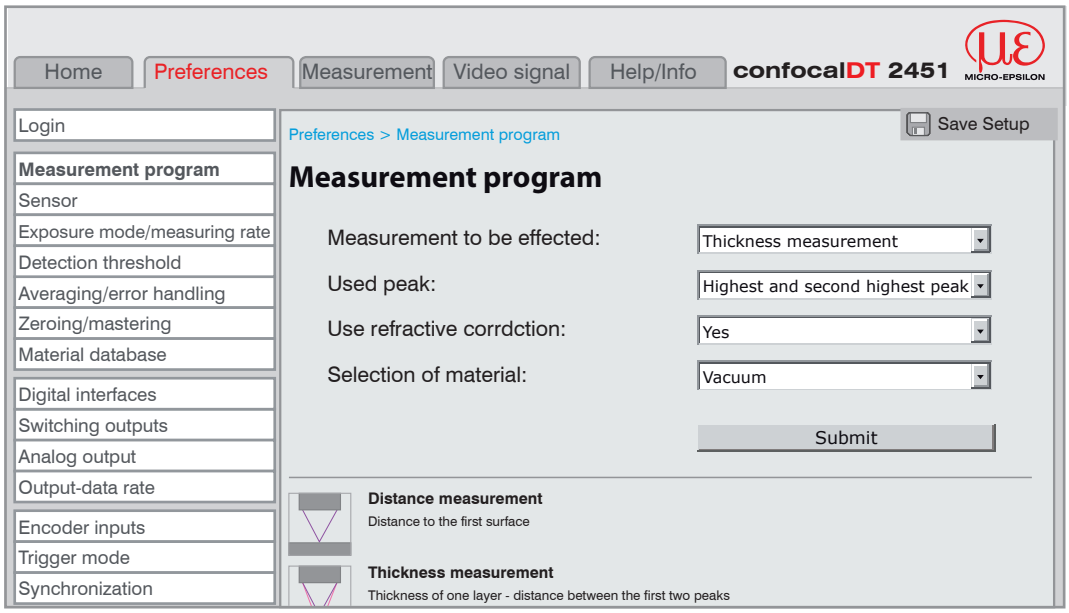


Fig. 62 Advanced measurement program with individual peak selection

The selection of the peaks determines which areas in the signal are used for the distance or thickness measurement. If a measurement object contains multiple transparent layers, a correct measurement result is determined only for the first peak (distance measurement) and the first two peaks (thickness measurement).

Distance measurement	Thickness measurement
first peak	first and second peak
last peak	first and last peak
highest peak	second to last and last peak
	highest and second highest peak

Fig. 63 Menu items used peaks

The determination of the peak heights is performed using the light corrected signal. In the following example the thickness is measured between the highest and second highest peak.

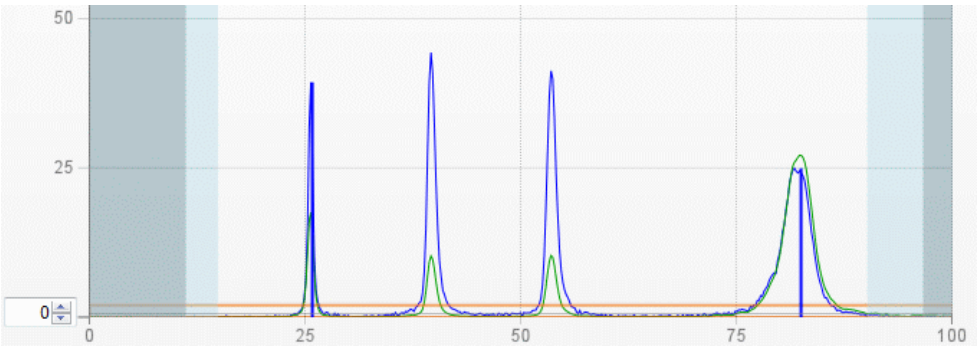


Fig. 64 Extract of a video signal with multiple peaks in the measuring range

By default the refractive correction is performed. If more than two peaks are within the measuring range, an exact refractive correction is performed with the same amount of peaks only.

Example: 3 peaks, the first or the last peak leaves the measuring range sometimes. Switch off the refractive correction, because the refractive correction is applied on a different layer, a clear assignment of the material is not possible.

6.19 Timing, Measurement Value Flux

The controller operates in cycles for measuring and processing:

1. Exposure: Charging the incoming light in the spectrometer/receiver,

2. Conversion of the video signal as digital values,

3. Computing the distance and thickness, average and so on,

4. Measurement output.

The measured value N is available after three cycles on the output.

The processing of the cycles occurs sequentially in time and parallel in space (pipe-lining). After another cycle the next measurement value (N +1) is output.

Each cycle takes about 200 µs at a measuring rate of 5 kHz. The delay between the input reaction and the output signal is therefore about 600 µs for this measuring rate.

Cycle	1. (N)	2. (N+1)	3. (N+2)	4. (N+3)
Time	200 µs	400 µs	600 µs	800 µs
1. Layer	Exposure N	Conversion N	Computing N	Output N
2. Layer	---	Exposure N+1	Conversion N+1	Computing N+1
3. Layer	---	---	Exposure N+2	Conversion N+2
4. Layer	---	---	---	Exposure N+3

Fig. 65 Controller timing after switching on

The measured value is available 3 cycles after the incoming trigger signal with active triggering.

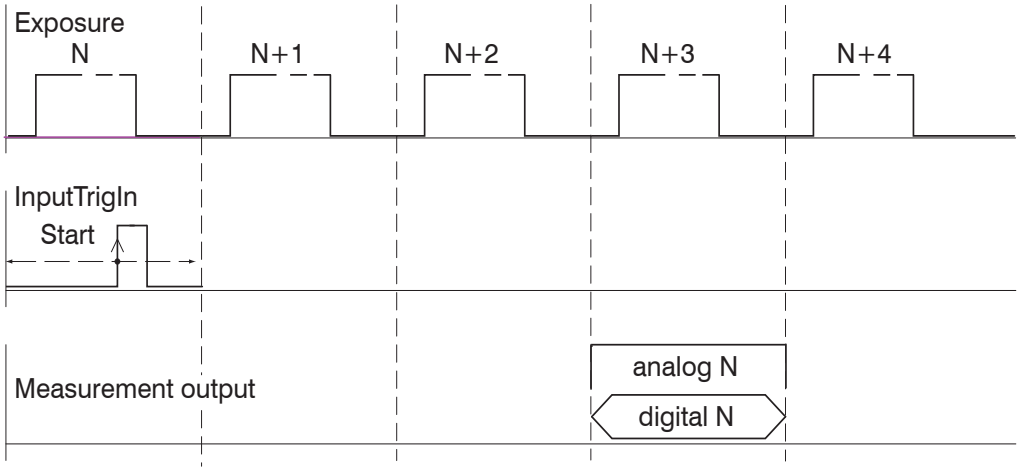


Fig. 66 Timing with triggering, rising edge, one value

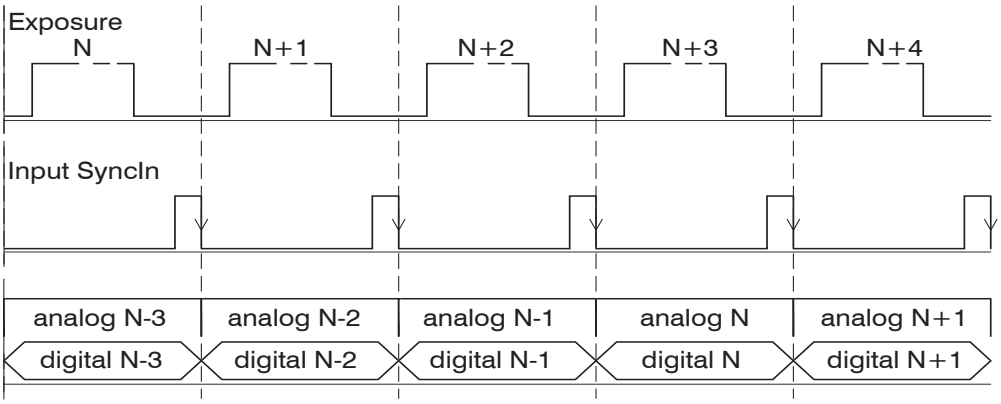


Fig. 67 Timing with synchronization, steady state

7. Errors, Repairs

7.1 Troubleshooting

7.1.1 Web Interface Communication

If an error page is displayed in the web browser, please check the following:

- Check if the controller is connected correctly, see 5.1.
- Check the IP configuration for PC and controller, and check if `sensorTOOL` can locate the controller, see 5.2.1.
  If controller and PC are connected directly, IP address detection may take up to 2 minutes.
- Check the proxy settings. If the controller uses a separate network adapter to connect to the PC, you need to disable the use of a proxy server for this connection. Contact your network specialist or administrator!

7.1.2 Distance Measurements

If the `Range` LED does not come on, even though a target object is positioned within range, check the following.

- The cable connections of the optical fibers and the sensor cable are plugged fully into the controller's cable socket.
- The sensor is sending out a light beam, and the light is visible on the target object.
- The target object is positioned within the measuring range, see 4.7.7.
- The sensor is aligned vertically to the target object. Local measuring point increases (ie. angle between the optical axis and the target object's vertical straight) do not exceed the maximum sensor tilt angle.
- The lowest measuring rate is selected, and Distance is set as measurement type.
- The dark signal was captured correctly.
- Check the video signal: is only one peak above the recognition threshold?

7.1.3 Thickness Measurements

If zero (0) comes up as a result for thickness measurements (error), please check the following:

- The thickness of the target object must correspond to the sensor's measuring range limits, see 4.7.7.
- The target object must be sufficiently transparent.
- The surfaces should not be anti-glare, as the coating allows only for minimum reflection.
- Optical axis and target object surface are perpendicular.
- The lowest measuring rate is selected.
- Both surfaces of the target object must be positioned within the measuring range, see Fig. 28.
- Check the video signal: are two peaks above the recognition threshold?

7.2 Changing the Sensor Cable for IFS2405 and IFS2406 Sensors

Disconnect the protective sleeve from the sensor.

Remove the damaged sensor cable. Loosen the swivel nut of the connector. Carefully peel off the adhesive protection and then pull out the connector

Guide the new sensor cable through the protective sleeve.

Remove the protective cap on the sensor cable and keep it.

- Guide the locking pin of the sensor cable into the connector cavity.
- Screw together the sensor's connector and socket ends.
- Screw the protective sleeve back onto the sensor.

- Run the dark reference, see 5.5.

7.3 Changing the Protective Glass for IFS2405 and IFS2406 Sensors

Changing the protective glass is required for

- irreversible pollution.
- scratches.

i Do not use the sensor without a protective glass, because this leads to a lower measurement accuracy.

7.3.1 IFS2405/IFS2406

- Loose the front socket with the protective glass from the sensor.

- Remove the seal and place the O-ring into the frame groove of the new socket.
- Screw the new socket with the protective glass back onto the sensor.

7.3.2 IFS2406/90-2.5

- Loose the grub screws on the sensor, see Fig. 68, and slide the protective glass aside, see Fig. 69.

Fig. 68 View on sensor from above

Fig. 69 View on sensor from below

- Slide the new protective glass flush back and clamp the protective glass with the two grub screws again firmly.

8. Software Update

Requirements for software update

➡ Connect the controller („Ethernet“ female connector) to a PC using an Ethernet direct connection (LAN). Use a LAN cable with RJ-45 connectors.

i A software update does not affect the parameter settings. Newly added parameters are set to default values.

Update

You will find the latest firmware update tool `Update_Sensor_Ethernet.exe` on our website:

www.micro-epsilon.com/download/software/confocalCDT_Update_Sensor_Ethernet.zip

You can get the latest firmware under www.micro-epsilon.com/service/download/software/ in the section confocalDT - Confocal Sensors.

If you have any questions, please feel free to contact the relevant sales person in our company.

9. Software Support with MEDAQLib

The Micro-Epsilon Data Acquisition Library offers you a high level interface library to access confocal displacement sensors from your Windows application in combination with

- RS422/USB converter (optional accessory) and a suitable SC2471-x/USB/IND cable or
- IF2008 PCI interface card and SC2471-x/IF2008 cable or
- Ethernet

into an existing or a customized PC software.

You need no knowledge about the controller protocol to communicate with the individual controllers. The individual commands and parameters for the controller to be addressed will be set with abstract functions. MEDAQLib translates the abstract functions in comprehensible instructions for the controller.

MEDAQLib

- contains a DLL, which can be imported into C, C++, VB, Delphi and many additional programs,
- makes data conversion for you,
- works independent of the used interface type,
- features by identical functions for the communication (commands),
- provides a consistent transmission format for all MICRO-EPSILON sensors.

For C/C++ programmers MEDAQLib contains an additional header file and a library file,

You will find the latest driver / program routine at:

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

10. Software Support with IFD2451/2461/2471 Tool

The software IFD2451/2461/2471 Tool

- transfers, reads and saves measurements
- supports controller configuration by calling up the web interface.

All data are transmitted through Ethernet or RS422 interface and can be saved on demand.

i Disconnect or connect the D-sub connection between RS422 and USB converter when the controller is disconnected from power supply only.

10.1 System Requirements

The following system requirements are recommended:

- Windows XP, Windows Vista or Windows 7 (32 or 64 bit) / Intel Core 2 Duo, 3 GHz / 1 GB RAM
- Ethernet port, USB port or IF2008

10.2 Cable and Program Routine Requirements

with RS422	with Ethernet
- SC2471-x/USB/IND Sensor cable with RS422-USB converter and 24 V power supply - RS422/USB converter, inclusive CD with driver	LAN cable

You will find the actual drivers or program routines under:

www.micro-epsilon.com/download/software/confocalDT_2451_Tool_Setup.zip

www.micro-epsilon.com/download/software/confocalDT_2461_Tool_Setup.zip

www.micro-epsilon.com/download/software/confocalDT_2471_Tool_Setup.zip

You will find details to the driver installation in the mounting instructions „Converter RS422 to USB“.

10.3 Measurement

This sub program can be used to acquire, evaluate and store data from an IFC24x1 controller.

11. Disclaimer

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

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

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

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

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

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

For translations into other languages, the German version shall prevail.

12. Service, Repair

If the sensor, sensor cable or the controller is defective:

- If possible, save the current sensor settings in a parameter set, see 6.12, to reload them into the sensor after the repair.
- Please send us the affected parts for repair or exchange.

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

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

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

13. Decommissioning, Disposal

➪ Remove the sensor cable as well as the controller's supply and output cables. Insert the dummy connectors.

➪ Remove the optical fiber cable that connects controller and external light source. Insert the dummy connectors.

Incorrect disposal may cause harm to the environment.

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

Appendix

A 1 Accessories, Services

Accessories IFS2402, IFS2403

CE2402-x	Sensor cable extension for IFS2402 sensors, length x = 3 m, 10 m, 30 m, 50 m
CE2402-x/PT	Sensor with protective tubing, length x = 3 or 10 m, costumer-specific up to 50 m

Accesories IFS2404

C2404-x	Sensor cable IFS2404 sensors, length x = 2 m, 3 m, 5 m

Accessories IFS2405, IFS2406, IFS2407-0,1

C2401 cable with FC/APC and E2000/APC connectors

C2401-x	Optical fiber (length x = 3 m, 5 m, 10 m, customer-specific length up to 50 m)
C2401/PT3-x	Optical fiber with metallic protection tube for mechanical stress (length x = 0.23 m, 0.3 m, 1 m, 3 m, 5 m, 10 m, 15 m, customer-specific length up to 50 m)
C2401-x(01)	Optical fiber core diameter 26 µm (length x = 3 m, 5 m, 15 m)
C2401-x(10)	Drag-chain suitable optical fiber (length x = 3 m, 5 m, 10 m)

C2400 cable with 2x FC/APC connector

C2400-x	Optical fiber (length x = 3 m, 5 m, 10 m, customer-specific length up to 50 m)
C2400/PT-x	Optical fiber with protection tube for mechanical stress (length x = 3 m, 5 m, 10 m, customer-specific length up to 50 m)
C2400/PT-x.Vac	Optical fiber with protection tube suitbale for use in vacuum (length x = 3 m, 5 m, 10 m, customer-specific length up to 50 m)

Installation bracket

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

Accessories IFS2407/90-0,3

C2407-x	Optical fiber with DIN connector and E2000/APC (2 m, 5 m)

Accessories light source

IFL24x1/LED	Lamp module for IFC24x1
IFL2451/LED(003)	Lamp module for IFC2451(003) with heat sink
IFX2471/Xe/75	External xenon light source for IFC2471 controller
IFX2471/Xe/75 lamp module	Exchangeable, completely adjusted lamp module for the IFX2471 xenon light source
CL2471-1/Xe	Light source cable, 1 m
Optical fiber reflector	Reflector for E2000/APC

Other accessories

SC2471-x/IF2008	Interface cable for interface IF2008, length x = 3 m, 10 m or 20 m
SC2471-x/RS422/OE	Interface cable for interface IF2030, length x = 3 m, 10 m
SC2471-3/IF2008ETH	Interface cable for interface IF2008/ETH, length 3 m
IF2001/USB	Converter RS422 to USB, type IF2001/USB, useable for cable SC2471-x/RS422/OE, inclusive driver, connections: 1× female connector 10-pin (cable clamp) type Würth 691361100010, 1x female connector 6-pin (cable clamp) type Würth 691361100006
IF2008/PCIE	Interface card IF2008/PCIE to capture four digital sensor signals synchronously, confocalDT 2421/2422/2451/2461/2471 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.
IF2008/ETH	8-fold RS422/Ethernet converter with industrial M12 plug/socket to connect up to 8 IFC242x/2451/2461/2471 controllers
IF2030/PNET	Interface component to connect an IFC242x/2451/2461/2471 controller to Profinet, housing for top-hat rail, software integration into PLC with GSDML file, certified according to PNIO V2.33
PS2020	Power supply unit for DIN rail mounting, input 230 VAC, output 24 VDC/2.5 A
EC2471-3/OE	Encoder cabel, 3 m

Vacuum feed trough

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

Services:

- Linearity tests and adjustments for the confocalDT measuring system
- Calibration of the confocalDT measuring system
- Exchange of lamp at the xenon light source IFX2471 or on removable lamp module

A 2 Factory Settings

User group: Professional; password: 000	Measuring program: Distance measurements
Measurement averaging: none	Video averaging: none
Statistics: all measured values	Troubleshooting: Error output
Data selection: Distance 1	Select digital out: Displayed as web diagram
RS422: 115.200K Baud	Ethernet: Static IP
Trigger mode: no trigger	Switching output 1: Error intensity
Language: de	Switching output 2: Error measuring range
Synchronization: No synchronization	Exposure mode: Automatic mode

A 3 Xenon Light Source IFX2471

A 3.1 Warnings

⚠ CAUTION

Dangerous high voltage within the Xenon light source. Maintenance of the light source must be carried out by qualified personnel only.

> Risk of injuries

Do not remove any safety devices.

> Risk of injuries

> Risk of insecure operation

The Xenon light source produces UV radiation.

> Risk of eye injuries

Do not look directly into the light source. Use appropriate eye protection.

NOTICE

Avoid shock and vibration to the Xenon light source.

> Damage or destruction of the Xenon light source

i Read all safety and operating instructions, before you start using the Xenon light source.

A 3.2 Functionality

The external light source uses a 75 W Xenon short arc lamp with an output performance of approx. 250 µW (values may vary depending on the measurement device). The optical axis has an integrated heat protection filter that is permeable to light.

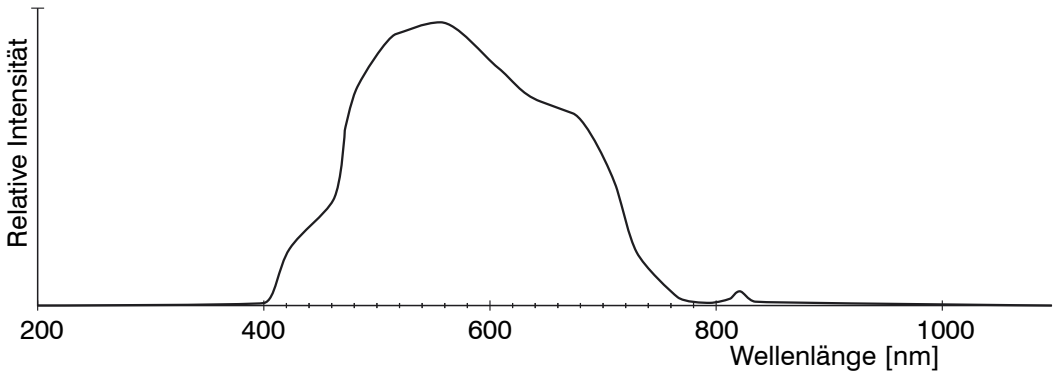


Fig. 70 Spectral distribution of the Xenon light source

To ensure optimum performance, the replaceable lamp module is accurately aligned for coupling into an optical fiber cable with a 50 µm fiber core and a E2000 connector. This is the reason why the Xenon lamp within the lamp module must be replaced by the manufacturer. It is not possible to manually restrict the light intensity, but controller IFC2471 can control the light exposure time. The average life span of a Xenon lamp is approximately 2000 hours, but may be less depending on frequency of operation and ambient temperature.

A 3.3 Unpacking, Items Included in Delivery, Accessories and Installation

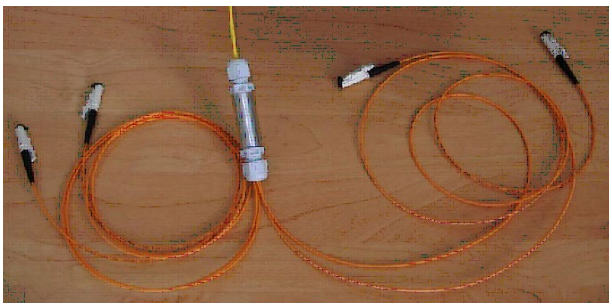
Check for completeness and any signs of transport damage immediately after unpacking. If your delivery is damaged or incomplete, please contact the manufacturer or your supplier without delay. Never use a damaged Xenon light source.

Items included in delivery

1	Xenon light source IFX2471, including power supply and status cable 1m (Binder M8, 4-pin)	2418002

Optional accessories

CL2471-1/Xe; optical fiber cable; 1 m; one cable to connect one controller	2570001
CL2471-1/Xe/Y4; optical fiber cable; 1 m; four cables to connect up to 4 controllers (optical performance slightly reduced)	2570002



Replaceable, pre-aligned lamp module	
Optical fiber reflector for bright referencing after changing a lamp	2418021

Use this device in a clean environment. Dust particles on the fiber can reduce performance.

The IFX2471 Xenon light source is ready for DIN rail mounting. Do not cover any ventilation holes during installation. To ensure sufficient air flow, you will need a space of 150 mm or more between the top of the Xenon light source and any adjacent objects.

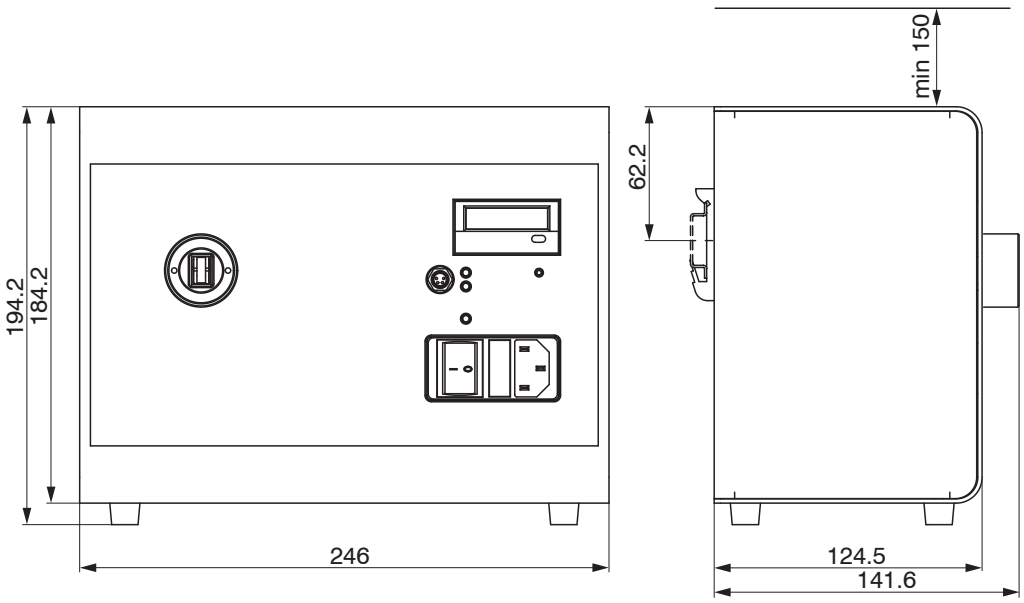


Fig. 71 Dimension drawing of Xenon light source IFX2471

Delivery includes a spring-loaded mechanical protection cover within the fiber connector and a dummy connector. It is recommended that you remove the dummy connector to connect a fiber only when the device is switched off. Avoid any direct eye contact with the other fiber end.

A 3.4 Tips for Operation

Handle the optical fiber cable with extreme caution. Please note the following:

- Never kink the optical fiber cable. This will permanently damage the cable.
- Do not fall short of the minimum bending radius when laying the optical fiber cable. This may impact performance.

Minimum bending radius: 30 mm (fixed), 40 mm (permanent flexible)

➨ Leave the optical fiber cable connected; avoid frequent connecting and disconnecting to prevent dust from damaging the mating connector.

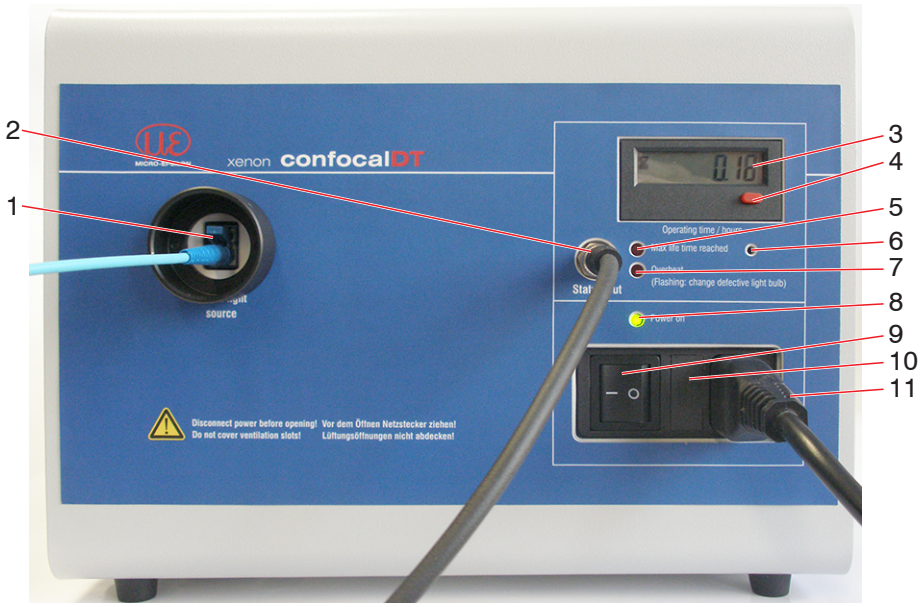
➨ Do not touch, contaminate or scratch the polished exit portal of the fiber (face of the ceramic ferrule). Clean only using pure alcohol and a cleaning cloth for optical surfaces.

The connector cannot be repolished. Re-confectioning or a new cable will be required.

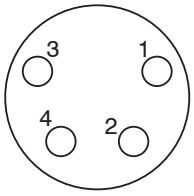
A 3.5 Technical Data

Description	**confocalDT IFX2471**
Connector type	E2000
Glass fiber cable	Step index fiber 50 µm core / 125 µm cladding
Optical performance	approx. 250 µW at the fiber connector (with 650 nm)
Warm-up time	≤ 30 min (95 % of full performance after approx. 2 min)
Stability (optical performance)	~ 1 %
Lamp life (manufacturer's specifications)	1000 hours (average life span: 2000 hours)
Long-term stability (loss of power)	50 % (for lamp life)
Wavelength range	400 …800 nm, heat protection filter for IR range
Power supply	Wide range input 100 ... 250 VAC, 50 … 60 Hz; 105 W, fine-wire fuse mains switch 5 x 20 mm; 2 A (Littlefuse, series 213)
Cover dimensions (wxhxd)	246 x 195 x 125 mm
Weight	3.84 kg
Protection rating	IP 40
Operating temperature	5 °C to 40 °C
Storage temperature	-20 °C to 60 °C (up to 70 °C for very short periods, reduces life span)
CE Conformity	Low Voltage Directive 2006/95/EC, EN 61010, EMC standards: DIN EN 61326-1, DIN EN 55011, DIN EN 61000-6-2

A 3.6 Operating Elements



1	Light exit socket. The socket is designed for E2000 fiber connectors. The dummy connector is used to prevent any direct eye contact with the light beam. Before switching on the light source, plug in the 50 µm fiber cable. Avoid any direct eye contact with the other fiber end.
2	Status socket (Binder M8, series 718). For the included status cable to transmit Lifetime and Overheat LED information to the outside (e.g. to the base unit).
3	Operating hours counter for the Xenon lamp. Counter service life is 1500 hours, after that the Lifetime LED will light up.
4, 6	Operating hours reset switch for use after changing the lamp module.
5	Lifetime LED (red). Permanently on if a Xenon lamp exceeds its life span of 1500 hours. The Xenon lamp will continue to work. The average life span is approx. 2000 hours, but may be less depending on frequency of operation and ambient temperature.
7	Overheat LED (red). If this LED is permanently on, this indicates that the Xenon lamp was switched off temporarily due to overheating. Check the ventilation holes. Caution: Power supply has not been switched off, electrical components are still working. The lamp will start to work again when it has cooled down sufficiently. A flashing LED indicates that the Xenon lamp is defective, and the lamp module must be replaced.
8	Power LED (green). Indicates that the power supply is on.
9	Power switch. When the power switch is switched on, the device is supplied with power. The Power LED is on. Caution: Frequent switch use will reduce the life span of the Xenon lamp.
10	Fuses. This area contains fuses that protect the device from overload. Type: fine wire 5 x 20 mm; 2 A; idle fuse.
11	Socket for power cable. Input voltage 100 .. 250 VAC, 50/60 Hz



Pin	Assignment
1	Overheat (collector)
2	Overheat (emitter)
3	Lifetime (collector)
4	Lifetime (emitter)

Fig. 72 Status socket pin assignment

The status outputs are internally unwired opto-coupler outputs.

A 3.7 Changing the Xenon Lamp Module

CAUTION

Caution: While the light source is in operation, the module can reach a temperature of approx. 250°C. Risk of burns. Please let the module cool down for at least 20 minutes, before replacing it.

- You must disconnect the power cable, before opening the cover.
- Disconnect the status and the fiber cables, and put on the protective caps.
- Unscrew the four screws (1) on the top and bottom of the light source, see Fig. 73

Fig. 73 Xenon light source from the outside

- Pull the cover forward, until it comes off.
- Carefully disconnect the green connector (3), see Fig. 74.
- Manually disconnect and remove the four knurled screws (2) with caution. Remove the lamp module.

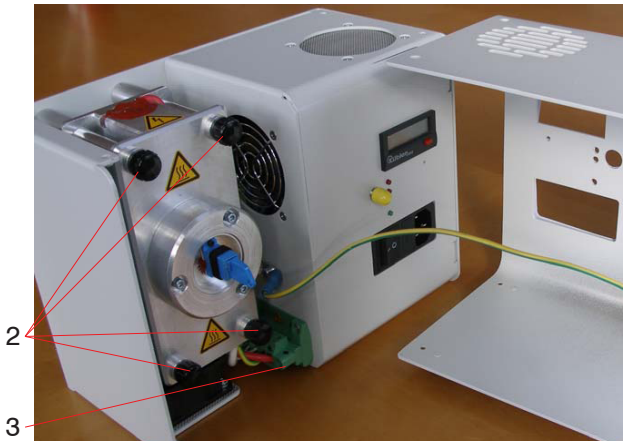


Fig. 74 Open Xenon light source with lamp module

- Remove the 4 retaining rings on the bolts of the new lamp module.
- Insert the new lamp module. Be careful to prevent any knocks to the fiber connector, as they could cause a loss of alignment. Use the knurled screws to attach the lamp module, and reinsert the green connector.
- Assemble the cover, and place the ground connector in the open space.

Resetting the operating hours counter

➡ Plug in the power plug and the fiber cable, and turn the light source back on.

Fig. 75 Operating time counter on the front of the Xenon light source

➡ Use a tool (such as a pen) to keep the switch (5) on the front of the light source pressed, see Fig. 75. At the same time, press the red button (4) twice.

The operating hours are reset to 0.00.

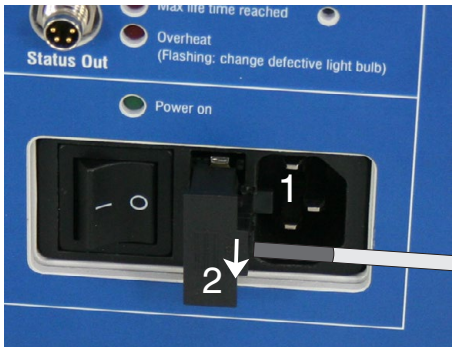
➡ In the controller, perform a light reference, see 6.15.

A 3.8 Change Fuses

⚠ CAUTION

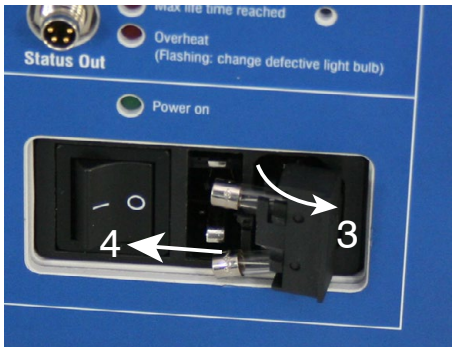
Electric shock. Unplug the power cable to disconnect the light source from the mains power supply.

The xenon light source contain two micro-fuses (5 x 20 mm) in the power entry element, 2 A (Littlefuse, series 213).



➡ Remove the mains cable (1).

➡ Pull the fuse holder (2) out. Use a screw driver.



➡ Rotate the fuse holder to the right (3).

➡ Replace the damaged fuses (4). Use a flat nose plier.

➡ Close the fuse holder.

A 3.9 Troubleshooting

Error	Possible causes	Solutions
Lamp performance of the fiber strongly decreases.	Fiber face(s) are dirty.	Clean fiber faces with alcohol and a cleaning cloth for optical surfaces.
	Fiber faces are damaged.	Replace fiber cable.
	Fiber was kinked.	Replace fiber cable.
	Knocks caused loss of adjustment to the fiber coupling.	Replace lamp module, or send device in for repair.
	Lamp is too old.	Replace lamp module.
Xenon lamp does not come on. Power switch is on, but no LED is coming on.	No power supply.	Check power supply.
	Fuse has blown.	Replace the fuse.
Xenon lamp is not coming on, Overheat LED is permanently on.	Overheated.	Do not cover any ventilation holes, if necessary, reduce ambient temperature, wait.
	Overheating repeatedly due to defective fan.	Send the device in for repair.
Xenon lamp is not coming on, Overheat LED is flashing.	Internal green connector is not connected properly.	Disconnect the power plug, open the cover, plug in the connector.
	Xenon lamp is defective.	Replace lamp module.

A 4 Multilayer Measurement, Controller IFC24x1MP

A 4.1 User Interface

A 4.1.1 General, Settings / Measuring Program

When measuring through transparent layers, each boundary area between two materials with a visually different density will reflect a part of the light.

As refraction of the rays varies, all materials (refractive index) must be known.

To safely separate peaks within the video signal, the individual layers must not be too thin in relation to the measuring range (guide value: minimum layer thickness > approx. 10 % of the measuring range, does not apply to miniature and hybrid sensors).

All peaks must be within the measuring range to ensure that thickness can be calculated correctly.

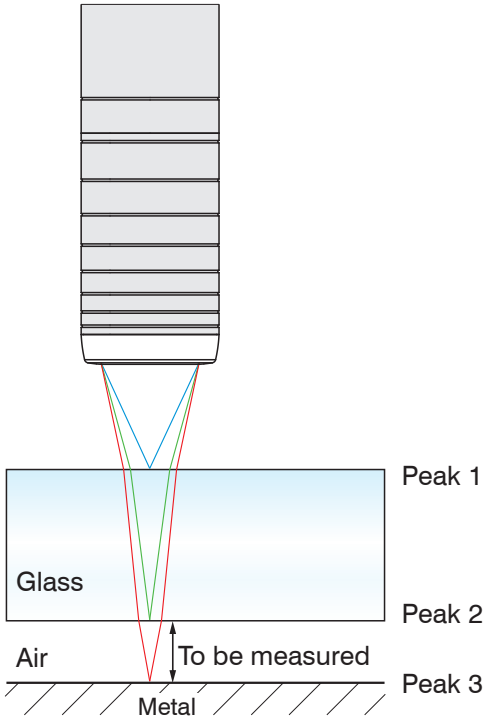
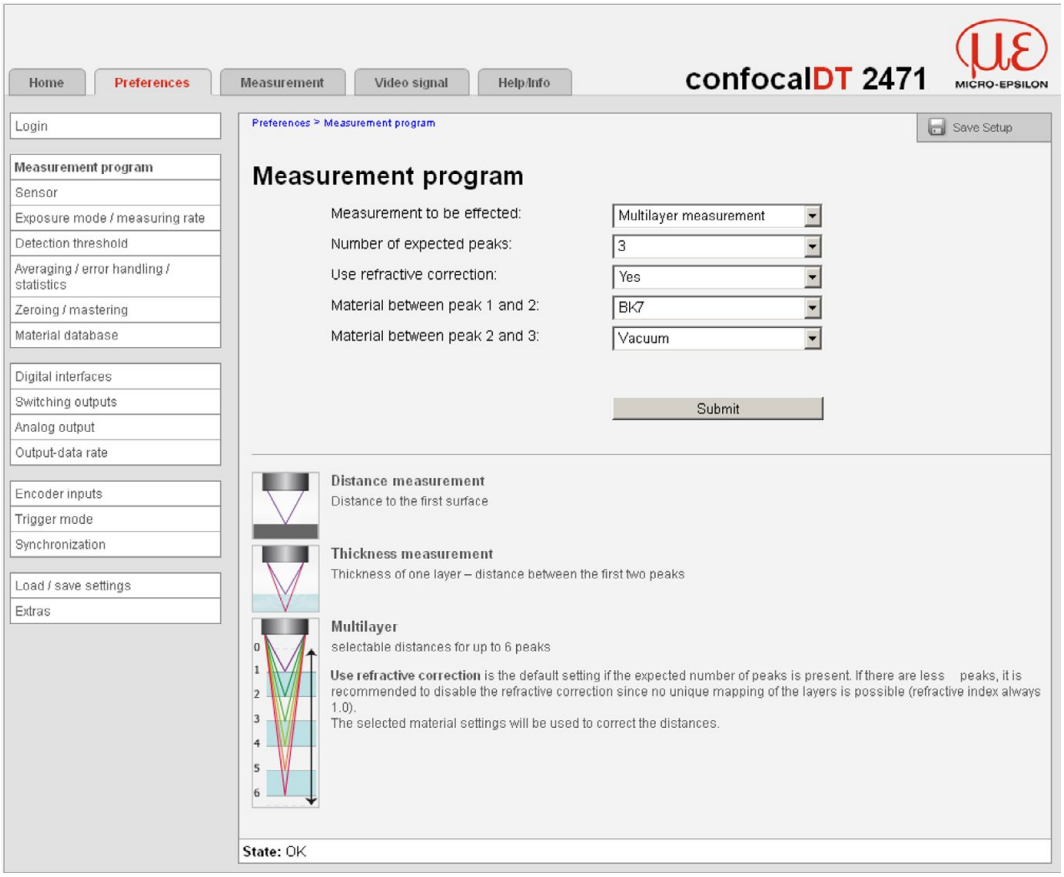


Fig. 76 Example of a measurement task: Number of expected peaks: in this instance 3 (possible maximum of 6)



Define materials: here refractive correction of BK7 between peaks 1 and 2 plus vacuum between peaks 2 and 3.

Deactivating refractive correction

A variety of factors can cause the measurement device to recognize less peaks than expected (in this example 2 peaks instead of 3, see Fig. 76):

① The last peak is located behind the linearized measuring range, the masked range of the CCD line or not in the CCD line at all.

② The first peak is located in front of the linearized measuring range, the masked range of the CCD line or not in the CCD line at all.

③ The distance between any two peaks is too small, the peaks converge and can not be separated.

At ① it is possible to allocate glass as material to the correct area and to perform accurate refractive correction. At ② and ③ errors are introduced due to incorrect material allocation.

If only ① appears because of your measurement arrangement, you can use the default setting: “Use refractive correction: Yes”

Refractive correction is performed, any existing values are displayed, and missing measurement values receive an error status.

If you don’t know the cause but want to analyze at least the peaks for which no refractive correction was performed, you deactivate refractive correction. In this case all measurement values are calculated using a refractive correction of 1.0 (vacuum/air), while any material settings are ignored. Again, any missing measurement values receive an error status.

If more than the required peaks are recognized, any additional peaks are ignored. For error-free allocation of refractive correction, please ensure that the first peak in your measurement arrangement always falls within the measuring range and that no two peaks converge.

A 4.1.2 Video Signal for Multilayer Measurements

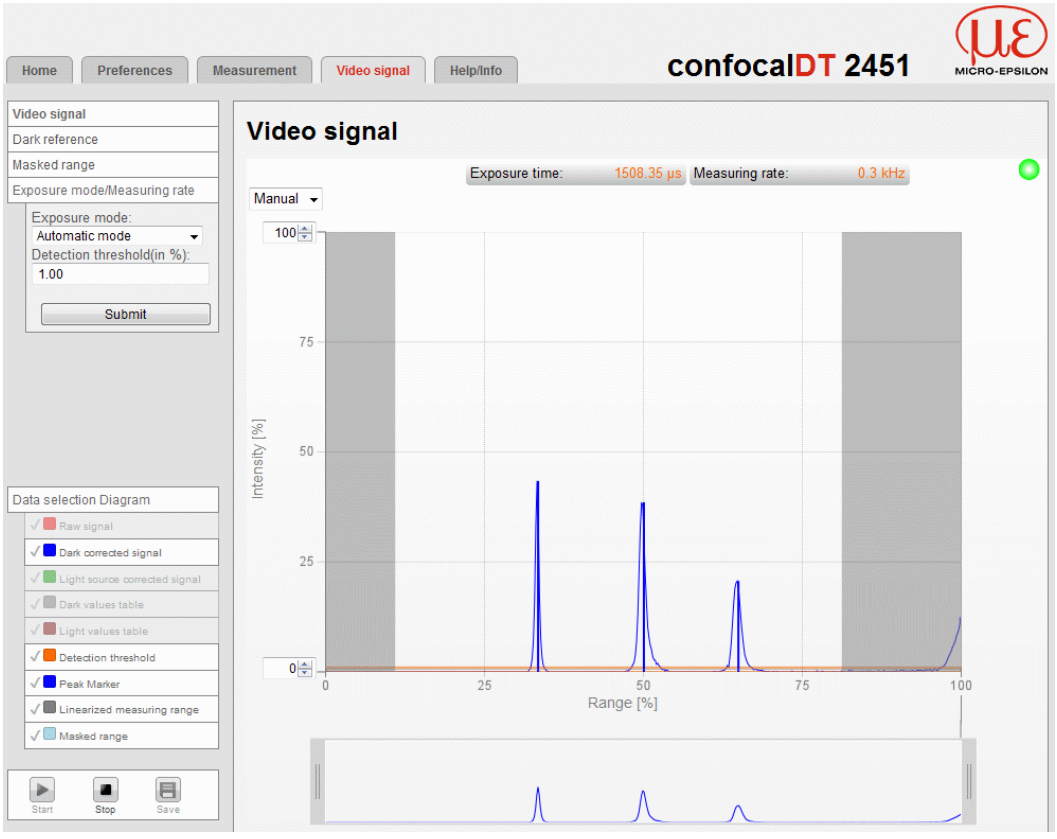


Fig. 77 Video signal, example using 3 peaks

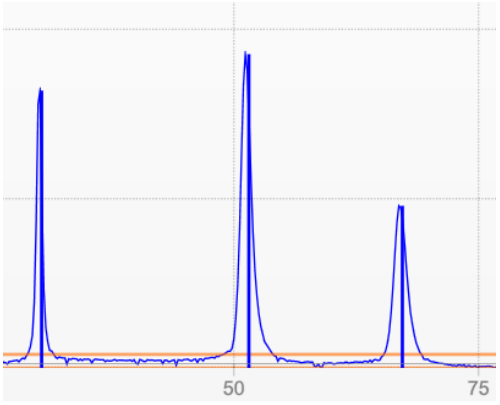


Fig. 78 Separate peaks: Measurement possible

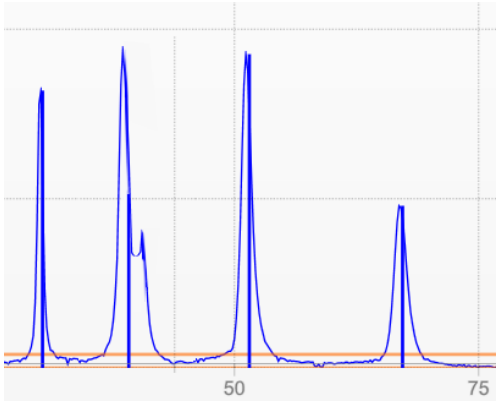


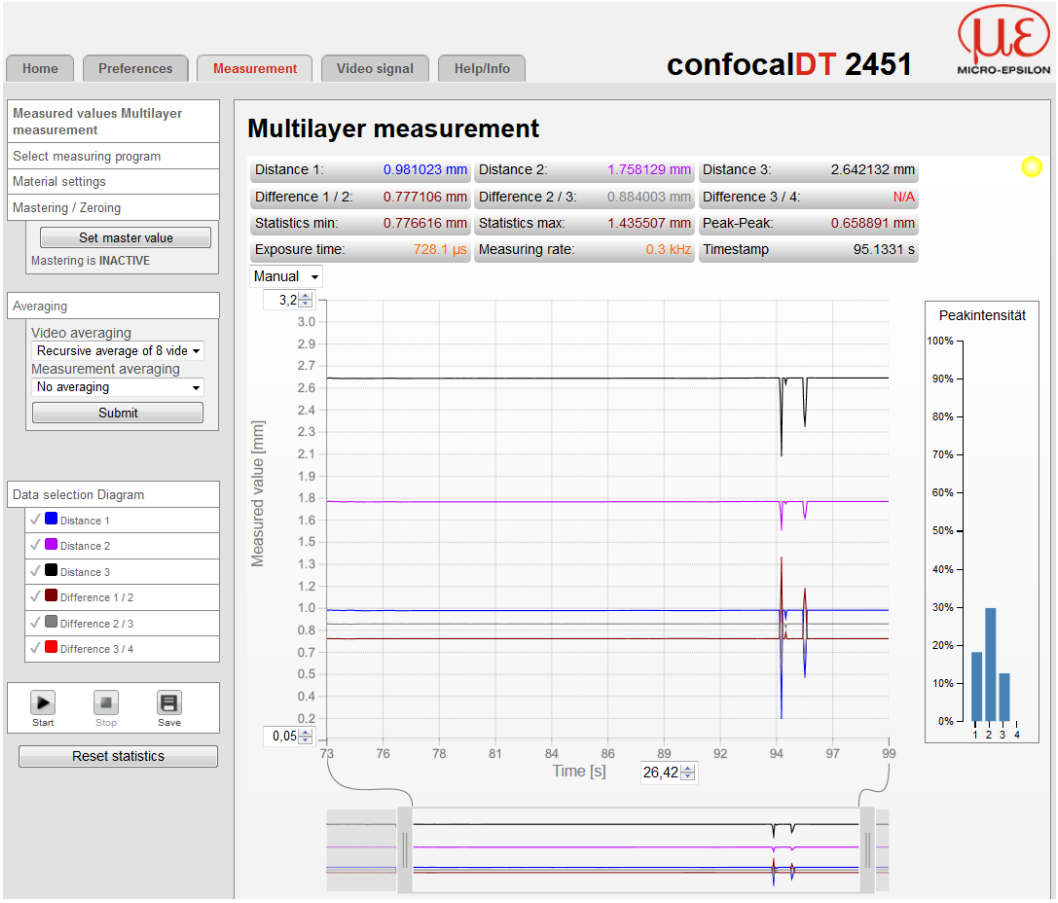
Fig. 79 Peaks into each other: Measurement inaccuracy probably

If a layer is too thin, two peaks lie near together or into each other. Please note that two approaching peaks, see Fig. 79, will influence each other's values.

If the video signal displays peaks with extreme height differences, go forward as follows:

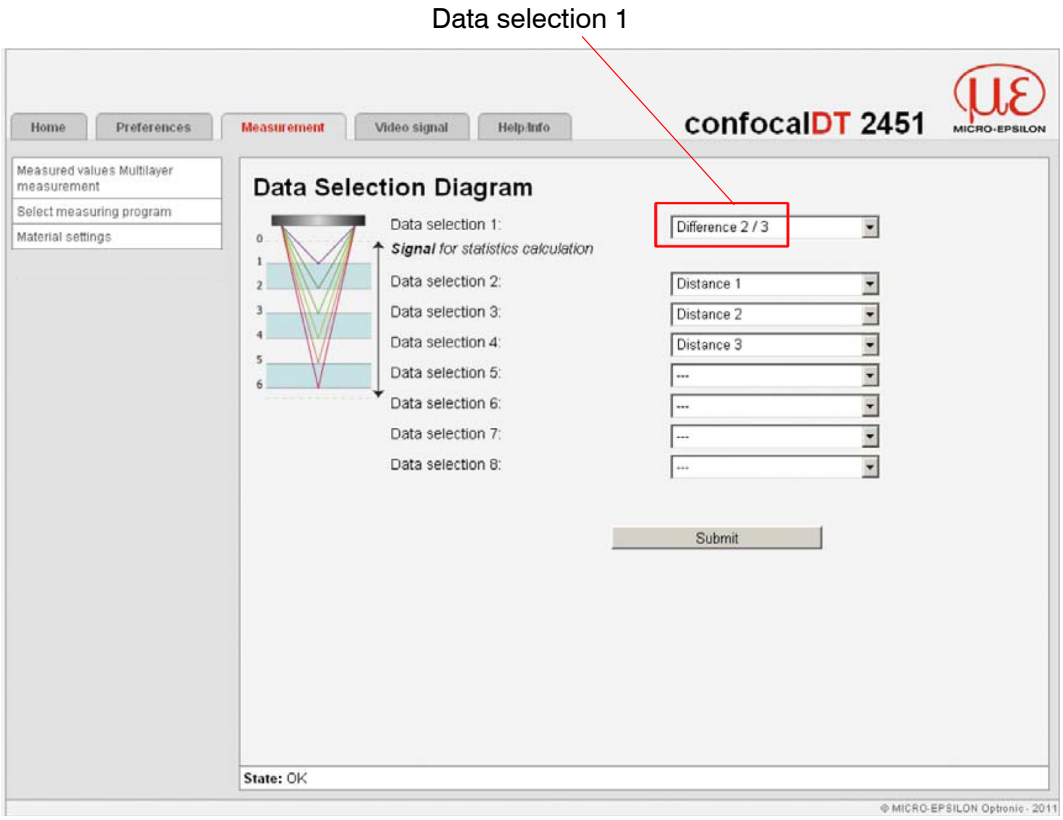
- Change to "manual" exposure mode and
- increase the exposure time.

A 4.1.3 Measurements (Measurement Values Versus Time Diagram)



You can hide and display selected values within the diagram.

Use “Data Selection Diagram” to select measurement values. Statistic values always refer to the first parameter (data selection 1).

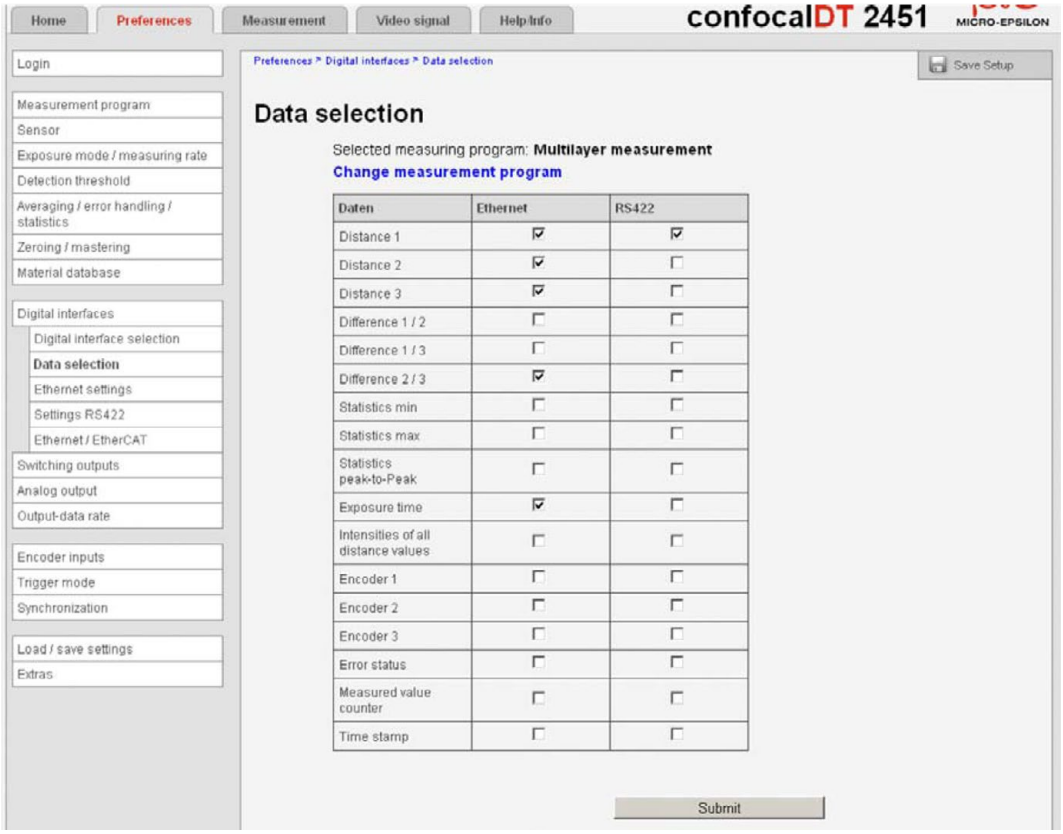


A 4.2 LED Meaning for Multilayer Measurements

Name	State	Description
LED 1 Intensity	Red	Intensity too high, at least one of the peaks is in saturation.
	Yellow	Intensity too low, at least one of the peaks is below the recognition threshold.
	Green	Signal ok
LED 2 Range	Red	Focus of too less (<N) peaks within the linearized (or masked) range.
	Yellow	Average value from first and nth peak in the centre of measuring range (47.5 … 52.5 %)
	Green	OK, all used peaks are within the linearized (or masked) range.
Error 1	Intensity = 1	Warning if the intensity of one or more peaks falls within saturation or below the recognition threshold.
Error 2	Out of range = 1	Too less (<N) peaks within the linearized area.

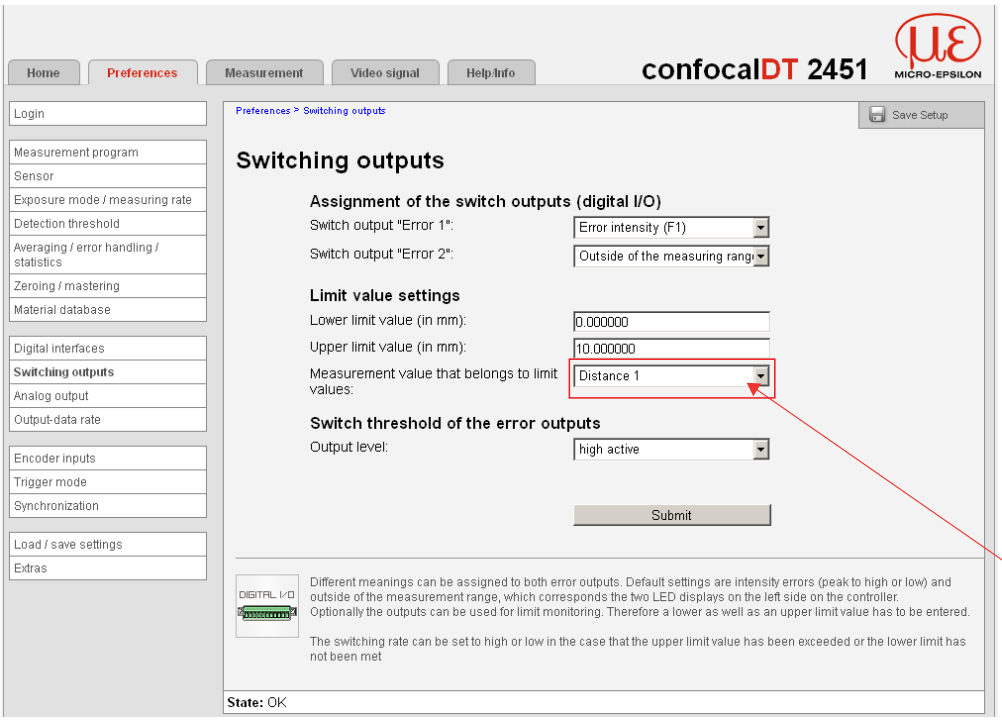
N - Number of (expected) peaks

A 4.3 Digital Interfaces / Data Selection



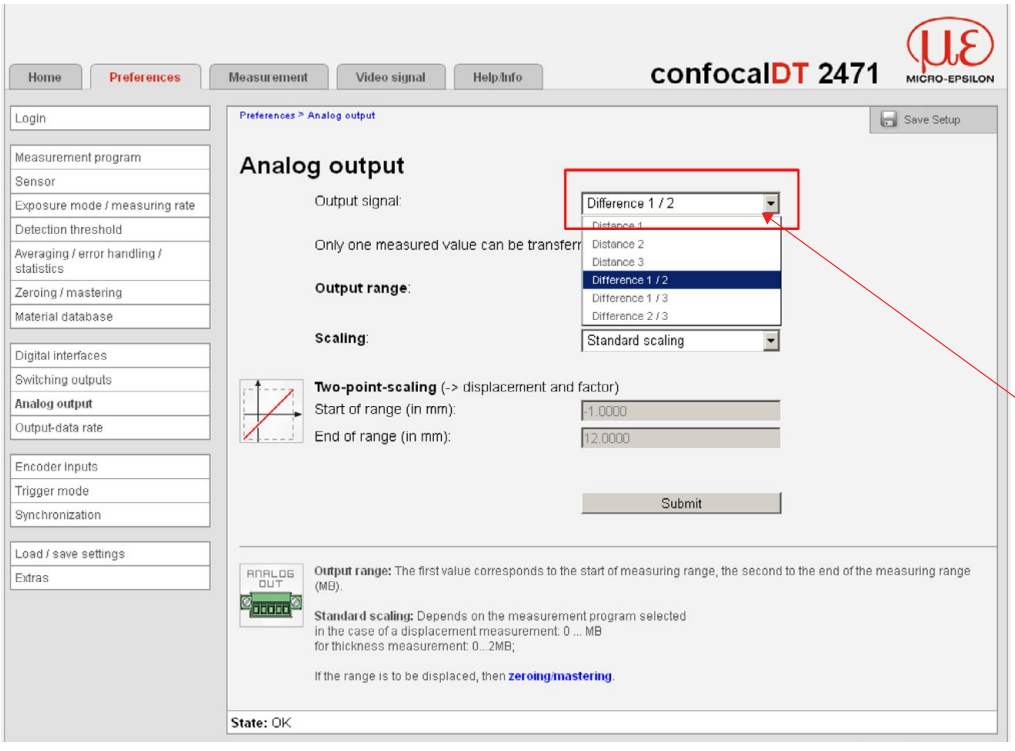
Here the data which should be transferred via the digital interfaces can be selected.

A 4.3.1 Switching Outputs / Limit Values



Use the multilayer measuring mode to freely select the measurement value to which the limit outputs relate.
In addition, the selected measurement value is output via Ethernet interface.

A 4.3.2 Analog Output



Use the multilayer measuring mode to freely select the measurement value to be output via the analog output.

In addition, the selected measurement value is output via Ethernet interface.

A 5 Adjustable Mounting Adapter JMA-xx

A 5.1 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

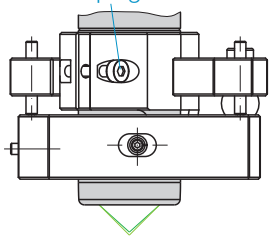
A 5.2 Sensor Mounting, Compatibility

Radial clamping for sensors with

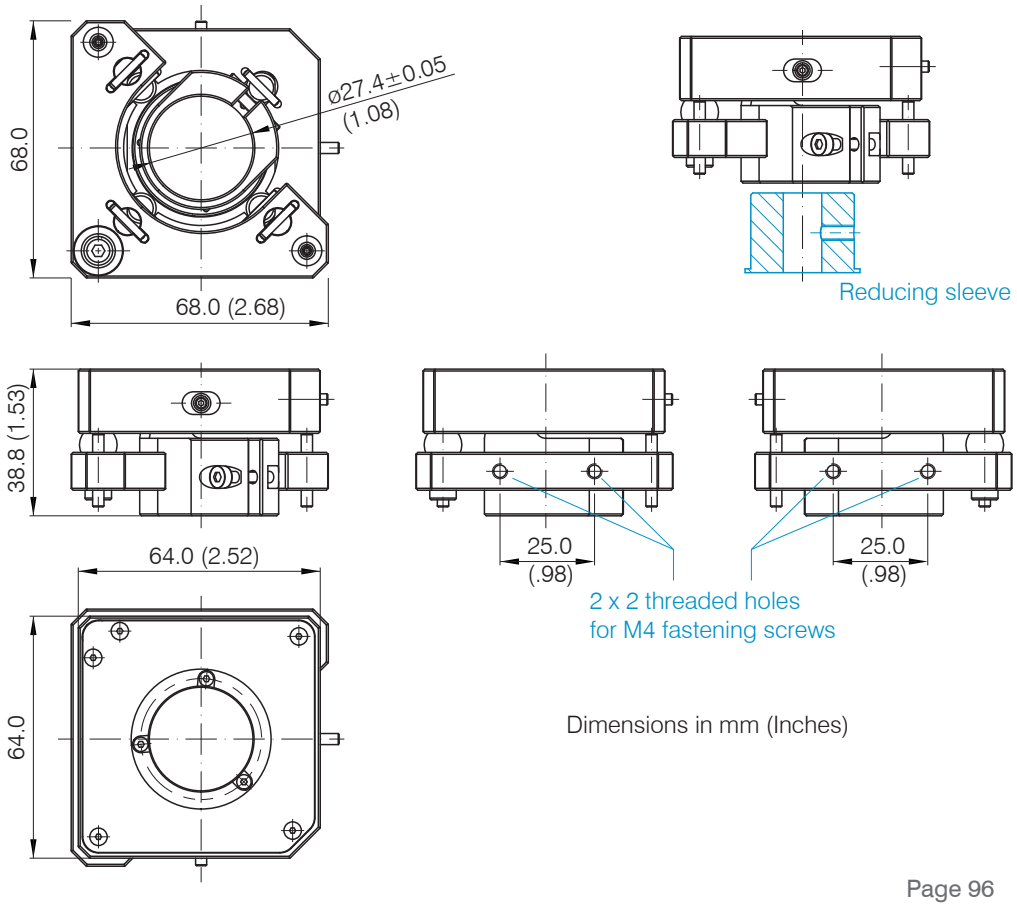
ø 8 mm	ø 12 mm	ø 20 mm	ø 27 mm
Reducing sleeve			
D27-D8 adapter	D27-D12 adapter	D27-D20 adapter	
confocalDT: IFS2403 series	confocalDT: IFS2404-2 IFS2407-0,1 IFS2407-0,8	confocalDT: IFS2406-2,5/VAC	confocalDT: IFS2405-0,3 IFS2405-1 IFS2406-3 IFS2406-10

A 5.3 Assembly

- 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 5.4 Dimensional Drawing of Mounting Adapter



Dimensions in mm (Inches)

A 5.5 Perpendicular Alignment of Sensor

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

Horizontal shift ±2 mm

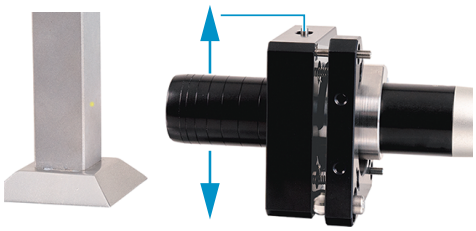
Shift to the left:

➪ Turn the hexagon socket screw clockwise

Shift to the right:

➪ Turn the hexagon socket screw counterclockwise

Vertical shift ±2 mm



Shift downwards:

➪ Turn the hexagon socket screw clockwise

Shift upwards:

➪ Turn the hexagon socket screw counterclockwise

Horizontal tilt angle ±4°

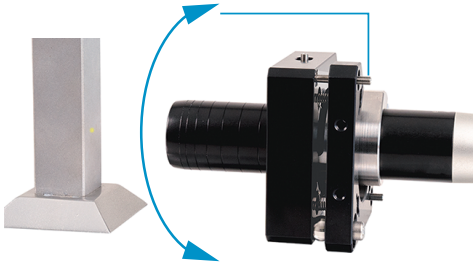
Tilt to the left:

➪ Turn the hexagon socket screw clockwise

Tilt to the right:

➪ Turn the hexagon socket screw counterclockwise

Vertical tilt angle ±4°



Tilt downwards:

➪ Turn the hexagon socket screw clockwise

Tilt upwards:

➪ Turn the hexagon socket screw counterclockwise

A 6 Cleaning Optical Components

A 6.1 Contamination

Contaminated boundary surfaces and components can cause an increase in dark value and will affect sensitivity and accuracy. To avoid this, it is necessary to clean the optical components and record the dark value. The 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. The calculated distance of the measuring object therefore does not match the actual one.

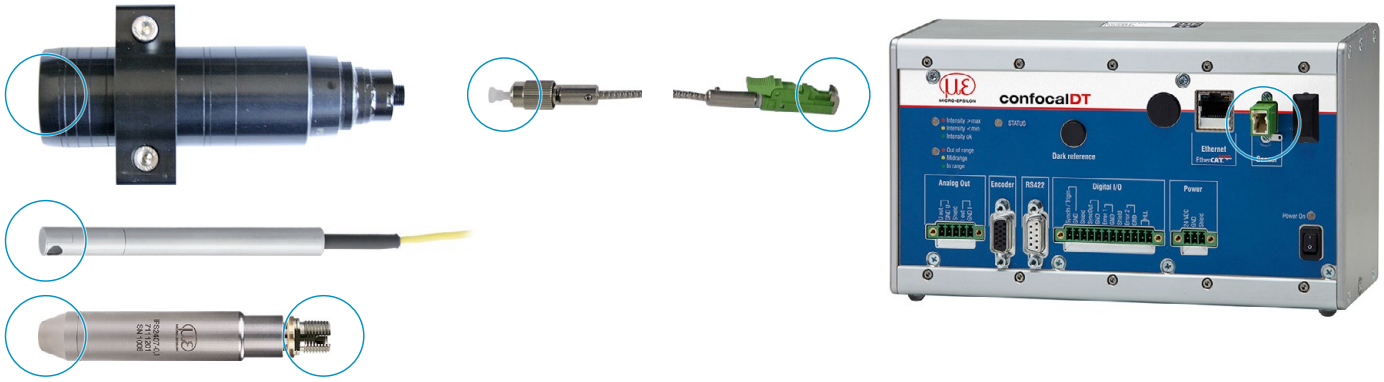
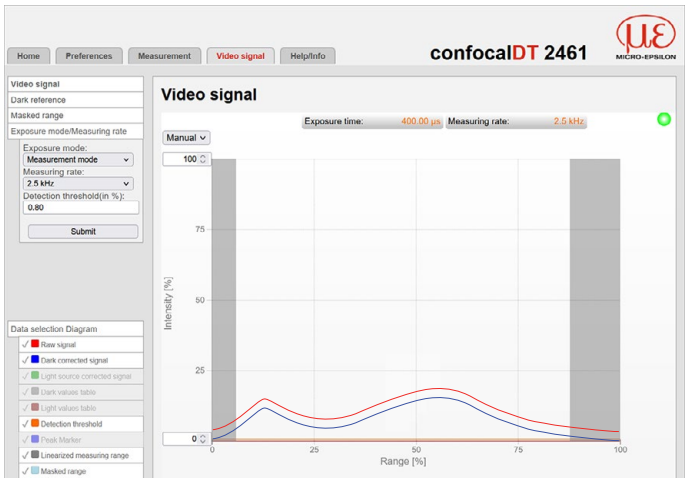
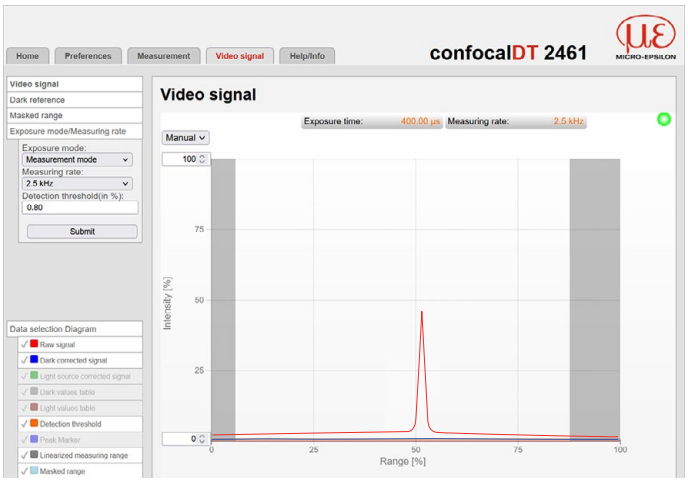


Fig. 80 Optical boundary surfaces of a confocal measuring system

➥ Perform dark referencing, see 5.5.



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



Video signal after dark reference

If the video signal corresponds to the condition before the dark reference, you must clean the optical boundary surface 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 6.2 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 6.3 Protective Glass of Sensor

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 IFS2403 series:

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

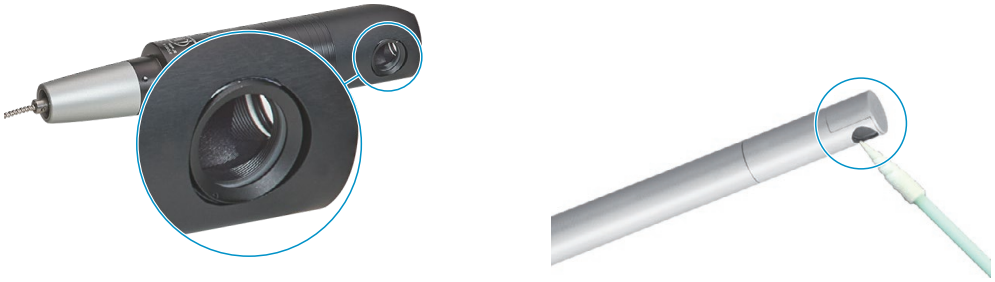


Fig. 81 Protective glass, sensors for radial measurement

➡ Perform dark referencing.

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

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

A 6.4 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.

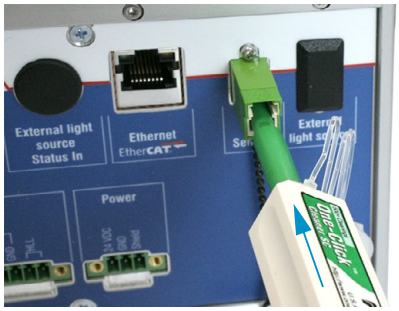
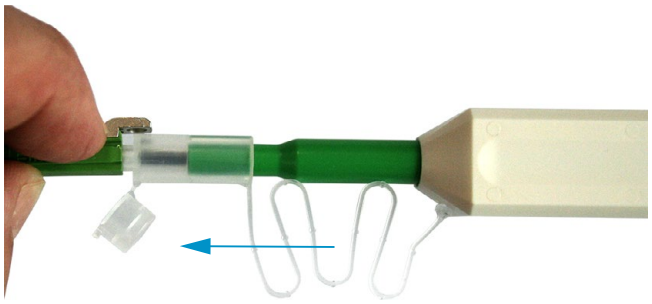


Fig. 82 One-Click™ for cleaning E2000 optical fiber transitions

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



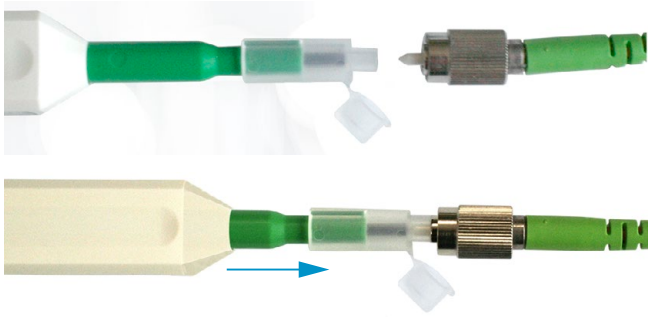
- Plug the sensor cable into the controller.
- Perform dark referencing.

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

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

A 6.5 Interface between Sensor Cable and Sensor

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



- Put a protective cap on the fiber optic cable.

Sensors with fiber optics, e.g. IFS2407 series:

- 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.

- Connect the sensor cable to the sensor.
- Perform dark referencing.

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

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

A 6.6 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 7 ASCII Communication with Controller

A 7.1 General

The ASCII commands can be sent to the controller via the RS422 interface or Ethernet (Port 23). All commands, inputs and error messages are in English. A command always consists of the command name and zero or more parameters, which are separated by spaces and are completed with LF. If spaces are used in parameters, the parameters must be placed in quotation marks (e.g. "password with spaces").

Example: Switch on the output via RS422

OUTPUT RS422 ↵

Advice: ↵ must include LF, but may also be CR LF.

Declaration: LF Line feed (line feed, hex 0A)

CR Carriage return (carriage return, hex 0D)

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

The currently set parameter value is returned, if a command is activated without parameters.

The output format is:

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

The reply can be used again as command for the parameter setting without changes. In this case, optional parameters are returned only where necessary. For example, `Select data for additional values`, see A 7.5.2.4, will return enabled output values only.

After processing a command, the system always returns a line break and a command prompt. In the event of an error, an error message starting with “Exx” will appear before the prompt, where xx represents a unique error number. In addition, the system may display a warning (“Wxx”) instead of an error message. Warnings are structured like error messages, such as “If Xenon lamp is too hot...” Warnings do not prevent commands from being executed.

A 7.2 Commands Overview

Group	Chapter	Command	Short info
General			
	Chap. A 7.3.1.1	HELP	Help
	Chap. A 7.3.1.2	GETINFO	Controller information
	Chap. A 7.3.1.3	ECHO	Reply type
	Chap. A 7.3.1.4	PRINT, PRINT ALL	Overview parameters
	Chap. A 7.3.1.5	SYNC	Synchronization
	Chap. A 7.3.1.6	RESET	Booting the controller
	Chap. A 7.3.1.7	GETTEMP	Controller temperature
User level			
	Chap. A 7.3.2.1	LOGIN	Change of the user level
	Chap. A 7.3.2.2	LOGOUT	Change to user level
	Chap. A 7.3.2.3	GETUSERLEVEL	Request user level
	Chap. A 7.3.2.4	STDUSER	Set standard user
	Chap. A 7.3.2.5	PASSWD	Change password
Sensor			
	Chap. A 7.3.3.1	SENSORTABLE	Display available sensors
	Chap. A 7.3.3.2	SENSORHEAD	Select a sensor
	Chap. A 7.3.3.3	SENSORINFO	Sensor information
	Chap. A 7.3.3.4	DARKCORR	Start dark reference
	Chap. A 7.3.3.5	DARKCORRTHRES	Warning threshold in the event of contamination
	Chap. A 7.3.3.6	LIGHTCORR	Start light source reference

Triggering			
	Chap. A 7.3.4.1	TRIGGER	Select trigger
	Chap. A 7.3.4.2	TRIGGERAT	Effect of the trigger input
	Chap. A 7.3.4.3	TRIGGERLEVEL	Select level active trigger input
	Chap. A 7.3.4.4	TRIGGERCOUNT	Number of measurements displayed
	Chap. A 7.3.4.5	TRIGGERSW	Software trigger pulse
	Chap. A 7.3.4.6	TRIGGERENC	Set encoder triggering
Encoder			
	Chap. A 7.3.5.1	ENCINTERPOLn	Set interpolation depth
	Chap. A 7.3.5.2	ENCREFn	Set reference track
	Chap. A 7.3.5.3	ENCVALUEn	Prepare encoder value
	Chap. A 7.3.5.4	ENCSET	Set encoder value
	Chap. A 7.3.5.5	ENCRESET	Reset encoder value
	Chap. A 7.3.5.6	ENCMAXn	Set max encoder value
Interfaces			
	Chap. A 7.3.6.1	IPCONFIG	Ethernet settings
	Chap. A 7.3.6.2	MEASTRANSFER	Set measurement server
	Chap. A 7.3.6.3	BAUDRATE	RS422 settings
	Chap. A 7.3.6.4	ETHERMODE	Change Ethernet - EtherCAT
Parameters, load/save settings			
	Chap. A 7.3.7.1	STORE	Save parameters
	Chap. A 7.3.7.2	READ	Load parameters
	Chap. A 7.3.7.3	SETDEFAULT	Set default setting
Measurement			
	Chap. A 7.4.1.1	MEASMODE	Measurement mode
	Chap. A 7.4.1.2	MEASPEAK	Peak selection
	Chap. A 7.4.1.3	SHUTTERMODE	Exposure mode
	Chap. A 7.4.1.4	MEASRATE	Measuring rate
	Chap. A 7.4.1.5	SHUTTER	Exposure time
	Chap. A 7.4.1.6	TAKESHUTTER	Takeover exposure time from search mode into manual mode
	Chap. A 7.4.1.7	GETVIDEO	Request video signal
Video signal			
	Chap. A 7.4.2.1	ROI	Reduce region of interest
	Chap. A 7.4.2.2	VSAVERAGE	Video averaging
	Chap. A 7.4.2.3	THRESHOLD	Set peak threshold
Material data base			
	Chap. A 7.4.3.1	MATERIALTABLE	Read material table
	Chap. A 7.4.3.2	MATERIAL	Select material
	Chap. A 7.4.3.3	MATERIALINFO	Display material
	Chap. A 7.4.3.4	MATERIALEDIT	Edit material table
	Chap. A 7.4.3.5	MATERIALDELETE	Delete material table
Number of peaks, refractive correction, and material settings / multilayer measurement			
	Chap. A 7.4.4.1	REFRACCORR	Number of peaks and enabling/ disabling refractive correction
	Chap. A 7.4.4.2	MATERIALMP MATERIALINFO	Material settings and properties

Measurement value processing			
	Chap. A 7.4.5.1	AVERAGE	Averaging of measurement value
	Chap. A 7.4.5.2	SPIKECORR	Spike correction
	Chap. A 7.4.5.3	STATISTICSIGNAL	Selecting the signal for statistics
	Chap. A 7.4.5.4	STATISTICDEPTH	Values used for statistics
	Chap. A 7.4.5.5	RESETSTATISTIC	Reset the statistics
	Chap. A 7.4.5.6	MASTERSIGNAL	Selecting the signal for mastering/ zero setting
	Chap. A 7.4.5.7	MASTERMV	Setting masters / zero
Data output			
	Chap. A 7.5.1.1	OUTPUT	Selection digital output
	Chap. A 7.5.1.2	OUTREDUCE	Output data rate
	Chap. A 7.5.1.3	OUTHOLD	Error processing
Select measurement values to be output via the interfaces			
	Chap. A 7.5.2.1	OUTDIST_RS422 OUTDIST_ETH	Data selection displacement measurement
	Chap. A 7.5.2.2	OUTTHICK_RS422 OUTTHICK_ETH	Data selection thickness measurement
	Chap. A 7.5.2.3	OUTSTATISTIC_RS422 OUTSTATISTIC_ETH	Data selection statistic values
	Chap. A 7.5.2.4	OUTADD_RS422 OUTADD_ETH	Data selection optional values
	Chap. A 7.5.2.5	SWITCHMD2	Switching on output of non linearized distances
	Chap. A 7.5.2.5	OUTVIDEO	Set video output
Switching outputs			
	Chap. A 7.5.3.1	ERROROUTn	Selection error signal for output
	Chap. A 7.5.3.2	ERRORLIMIT	Set the limit values
	Chap. A 7.5.3.3	ERRORLEVEL	Active level of switching outputs
Analog output			
	Chap. A 7.5.4.1	ANALOGOUT	Data selection for the analog output
	Chap. A 7.5.4.2	ANALOGRANGE	Set current-/voltage range of digital-analog converter (DAC)
	Chap. A 7.5.4.3	ANALOGSCALE	Setting the scaling of DAC

A 7.3 General Commands

A 7.3.1 General

A 7.3.1.1 Help

```
HELP [<command>]
```

Help is displayed for a command. If no command is specified, general help information is displayed.

A 7.3.1.2 Controller Information

Sensor data are queried. Output as per example below:

```
->GETINFO
Name:              IFC2451
Serial:            11020009
Option:            001
Article:           2418004
MAC-Address:       00-0C-12-01-06-08
Version:           004.093.087.02
Imagetype:         User
->
```

Name: Name of the controller model / controller series

Serial: Controller serial number

Option: Controller option number

Article: Controller article number

MAC Address: Network adapter address

Version: Version of the booted software

Image type: Type of the booted software (Factory- or User Images)

The Factory Image is installed by the manufacturer of the controller and cannot be overwritten. An update of User Images can be done by the end user. If an error occurs when updating the User Images, then the Factory Images is loaded when the system starts the next time.

Error	Description
E34	The Controller has not been trained or lost of flash memory. -> Send the controller back to the manufacturer.

A 7.3.1.3 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: Only the command reply or an error message is returned.

A 7.3.1.4 Parameter Overview

```
PRINT
```

This command outputs a list of all setting parameters and its values.

```
PRINT ALL
```

This command outputs a list of all setting parameters and its values, as well as information such as sensor table or GETINFO.

A 7.3.1.5 Synchronization

```
SYNC NONE|MASTER|SLAVE|SLAVE_EXT
```

Setting the type of synchronization:

- NONE: No synchronization
- MASTER: The controller is master, ie. it transmits synchronization pulses.
- SLAVE: The controller is slave and receives synchronous pulses from another IFC24x1.
- SLAVE_EXT: The controller is slave and receives synchronous pulses from another source.

Error	Description
E02	Incorrect parameter type (not a valid type of synchronization).
E11	Parameter 1 is too long.

Sync may be an input or output, so you need to ensure that one of the controllers is defined as a master and the other one as a slave.

The sync input is also used as trigger input for flank and level triggering, , see A 7.3.4.1, “Trigger”.

A 7.3.1.6 Booting the Sensor

```
RESET
```

The controller restarts.

A 7.3.1.7 Querying the Controller Temperature

```
GETTEMP
```

Request the internal temperature sensor in controller

Response example: GETEMP 34.51

Temperature in °C with two decimals

A 7.3.2 User Level

A 7.3.2.1 Changing the User Level

```
LOGIN <Password>
```

Enter the password to switch to a different user level. The following user levels exist:

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

Error	Description
E06	Access denied -> Incorrect password
E11	Password is too long (more than 31 characters)

A 7.3.2.2 Changing to User Level

```
LOGOUT
```

Sets the user level to USER.

A 7.3.2.3 Querying the User Level

```
GETUSERLEVEL
```

Request the current user level.

For possible responses, see A 7.3.2.1, “Changing the user level”.

A 7.3.2.4 Defining a Standard User

```
STDUSER USER|PROFESSIONAL
```

Sets the standard user, who is logged in after system start.

A 7.3.2.5 Changing the Password

```
PASSWD <Old Password> <New Password> <New Password>
```

Changes the password for the `PROFESSIONAL` level. The default (preset) password is `000`.

The old password must be entered once, and the new password twice.
If the new passwords do not match, an error message is displayed. Passwords are case sensitive. A password may only contain letters (A to Z) and numbers, but no special characters and no letters with accents or umlauts. The maximum length is 31 characters.

A 7.3.3 Sensor

A 7.3.3.1 Info about Calibration Tables

```
SENSORTABLE
```

```
->SENSORTABLE
Pos, Sensor name,      Range,       Serial
  0, ifs-2405x,        3,000mm,     12345678
  8, ifs-2405x,        10,000mm,    12345678
  9, ifs-2405x,        3,000mm,     12345678
->
```

All available (learned) sensors are displayed.

A 7.3.3.2 Sensor Number

```
SENSORHEAD <sensor position>
```

Selects the current sensor from its position, see A 7.3.3.1.

Minimum 0, maximum 19.

Error	Description
E39	Sensor is not available

A 7.3.3.3 Sensor Information

SENSORINFO

Displays sensor data (name, measuring range and serial number).

```
->SENSORINFO
Position:                  0
Name:                      ifs-2405x
Measuring range:           3.000 mm
Serial:                    12345678
->
```

A 7.3.3.4 Dark Correction

```
DARKCORR
```

Performs a dark correction. Dark correction is sensor-dependent and is stored separately in the controller for each sensor. Before carrying out a dark correction, select the required sensor.

A 7.3.3.5 Warning Threshold in the Event of Contamination

```
DARKCORRTHRES <threshold>
```

Threshold: Deviation (in %) of the intensity/exposure time from the stored value, above which a warning message will appear. Default setting: 50 %.

The warning threshold is set in % with one decimal.

A 7.3.3.6 Light Correction

`LIGHTCORR`

Performs a light correction. The correction is light source-dependent not sensor-dependent. The light correction is already performed by the manufacturer.

For the IFC with xenon light source can this correction be performed by the user after a light source change in the user level PROFESSIONAL. The IFC2451, IFC2461 and the IFC2471LED require no light correction by the customer.

Error	Description
E04	Error with the setting of internal parameters (should never occur)
E16	Timeout when light correction
E18	A data transmitting is already running -> Light correction not possible

A 7.3.4 Trigger Modes

Trigger-input serves also as synchronous input, which means level and edge triggering is only alternatively possible to sync mode.

A 7.3.4.1 Trigger Type

`TRIGGER NONE|EDGE|PULSE|SOFTWARE|ENCODER`

- NONE: No triggering
- PULSE: Level triggering
- EDGE: Edge triggering
- SOFTWARE: Software triggering
- ENCODER: Encoder triggering

A 7.3.4.2 Effect of the Trigger Input

`TRIGGERAT [INPUT|OUTPUT]`

INPUT: Triggering the measured value recording. When calculating the mean, measured values immediately before the trigger event are not included; instead older measured values are used, which were the output in previous trigger events.

OUTPUT: Triggering the measurement value output. When calculating the mean, measured values immediately before the trigger event are used.

Triggering of measured value recording is enabled as a factory default setting.

A 7.3.4.3 Trigger Level

`TRIGGERLEVEL HIGH|LOW`

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

A 7.3.4.4 Number of Output Measurement Values

`TRIGGERCOUNT <1...16382>|16383`

Number of measurement values which are displayed when edge triggering or software triggering.

- 1...16382: Number of measurement values which are displayed after a trigger impulse when edge triggering or software triggering.
- 16383: Start infinite output of measurement values after a trigger impulse when edge triggering or software triggering.
- 0: Stop triggering

A 7.3.4.5 Software Trigger Pulse

```
TRIGGERSW
```

Creates a software trigger pulse

Error	Description
E43	The controller is not in the software trigger mode, see A 7.3.4.1.

A 7.3.4.6 Settings Encoder Triggering

```
TRIGGERENC 1|2|3[<Step> [<Min> [<Max>]]]
```

Settings for the encoder triggering

- 1|2|3: Selection of encoder track for the encoder triggering
- Step: Number of encoder steps, after which each one a measured value is output (min: 0 max: 2^{31}-1). Measured values are output continuously between min. and max at 0.
- Min: Minimal encoder value, up to that is triggered (min: 0 max: 2^{32}-1)
- Max: Maximum encoder value, up to that is triggered (min: 0 max: 2^{32}-1)

A 7.3.5 Encoder

A 7.3.5.1 Encoder Interpolation Depth

```
ENCINTERPOL1 1|2|4
ENCINTERPOL2 1|2|4
ENCINTERPOL3 1|2|4
```

Set the interpolation depth of each encoder input.

A 7.3.5.2 Effect of the Reference Track

```
ENCREF1 NONE|ONE|EVER
ENCREF2 NONE|ONE|EVER
ENCREF3 NONE|ONE|EVER
```

Setting the effect of encoder reference track.

- NONE: Reference mark of the encoder has no effect.
- ONE: Unique setting (the encoder value is taken over at first reaching of reference marker position, see A 7.3.5.3).
- EVER: Setting at all marker positions (the encoder value is taken over at first reaching of reference marker position), see A 7.3.5.3.

A 7.3.5.3 Encoder Value

```
ENCVALUE1 <Encoder value>
ENCVALUE2 <Encoder value>
ENCVALUE3 <Encoder value>
```

Indicates, on which value the applicable encoder is to be set when reaching a reference marker position (or per software).

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

When setting the ENCVALUE, the algorithm for detecting the first reference marker position, see A 7.3.5.2, is reset automatically.

A 7.3.5.4 Setting Encoder Value per Software

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

Setting the encoder value, see A 7.3.5.3, in the specified encoder per software (only possible with ENCREF NONE, otherwise the command returns immediately without an error message).

A 7.3.5.5 Reset the Detection of the First Marker Position

```
ENCRESET 1|2|3
```

Reset the detection of the first reference marker position, see A 7.3.5.2 (only possible with ENCREF ONE, otherwise the command returns immediately without an error message).

A 7.3.5.6 Maximum Encoder Value

```
ENCMAX1 <Encoder value>
ENCMAX2 <Encoder value>
ENCMAX3 <Encoder value>
```

Specifies the maximum value of the encoder, after which the encoder returns to 0. Can be used e.g. for rotary encoder without reference track.

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

A 7.3.6 Interfaces

A 7.3.6.1 Ethernet IP Settings

```
IPCONFIG DHCP|STATIC [<IPAddress> [<Netmask> [<Gateway>]]]
```

Set Ethernet interface.

DHCP: IP address and gateway are automatically requested by DHCP. System looks for a LinkLocal address after appr. 2 minutes if no DHCP server is available.

STATIC: Set IP address, net mask and gateway in format xxx.xxx.xxx.xxx.

Values stay the same if no IP address, net mask, and gateway is typed in.

A 7.3.6.2 Setting for Ethernet Measured Value Transfering

```
MEASTRANSFER NONE|SERVER/TCP [<PORT>]|(CLIENT/TCP|CLIENT/UDP
[<IPAddress> [<Port>]])
```

The IFC24xx can be operated as a server as well as a client for measurement output via Ethernet.

- NONE: No measurement transmission via Ethernet.
- SERVER/TCP: Controller provides a server for the typed in port, under which the measured values can be sent. This is only possible via TCP/IP.
- CLIENT/TCP: Controller sends measured values via TCP/IP connection oriented to server. The specifying of the IP address and server port are required, see A 7.5.1.1.
- CLIENT/UDP: Controller sends measured values via UDP/IP connectionless to server. Therefore the IP address and the server port are specified.
- IPAddress: IP address of the server, to which measured values are sent when in client-mode, (only valid for CLIENT/TCP or CLIENT/UDP).
- Port: Port, to which the server gets assigned to in server-mode or to which the measured values are sent in client-mode (min: 1024, max: 65535).
- Commands are expected at port 23, the data port is factory-set to 1024.

A 7.3.6.3 Setting RS422 Baud Rate

```
BAUDRATE <Baudrate>
```

Adjustable baud rates in examples:

9600, 115200, 230400, 460800, 691200, 921600, 1500000, 2000000, 2500000, 3000000, 3500000, 4000000

A 7.3.6.4 Change Ethernet / EtherCAT

```
ETHERMODE ETHERNET|ETHERCAT
```

Select whether the controller starts with Ethernet or EtherCAT mode. The setting is active after save and reboot the controller only.

A 7.3.7 Parameter Management, Load / Save Settings

A 7.3.7.1 Save Parameter

`STORE 1|2|3|4|5|6|7|8`

Save the current parameter under the specified number in the flash.

A 7.3.7.2 Load Parameter

`READ ALL|DEVICE|MEAS 1|2|3|4|5|6|7|8`

Load the parameter under the specified number from the flash.

In addition, the size of the loaded data needs to be specified.

- ALL: All parameters are loaded.
- DEVICE: Only the standard device settings are loaded (interface parameter).
- MEAS: Only the measurement settings are loaded (all features for the measurement).

A 7.3.7.3 Default Settings

`SETDEFAULT ALL|NODEVICE|MATERIAL`

Sets the default values (Reset to default setting).

- ALL: All setups are deleted and default parameters are loaded. In addition, the current material table is overwritten by standard material table.
- NODEVICE: All setups are deleted and default parameters are loaded. Settings of IP address and RS422 are kept temporarily.
- MATERIAL: Only current material table is overwritten by standard material table.

A 7.4 Measurements

A 7.4.1 General

A 7.4.1.1 Measurement Mode

`MEASMODE DISTANCE|THICKNESS|MULTILAYER|VIDEO|VIDEOSTREAM`

- DISTANCE: Distance measurement. Only distance 1 can be displayed.
- THICKNESS: Thickness measurement. Distances 1 and 2 and the difference between the two distances may be displayed.
- MULTILAYER: Multilayer measurement. Up to six distances and differences can be output between them.
- VIDEO: Video images are transmitted. The video images must be requested individually using the video signal command.
- VIDEOSTREAM: Video transmission. The video data are transferred permanently after the transfer has been started with the `OUTPUT` command. A single image transfer is not necessary. Depending on the number of output signals, an uninterruptible video output is possible up to 1 kHz.

A 7.4.1.2 Peak Selection

`MEASPEAK F_L|L_SL|F_S|H_SH`

Selection of the used peak for measurement.

Distance measurement		**Thickness measurement**	
F_L:	first peak	F_L:	first and last peak
L_SL:	last peak	L_SL:	second to last and last peak
F_S:	first peak	F_S:	first and second peak
H_SH:	highest peak	H_SH:	highest and second highest peak

A 7.4.1.3 Exposure Mode

```
SHUTTERMODE SEARCH|MEAS|MANUAL|2TIMEALT|2TIMES
```

- SEARCH: Search mode to determine the best exposure time and measurement rate.
- MEAS: Exposure time is controlled automatically, measuring rate is fixed. Recommended for measurements.
- MANUAL: User can select exposure time and measuring rate.
- 2TIMEALT: Mode with 2 manually defined exposure times that are used alternately for two distinctly differently high peaks (for thickness measurements). We recommend using this mode in particular, if the smaller peak disappears or the higher peak overshoots.
- 2TIMES: Fastest mode with two manually preset exposure times. The more suitable time is automatically selected. Recommended to measure distances for fast changing surface properties, such as mirrored or anti-glare glass.

A 7.4.1.4 Measuring Rate

```
MEASRATE <Measuring rate>
```

Selects the measuring rate in kHz.

- IFC2471: 0.3 kHz ... 70 kHz
- IFC2471LED: 0.1 kHz ... 70 kHz
- IFC2461: 0.1 kHz ... 25 kHz
- IFC2451: 0.1 kHz ... 10 kHz

No more than one decimal place may be specified.

A 7.4.1.5 Exposure Time

```
SHUTTER <Exposure Time1> [<Exposure Time2>]
```

Specifies the exposure times for the manual and the two-times exposure mode.

- The exposure time is indicated in µs and must be with
- IFC2471: between 0.1 µs ... 3333.325 µs.
- IFC2461: between 0.1 µs ... 10000 µs.
- IFC2451: between 0.1 µs ... 10000 µs.

The exposure time is processed with three decimal places. The minimum increment is 0.025 µs.

A 7.4.1.6 Apply Exposure Time

```
TAKESHUTTER
```

Apply in the search mode determined exposure times in the exposure time parameters.

A 7.4.1.7 Video Signal Request

```
GETVIDEO
```

Request of video signal via Ethernet interface.

A 7.4.2 Video Signal

A 7.4.2.1 Reduction of Region of Interest

```
ROI <Start> <End>
```

Set region of interest. ROI for start and end must be between 0 and 511. The specification is effected in the unit pixels. “Start” value is smaller than “End” value.

A 7.4.2.2 Video Averaging

```
VSAVERAGE NONE|REC2|REC4|REC8|MOV2|MOV4|MOV3|MED3
```

NONE: No video signal averaging

REC2, REC4, REC8: Recursive average value over 2, 4 or 8 video signals

MOV2,MOV3,MOV4: Moving average value over 2, 3 or 4 video signals

MED3: Median over 3 video signals

A 7.4.2.3 Peak Detection Threshold

```
THRESHOLD <Threshold>
```

Setting the detection threshold in % (0.0 % up to 99.0 %).

The detection threshold is given with two decimal places.

A 7.4.3 Material Data Base

A 7.4.3.1 Material Table

```
->MATERIALTABLE
                                Refraction index              Abbenumber
Pos,   Name,          nF at 486nm,   nd at 587nm,  nC at 656nm,      vd          Description
0      Vacuum,        1.000000,      1.000000,     1.000000,         0.000000    Vacuum; air(approximately)
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 7.4.3.2 Select Material

```
MATERIAL <Material name>
```

Change of material between displacement 1 and 2.

Material name must be typed in with a blank. The command supports case sensitive inputs. The maximum length of material name is 30 characters.

A 7.4.3.3 Display Material Properties

```
MATERIALINFO
```

Output of properties of selected material.

```
->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 7.4.3.4 Edit Material Table

```
MATERIALEDIT <Name> <Description> (NX <nF> <nd> <nC>)|(ABBE <nd> <Abbe number>)
```

Add or edit material for multilayer measurement, see A 7.4.4.2.

- Name: Name of material (Length: max. 30 characters)
- Description: Description of material (Length: max. 62 characters)
- NX: Material is characterized by three refractive indices
- ABBE: Material is characterized by a refractive index and the Abbe number
- nF: Refractive index nF at 486 nm (min: 1.0, max: 4.0)
- nd: Refractive index nd at 587 nm (min: 1.0, max: 4.0)
- nC: Refractive index nC at 656 nm (min: 1.0, max: 4.0)
- Abbe number: Abbe number vd (min: 10.0, max: 200.0)

The refractive indices and Abbe number are processed with six decimal places.

If the material name is already assigned, this material is being edited. Otherwise a new material is applied.

There is a maximum of 20 materials.

The refractive index is set with 6 decimals.

A 7.4.3.5 Delete a Material

```
MATERIALDELETE <Name>
```

Delete a material

- Name: Name of material (Length: max. 30 characters)

A 7.4.4 Number of Peaks, Material Settings Multilayer Measurements

A 7.4.4.1 Number of Peaks and Enabling/Disabling Refractive Correction

```
REFRACCORR on|off [<Number of peaks>]
```

On: The refractive index correction is performed with the adjusted materials, default setting.

Off: The refractive index 1.0 is expected for all layers.

Number of peaks: Number of the used peaks expected for the multilayer measurement. The number must be between 3 ... 6 (the distance and thickness measurement modes are available for a few peaks).

A 7.4.4.2 Material Settings

```
MATERIALMP [<Material1>[<Material2>[<Material3>[<Material4>[<Mat
erial5>]]]]]
```

Displaying and setting the materials for the layers between the peaks 1 up to 6.

The existing material is maintained with input from „“.

```
MATERIALINFO [<Number of layer>]
```

Display the material for the opposite layer. The information is output to layer 1 without parameter.

A 7.4.5 Measurement Value Processing

A 7.4.5.1 Averaging of Measurement Value

```
AVERAGE NONE|MOVING|RECURSIVE|MEDIAN [<Averaging depth>]
```

- The averaging value always affects all to be output displacement and difference values.
- NONE: No averaging value
- MOVING: Moving averaging value (averaging depth 2, 4, 8, 16, 32, 64, 128, 256, 512 and 1024 possible)
- RECURSIVE: Recursive averaging value (averaging depth 2 up to 32768 possible)
- MEDIAN: Median (averaging depth 3, 5, 7 and 9 possible)

A 7.4.5.2 Spike Correction

```
SPIKECORR [ON|OFF[[<Number of evaluated measured values>][[<Tol-
erance range in mm>][<Number of corrected values>]]]
```

Spike correction is not enabled in the factory default settings.

	Factory settings	Min	Max
Number of measured values evaluated	3	1	10
Tolerance range in mm	0.1000000	0.0000000	100.0000000
Number of corrected values	1	1	100

The tolerance range is set in mm with seven decimals.

A 7.4.5.3 Selection of the Signal for the Statistics, Multilayer Measurement

```
STATISTICSIGNAL DIST1|DIST2|DIST3|DIST4|DIST5|DIST6|THICK12|
THICK13|THICK14|THICK15|THICK16|THICK23|THICK24|THICK25|THICK26|
THICK34|THICK35|THICK36|THICK45|THICK46|THICK56
```

Information of the signal for which the statistics calculation should be applied.

A 7.4.5.4 Setting the Statistics Calculation

```
STATISTICDEPTH ALL|2|4|8|...|8192|16384
```

Input on how many measurement values the statistics data minimum, maximum and peak to peak are determined.

A 7.4.5.5 Reset the Statistics Calculation

```
RESETSTATISTIC
```

Reset the statistics (of the current min and max value).

A 7.4.5.6 Selection of the Signal for the Mastering / Zero Setting, Multilayer Measurement

```
MASTERSIGNAL DIST1|DIST2|DIST3|DIST4|DIST5|DIST6|THICK12|
THICK13|THICK14|THICK15|THICK16|THICK23|THICK24|THICK25|
THICK26|THICK34|THICK35|THICK36|THICK45|THICK46|THICK56
```

Information of the signal for which the mastering or the zero setting should be applied.

The distance or the difference 1-2 is used in the distance or thickness measurement mode. The free selection of the signal is only possible in the measurement program multilayer measurement.

A 7.4.5.7 Setting Masters / Zero

```
MASTERMV NONE|MASTER <Master value>
```

- NONE: Reset the mastering
- MASTER: Setting the current measurement value to the master value
- Master value: Master value in millimeters (min: -measuring range, max: +measuring range)

In case of master value is 0, then the mastering function has the same functionality as the zero setting. The master command awaits the next measurement value a maximum of 2 seconds and uses it as master value. If no measurement value is received within this time, for example, by external triggering, the command returns with the error “E32 Timeout“. The master value is processed with six decimal places.

A 7.5 Data Output

A 7.5.1 General

A 7.5.1.1 Selection Digital Output

```
OUTPUT NONE|RS422|ETHERNET|ETHERCAT
```

- NONE: No measurement value output
- RS422: Output of measurement values via RS422
- ETHERNET: Output of measurement values via Ethernet
- ETHERCAT: Output of measurement values via EtherCAT

A 7.5.1.2 Output Data Rate

```
OUTREDUCE <Output reduction> [ANALOG|RS422|ETHERNET|NONE]
```

Reduces the measurement value output for all available interfaces.

- 1: Output each measurement value
- 2...1000: Output of each n-th measurement value

A 7.5.1.3 Error Processing

```
OUTHOLD NONE|0|<Number>
```

Setting the behavior of the measurement value output in case of error.

- NONE: No holding the last measurement value, output of error value
- 0: Infinite holding of the last measurement value
- Number: Holding the last measurement value on the number of measuring cycles; then an error value (maximum of 1024) is output.

A 7.5.2 Select Measurement Values to be Output

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

Maximum 32 measurement values are transmitted with RS422 in parallel.

The maximum output rate via the Ethernet interface depends on the number of output values.

Any distances and differences can be selected for the output in the multilayer measurement mode. All measurement values required for the difference calculations are output in addition to the Ethernet measuring value transmission.

Via the Ethernet interface always the displacement 1 and in case of thickness measurement the displacement 1 and 2 and the difference 1-2 is output .

A 7.5.2.1 Data Selection Displacement Measurement for RS422 / Ethernet

Controller IFC24x1	Controller IFC24x1MP
OUTDIST_RS422 NONE|[DIST1] [DIST2] OUTDIST_ETH NONE|[DIST1] [DIST2]	OUTDIST_RS422 NONE|[DIST1] [DIST2] [DIST3] [DIST4] [DIST5] [DIST6] OUTDIST_ETH NONE|[DIST1] [DIST2] [DIST3] [DIST4] [DIST5] [DIST6]

Setting, which displacement values are output through RS422 or Ethernet. All active distance and thickness values are transmitted via Ethernet.

- NONE: No output of a displacement
- DIST1: Output of displacement 1
- DIST2: Output of displacement 2

In measurement mode `Thickness measurement` the displacement 1 and/or 2 can be output.

The selection of the distances 1 or 2 can be done only in the video mode when output via Ethernet. The other modes transmit the values according to the selected measurement program.

In `distance` measurement mode the controller accepts the `OUTDIST_ETH DIST1` command (no output with `NONE`).

In `thickness` measurement mode the controller accepts the `OUTDIST_ETH DIST1 DIST2` command (no output with `NONE`, it must always be both).

In `multi peak` measurement mode the controller accepts the `OUTDIST_ETH DIST1|...` command (no output with `NONE`, it must always be all distances required for thickness calculation).

A 7.5.2.2 Data Selection Thickness Measurement for RS422 / Ethernet

Controller IFC24x1	Controller IFC24x1MP
OUTTHICK_RS422 NONE|[THICK12] OUTTHICK_ETH NONE|[THICK12]	OUTTHICK_RS422 NONE|[THICK12] [THICK13][THICK14] [THICK15] [THICK16][THICK23][THICK24] [THICK25][THICK26][THICK34] [THICK35][THICK36][THICK45] [THICK46][THICK56] OUTTHICK_ETH NONE|[THICK12] [THICK13][THICK14] [THICK15] [THICK16][THICK23][THICK24] [THICK25][THICK26][THICK34] [THICK35][THICK36][THICK45] [THICK46][THICK56]

Defines, which calculated layer thicknesses are output via RS422 or Ethernet.

- NONE: No output of calculated layer thickness
- THICK12: Output of the layer thickness between displacement 1 and 2

This setting is only available in measurement program “Thickness measurement“ or “Multilayer measurement”.

In video mode the difference between displacement 1 and 2 can be output in addition to the video signal. Displacement 1 and 2 is output automatically when transmitting the differential value via Ethernet.

In `distance` measurement mode the controller accepts the `OUTTHICK_ETH NONE` command (no output with `THICK12`).

In `thickness` measurement mode the controller accepts the `OUTTHICK_ETH THICK12` command (no output with `NONE`).

A 7.5.2.3 Data Selection Statistic Values for RS422 and Ethernet

```
OUTSTATISTIC_ETH NONE|([MIN] [MAX] [PEAK2PEAK])
```

```
OUTSTATISTIC_RS422 NONE|([MIN] [MAX] [PEAK2PEAK])
```

- NONE: No output of statistics
- MIN: Output of the minimum
- MAX: Output of the maximum
- PEAK2PEAK: Output of peak to peak

A 7.5.2.4 Data Selection Optional Values for RS422 and Ethernet

```
OUTADD_ETH NONE|([SHUTTER] [MEASRATE] [COUNTER] [TIMESTAMP]
[INTENSITY] [STATE] [ENC1] [ENC2] [ENC3] [TRIGTIMEDIFF])
```

```
OUTADD_RS422 NONE|([SHUTTER] [MEASRATE] [COUNTER] [TIMESTAMP]
[INTENSITY] [STATE] [ENC1] [ENC2] [ENC3] [TRIGTIMEDIFF])
```

Declaration of further outputs.

- NONE: No further outputs
- SHUTTER: Output of the exposure time
- COUNTER: Output of measured value counter
- TIMESTAMP: Output of the time stamps
- INTENSITY: Output of the intensity parallel to any displacement value
- STATE: Output of the error status
- ENC1, ENC2, ENC3: Output of the encoder values 1, 2, 3
- TRIGTIMEDIFF: Output of the trigger time difference
- MEASRATE: Output of the measuring rate

More optional values can be out parallel via Ethernet.

A 7.5.2.5 Switching on output of non linearized distances

```
SWITCHMD2[0|1]
```

- 0 Output of linearized distances - standard in factory setting
- 1 Output of non linearized distances

The non linearized distance is output as 18-bit value via RS422 and Ethernet. When using the non linearized distances the calibration data are not applied. The assignment of the output value to a distance value is to be done by the user. Either non linearized or linearized distances can be output.

A 7.5.2.6 Set Video Output

```
OUTVIDEO NONE|[RAW] [DARK] [LIGHT] [DARKTAB] [LIGHTTAB] [THRES]
```

Setting the data to be transmitted in a video transmission.

- NONE: No video signals
- RAW: Output of the unconditioned signal
- DARK: Output of the dark-corrected signal

- LIGHT: Output of the light source corrected signal
- DARKTAB: Output of the dark-correction table
- LIGHTTAB: Output of the light-correction table
- THRES: Output of the threshold table

Video signals can only be transmitted via the Ethernet interface.

A 7.5.3 Switching Outputs

A 7.5.3.1 Error Switching Outputs

```
ERROROUT1 NONE|ER1|ER2|ER12|LI1|LI2|LI12
```

```
ERROROUT2 NONE|ER1|ER2|ER12|LI1|LI2|LI12
```

Setting the error switching outputs.

- NONE: No output on the error switching outputs
- ER1: Switching output is switched in case of intensity error
- ER2: Switching output is switched in case of a measured value outside of the measuring range
- ER12: Switching output is switched in case of an intensity error or a measured value outside of the measuring range
- LI1: Switching output is switched in case of deceeding the lower limit
- LI2: Switching output is switched in case of exceeding the upper limit
- LI12: Switching output is switched in case of deceeding the lower limit or exceeding the upper limit

A 7.5.3.2 Limit Values

Controller IFC24x1	Controller IFC24x1MP
`ERRORLIMIT DIST1|DIST2 |THICK12[<Unterer Grenzwert> [<Oberer Grenzwert>]]`	`ERRORLIMIT DIST1|DIST2| DIST3|DIST4|DIST5|DIST6| THICK12|THICK13|THICK14| THICK15|THICK16|THICK23| THICK24|THICK25|THICK26| THICK34|THICK35|HICK36| THICK45|THICK46|THICK56 [<Unterer Grenzwert> [<Oberer Grenzwert>]]`

Selection of the signal and setting the limits for a limit consideration via the error switching outputs.

- DIST1: The limits refer to the displacement 1
- DIST2: The limits refer to the displacement 2 (only for thickness measurement)
- THICK12: The limits refer to the difference between displacement 1 and 2 (only for thickness measurement)

The limits are specified in millimeters with six decimals and must be between -120.0 and 120.0.

A 7.5.3.3 Switching Level

```
ERRORLEVEL HIGH|LOW
```

- HIGH: Switching output is High upon error
- LOW: Switching output is Low upon error

A 7.5.4 Analog Output

A 7.5.4.1 Data Selection

Controller IFC24x1	Controller IFC24x1MP
ANALOGOUT DIST1|DIST2|THICK12	ANALOGOUT DIST1|DIST2|DIST3| DIST4|DIST5|DIST6|THICK12| THICK13|THICK14|THICK15| THICK16|THICK23|THICK24| THICK25|THICK26|THICK34| THICK35|HICK36|THICK45| THICK46|THICK56

Selection of the signal which should be output via the analog output.

DIST1: Output of displacement 1

- DIST2: Output of displacement 2
- THICK12: Output of the difference between displacement 1 and 2

A 7.5.4.2 Output Range

```
ANALOGRANGE NONE|0-5V|0-10V|-5-5V|-10-10V|4-20mA
```

- NONE: No analog output (inactive)
- 0 - 5 V: The analog output outputs a voltage between 0 up to 5 volt.
- 0 - 10 V: The analog output outputs a voltage between 0 up to 10 volt.
- -5 - 5 V: The analog output outputs a voltage between -5 up to 5 volt.
- -10 - 10 V: The analog output outputs a voltage between -10 up to 10 volt.
- 4 - 20 mA: The analog output outputs an intensity of current of 4 up to 20 milliamperes.

A 7.5.4.3 Two-Point Scaling

```
ANALOGSCALE STANDARD|(TWOPOINT <Minimum measured value> <Maximum
measured value>)
```

Setting the scaling of analog output.

The default scaling is for displacements -MR/2 up to MR/2 and for thickness measurement on 0 up to 2 MR (MR=Measuring range).

In case of minimum and maximum measured value is ‚0', the default scaling is used.

The minimum and maximum measured value is to output in millimeters. The available output range of the analog output is then spread between the minimum and maximum measured value. The minimum and maximum measured value must be between -120.0 and 120.0.

The minimum and maximum measured value is processed with four decimal places.

A 7.6 Measured Value Format

This Chapter describes the assembly of measured value frames. Informations to transfer via Ethernet or RS422 succeed, see A 7.7.

The data block has a fixed structure (sequence):

- Video signals (+ adjustments) (N * 512 pixel * 16 bit)
- Exposure time (1 * 32 bit)
- Measuring rate (1 * 32 Bit)
- Encoder (Ne * 32 bit) (Ne = {0, 1, 2, 3})

- Measured value counter (1 * 32 bit)
- Time stamp (1 * 32 bit)
- Displacement values / Intensities (n * (i+1) * 32 bit)
- Error status (1 * 32 Bit)
- Trigger time difference (1 * 32 bit)
- Differences ((n-1) * 32 bit)
- Statistic values (min/max/peak2peak) (per 32 bit)

n = {0, 1, 2} n = 0 only for RS422

i = {0, 1} i = 0 -> Intensity output off, i = 1 -> Intensity output activated

n = 1 -> Displacement measurement

n = 2 -> Thickness measurement

The measured value frame is set up dynamically, that means not selected values, see Fig. 83, are not transmitted.

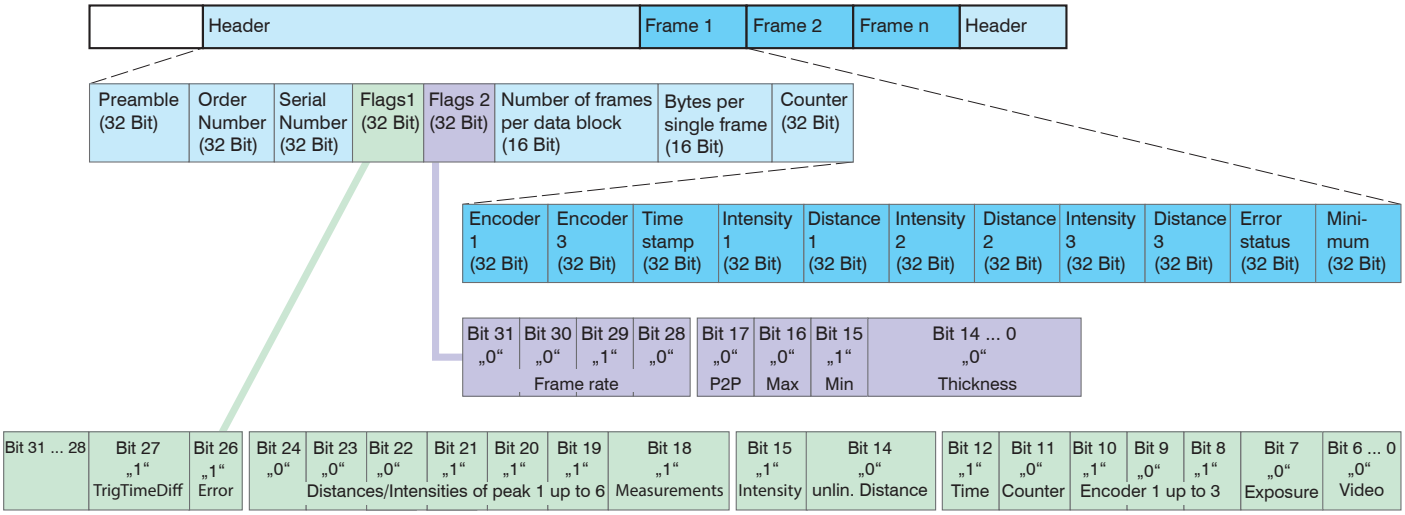


Fig. 83 Example for a data transmission via Ethernet

With Ethernet distance and thickness values are transmitted as 32 bit signed integer with 1 nm resolution.

A 7.6.1 Video Signal

Video signals, which were calculated in signal processing, can be transmitted. A video signal consists of 512 pixel. A pixel is described by a 16-bit word. The used value range is 0 …16383.

There are five available video signals:

- Raw signal
- Dark-corrected signal
- Light source corrected signal
- Dark values table
- Light values table
- Peak threshold

Data structure of video signals:

Pixel 0	Pixel 2	...	Pixel 511
Raw signal, 16 bit Dark corrected signal, 16 bit Light source corrected signal, 16 bit Dark values table, 16 bit Light values table, 16 bit Peak threshold, 16 bit	Raw signal Dark corrected signal Light source corrected signal Dark values table Light values table Peak threshold	...	Raw signal Dark corrected signal Light source corrected signal Dark values table Light values table Peak threshold

A 7.6.2 Exposure Time

The data word to the exposure time is 32-bit wide during transmission via Ethernet. The resolution is 25 ns, in addition informations according to table 5-1 are transmitted.

Bit position	**Description**		
0 up to 19	Exposure time in 25 ns steps		
20 up to 27	Reserved (can be non-zero)		
28 up to 31	Frame rate		
	Bits	Measuring rate	Max. exposure time [µs]
	0	70 kHz	14.275
	1	50 kHz	20
	2	25 kHz	40
	3	10 kHz	100
	4	5 kHz	200
	5	2.5 kHz	400
	6	1 kHz	1000
	7	0.3 kHz	3333.25
	8	0.2 kHz	5000
	9	0.1 kHz	10000
	14	manual measuring rate	1/f
	15	auotmatic mode	...

Fig. 84 Table exposure time

- IFC2471: 0.3 kHz; 1 kHz; 2.5 kHz; 5 kHz; 10 kHz; 25 kHz; 50 kHz and 70 kHz
- IFC2471LED: 0.1 kHz; 1 kHz; 2.5 kHz; 5 kHz; 10 kHz; 25 kHz; 50 kHz and 70 kHz
- IFC2461: 0.1 kHz; 0.2 kHz; 0.3 kHz; 1 kHz; 2.5 kHz; 5 kHz, 10 kHz, 25 kHz
- IFC2451: 0.1 kHz; 0.2 kHz; 0.3 kHz; 1 kHz; 2.5 kHz; 5 kHz; 10 kHz

The output of the exposure time via the RS422 interface is effected by a resolution of 100 ns. For that the data word is 18 bits wide. The bits 9 up to 2 of the 32 bit data word are output by Ethernet.

A 7.6.3 Measuring rate

The generated measuring rate from the controller or the measured rate of the SyncIn signal with Slave Sync operation mode.

RS422, 18 bit unsigned integer: Measuring rate = 20 000 000 / value

Ethernet, 32 bit unsigned integer: Measuring rate = 40 000 000 / value

A 7.6.4 Encoder

The encoder values for transmission can be selected individually. A 32 bit data word (unsigned integer) with the encoder position is output via Ethernet. Only the lower 18 bits of the encoder values are transmitted by the transmission via RS422.

A 7.6.5 Measured Value Counter

The transmission of the measured value counter via Ethernet is effected as 32 bit value (unsigned integer). On the RS422 interface, only the lower 18 bits of the profile counter are transmitted.

A 7.6.6 Time Stamp

Intrasystem the resolution of time stamp is 1 µs. For the Ethernet transfer a 32 bit data word (unsigned integer) with the intrasystem resolution is output.

During transmission via RS422 only the bits 25 up to 8 of the time stamp are provided in a 18 bit data word. It follows a resolution of 0.25 ms, an overflow is effected after approximately 65 seconds.

A 7.6.7 Measurement Data (Displacements and Intensities)

An intensity (if selected) and a measurement value are transmitted for each selected displacement. For the Ethernet transmission 32 bit for each are used. The assembly of the data word for the intensity is shown in the following table, see Fig. 85. The resolution of the displacement values is 1 nm on the Ethernet line, the output is signed. The format for RS422 is described, see A 7.7.1.

Bit position	Description
0 - 10	Intensity of peak (100 % comply with 1024)
11 - 15	Reserved
16 - 29	Maximum of peak (from dark corrected signal)
30 - 31	Reserved

Fig. 85 Table Intensity

During transmission via RS422 only the ‚Intensity of peak' is transmitted (the lower 10 bit).

The intensity value is determined using the following calculation rule:

$$\text{Intensity} = \frac{\text{Max\_dark}}{\text{Saturation - Max\_raw + Max\_dark}}$$

- Max_dark refers to the dark corrected signal.
- Max_raw refers to the raw signal.
- Saturation refers to the AD range (2 ^ 14-1).

A 7.6.8 Trigger Time Difference

The trigger time difference is output via Ethernet as an unsigned 32 bit integer or via RS422 as an unsigned 18 bit integer with a resolution of 100 ns.

Value range 0… 33333 (IFC2471) or 0….100000 (IFC2541)

A 7.6.9 Error Status

Bit position	Description
0	Peak starts too early.
1	Peak ends too late.
2	There is no peak present.
3	There are fewer peaks available as selected.
4	Not all peaks are calculated, peaks are too close to each other (from 3 peaks)
5	Peak is located in front of the measuring range (MR).
6	Peak is located behind the measuring range (MR)
7 up to 9	Reserved
10	Display value: orange, Ethernet LED, speed
11	Display value: green, Ethernet LED, link detection & activity
12, 13	Display value of LED 3 - State Off (0x0) green (0x1) red (0x2) yellow (0x3)
14	Reserved
15	Triggered measurement output. Trigger bit: 0 – continous output 1 – triggered output
16 up to 17	Display value LED 1 - Intensity Off (0x0) Green (0x1) Red (0x2) Yellow (0x3)
18 up to 19	Display value LED 2 – Range or measuring range. Off (0x0) Green (0x1) Red (0x2) Yellow (0x3)
20	Switching output error 1 is active
21	Switching output error 2 is active
24	Durability of the external light source exceeded.
26	External xenon light source is too hot.
27	External xenon light source is out of order.
28	Reserved
29	Overload of the switching outputs
30	DA converter error The DAC is used as a current output, then this bit is set when no load is present. A further function is to display an overheating of the DACs.
31	Reserved

During transmission via RS422 only the upper bits 16 up to 31 of error status word are transmitted. For the Ethernet transfer are all 32 bits ready to issue.

The error status represents the status of the entire video signal, independent from the linearized range. If masking (not equal to 0 ... 511) is used, the status of the masked area is shown.

A 7.6.10 Differences (Thicknesses)

Calculated differences between two displacements have the same format as the displacements.

At first, the selected differences between the displacement 1 and the other displacements are output, then these of displacement 2,...

The differences are displayed as 32 bit signed integer value with a resolution of 1 nm. The RS422 format is documented, see A 7.7.1.

A 7.6.11 Statistic Values

The statistic values have the same format as the displacements.

At first minimum, then maximum and at the end peak to peak is transmitted (if selected).

The statistic values are displayed as 32 bit signed integer value with a resolution of 1 nm or in format for the RS422 interface.

A 7.7 Measurement Data Format

A 7.7.1 Data Format RS422 Interface

The output of displacement measurement values, differences between measurement values and statistic values via RS422 need a subsequent conversion in mm. Other values as exposure time, time stamp, profile counter, encoder, intensities or status data are transmitted as 18 bit data words, a conversion is not required.

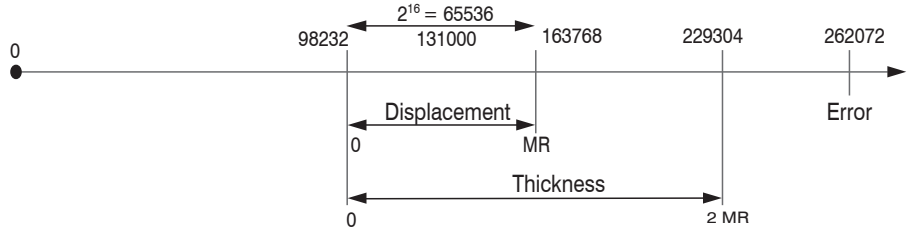
Measurement value 1:

	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

Measurement value 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 displacement and thickness measurement:



131000 = Midrange for the displacement measurement

MR = Measuring range

The linearized measurement values can be converted in millimeters using the subsequent formula:

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

x = Displacement / Thickness in mm

d_{OUT} = digital output value

MR = Measuring range in mm

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

Error code	Description
262073	Scaling error RS422 interface underflow
262074	Scaling errors RS422 interface overflow
262075	Too much data for selected baud rate[1)]
262076	There is no peak present.
262077	Peak is located in front of the measuring range (MR)
262078	Peak is located behind the measuring range (MR)
262079	Measuring value cannot be calculated.

The restrictions for all other data outputs except the measurement value data are defined in the relevant Chapters, see 5

[1)] This error occurs when more data are to be output as with selected baud rate for the selected measuring can be transmitted. To remove the error, there are the following possibilities:

- Increase the baud rate, see A 7.3.6.3
- Decrease measuring rate, see A 7.4.1.4
- Decrease data; if 2 data words have been selected, then reduce to a data word, see A 7.5.2
- Reduce output data rate, see A 7.5.1.2

A 7.7.2 Measurement Data Transmission to a Measurement Value 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.

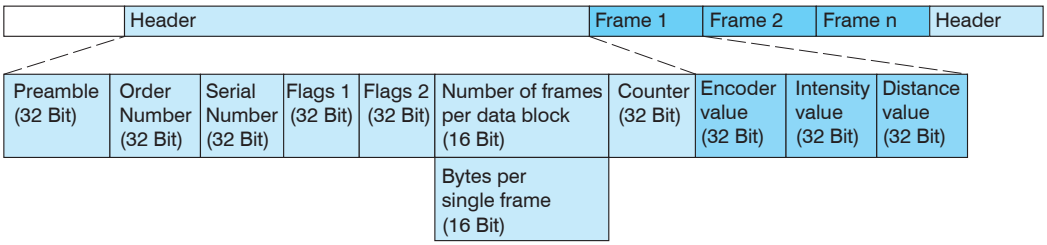
All distances and additional informations to be transmitted, which were recorded at a time, are combined to a measurement value frame. Different measurement value frames are combined to a measurement value block, which contains a header and fits a TCP/IP or UDP/IP packet. The header is mandatory at the 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)	
Flags1 (32 bit)	
Flags2 (32 bit)	
Frame number (16 bit)	Bytes per Frame (16 bit)
Counter (32 bit)	

Header input	Description
Preamble	Identify the header 0x4D454153 – Measurement data 0x56494445 – Video data
Order number	
Serial number	
Flags1	Provide information about the content of the measurement value frame
Flags2	Provide information about the content of the measurement value frame inclusive frame rate
Bytes per Frame	Number of bytes, that contains a measurement value frame
Frame number	Number of frames, that cover this header
Counter	Counter on the number of processed measurement values

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



A 7.7.2.1 Description Flags1

Flag bit	Description
0	Video raw signal
1	Reserved
2	Video dark corrected
3	Video light corrected
4	Dark correction table
5	Light correction table
6	Threshold table
7	Exposure time
8 up to 10	Encoder 1 up to 3
11	Measured value counter
12	Time stamp
13	Reserved
14	Non linearized distance
15	Intensity output
16 up to 17	Reserved
18	Measurement value output
19 up to 24	Output of measurement values/Intensities of peak 1 up to 6
25	Reserved
26	Error status
27	Trigger time difference

A 7.7.2.2 Description Flags2

Flag bit	Description
0	Thickness of peak 1 up to 2
1 up to 14	Reserved
15	Statistics minimum
16	Statistics maximum
17	Statistics peak to peak
18 up to 27	Reserved
28 up to 31	Frame rate: 0 - 70 kHz 1 - 50 kHz 2 - 25 kHz 3 - 10 kHz 4 - 5 kHz 5 - 2.5 kHz 6 - 1 kHz 7 - 0.3 kHz 8 - 0.2 kHz 9 - 0.1 kHz 14 - manual measuring rate 15 - Automatic mode

A 7.7.2.3 Error Codes Ethernet Interface

Error code	Description
0x7ffffffb	There is no peak present
0x7ffffffa	Peak is located in front of the measuring range (MR)
0x7ffffff9	Peak is located behind of the measuring range (MR)
0x7ffffff8	Measuring value cannot be calculated.

A 7.7.3 Ethernet Video Signal Transmission

The video signal transmission is effected to a measurement value server via Ethernet analog to the measurement data transmission, see A 7.7.2, except, that only one video signal is transmitted in a measurement value block and each video signal must be requested individually, see A 7.4.1.7.

This measurement value block can vary also over different TCP/IP or UDP/IP packets depending on the size of the video signal.

The preamble for the video signals is 0x56494445 (conforms „VIDE“).

Request a video signal:

`MEASMODE VIDEO`	-> Mode video
`OUTVIDEO RAW`	-> Output of the raw signal
`OUTPUT ETHERNET`	-> Output via the Ethernet
`GETVIDEO`	-> The raw signal is transmitted to a server/client

The Getvideo command requests one video image each. In addition measurement values and different signals can be transmitted, see A 7.3.2.1 up to, see A 7.5.2.4.

Advice: The correction tables as well as the threshold information must be always required together with one signal raw signal or dark corrected signal.

A 7.8 Warning and Error Messages

The following table lists all warning messages:

Warning message	Description
W01 EtherCAT stopped.	
W02 Encoder-Triggerung stops.	
W03 Disable zeroing/mastering after change of sensor.	
W04 The output starts after switch to mode EtherCAT.	
W05 EtherCAT will be activated after saving the settings and restarting the controller.	
W06 High level of dark signal, please encure that the measurement object is within the measurement range. Furthermore, please protect the sensor connector from soiling.	

The following table lists all error messages:

Error message	Description
E01 unknown command	Unknown command (rights to small to read).
E02 wrong or unknown parameter type	A transmitted parameter has a wrong type or a wrong number of parameters were transmitted.
E03 internal error	Internal error code
E04 I/O operation failed	Can not write data to the output channel.
E05 the entered command is too long to be processed.	The entered command with the parameters is too long (greater than 255 bytes).
E06 access denied	Access denied; login as professional is necessary.
E07 the answer is too long to be displayed by this interpreter.	Answer is too long.
E08 unknown parameter	Unknown Parameter
E09 the command or parameter processing has been canceled.	The command was canceled.
E10 the command or parameter processing is pending.	The command or parameter is in progress.
E11 the entered value is out of range or its format is invalid.	The parameter value is out of range of the value range.
E12 the info-data of the update are wrong.	For update only. The header of the update data contains an error.
E13 error during the data transmission for the update	For update only. Error during update data transmission.
E14 timeout during the update	For update only: Timeout in the transfer of update data.
E15 update file is too big	For update only: The update data are too large.
E16 timeout, command aborted.	The corrections have been aborted with a timeout.
E17 processing aborted	
E18 a signal transfer is already active. Please stop this.	A measurement value transmission is active. Stop the data transmission in order to execute the command.
E19 the file is not valid for this sensor.	The transferred parameter file is for a different sensor type.
E20 invalid file type	Invalid file type (Setup file or material table).

E21 versions do not match.	The versions do not match (Setup file or material table).
E22 checksum invalid	Checksum invalid (Setup file or material table).
E23 the set of parameters does not exist.	The set of parameters does not exist.
E24 selection of section invalid	The selection of section is invalid.
E26 no signals selected.	There were no measurement values selected for transmission
E27 invalid combination of signal parameters - please select at least one distance value.	Invalid signal combination; please select a distance value.
E28 the entry already exists.	The material already exists.
E30 master value is out of range	The master value is out of range.
E31 The material was not found by given name.	The selected material does not exist in the material list.
E32 timeout, get no measurement values	Timeout, no measurements available
E33 wrong parameter count	Too high or too small number of parameters.
E34 The controller has no calibration data	The controller has no calibration data.
E35 cannot start transfer of measurement data.	Measurement value output cannot boot (only adjustments).
E36 Encoders minimum is greater than maximum.	The minimum value of the encoder is greater than its maximum value.
E37 ROI start must be lower than end.	The start value for masking must be less than the end value.
E38 too much output values for RS422 enabled.	Too much output values for RS422 enabled.
E39 sensor head is empty.	Sensor is not available.
E41 The given passwords are not equal.	Errors in the repeated entry of the new password.
E42 Encoder start value must be less than maximum encoder value.	The initial encoder value must be less than the maximum value of the encoder.
E43 Software triggering is not active.	Software triggering is not enabled, no software trigger pulse can be triggered.
E44 Material table full	There are already 20 materials stored in the database.
E45 No video signal now	No video signal is available at this time. The intervals between the queries must be increased.
E46 Receive unsupported character	An unsupported character is received.
E47 The selection of signals is denied in current measurement mode.	In current measurement mode the signal selection cannot be made.
E48 Material table is empty.	No entry in the material table.
E49 For less than three peaks please use distance or thickness measurement.	Use the distance or thickness measurement, if you receive less than three peaks
E50 No video averaging is allowed for Two-Time-mode.	With the “Two-Time” exposure mode video averaging is not allowed.
E51 The given signal is not selected for output.	The current signal is not selected for output.
E52 No new dark correction data available.	First perform a dark correction to save a new reference contamination.
E53 Refractivity correction is disabled, using vacuum for material settings.	Material setting is not possible with deactivated refractive correction.

E54 Output of non linearized values is enabled or was trying to enable. Statistic, averaging and analog output are not available.	During the output of non linearized focuses the use of statistics, averaging and analog output is not possible.
E55 Synchronisation as slave and triggering at level or edge are not possible at the same time.	Synchronisation as Slave and triggering at level or edge were tried to activate at the same time. It can be used only one of the two modes.

A 8 EtherCAT Documentation

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

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

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

A 8.1 Preamble

A 8.1.1 Structure of EtherCAT®-Frames

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

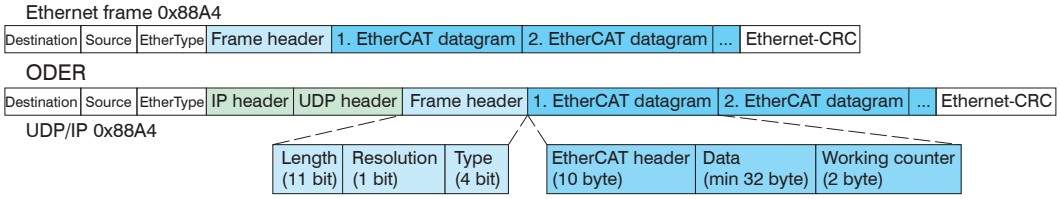


Fig. 86 Setup of EtherCAT frames

A 8.1.2 EtherCAT® Services

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

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

A 8.1.3 Addressing and FMMUs

In order to address a slave in the EtherCAT® system, various methods from the master can be used. The confocalDT 24x1 supports as full slave:

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

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

A 8.1.4 Sync Manager

Sync Managers serve the data consistency during the data exchange between EtherCAT® master and slaves. Each Sync Manager channel defines an area of the application memory. The confocalDT 24x1 has four channels:

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

A 8.1.5 EtherCAT State Machine

The EtherCAT® state machine is implemented in each EtherCAT®. Directly after switching on the confocalDT 24x1, the state machine is in the “Initialization“ state. In this state, the master has access to the DLL information register of the slave hardware. The mailbox is not yet initialized, i.e. communication with the application (sensor software) is not yet possible. During the transition to the pre-operational state, the Sync Manager channels are configured for the mailbox communication. In the „Pre-Operational“ state, communication via the mailbox is possible, and it can access the object directory and its objects. In this state, no process data communication occurs. During the transition to the „Safe-Operational“ state, the process-data mapping, the Sync Manager channel of the process inputs and the corresponding FMMU are configured by the master. Mailbox communication continues to be possible in the „Safe-Operational“ state. The process data communication runs for the inputs. The outputs are in the „safe“ state. In the „Operational“ state, process data communication runs for the inputs as well as the outputs.

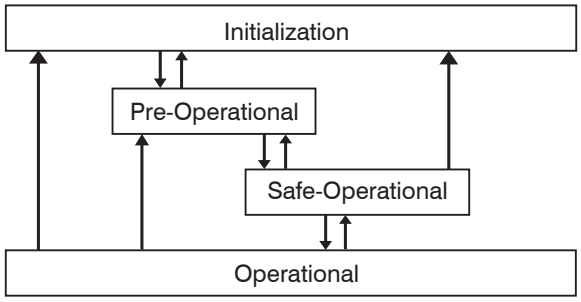


Fig. 87 EtherCAT State Machine

A 8.1.6 CANopen over EtherCAT

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

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

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

A 8.1.7 Process Data PDO Mapping

Process Data Objects (PDOs) are used for the exchange of time-critical process data between master and slaves. Tx PDOs are used for the transmission of data from the slaves to the master (inputs), Rx PDOs are used to transmit data from the master to the slaves (outputs); not used in the confocalDT 24x1. The PDO mapping defines which application objects (measurement data) are transmitted into a PDO.
The confocalDT 24x1 has a Tx PDO for the measuring data. The following measurements are available as process data:

- Distance 1 Ethernet/EtherCAT (default)	Distance 1
- Distance 1 Ethernet/EtherCAT	Distance 2
- Difference 1-2 Ethernet/EtherCAT	Difference 1-2 (Thickness)
- Intensity 1 Ethernet/EtherCAT	Intensity 1
- Intensity 1 Ethernet/EtherCAT	Intensity 2
- Shutter time Ethernet/EtherCAT	Exposure time (32 bit)
- Encoder 1 Ethernet/EtherCAT	Encoder 1 (32 bit)
- Encoder 2 Ethernet/EtherCAT	Encoder 2 (32 bit)
- Encoder 3 Ethernet/EtherCAT	Encoder 3 (32 bit)
- Value counter Ethernet/EtherCAT	Measured value counter (32 bit)
- Timestamp Ethernet/EtherCAT	Timestamp (32 bit)
- Error state Ethernet/EtherCAT	Error Feld
- Statistic minimum value Ethernet/EtherCAT	Statistical value (minimum)
- Statistic maximum value Ethernet/EtherCAT	Statistical value (maximum)
- Statistic peak-peak value Ethernet/EtherCAT	Statistical value (peak to peak)

In EtherCAT the PDOs are transported in objects of the Sync Manager channel. The sensor uses the Sync Manager channel SM3 for input data (Tx data). The PDO assignments of the Sync Manager can only be changed in the “Pre-Operational” state. The mapping in the confocalDT 24x1 is not carried out directly in the object 0x1A00, but rather by switching on and off individual measurements in the application object 0x21B0. The mapping result is available to the master after reloading the object directory.

Note: Subindex 0h of the object 0x1A00 contains the number of valid entries within the mapping report. This number also represents the number of application variables (parameters) that should be transmitted/received with the corresponding PDO. The subindices from 1h up to the number of objects contain information about the depicted application variables. The mapping values in the CANopen objects are coded in hexadecimal form.

The following table contains an example of the entry structure of the PDO mapping:

MSB				LSB
31	16	15 8	7	0
Index e.g. 0x6065 (16 bits)		Subindex e.g. 0x02	Object length in bits, e.g. 20h = 32 bits	

Fig. 88 Entry structure of the PDO mapping, example

A 8.1.8 Service Data SDO Service

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

A 8.2 CoE – Object Directory

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

A 8.2.1 Communication Specific Standard Objects (CiA DS-301)

Overview

Index (h)	Name	Description
1000	Device type	Device type
1001	Error register	Error register
1003	Error history	Predefined error field
1008	Device name	Manufacturer device name
1009	Hardware version	Hardware version
100A	Software version	Software version
1018	Identity	Device identification
1A00	Sample 0	TxPDO mapping
1A01 ... ... 1A27	Sample x	TxPDO Mapping (for oversampling)
1C00	Sync. manager type	Sync. manager type
1C13	TxPDO assign	TxPDO assign
1C33	SM input parameter	Synchronous mode parameter (DC)

Object 1000h: Device type

1000	VAR	Device type	0x00200000	Unsigned32	ro

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

Object 1001h: Error register

1001	VAR	Error register	0x00	Unsigned8	ro

The error register contains generic informations about the kind of the internally adjacent device errors. The general error bit is set on each case.

Structure of error register

7	6	5	4	3	2	1	0
Manufacturer	Reserved	Reserved	Reserved	Temperature	Voltage	Current	General

Object 1003h: Predefined error field

1003	RECORD	Error history			

Subindices

0	VAR	Number of entries	1	Unsigned8	rw
1	VAR			Unsigned32	ro

The occurring device errors are registered here. The last error is saved in the error field. The entry under Sub-Index 0 contains the number of saved errors, by writing the value 0, the errors are eliminated.

Object 1008h: Manufacturer device name

1008	VAR	Device name	IFC24x1	Visible String	ro

Object 1009h: Hardware version

1009	VAR	Hardware version	V x.xxx	Visible String	ro

Object 100Ah: Software version

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

Object 1018h: Device identification

1018	RECORD	Identity			
Subindices					
0	VAR	Number of entries	4	Unsigned8	ro
1	VAR	Vendor ID	0x00000607	Unsigned32	ro
2	VAR	Product code	0x003EDE73	Unsigned32	ro
3	VAR	Revision	0x00010000	Unsigned32	ro
4	VAR	Serial number	0x009A4435	Unsigned32	ro

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

Object 1A00h: TxPDO Mapping

1A00	RECORD	TxPDO Mapping			
Subindices					
0	VAR	Number of entries	43	Unsigned8	ro
1	VAR	Shutter time Ethernet/ EtherCAT	0x60650120	Unsigned32	ro
2	VAR	Encoder 1	0x60650220	Unsigned32	ro
3	VAR	Encoder 2	0x60650320	Unsigned32	ro
4	VAR	Encoder 3	0x60650420	Unsigned32	ro
5	VAR	Value counter Ethernet/ EtherCAT	0x60650520	Unsigned32	ro
6	VAR	Timestamp Ethernet/ EtherCAT	0x60650620	Unsigned32	ro
7	VAR	Unlin 1	0x60650720	Unsigned32	ro
8	VAR	Intensity 1	0x60650820	Unsigned32	ro
9	VAR	Distance 1 Ethernet/ EtherCAT	0x60650920	Signed32	ro
10	VAR	Unlin 2	0x60650A20	Unsigned32	ro
11	VAR	Intensity 2	0x60650B20	Unsigned32	ro
12	VAR	Distance 2 Ethernet/ EtherCAT	0x60650C20	Signed32	ro
25	VAR	Errorstate Ethernet/ EtherCAT	0x60651920	Unsigned32	ro
26	VAR	Difference 1-2 Ethernet/EtherCAT	0x60651A20	Signed32	ro
41	VAR	Statistic minimum value Ethernet/EtherCAT	0x60652920	Signed32	ro
42	VAR	Statistic maximum value Ethernet/EtherCAT	0x60652A20	Signed32	ro
43	VAR	Statistic peak-peak value Ethernet/EtherCAT	0x60652B20	Signed32	ro

Objects 1A01 - 1A27: TxPDO Mapping

Contents are identical to object 1A00. The objects 1A01 - 1A27 are used for oversampling, see A 8.6.

Object 1C00h: Synchronous manager type

1C00	RECORD	Sync manager type			ro
Subindices					
0	VAR	Number of entries	4	Unsigned8	ro
1	VAR	Sync manager 0	0x01	Unsigned8	ro
2	VAR	Sync manager 1	0x02	Unsigned8	ro
3	VAR	Sync manager 2	0x03	Unsigned8	ro
4	VAR	Sync manager 3	0x04	Unsigned8	ro

Object 1C13h: TxPDO assign					
1C13	RECORD	TxPDO assign			
Subindices					
0	VAR	Number of entries	1	Unsigned8	ro
1	VAR	Subindex 001	0x1A00	Unsigned16	ro

Further subindices contain other inputs (0x1A01, 0x1A02, ...) when oversampling, see A 8.6.

Object 1C33h: SM input parameter

1C33	RECORD	SM input parameter			ro
Subindices					
0	VAR	Number of entries	32	Unsigned8	ro
1	VAR	Sync mode	0	Unsigned8	ro
2	VAR	Cycle time	100000	Unsigned32	ro
4	VAR	Sync modes supported	0x4005	Integer16	ro
5	VAR	Minimum cycle time	1000000	Integer32	ro
6	VAR	Calc and copy time	0	Integer32	ro
8	VAR	Get cycle time	0	Integer16	rw
11	VAR	SM event missed counter	0	Integer32	ro
12	VAR	Cycle exceeded counter	0	Integer32	ro
32	VAR	Sync error	FALSE	Bool	ro

A 8.2.2 Manufacturer Specific Objects

Overview

Index (h)	Name	Description
2001	User level	Login, logout, change password
2005	Controller info	Controller informations (further)
2010	Setup	Load/save settings
2011	Correction	Light and dark correction
2101	Reset	Reset
2105	Factory settings	Reset factory settings
2140	Video	Select video signal, correction tables
2150	Sensor	Sensor informations
2152	Select sensor	Selection of the sensor
2154	Measuring program	Measuring program
2156	Multilayer options	Options for multilayer measurement
2181	Averaging/error handling/statistics	Averaging/error handling/statistics and spike correction
21B0	Digital interfaces	Digital interfaces, data selection
21C0	Ethernet	Ethernet parameter (IP address, subnet, gateway)
21D0	Analog output	Analog output
21E0	Zeroing/mastering	Zeroing/mastering
21F1	Switching outputs	Switching outputs
2250	Shutter mode/measuring range	Exposure mode/measuring range
2410	Trigger mode	Trigger modes
2550	Threshold	Peak detection threshold
25A0	Encoder	Encoder
2711	Range of interest	Reduction of Region of Interest
2800	Material info	Material informations
2801	Material selection	Material selection
2802	Material table edit	Material table edit
6010	Video signal	Video signal
603F	Sensor error	Error message of the sensor
6065	Measvalues	Measurement values

Object 2001h: User level

2001	RECORD	User level			
Subindices					
0	VAR	Number of entries	7	Unsigned8	ro
1	VAR	Actual user	x	Unsigned8	ro
2	VAR	Login	******	Visible string	wo
3	VAR	Logout	FALSE	BOOL	rw
4	VAR	Default user	x	Unsigned8	rw
5	VAR	Password old	*****	Visible string	wo
6	VAR	Password new	*****	Visible string	wo
7	VAR	Password repeat	*****	Visible string	wo

Further details can be found in the section Login, see 6.1 and Change User Level, see A 7.3.2.

Actual user, Default user:

0 - User

1 - Professional

For changing the password, the three password fields Old, New and Repeat must be described in the specified sequence. The maximum length of a password is 31 characters.

Object 2005h: Controller informations (further)

2005	RECORD	Controller Info			ro
Subindices					
0	VAR	Number of entries	8	Unsigned8	ro
1	VAR	Name	IFC24x1	Visible String	ro
5	VAR	Serial No	xxxxxxxx	Visible String	ro
6	VAR	Option No	xxx	Visible String	ro
8	VAR	Article No	xxxxxxx	Visible String	ro
11	VAR	Temperature	x.xx	FLOAT32	ro

The temperature (float value) is output in degree Celsius with 0.25 °C resolution.

Further details can be found in the section Controller information, see A 7.3.1.2.

Object 2010h: Loading/saving settings

2010	RECORD	Setup			ro
Subindices					
0	VAR	Number of entries	4	Unsigned8	ro
1	VAR	Setup number	0x0000	Unsigned16	rw
2	VAR	Setup store	FALSE	BOOL	rw
3	VAR	Setup read	FALSE	BOOL	rw
4	VAR	Keep device settings	FALSE	BOOL	rw

Further details can be found in the section Load/save settings in the controlle, see 5.7 and Parameter management, load/save settings, see A 7.3.7

Object 2011h: Corrections

2011	RECORD	Correction			ro
Subindices					
0	VAR	Number of entries	3	Unsigned8	ro
1	VAR	Dark correction	FALSE	BOOL	rw
2	VAR	Light correction	FALSE	BOOL	rw
3	VAR	Correction result	0x00	Unsigned32	rw
4	VAR	Threshold for dark correction	50.0	FLOAT32	rw

Further details can be found in the section Dark reference, see 5.5, Light source reference, see 6.15, Dark correction, see A 7.3.3.4 and Light correction, see A 7.3.3.6.

After triggering a correction the status (error code) of the correction can be queried under `Correction result`. You can read under section Error codes, see A 8.3, for the possible error codes.

Object 2101h: Reset

2101	VAR	Reset	FALSE	BOOL	rw

Further details can be found in the section Booting the sensor, see A 7.3.1.6.

Object 2105h: Factory settings

2105	RECORD	Factory settings			ro
Subindices					
0	VAR	Number of entries	3	Unsigned8	ro
1	VAR	Factory settings	FALSE	BOOL	rw
2	VAR	Keep device settings	FALSE	BOOL	rw
3	VAR	Reset current setup	FALSE	BOOL	rw

Further details can be found in the section Extras, see 6.13, and Default settings, see A 7.3.7.3.

Object 2140h: Video

2140	RECORD	Video			ro
Subindices					
0	VAR	Number of entries	3	Unsigned8	ro
1	VAR	Video type	0	Unsigned8	rw
2	VAR	Dark table	xxh xxh ...	Octed String [1024]	ro
3	VAR	Light table	xxh xxh ...	Octed String [1024]	ro

The entry `Video type` defines which signal is available in 0x6010:01. The options are:

- 1 – output of the raw signal
- 3 – output of the dark corrected signal
- 4 – output of the light source corrected signal

With factory setting the video type is set on `0`. If you change from measurement mode to video mode, the video type is set on 3 as long as the value was 0 before.

The set value is stored in a setup, command `STORE`.

In the subindices 2 and 3 of the object the correction tables can be read. Subindice 2 contains the dark level table and subindice 3 the light source table. Both are 1024 bytes long byte vectors (Octed String). As in the entry 0x6010: 01, the byte vector contains 16 bit values for each 512 pixels.

Object 2150h: Sensor

2150	RECORD	Sensor			ro
Subindices					
0	VAR	Number of entries	5	Unsigned8	ro
1	VAR	Sensor info	IFS24xx-xx	Visible String	ro
2	VAR	Sensor range	xx.xxxxxx	FLOAT32	ro
3	VAR	Sensor serial No	xxxxxxxx	Visible String	ro
4	VAR	Sensor article No	xxxxxxxx	Visible String	ro
5	VAR	Sensor option No	xxx	Visible String	ro

Further details can be found in the section Sensor, see A 7.3.3.

Object 2152h: Sensor selection

2152	RECORD	Select sensor			ro
Subindices					
0	VAR	Number of entries	1	Unsigned8	ro
1	VAR	Number of sensor	x	Unsigned8	rw

Further details can be found in the section Select sensor, see 5.3.4 and Sensor number, see A 7.3.3.2.

Object 2154h: Measuring program

2154	VAR	Measuring program	0x00	Unsigned8	rw

Further details can be found in the section Measurement program, see 5.3.2 and Measurement mode, see A 7.4.1.1.

Measuring program:

0 - Displacement measurement
1 - Thickness measurement
2 - Multilayer measurement
3 - Video signal output

Objekt 2156h: Multilayer measurement options

2156	RECORD	Multilayer options			ro
Subinzes					
0	VAR	Number of entries	2	Unsigned8	ro
1	VAR	Number of peaks for multilayer	2	Unsigned8	rw
2	VAR	Disable refractivity correction	FALSE	BOOL	rw

Further details can be found in the chapter multilayer measurement, see A 4.

Refrac count:

Number of processed distances (2 ... 6)

Disable refractivity correction:

Deactivation of the refractive index correction

Objekt 2158h: Thickness measurements options

2158	RECORD	Thickness options			ro
Subinzes					
0	VAR	Number of entries	1	Unsigned8	ro
1	VAR	Disable refractivity correction	FALSE	BOOL	rw

Further details can be found in the chapter multilayer measurement, see A 4.

Disable refractivity correction:

Deactivation of the refractive index correction

Objekt 2161h: Peak position

2161	VAR	Peak position	0	Unsigned8	rw

The peak/peaks that is/are evaluated in the distance or thickness measurement mode can be set using this command.

Standard: first peak / first and second peak

In order to get a reproducible measurement result, the default setting should be changed only in urgent cases.

Position for displacement		Position for thickness measurement	
0	first peak	0	first and last peak
1	last peak	1	second to last and last peak
2	first peak	2	first and second peak
3	highest peak	3	highest and second highest peak

Object 2181h: Averaging, error processing and statistics

2181	RECORD	Averaging/error handling/statistics			ro
Subindices					
0	VAR	Number of entries	15	Unsigned8	ro
1	VAR	Measured value averaging type	x	Unsigned32	rw
2	VAR	Number of values for moving average	x	Unsigned32	rw
3	VAR	Number of values for median	x	Unsigned32	rw
4	VAR	Number of values for recursive average	x	Unsigned32	rw
5	VAR	Statistic depth	x	Unsigned8	rw
6	VAR	Reset statistic	FALSE	BOOL	rw
7	VAR	Error handling	x	Unsigned8	rw
8	VAR	Number of held values	x	Unsigned16	rw
9	VAR	Video averaging	x	Unsigned8	rw
10	VAR	Signal for statistics	x	Unsigned8	rw
11	VAR	Reduce video signal	x	Unsigned8	rw
12	VAR	Use spike correction	FALSE	BOOL	rw
13	VAR	Spike correction evaluation length	x	Unsigned32	rw
14	VAR	Spike correction range	xx	FLOAT32	rw
15	VAR	Spike correction count	x	Unsigned32	rw

Further details can be found in the section Averaging/ error handling/ statistics, see 6.3, and Video averaging, see A 7.4.2.2.

Measured value averaging type:

0 - No averaging	
1 - Moving average	(Number of values for moving average: 2, 4, 8, 16, 32, 64, 128, 256, 512 and 1024)
2 - Recursive average	(Number of values for recursive average: 2…32768)
3 - Median	(Number of values for median: 3, 5, 7 and 9)

Statistic depth:

0, 2, 4, 8, 16…16384; 0 = infinite

Error handling:

0 - Output of error value

1 - Hold last valid value for a number of measurement values
(Number of held values: 0….1024, 0 = infinite)

Video averaging:

0 - No averaging

1 - Recursive average of 2 video signals

2 - Recursive average of 4 video signals

3 - Recursive average of 8 video signals

4 - Moving average of 2 video signals

5 - Moving average of 4 video signals

6 - Moving average of 3 video signals

7 - Median of 3 video signals

Statistic signal: Measurement, for which the statistics is calculated (only in measurement program multilayer)

- 0 - Distance 1
- 1 - Distance 2
- 2 - Distance 3
- 3 - Distance 4
- 4 - Distance 5
- 5 - Distance 6
- 32 - Difference 1 - 2
- 33 - Difference 1 - 3
- 34 - Difference 1 - 4
- 35 - Difference 1 - 5
- 36 - Difference 1 - 6
- 37 - Difference 2 - 3
- 38 - Difference 2 - 4
- 39 - Difference 2 - 5
- 40 - Difference 2 - 6
- 41 - Difference 3 - 4
- 42 - Difference 3 - 5
- 43 - Difference 3 - 6
- 44 - Difference 4 - 5
- 45 - Difference 4 - 6
- 56 - Difference 5 - 6

The data selection is possible according to the selected measurement program: Only Distance 1 in case of displacement measurement.

Reduce video signal

- 0 - No reduction (512 points and 16 bits)
- 1 - Reduction on 512 points and 8 bits
- 2 - Reduction on 256 points and 16 bits
- 3 - Reduction on 256 points and 8 bits

In case of reduction on 8 bits the original video signal is divided by 64.

Use spike correction

- 0 - without spike correction
- 1 - with spike correction

Spike correction evaluation length: Number of evaluated values (1 ... 10)

Spike correction range: max. tolerance range in mm (0.0000000 ... 100.0000000)

Spike correction count: Number of corrected values (1 ... 100)

Object 21B0h: Digital interfaces, selection of transmitted data (measurement values)

21B0	RECORD	Digital interfaces			ro
Subindices					
0	VAR	Number of entries	37	Unsigned8	ro
1	VAR	Output device	5	Unsigned8	rw
2	VAR	RS422 baud rate	x	Unsigned32	rw
3	VAR	Ethernet/EtherCAT	TRUE	BOOL	rw
4	VAR	Distance 1 Ethernet/ EtherCAT	TRUE	BOOL	rw
5	VAR	Distance 2 Ethernet/ EtherCAT	FALSE	BOOL	rw
6	VAR	Distance 3 Ethernet/ EtherCAT	FALSE	BOOL	rw
7	VAR	Distance 4 Ethernet/ EtherCAT	FALSE	BOOL	rw
8	VAR	Distance 5 Ethernet/ EtherCAT	FALSE	BOOL	rw
9	VAR	Distance 6 Ethernet/ EtherCAT	FALSE	BOOL	rw
10	VAR	Intensity Ethernet/ EtherCAT	FALSE	BOOL	rw
11	VAR	Encoder 1 Ethernet/ EtherCAT	FALSE	BOOL	rw
12	VAR	Encoder 2 Ethernet/ EtherCAT	FALSE	BOOL	rw
13	VAR	Encoder 3 Ethernet/ EtherCAT	FALSE	BOOL	rw
14	VAR	Value counter Ethernet/ EtherCAT	FALSE	BOOL	rw
15	VAR	Statistic minimum value Ethernet/EtherCAT	FALSE	BOOL	rw
16	VAR	Statistic maximum value Ethernet/EtherCAT	FALSE	BOOL	rw
17	VAR	Statistic peak-peak value Ethernet/EtherCAT	FALSE	BOOL	rw
18	VAR	Timestamp Ethernet/ EtherCAT	FALSE	BOOL	rw
19	VAR	Shutter time Ethernet/ EtherCAT	FALSE	BOOL	rw
20	VAR	Error state Ethernet/ EtherCAT	FALSE	BOOL	rw
21	VAR	Difference 1-2 Ethernet/ EtherCAT	FALSE	BOOL	rw
22	VAR	Difference 1-3 Ethernet/ EtherCAT	FALSE	BOOL	rw
23	VAR	Difference 1-4 Ethernet/ EtherCAT	FALSE	BOOL	rw
24	VAR	Difference 1-5 Ethernet/ EtherCAT	FALSE	BOOL	rw
25	VAR	Difference 1-6 Ethernet/ EtherCAT	FALSE	BOOL	rw

26	VAR	Difference 2-3 Ethernet/ EtherCAT	FALSE	BOOL	rw
27	VAR	Difference 2-4 Ethernet/ EtherCAT	FALSE	BOOL	rw
28	VAR	Difference 2-5 Ethernet/ EtherCAT	FALSE	BOOL	rw
29	VAR	Difference 2-6 Ethernet/ EtherCAT	FALSE	BOOL	rw
30	VAR	Difference 3-4 Ethernet/ EtherCAT	FALSE	BOOL	rw
31	VAR	Difference 3-5 Ethernet/ EtherCAT	FALSE	BOOL	rw
32	VAR	Difference 3-6 Ethernet/ EtherCAT	FALSE	BOOL	rw
33	VAR	Difference 4-5 Ethernet/ EtherCAT	FALSE	BOOL	rw
34	VAR	Difference 4-6 Ethernet/ EtherCAT	FALSE	BOOL	rw
35	VAR	Difference 5-6 Ethernet/ EtherCAT	FALSE	BOOL	rw
36	VAR	Un lin	FALSE	BOOL	rw
37	VAR	Video as PDO	FALSE	BOOL	rw

Output device:

- 0 - No output channel
- 1 - RS422
- 5 - EtherCAT

RS422 baud rate: 9600, 115200, 230400, 460800, 691200, 921600, 1500000, 2000000, 3500000, 4000000

Ethercat-Ethernet: (Change of interface)

- 0 - Ethernet (works only from restarting, previously setup store)
- 1 - EtherCAT

Subindices 4 … 36: Data selection for the PDO mapping

Distance 1 to Distance 6 are only individually selectable in the measurement program multilayer measurement and video, otherwise, these values are selected automatically according to the selected measurement program.

Difference 1-2 to Difference 5-6 can be selected in the measurement program multilayer and video.

Intensity - Intensities for all displacements, that are transmitted.

Un lin - Switching on output of non linearized distances

- 0 - Output of non linearized distances (factory setting)
- 1 - Output of non linearized distances

Video as PDO:

Transmitting the video signal and the additionally activated measurement values by PDO. This is only possible in the measurement program video. Transmitting the video signal reduces the transmission rate by half (e.g. transmission instead of the set 1 kHz only with 500 Hz). In addition, the transmission limits the maximum measurement frequency to 1 kHz (500 Hz transmission frequency).

Object 21C0h: Ethernet

21C0	RECORD	Ethernet			ro
Subindices					
0	VAR	Number of entries	8	Unsigned8	ro
1	VAR	IP address	xxx.xxx.xxx.xxx	Visible String	rw
2	VAR	Subnet mask	xxx.xxx.xxx.xxx	Visible String	rw
3	VAR	Gateway	xxx.xxx.xxx.xxx	Visible String	rw
4	VAR	DHCP	FALSE	BOOL	rw
5	VAR	Measured value server protocol	0	Unsigned8	rw
6	VAR	Measured value server IP-Address	xxx.xxx.xxx.xxx	Visible String	rw
7	VAR	Measured value server port	x	Unsigned16	rw
8	VAR	MAC address	xx.xx.xx.xx.xx.xx	Visible String	ro

Further details can be found in the section Ethernet IP settings, see A 7.3.6.1 and Settings for the Ethernet measured value transfer, see A 7.3.6.2.

DHCP:

0 - Static IP address

1 - DHCP

Measured value server protocol:

0 - No transmission

1 - Client/TCP

2 - Client/UDP

3 - Server/TCP

Object 21D0h: Analog output

21D0	RECORD	Analog output			ro
Subindices					
0	VAR	Number of entries	1	Unsigned8	ro
1	VAR	Analog output	x	Unsigned8	rw
2	VAR	Analog output signal	x	Unsigned8	rw
3	VAR	Analog output type of scaling	x	Unsigned8	rw
4	VAR	Analog output two-point-scaling start	x.x	FLOAT32	rw
5	VAR	Analog output two-point-scaling end	x.x	FLOAT32	rw

Further details can be found in the section Analog output, see 6.7, see A 7.5.4.

Analog output:

- 4 - No analog output (inactive)
- 0 - Voltage 0 … 5 V
- 1 - Voltage 0 … 10 V
- 2 - Voltage -5 … 5 V
- 3 - Voltage -10 … 10 V
- 7 - Current 4 … 20 mA

Analog output signal: Data selection only possible according to the selected measurement program - Only Distance 1 in case of displacement measurement

- 0 - Distance 1
- 1 - Distance 2
- 2 - Distance 3
- 3 - Distance 4
- 4 - Distance 5
- 5 - Distance 6
- 32 - Difference 1-2
- 33 - Difference 1-3
- 34 - Difference 1-4
- 35 - Difference 1-5
- 36 - Difference 1-6
- 37 - Difference 2-3
- 38 - Difference 2-4
- 39 - Difference 2-5
- 40 - Difference 2-6
- 41 - Difference 3-4
- 42 - Difference 3-5
- 43 - Difference 3-6
- 44 - Difference 4-5
- 45 - Difference 4-6
- 56 - Difference 5-6

Analog output type of scaling:

- 0 - Standard Scaling
- 1 - Two-point scaling

Object 21E0h: Zeroing/Mastering

21E0	RECORD	Zeroing/Mastering			ro
Subindices					
0	VAR	Number of entries	5	Unsigned8	ro
2	VAR	Master value	x.xx	FLOAT32	rw
3	VAR	Zeroing/Mastering active	FALSE	BOOL	rw
4	VAR	Zeroing/Mastering	FALSE	BOOL	rw
5	VAR	Reset master value	FALSE	BOOL	rw
6	VAR	Master signal	x	Unsigned8	rw

Further details can be found in the section Zeroing/Mastering, see 6.4 and Setting masters and zero, see A 7.4.5.7.

Master value:

-2*Sensor-measuring range … 2*Sensor-measuring range (in mm)

Zeroing/Mastering active:

0 - Measured value not zeroed/ mastered

1 - Measured value moved by zeroing/ mastering

Master signal: Measurement value, which is mastered (only in measurement program multilayer).

0 - Distance 1
1 - Distance 2
2 - Distance 3
3 - Distance 4
4 - Distance 5
5 - Distance 6
32 - Difference 1-2
33 - Difference 1-3
34 - Difference 1-4
35 - Difference 1-5
36 - Difference 1-6
37 - Difference 2-3
38 - Difference 2-4
39 - Difference 2-5
40 - Difference 2-6
41 - Difference 3-4
42 - Difference 3-5
43 - Difference 3-6
44 - Difference 4-5
45 - Difference 4-6
56 - Difference 5-6

Object 21F1h: Switching outputs

21F1	RECORD	Switching outputs			ro
Subindices					
0	VAR	Number of entries	6	Unsigned8	ro
1	VAR	Switching output error 1	x	Unsigned8	rw
2	VAR	Switching output error 2	x	Unsigned8	rw
3	VAR	Lower limit value (mm)	x.xx	FLOAT32	rw
4	VAR	Upper limit value (mm)	x.xx	FLOAT32	rw
5	VAR	Signal for limit value output	x	Unsigned8	rw
6	VAR	Level of switching outputs	x	Unsigned8	rw

Further details can be found in the section Switching outputs, see 6.6, see A 7.5.3.

Switching output error 1 and 2: Assignment of both switching outputs

- 0 - No output
- 1 - Intensity error
- 2 - Measured value out of range
- 3 - Intensity error or measured value out of range
- 4 - Deceed the lower limit
- 5 - Exceed the upper limit
- 6 - Deceed the lower limit or exceed the upper limit

Lower and upper limit value:
-120.000000 … 120.000000 (in mm)

Signal for limit value output: The limits refer to

- 0 - Distance 1
- 1 - Distance 2
- 2 - Distance 3
- 3 - Distance 4
- 4 - Distance 5
- 5 - Distance 6
- 32 - Difference 1-2
- 33 - Difference 1-3
- 34 - Difference 1-4
- 35 - Difference 1-5
- 36 - Difference 1-6
- 37 - Difference 2-3
- 38 - Difference 2-4
- 39 - Difference 2-5
- 40 - Difference 2-6
- 41 - Difference 3-4
- 42 - Difference 3-5
- 43 - Difference 3-6
- 44 - Difference 4-5
- 45 - Difference 4-6
- 56 - Difference 5-6

(Data selection only possible according to the selected measurement program: at displacement measurement only distance 1)

Level of switching outputs:

- 0 - High upon error
- 1 - Low upon error

Object 2250h: Exposure mode/Measuring rate

2250	RECORD	Shutter mode/measuring rate			
Subindices					
0	VAR	Number of entries	4	Unsigned8	ro
1	VAR	Shutter mode	x	Unsigned8	rw
2	VAR	Measuring rate	x	Unsigned8	rw
3	VAR	Shutter time 1	x.xx	FLOAT32	rw
4	VAR	Shutter time 2	x.xx	FLOAT32	rw
5	VAR	Manual measuring rate	x.xx	FLOAT32	rw

Further details can be found in the section Exposure mode / Measuring rate, see 5.3.5), Exposure mode, see A 7.4.1.2, Measuring rate, see A 7.4.1.4 and Exposure time, see A 7.4.1.5.

Shutter mode:

0 - Automatic mode
1 - Measurement mode
2 - Manual mode
3 - Two-time mode alternating
4 - Two-time mode automatically

Measuring rate:

Setting value	IFC2451	IFC2461	IFC2471LED	IFC2471
0	-		70 kHz	70 kHz
1	-		50 kHz	50 kHz
2	-	25 kHz	25 kHz	25 kHz
3	10 kHz	10 kHz	10 kHz	10 kHz
4	5 kHz	5 kHz	5 kHz	5 kHz
5	2.5 kHz	2.5 kHz	2.5 kHz	2.5 kHz
6	1 kHz	1 kHz	1 kHz	1 kHz
7	0.3 kHz	0.3 kHz	-	0.3 kHz
8	0.2 kHz	0.2 kHz	-	-
9	0.1 kHz	0.1 kHz	0.1 kHz	-
10	Choice from subindice 5			

Objekt 2410h: Triggermodes

2410	RECORD	Trigger mode			ro
Subindices					
0	VAR	Number of entries	9	Unsigned8	ro
1	VAR	Trigger mode	0	Unsigned8	rw
2	VAR	Trigger edge/level	0	Unsigned8	rw
3	VAR	Number of values per trigger pulse	1	Unsigned16	rw
4	VAR	Number of input for encoder trigger	0	Unsigned8	rw
5	VAR	Step width for encoder trigger	1	Unsigned8	rw
6	VAR	Minimum value for encoder trigger	0	Unsigned8	rw
7	VAR	Maximum value for encoder trigger	0xffffffff	Unsigned8	rw
8	VAR	Software trigger pulse	FALSE	BOOL	rw
9	VAR	Trigger In/Out	FALSE	BOOL	rw

Further details can be found in the section Triggering, see 6.10 and Triggermodes, see A 7.3.4.

Trigger mode:

- 0 - No triggering
- 1 - Level triggering
- 2 - Edge triggering
- 3 - Software triggering
- 4 - Encoder triggering

Trigger edge/level:

- 0 - At edge triggering: Falling edge; at level triggering: Low
- 1 - At edge triggering: Rising edge; at level triggering: High

Number of value per trigger pulse: Number of output data after a trigger pulse for edge or software triggering, 0...16382, 16383 = infinite, 0 = Stop

Number of input for encoder trigger:

- 0 - Encoder 1 for the encoder triggering
- 1 - Encoder 2 for the encoder triggering
- 2 - Encoder 3 for the encoder triggering

Step width for encoder trigger:

Number of encoder steps by which a measured value has ever been output (1…2^{31}-1). 0 = all measured values (continuously, regardless of the encoder)

Minimum and Maximum value for encoder trigger:
0…2^{32}-1

Trigger In/Out:

- 0 - Triggering the measured value recording
- 0 - Triggering the measurement value output

Object 2550h: Peak detection threshold

2550	VAR	Threshold	1.0	FLOAT32	rw

Further details can be found in the section Detection threshold, see 6.2 ,and Peak detection threshold, see A 7.4.2.3.

Object 25A0h: Encoder

25A0	RECORD	Encoder			ro
Subindices					
0	VAR	Number of entries	15	Unsigned8	ro
1	VAR	Encoder 1 reference signal	x	Unsigned32	rw
2	VAR	Encoder 1 interpolation	x	Unsigned32	rw
3	VAR	Encoder 1 initial value	x	Unsigned32	rw
4	VAR	Encoder 1 maximal value	x	Unsigned32	rw
5	VAR	Encoder 1 set value	FALSE	BOOL	rw
6	VAR	Encoder 2 reference signal	x	Unsigned32	rw
7	VAR	Encoder 2 interpolation	x	Unsigned32	rw
8	VAR	Encoder 2 initial value	x	Unsigned32	rw
9	VAR	Encoder 2 maximal value	x	Unsigned32	rw
10	VAR	Encoder 2 set value	FALSE	BOOL	rw
11	VAR	Encoder 3 reference signal	x	Unsigned32	rw
12	VAR	Encoder 3 interpolation	x	Unsigned32	rw
13	VAR	Encoder 3 initial value	x	Unsigned32	rw
14	VAR	Encoder 3 maximal value	x	Unsigned32	rw
15	VAR	Encoder 3 set value	FALSE	BOOL	rw

Further details can be found in the section Encoder inputs, see 6.9 and Encoder, see A 7.3.5.

Encoder reference signal:

0 - Reference marker position of encoder without effect
1 - Unique setting
3 - Setting at all marker positions

Encoder interpolation:

1 - Unique interpolation
2 - Double interpolation
3 - Quad interpolation

Encoder initial value:

0 … 2^{32}-1

Encoder maximal value:

0 … 2^{32}-1

Object 2711h: Reduction of region of interest

2711	RECORD	Range of interest			
Subindices					
0	VAR	Number of entries	2	Unsigned8	ro
1	VAR	Range of interest start	x	Unsigned32	rw
2	VAR	Range of interest end	x	Unsigned32	rw

Further details can be found in the section Reduction of region of interest, see 6.14, see A 7.4.2.1.

Object 2800h: Material info

2800	RECORD	Material info			
Subindices					
0	VAR	Number of entries	3	Unsigned8	ro
1	VAR	Material name	xxxxx	Visible String	rw
2	VAR	Material description	xxxxxx	Visible String	rw
3	VAR	Type of refraction numbers	xx	Uint8	rw
4	VAR	nd	x.xxxx	FLOAT32	rw
5	VAR	nF	x.xxxx	FLOAT32	rw
6	VAR	nC	x.xxxx	FLOAT32	rw
7	VAR	Abbe number	x.xxxx	FLOAT32	rw

Further details can be found in the section Material data base, see 5.3.3, see A 7.4.3.

Material name: Actual selected material for a thickness measurement

Material description: Description of actual selected material

nd, nF and nC: Refractive numbers of the actual selected material at 587 nm, 486 nm and 656 nm.

Abbe number: Abbe number of actual selected material

Here the current material can also be edited in professional mode. Any custom settings will be saved immediately.

Object 2801h: Material select

2801	RECORD	Material selection			
Subindices					
0	VAR	Number of entries	9	Unsigned8	ro
1	VAR	Material names	„xx“ „xx“ ...	Visible String	ro
2	VAR	Material 1	xx	Visible String	rw
3	VAR	Material 2	xx	Visible String	rw
4	VAR	Material 3	xx	Visible String	rw
5	VAR	Material 4	xx	Visible String	rw
6	VAR	Material 5	xx	Visible String	rw
8	VAR	Selected material	xx	Visible String	rw

Material names: Output of all names of materials contained in the material table

Material 1 to 5:

Specification of material between the Distance 1 - 2, 2 - 3, 3 - 4, 4 - 5 and 5 - 6. The selected material must be present in the material table.

Selected material:

Selection of material from the material table, which is displayed and edited in the object “Material info“.

Object 2802h: Material table edit

2802	RECORD	Material table edit			
Subindices					
0	VAR	Number of entries	3	Unsigned8	ro
1	VAR	Material delete	x	Visible String	rw
2	VAR	Reset materials	x	BOOL	rw
3	VAR	New material	x	BOOL	rw

Material delete: Specification of name to be deleted from the material table

Reset Materials: Resetting the material table to factory settings

New material: Creating a new material in the material table. Then the newly created material („NewMaterial“) is to be edit in object 2800h „Material info“.

Object 6010h: Videosignal

6010	RECORD	Video signal			ro
Subindices					
0	VAR	Number of entries	1	Unsigned8	ro
1	VAR	Video signal	xxh xxh xxh xxh xxh	Octed String	

The dark corrected video signal is transmit.

Object 603Fh: Sensor error

603F	RECORD	Sensor error			
Subindices					
0	VAR	Number of entries	2	Unsigned8	ro
1	VAR	Sensor error number	x	Unsigned16	ro
2	VAR	Sensor error description	x	Visible String	ro

Further details can be found in the section Error messages, see A 7.8.

Sensor error number: Output of sensor error in communication

Sensor error description: Sensor error as plain text

Object 6065h: Measurement values

6065	RECORD	Measuring values			
Subindices					
0	VAR	Number of entries	43	Unsigned8	ro
1	VAR	Distance 1 Ethernet/ EtherCAT	x	Signed32	ro
...		...			

All in the object 21B0h Digital interfaces selected measurement values.

A 8.3 Error Codes for SDO Services

In case of a negative evaluation of a SDO requirement, a corresponding error code is output in “Abort SDO Transfer Protocol“.

Error code hexadecimal	Meaning
0503 0000	Toggle-Bit has not changed.
0504 0000	SDO protocol timeout expired
0504 0001	Invalid command registered
0504 0005	Not enough memory
0601 0000	Access to object (parameter) not supported.
0601 0001	Attempt to write to a “read-only parameter“
0601 0002	Attempt to write to a “read-only parameter“
0602 0000	Object (parameter) is not listed in the object directory.
0604 0041	Object (parameter) is not mapped on PDO
0604 0042	Number or length of objects to be transmitted exceeds PDO length.
0604 0043	General parameters incompatibility
0604 0047	General internal device incompatibility
0606 0000	Excess denied because of a hardware error
0607 0010	False data type or length of service parameter is incorrect.
0607 0012	False data type or length of service parameter is too large.
0607 0013	False data type or length of service parameter is too small.
0609 0011	Subindex does not exist
0609 0030	Invalid value of parameter (only for write access)
0609 0031	Value of the parameter too large
0609 0032	Value of the parameter too small
0609 0036	Maximum value deceeds minimum value.
0800 0000	General error
0800 0020	Data can not be transmitted or saved in application.
0800 0021	Data can not be transmitted or saved in application, because of local control.
0800 0022	Data can not be transmitted or saved in application, because device state.
0800 0023	Dynamic generation of object directory failed or no object directory is available

A 8.4 Measurement Data Formats

A 8.4.1 Measured Values

- Exposure time (1 * 32 bit)
- Encoder (Ne * 32 bit) (Ne = {0, 1, 2, 3})
- Measured value counter (1 * 32 bit)
- Time stamp (1 * 32 bit)
- Displacement values / Intensities / Unlinearized distances (n * (i+j+1) * 32 bit)
- Error field (1 * 32 bit)
- Differences ((n-1) * 32 bit)
- Statistic values (Min/Max/Peak2Peak) (each 32 bit)

n = {1 - 6}	n = 1 -> Displacement measurement, n =2 - 6 -> Multilayer measurement	n = 2 -> Thickness measurement,
i = {0, 1}	i = 0 -> Intensity output off,	i = 1 -> Intensity output activated
j = {0, 1}	j = 0 -> Unlinearized distances off	j = 1 -> Unlinearized distances activated

Further details to the setup of measured values can be found in Measured value format, see A 7.6.

A 8.4.2 Video Signal

A 8.4.2.1 Video Signal Output via Service Data Object

Only the dark corrected video signal can be transmitted. The video signal can be read using the SDO Object 0x6010.1.

For this purpose the confocalDT 24x1 is to bring first in the preoperational mode.

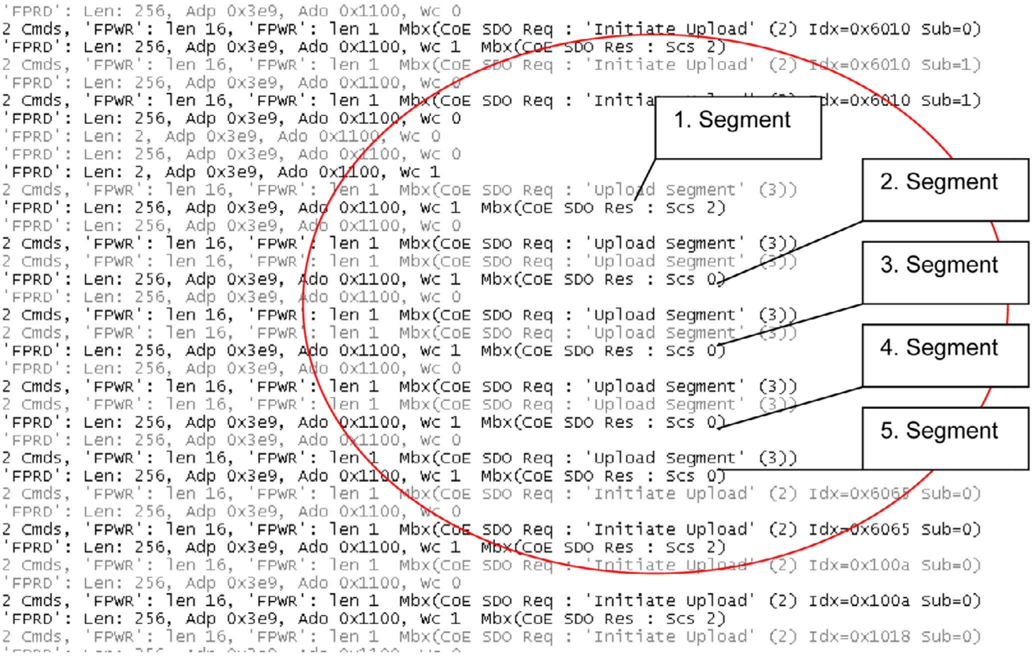
Then the measurement program is to set on video signal output using the object 0x2154 (Measuring program).

By SDO reading (Request-Response) of the object 0x6010.1 exactly one video signal with the related (in object 0x21B0.0x04 - 0x20 selected) measured values is stored in the memory of confocalDT 24x1 and the video signal is output. As long as no requirement for a new video signal is made, the measured values remain unchanged in the memory and can in turn be read by SDO reading. This ensures, that the measured values are part of the video signal.

The video signal is read “segmented”, because the mailbox is smaller than the video signal.

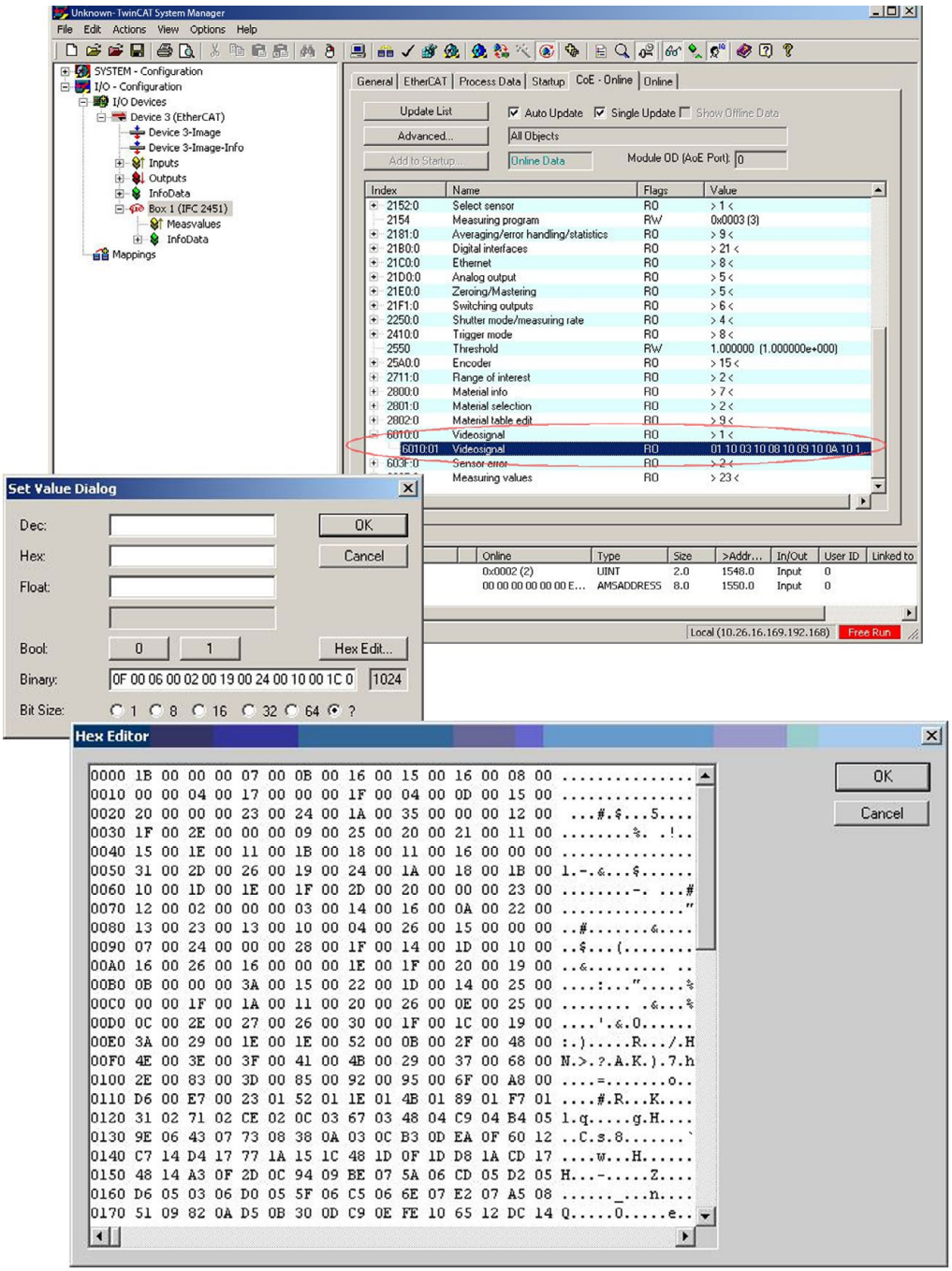
There are 5 request-response necessary for a video signal.

Segment from Wireshark:



A video signal consists of 512 pixels each with two bytes. The low byte is transmitted first, followed by the high byte.

In TwinCAT the video signal can unfortunately only be displayed as hex dump. Double clicking on the index Getvideo (0x6010.1) opens the `Set Value dialog`. `Hex Edit...` opens the hex dump of video signal.

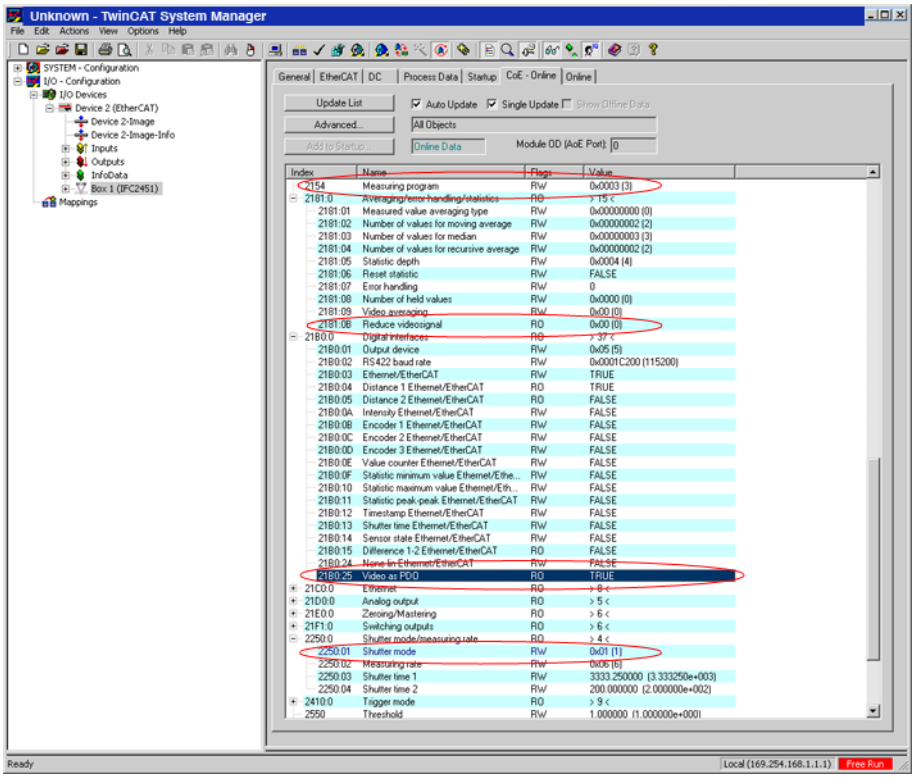


A 8.4.2.2 Video Signal Output via Process Data

For adding the video signal to the process data, proceed as follows:

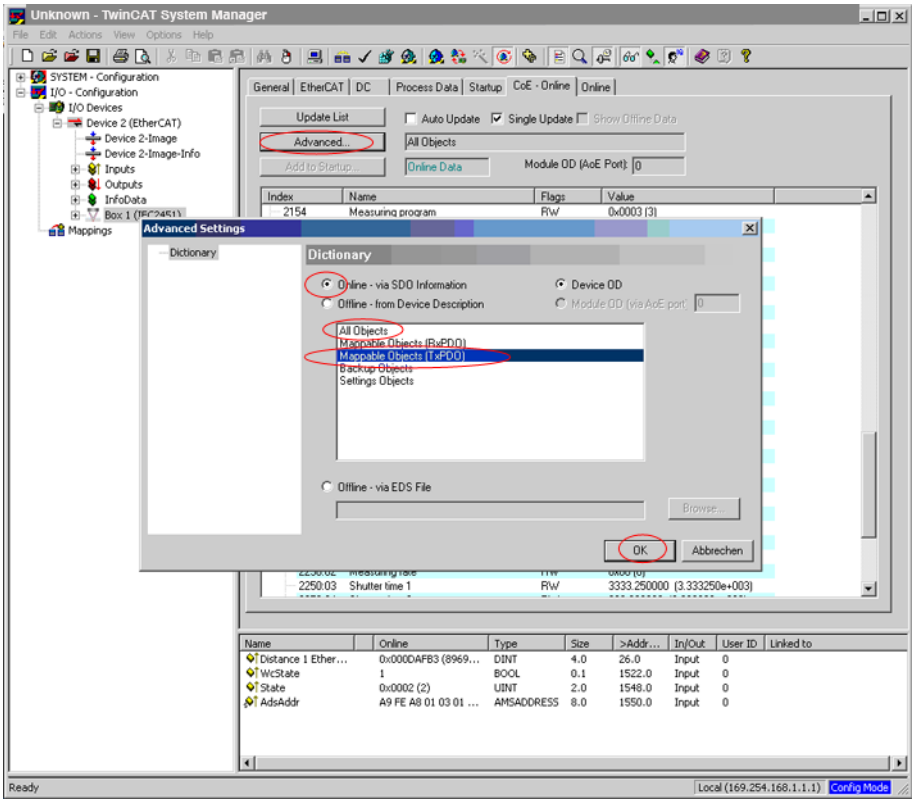
- Bring the IFC24x1 in the preoperational mode.
- Set the measurement program on video signal output (3) using the object 0x2154 (Measuring program).
- Set the shutter mode (Object 0x2250.1) on 1 (Measmode) and the object 0x21B0.25 on `TRUE`.

A reduction of video signal can be adjusted in object 0x2181, see A 8.2.2, object description 0x2181.

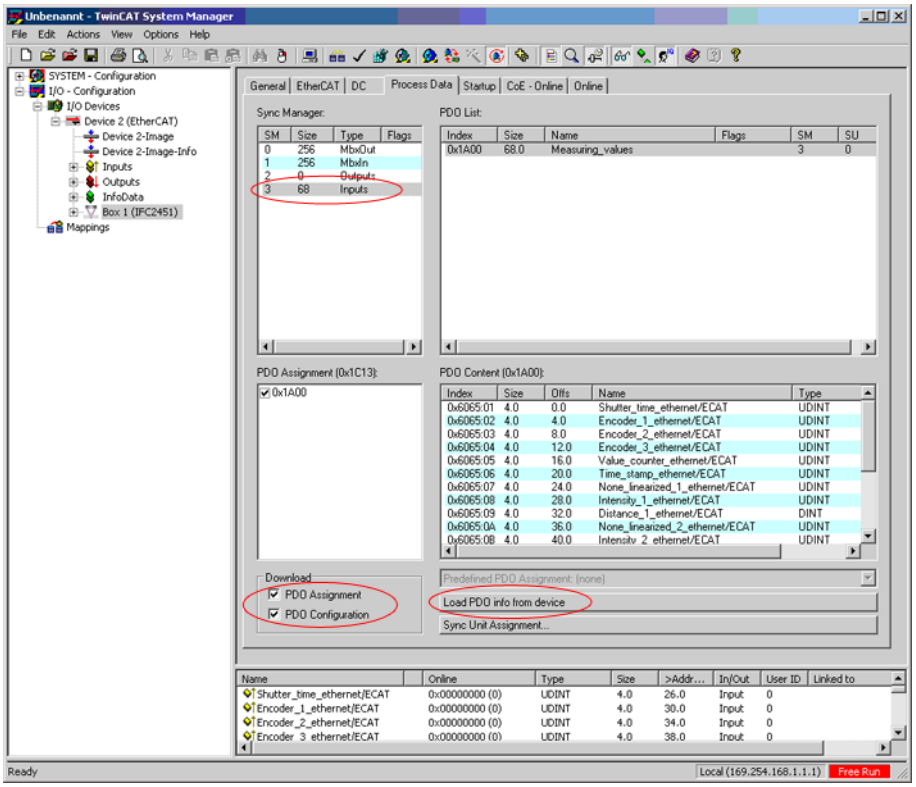


Because the object list changes, import it completely new as follows:

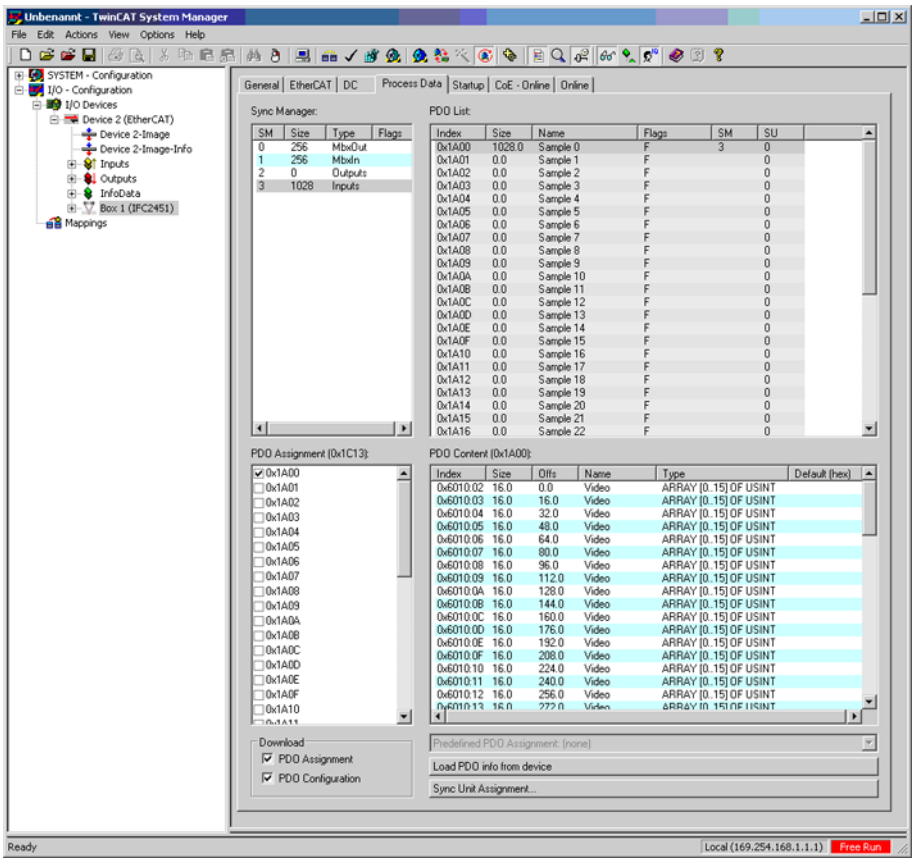
➡ Read the part directory e.g. `Mappable Objects (TxPDO)`, then `All Objects`.



Now you can read the PDO allocations on the `Process Data` side from the device.



After the reading:



The configuration is complete after `Reload Devices`.

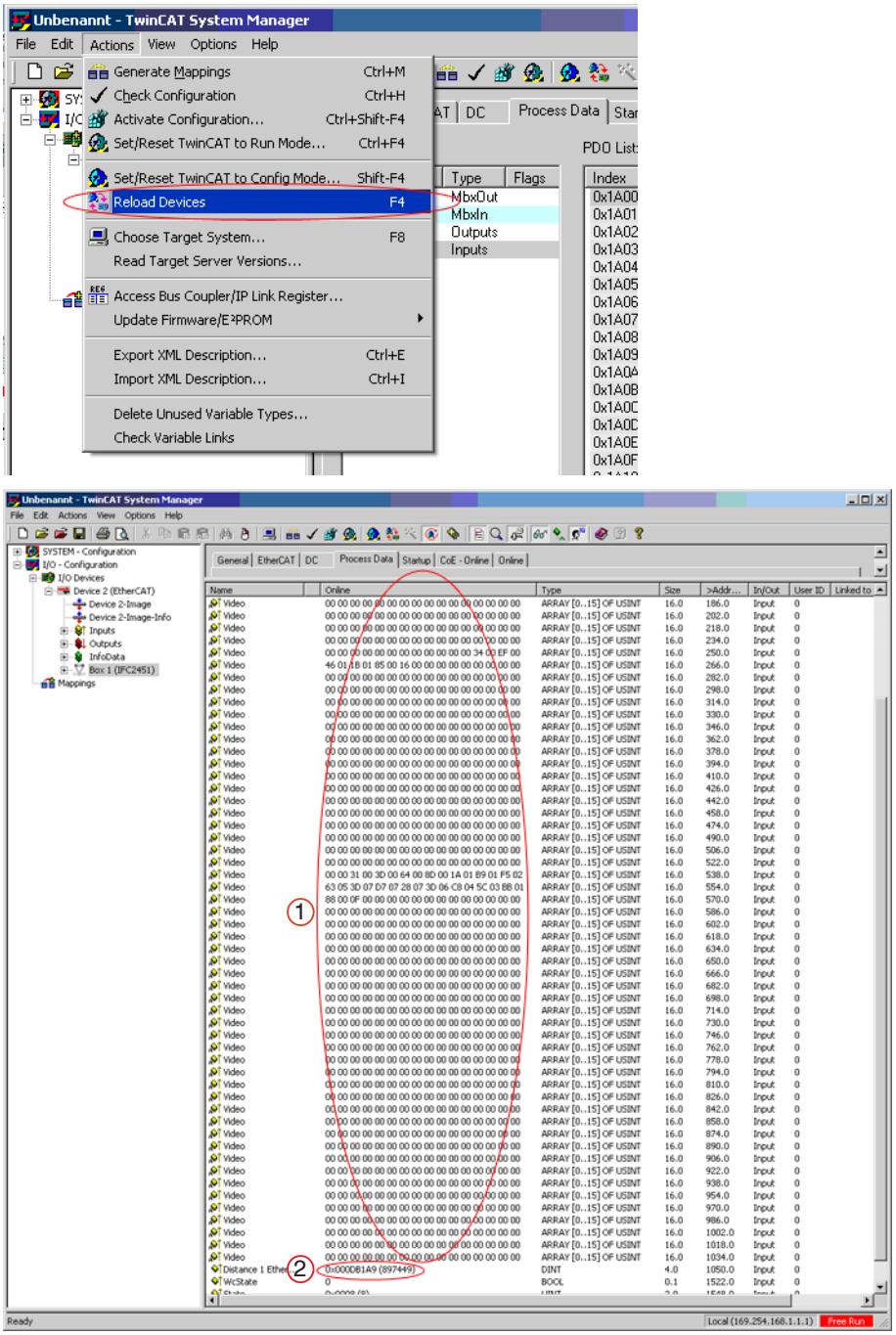


Fig. 89 Video signal and a measured value as process data

① Video signal

② Measured value

A 8.5 Distributed Clock

A 8.5.1 Introduction

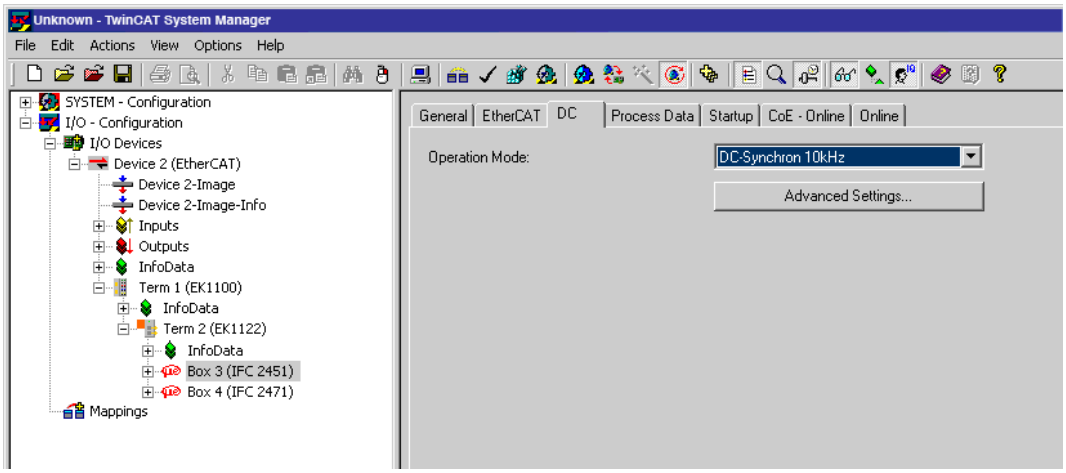
The synchronization of IFC24x1 among each other in the EtherCAT is realized via the `Distributed Clock`. With it it is not necessary or possible to transmit the synchronous signals via the synchronous input or output of the controller.

Unlike the Ethernet the synchronization does not occur via external signals but about the clocks in the controllers. Using the EtherCAT this results in the synchronous modes `Synchronization out` (= Free Run) and `Slave`.

The minimum cycle time for distributed clock is 100 µs for the IFC2451, 40 µs for the IFC2461 and 14.3 µs for the IFC2471.

A 8.5.2 Synchronization

IFC24x1, that support the synchronization in the EtherCAT mode, offer the additional tab `DC` in the TwinCat-Manager. In addition to the `FreeRun` mode (not synchronized), the controller can be operated synchronously with different frequencies.



A 8.5.3 Synchronization off

In the `FreeRun` mode no synchronization of controllers occurs.

A 8.5.4 Slave

In the `DC_Synchron xxxkHz` mode the controller is switched in the synchronization mode Slave.

Besides `xxx` means the measuring rate. The controller measures with the rate selected by `xxx`.

A 8.5.5 Apply Selected Settings

Once the required synchronization mode is selected using the drop-down-menu, it is applied with F4.

A 8.5.6 Setting Regardless of TwinCat

The setting of the synchronisation mode in EtherCAT occurs via the setting of the registers for the Distributed Clocks. You will find details under www.beckhoff.de or www.ethercat.org.

For reading the settings in the TwinCAT it is possible to display the requirements of the XML file using the button `Advanced Settings`.

A 8.6 Oversampling

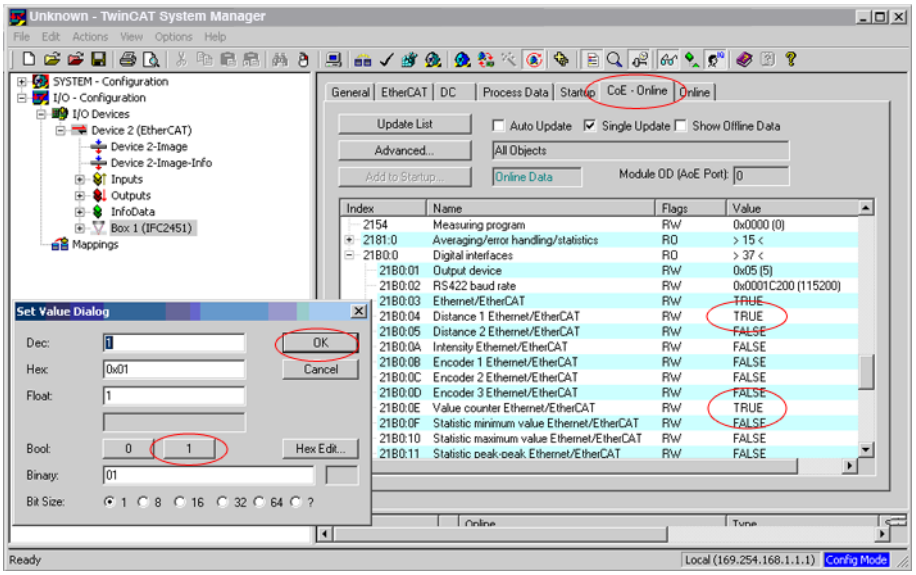
The last arised measurement value data record is transmitted to EtherCAT Master with each fieldbus cycle during operation without oversampling. Many measurement value data records are not available therefore for large fieldbus cycle times. All (or selectable) measurement value data records are collected with the configurable oversampling and are transmitted together to the master with the next fieldbus cycle.

Example:

The fieldbus/EtherCAT is operated with a cycle time of 1 ms, because, for example the PLC is operated with 1 ms cycle time. For this reason an EtherCAT frame is sent to the IFC24x1 for collection of process data every 1 ms. If the measuring rate in IFC24x1 is set to 10 kHz, an oversampling of 10 should be set.

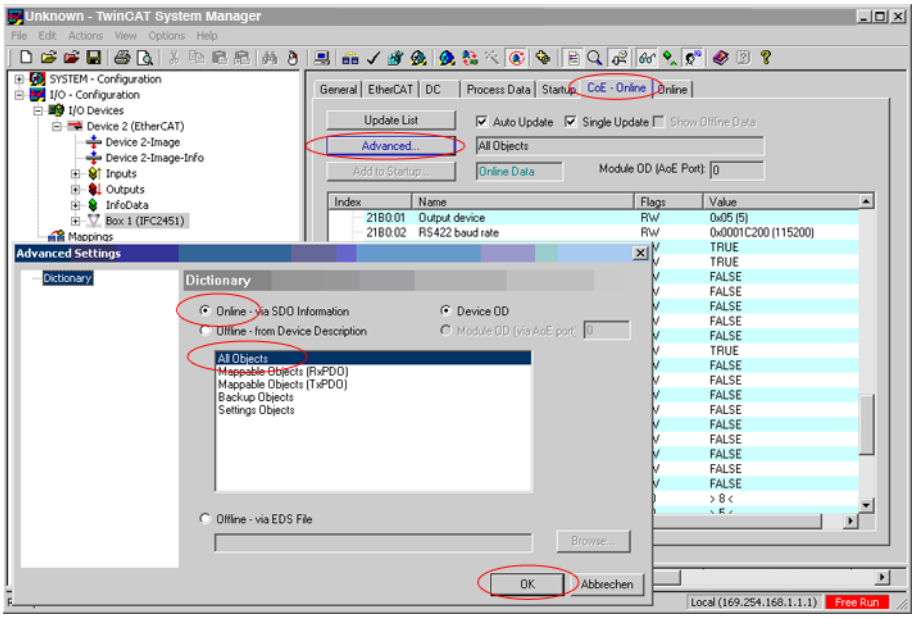
Procedure:

- Select the measuring data to be set in the object 0x21B0 (Digital interfaces) in preoparational state, for example
  - “Distance 1 Ethernet/EtherCAT“ (is always selected and not deselected)
  - “Value counter Ethernet/EtherCAT“

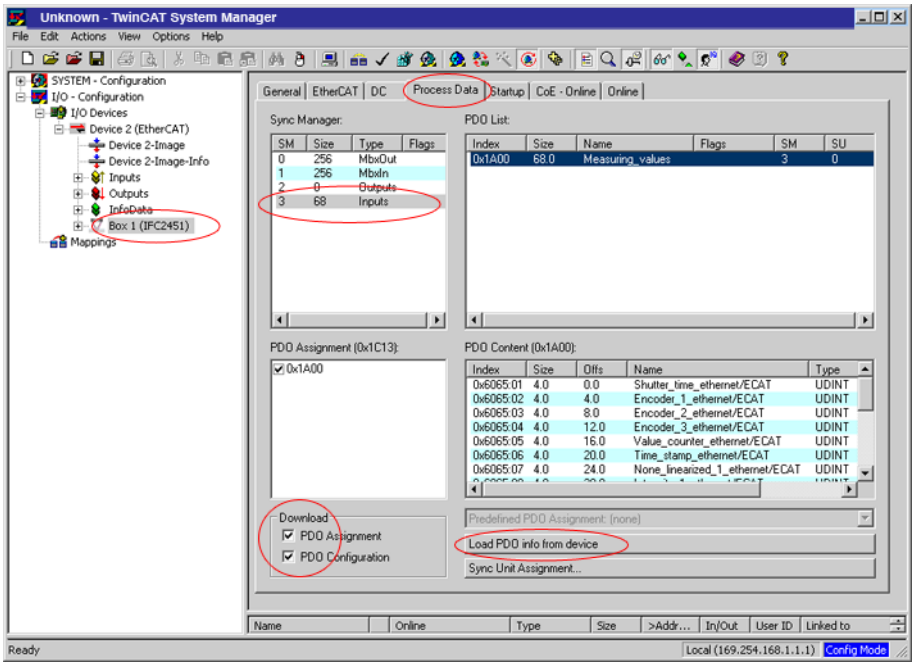


- Then read the object directory from the IFC24x1.
- Select another input as `All Objects` (e.g. `Mappable Objects (TxPDO)`) in the `Advanced Settings` dialog and then select `All Objects`.

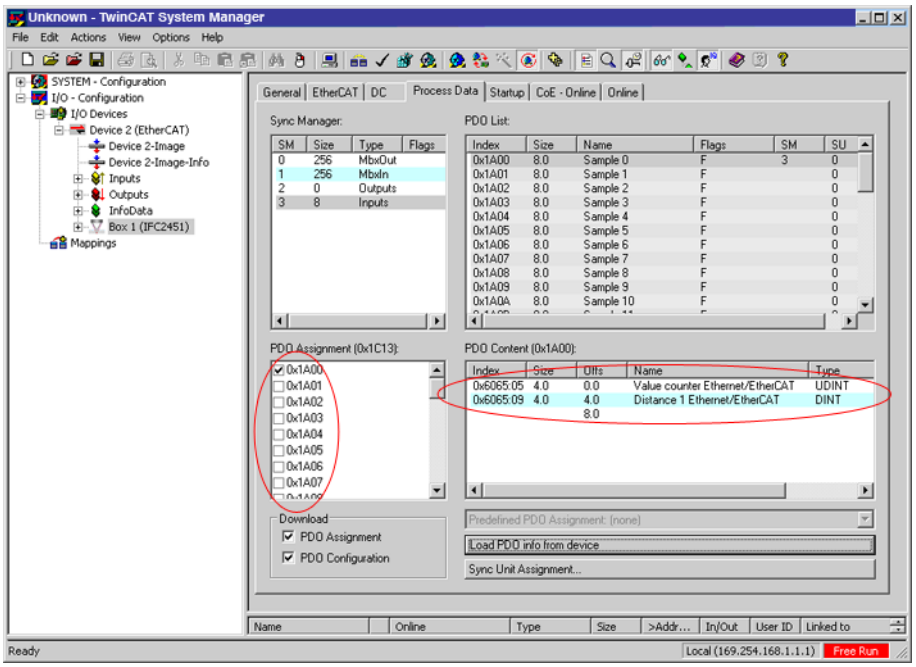
Otherwise, it may be, that TwinCAT only reads the values of the objects already known to it. This is important for the next steps, because the `Mapping` (objects 0x1A00, 0x1A01, … and 0x1C13) has changed.



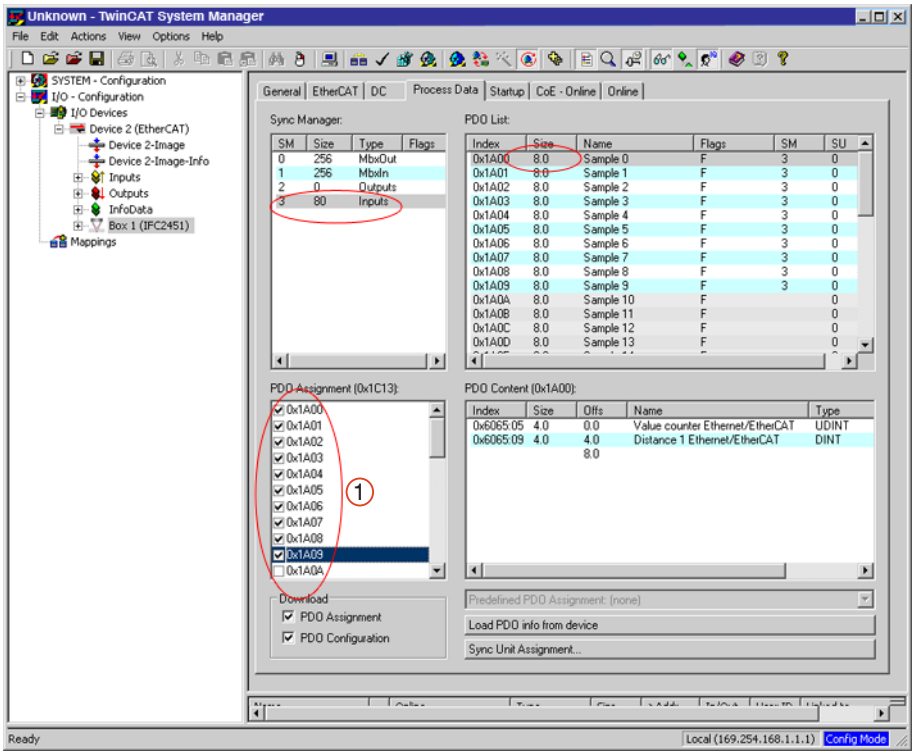
Read the PDO info on the process data tab from the IFC24x1.



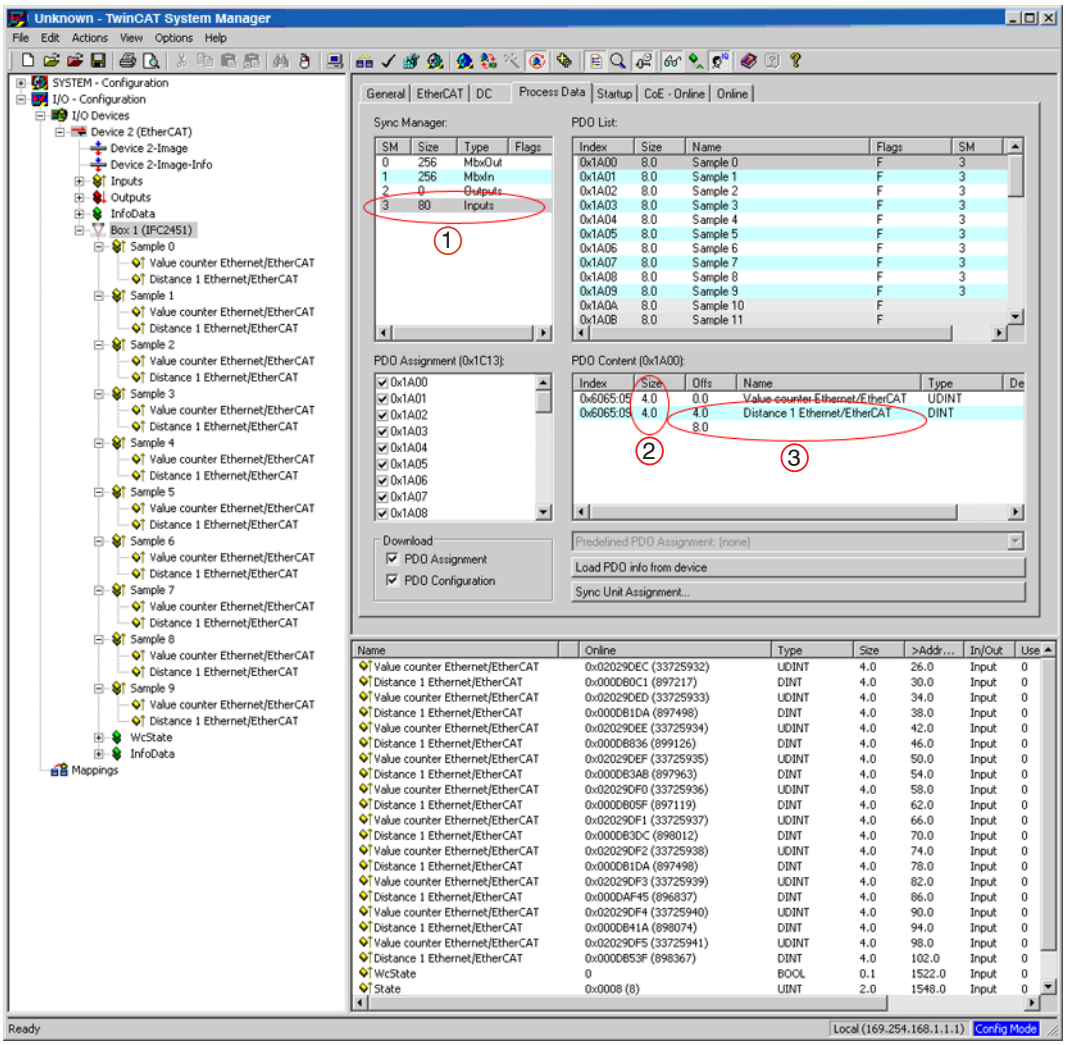
You can now view the size of the provided data and the mapping of SyncManager at delivery.



To set the oversampling (in example 10), 10 measurement data sets (samples) ① are selected in the PDO mapping (0x1C13).



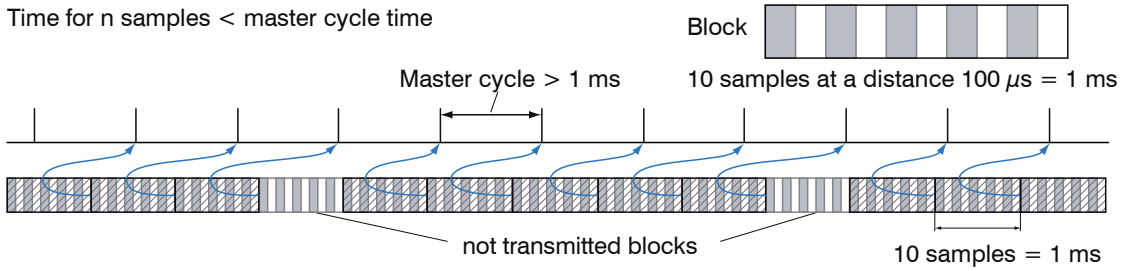
Load these settings with `Actions / Reload Devices (F4)` in the IF-C14x1.



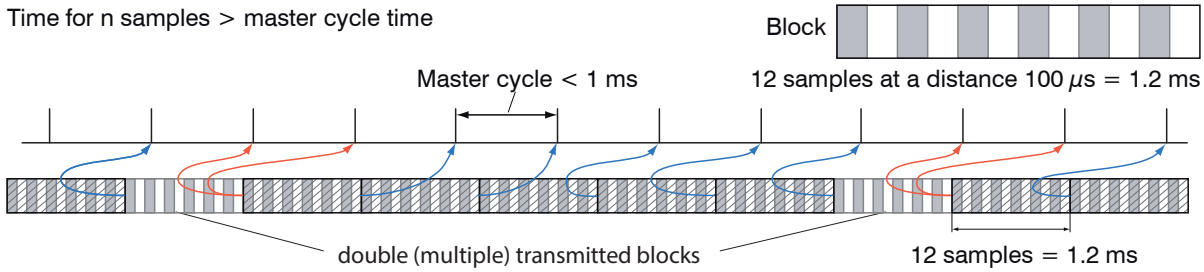
Every process data frame now contains 80 bytes ① measuring data (2 measurement values ③ per 4 bytes ② * 10 measuring data records).

In order to ensure that no samples will disappear, due to the high asymmetry between master cycle and slave cycle, the master cycle time is subject to be less than the time which is required for the generation of a block consisting of x samples.

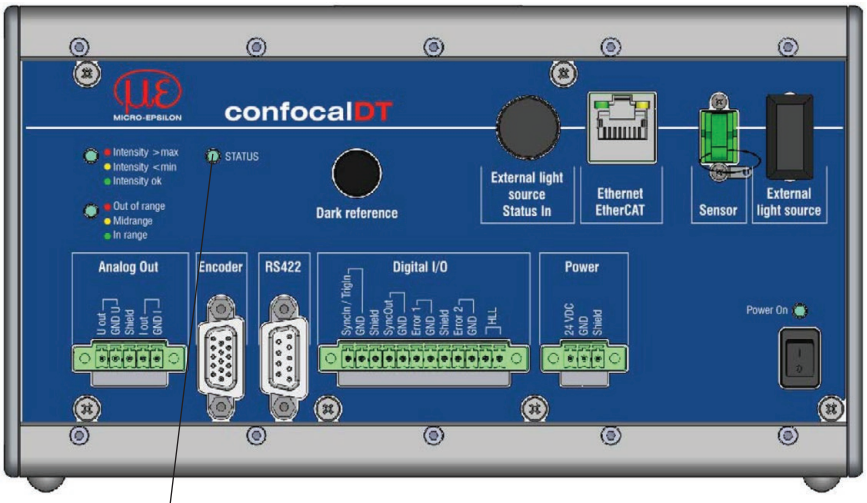
A complete block is generated from the stated samples and first presented to the EtherCAT side after all stated samples have been written into the block. If the time for the writing into the block is shorter than the master cycle time, unfortunately single blocks cannot be transmitted. It can happen that the next block has already been filled with samples, before the previous filled block has been picked up with a master cycle.



If the number of samples selected is to high, i.e. the time for the filling of a block is longer than the master cycle time, each block is picked up by a master cycle. However, single blocks and therefore samples are transmitted twice or even more often. This can be detected on the master side by the transmission of the Timestamp or Valuecounter, see object 0x21B0.



A 8.7 Meaning of STATUS-LED in EtherCAT Operation



Status LED	**Green**	
	Green off	INIT status
	Green flashing 2.5 Hz	PRE-OP status
	Green Single Flash, 200 ms ON / 1000 ms OFF	SAFE-OP status
	Green on	OP status
	Red (are displayed in the breaks of the green LED):	
	Red off	No error
	Red flashing 2.5 Hz	Invalid configuration
	Red Single Flash, 200 ms ON / 1000 ms OFF	Not requested status change
	Red Double Flash, 200 ms ON / 200 ms OFF 200 ms ON 400 ms OFF	Timeout of the watchdog
	Red flashing 10 Hz	Error by initializing

A 8.8 EtherCAT Configuration with the Beckhoff TwinCAT© Manager

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

The device description file (EtherCAT®-Slave Information) `IFC242x.xml` can be found online at www.micro-epsilon.com/service/download/software/.

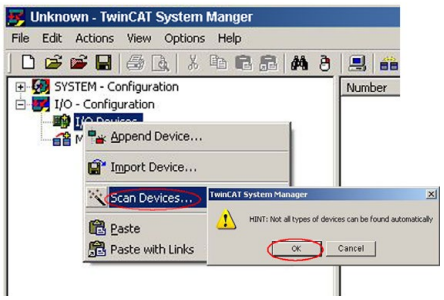
- Copy the device description file (EtherCAT®-Slave Information) confocalDT24XX.xml from the included CD in the directory \\TwinCAT\IO\EtherCAT before the measuring device can be configured via EtherCAT®.
- Delete any older files (IFC2451.xml, IFC2461.xml and IFC2471.xml).

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

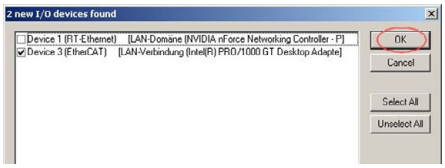
- Restart the TwinCAT Manager after copying.

Searching for a device:

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



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



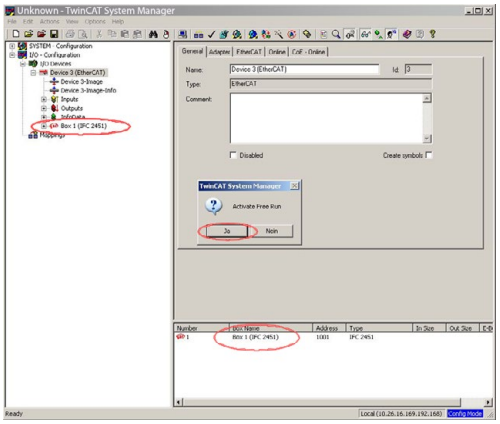
- Confirm with `OK`.

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

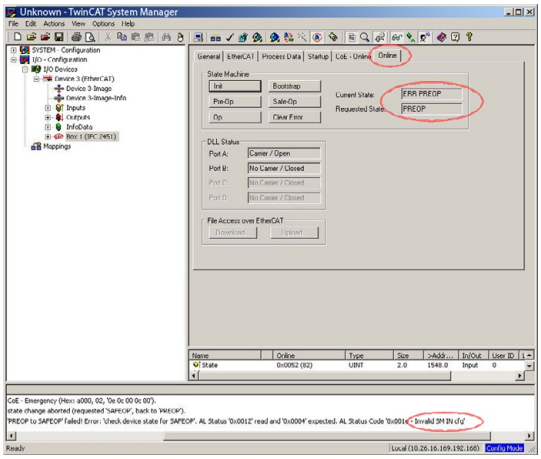
- Confirm with `Yes`.

The confocalDT 24x1 is now shown in a list.

- Now confirm the window `Activate Free Run` with `Yes`.



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



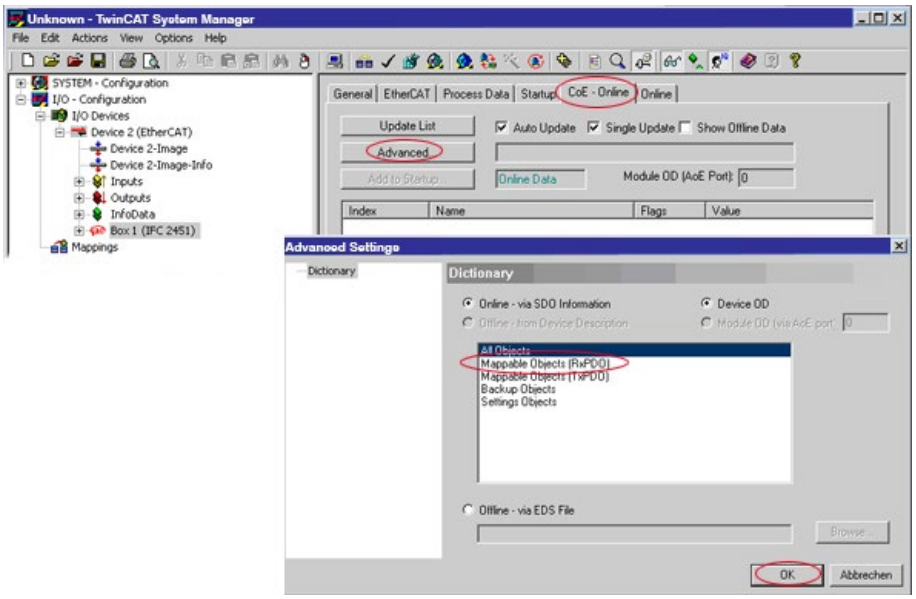
If `ERP PREOP` appears in the `Current State`, the cause is reported in the message window. In the example here the incorrect initialization of the synchronization manager is the reason. This will be the case if the settings for the PDO mapping in the sensor are different from the settings in the ESI file (confocalDT24XX.xml).

On delivery of the sensor only one measurement value (distance 1) is set as output size (in both the sensor and in the ESI file).

Additional data can be selected in the object 21B0h, for example intensity or minimum.

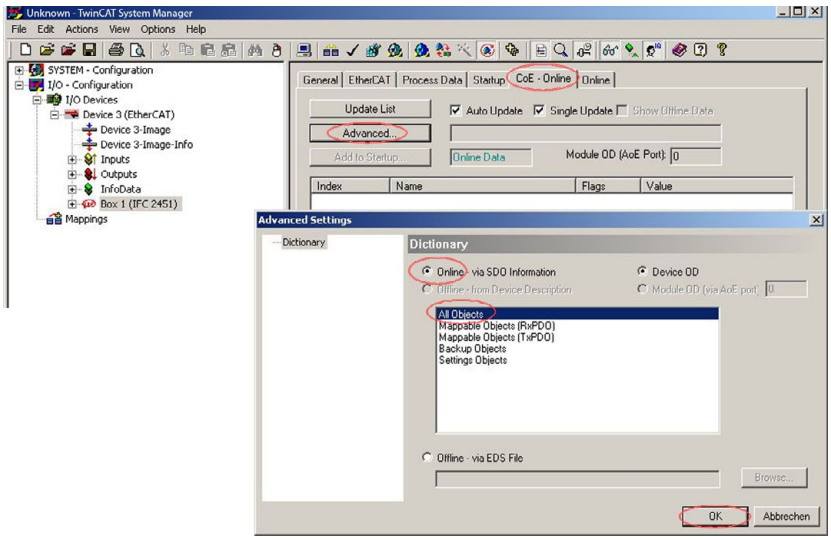
To configure the synchronous manager correctly, it is first necessary to read the object directory of IFC24x1.

Select `Mappable Objects (TxPDO)`.

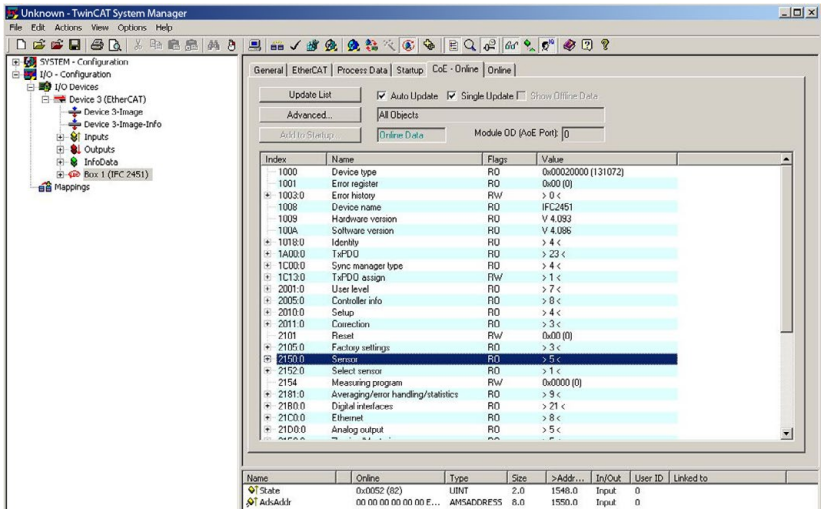


Thus TwinCAT reads all values of objects known to it. This is important for the next step, because the mapping (objects 0x1A00, 0x1A01, ... and 0x1C13) has changed.

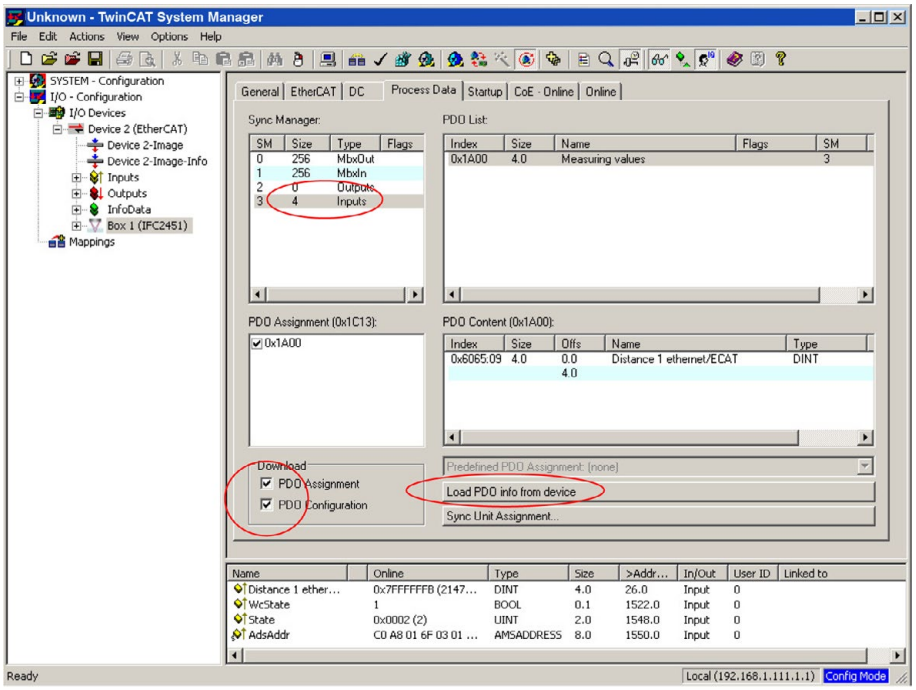
➡ Confirm with `OK`.



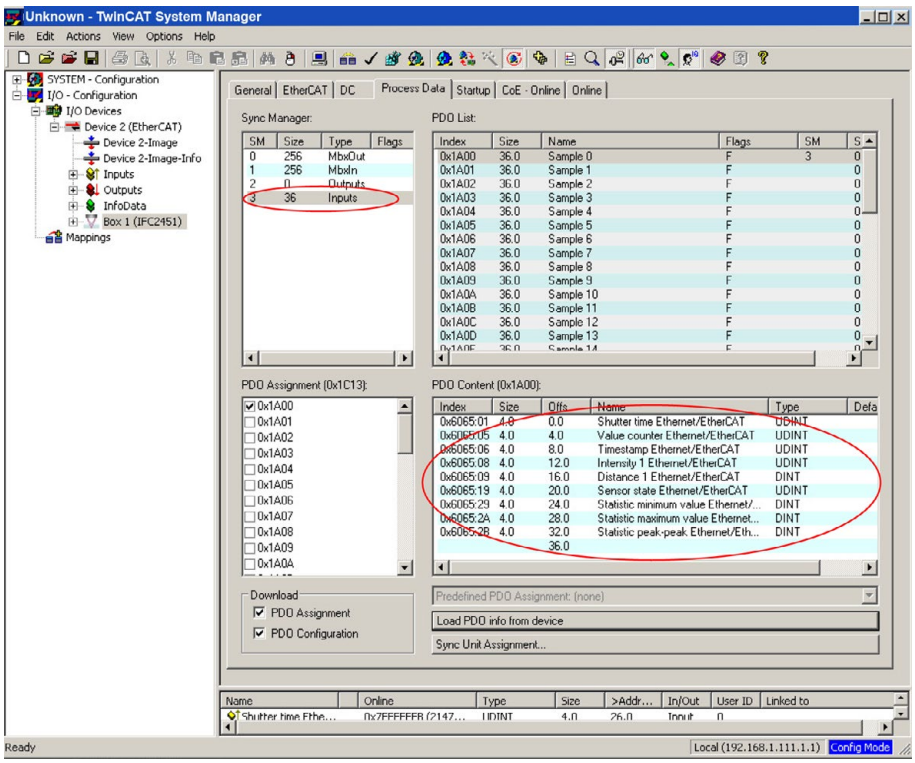
Example for a complete object directory (subject to change without prior notice).



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



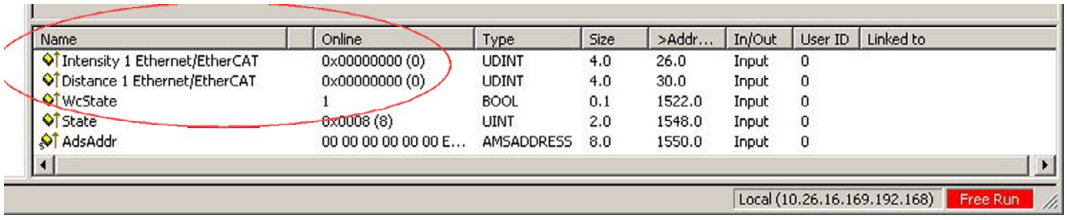
The scope of the provided process data and the assignment of the SyncManager may be viewed now.



➡ Now select the tab `Reload Devices` under the menu item `Actions`.

The configuration is now complete.

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



A 9 Operating Menu

Login	Announced user level	*Value*	*only reading*
	Change to user- / professional level	*Button logoff or enter password*	
	Change password	Old password	*Value*
		New password	*Value*
		Repeat new password	*Value*
	User level by restart	Professional / User	

Type of measurement	*Distance measurement*	Used peak	*first / highest / last peak*	*Distance measurement: Distance to the n-th surface, depends on the selected peak.*
	Thickness measurement	Used peak	*first and second / first and last / second to last and last / highest and second highest peak*	*One-sided thickness measurement of transparent materials; the relevant material needs to be selected (refractive index).*
		Selection of material	*Vacuum / water ...*	
	Multilayer Measurement [1)]			*Multilayer Measurement: Selectable distances for up to 6 peaks*
				Use refractive correction: Yes / No
				Material between Peak 1 / 2 ...6 and Peak 2 / 3 / ... 6

Sensor	*Sensor type and serial number*	*Controller stores max. 20 different sensors.*

Exposure mode/ measuring rate	Exposure mode	*Automatic mode / Measurement mode / Manual mode / Alternating Two-Time-Mode / Automatic Two-Time-Mode*
	Measuring rate	- *with IFC2451: 0.1 / 0.2 / 0.3 / 1 / 2.5 / 5 / 10 kHz* - *with IFC2461: 0.1 / 0.2 / 0.3 / 1 / 2,5 / 5 / 10 / 25 kHz* - *with IFC2471LED: 0.1 / 1 / 2.5 / 5 / 10 / 25 / 50 / 70 kHz* - *with IFC2471: 0.3 / 1 / 2.5 / 5 / 10 / 25 / 50 / 70 kHz*
	Exposure time 1 in µs	*Value (0.1 µs ... 10.000 µs (IFC2451))*
		Value (0.1 µs ... 10.000 µs (IFC2461))
		Value (0.1 µs ... 3333.3 µs (IFC2471))
	Exposure time 2 (shorter) in µs	*Value (Value smaller than Exposure time 1)*

Detection threshold	*Value*	Value in %, factory setting 1 %

[1)] Only with controller IFC24x1MP available

Averaging, error handling, statistics	Video averaging	*Recursive 2 / 4 / 8* *Moving 2 / 4 / 3* *Median 3 / No averaging*			*The video averaging is carried out before measuring distances or thickness. Recommended for very small peaks.*
	Measured value averaging	*No averaging*			*Specify the type of averaging. The averaging value N defines how many sequential measurements the controller will use for averaging, before issuing the next reading. Averaging does not affect the measurement frequency.*
		Moving *N values*	2 / 4 / 8 ... 1024	*Value*	
		Recursive *N values*	2 ... 32768	*Value*	
		Median *N values*	3 / 5 / 7 / 9	*Value*	
	Error handling	*Error output, no measurement*			*Sensor displays an error number.*
		Hold last value	0 ... 1024	*Value*	*If no valid reading can be obtained, the last valid value can be hold for a certain period of time, and will be issued repeatedly. If the reading is 0, the last valid value is hold permanently.*
	Spike correction	*No*			
		Yes	Evaluation length 1 - 10	*Value*	*This filter removes individual very high spikes from a relatively constant course of measurement value. Smaller spikes are preserved.*
			Max. tolerance range (mm) 0 - 100	*Value*	
			Number of corrected value 1 - 100	*Value*	
	Statistics	*2 / 4 / 8 / 16 ... 16384 / All measured values*			*The statistical values Minimum, Maximum and Peak-to-Peak are calculated and output from a predefined number of readings.*
	Signal for statistics calculation	*Distance 1 ... 6 / Difference 1 - 2 up to 5 - 6* [1]			*For multilayer measurement program the signal is selectable and will if not already done, added to the output via Ethernet automatically.*

Zeroing, mastering	Master value in mm	*Value*	*Specify the thickness of a master object.* *Value range: – 2 x measuring range to + 2 x measuring range*

Material database	Material	*Value*	*only reading*
	Material parameter input	*Material name*	*Value*
		Material description	*Value*
		Description by	*One refractive index and Abbe value / Three refractive indices*
		nF at 486 nm	*Value*
		nd at 587 nm	*Value*
		nC at 656 nm	*Value*
		Abbe value vd	*Value*

1) Only with controller IFC24x1MP available

Digital interfaces	Digital interface selection	*Output in the web diagram/ Ethernet measurement transfer / RS422 / EtherCAT*		*Defines which interface is used for data output. No parallel data output via multiple channels.*	
	Data selection	*Distance 1, 2 / Distance 3 ... 6 / Difference 1 - 2 / Difference 1 - 3 up 5 - 6 [1] / Statistics Min / Statistics Max / Statistics Peak-Peak / Exposure time / Intensity of the (all) distance value(s) / Encoder 1 / Encoder 2 / Encoder 3 / Error status / Measured value counter / Time stamp*		*Select the relevant check boxes to choose which data are used for transmission. The data are issued one after the other in a defined sequence. RS422 allows transmission of no more than 32 records.*	
	Ethernet settings	IP settings for controller	Address type	*static IP-Address / DHCP*	
			IP address	*Value*	*Values for IP address / gateway / subnet mask. Only for static IP address*
			Gateway	*Value*	
			Sub-network tag	*Value*	
		Ethernet measured value transfer settings	Transmission type	*Server TCP IP / Client TCP IP / Client UDP IP / No transfer*	
			IP-address	*Value*	*only for Client TCP IP and Client UDP IP*
			Port	*Value*	
	Settings RS422	Baud rate		*9.6 / 115.2 / 230.4 / 460.8 / 691.2 / 921.6 / 1500 / 2000 / 3500 / 4000 kBps*	
	Ethernet/ EtherCAT	Operating mode after start		*Ethernet / EtherCAT*	

Switching outputs	Assignment of the switch outputs (Digital I/O)	*Switch output “Error 1“ Switch output “Error 2“*	*Error intensity (F1) / Outside of the measuring range (F2) / F1 or F2 / Lower limit value (Gr1) / Upper limit value (Gr2) / Gr1 or Gr2 / no output*	
	Limit value settings	Lower limit value (in mm)	*Value*	-120.0 ... 120.0 mm
		Upper limit value (in mm)	*Value*	-120.0 ... 120.0 mm
		Measurement value that belongs to limit values		*Distance 1, 2 / Distance 3 ... 6 / Difference 1 - 2 / Difference 1 - 3 up 5 - 6 [1]*
	Switch threshold of the error outputs		*High active / low active*	

Analog output	Output signal	*Distance 1, 2 / Distance 3 ... 6 / Difference 1 - 2 / Difference 1 - 3 up 5 - 6 [1]*	*With the distance measurement program only Distance 1 can be measured.*		
	Output range	*4 ... 20 mA / 0 ... 5 V / 0 ... 10 V / -5 ... 5 V / -10 ... 10 V / inactive*	*Either the voltage or the current output on the controller can be used at any given time.*		
	Scaling	*Standard scaling*	*Distance measurement: scaled to 0 ... measuring range Thickness measurement: scaled to 0 ... 2 * measuring range*		
		Two-point-scaling	Start of range (in mm):	*Value*	-120.0 ... 120.0 mm
			End of range (in mm):	*Value*	-120.0 ... 120.0 mm

Output-data rate	Measured value	*Value*	*Only every nth value is used (n = 1, 2 ... 1000). All other measured values are discarded.*	
	Reducing interfaces	*Analog / RS422 / Ethernet*	*Select the relevant check boxes to choose which interfaces are used for data reductions.*	

1) Only with controller IFC24x1MP available

Encoder inputs	*Encoder 1 / 2 / 3*	Interpolation	*Single / Double / Quadruple resolution*	
		Effect on reference track	*No effect / Set on first track /Set with every track*	
		Set on value	*Value*	*Starting value is less than max. encoder value*
		Max. value	*Value*	0 ... 4294967294

Trigger mode	*Level triggering*	Measurement value input Measurement value output	*Measured value output at*	*Level low / level high*	
	Edge triggering	Measurement value input Measurement value output	Start of measured value output with	*Falling edge / increasing edge*	
			Number of measured values	*Value*	0 ... 16383
	Software triggering	Measurement value input Measurement value output	Number of measured values	*Value*	0 ... 16383
	Encoder triggering	Measurement value input Measurement value output	Triggering by	*Encoder 1 / Encoder 2 / Encoder 3*	
			Step size	*Value*	0 ... 2147483647
			Lower limit	*Value*	0 ... 4294967295
			Upper limit	*Value*	0 ... 4294967295
	No triggering		*continuous value output*		

Synchronization	*IFD24x1-Master*	*First controller in the measuring chain; synchronizes any subsequent controllers.*
	Slave on IFD24x1-Master	*Controller operates in dependence on the first controller.*
	Slave on external master	*External synchronization. Sync In at the controller is used by an external synchronization source, such as a frequency generator. Min. 0.1 ... 10 kHz (IFC2451) / Min. 0,1 ... 25 kHz (IFC2461) / Min. 0.1 ... 70 kHz (IFC2471LED) / Min. 0.3 ... 70 kHz (IFC2471). It is also possible to simultaneously synchronized multiple controllers externally.*

Load / save settings	Setup no	*1 / 2 / 3 ... 8*	*You can permanently store eight different parameter sets in the controller.*
	Mantuanerin interface settings	*Checkbox*	*Interface settings include network properties, such as the baud rate for the RS422 interface.*

Manage setups	Data selection for transmission	*Setup / material database*	*Depending on the selected measurement and interface settings, a parameter set contains all controller parameters except for the material database.*
	Setup no.	*1 / 2 / 3 ... 8*	*You can permanently store eight different parameter sets in the controller.*
	Maintaining interface settings	*Checkbox*	*Interface settings include network properties, such as the baud rate for the RS422 interface.*

Extras	Language	*English / Deutsch*		
	Factory settings	Only reset current setup	*Checkbox*	*Interface settings include network properties, such as the baud rate for the RS422 interface.*
		Maintain interface settings	*Checkbox*	

Selection required or checkbox

Value Specification of a value required

i The settings will be effective, if you click on the button Apply. After the programming, all settings must be permanently stored under a parameter set, so that they are available again when the sensor is switched on the next time.

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