MICRO-EPSILON

Operating Instructions

confocalDT IFD2410/2411/2415

IFD2410-1
IFD2410-3
IFD2410-6

IFD2411-1
IFD2411-2
IFD2411/90-2
IFD2411-3
IFD2411-6

IFD2415-1
IFD2415-3
IFD2415-10

EtherCAT

Confocal chromatic distance and thickness measurement

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Contents

1 Safety

1.1 Symbols used

System operation assumes knowledge of the operating instructions.

The following symbols are used in these operating instructions:

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

1.2 Warnings

⚠ CAUTION

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

- Risk of injury
- Damage to or destruction of the controller

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

- Risk of injury

NOTICE

The supply voltage must not exceed the specified limits.

- Damage to or destruction of the controller

Avoid shocks and impacts to the sensor and the controller.

- Damage to or destruction of the components.

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

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

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

- Incorrect measurement
- Failure of the measuring device

Protect the cables against damage.

- Failure of the measuring device

1.3 Notes on product marking

1.3.1 CE marking

The following apply to the product:

- Directive 2014/30/EU ("EMC")
- Directive 2011/65/EU ("RoHS")

Products which carry the CE marking satisfy the requirements of the EU Directives cited and the relevant applicable harmonized European standards (EN).

The product is designed for use in industrial and laboratory environments.

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

1.3.2 UKCA marking

The following apply to the product:

- SI 2016 No. 1091 ("EMC")
- SI 2012 No. 3032 ("RoHS")

Products which carry the UKCA marking satisfy the requirements of the directives cited and the relevant applicable harmonized standards.

The product is designed for use in industrial and laboratory environments.

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

1.4 Intended use

The confocalDT IFD2410/2411/2415 is designed for use in industrial and laboratory applications.

It is used for

- Displacement, distance and thickness measurements
- Measuring the position of parts or machine components

It is only permissible to operate the system with the values specified in the technical data, see Chap. 2.4

The system must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the system.

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

1.5 Proper environment

	confocalDT IFD2410/2415	confocalDT IFD2411	
		Sensor	Controller
Protection class	IP64 (front)	IP64 (front)	IP40
Operating temperature range	+5 ... +50 °C	+5 ... +70 °C	+5 ... +50 °C
Storage temperature range	-20 ... +70 °C		
Humidity	5 ... 95% (non-condensing)		
Ambient pressure	Atmospheric pressure		
Shock (DIN EN 60068-2-27)	15 g / 6 ms on XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)	2 g / 20 ... 500 Hz on XY axis, 10 cycles each		
EMC	In accordance with EN 61000-6-3 / EN 61326-1 (Class B) Electromagnetic emissions; EN 61 000-6-2 / EN 61326-1 Electromagnetic immunity		

confocalDT 2410
confocalDT 2411
confocalDT 2415

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2 Functional principle, technical data

2.1 Brief description

The measuring systems consist of:

Controller

(IFD2410-x,
IFD2415-x)

Sensor

Controller
(IFC2411,
IFC2416)

Optical fiber
(sensor cable)

Sensor
(IFSxxx)

confocalDT IFD2410/2415

With the IFD2410/2415, the sensor and controller form a single unit. It is not possible to exchange the sensor.

confocalDT IFC2411/2416

IFC2411/2416 series controllers can be operated with different sensors. The calibration tables of the sensors required to do so need to be saved in the controller.

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

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

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

2.2 Measuring principle

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

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

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

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

2.3 Term Definitions, Glossary

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

MR Mid of measuring range

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

Maximum distance between the front sensor face and the target

MR Measuring range

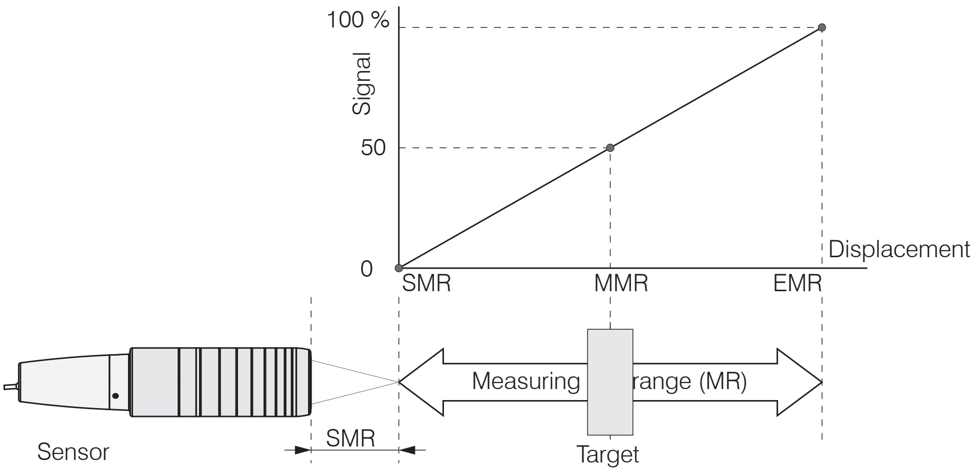


Fig. 2.1: Measuring range and output measuring system

Minimum target thickness see chapter Technical data:

- IFD2010, see Chap. 2.4
- IFD2015, see Chap. 2.5
- IFD2411, see Chap. 2.6

Maximum target thickness Sensor measuring range x Refractive index of target

2.4 Technical data confocalDT IFD2410

Model		IFD2410-1	IFD2410-3	IFD2410-6
Measuring range		1 mm	3 mm	6 mm
Start of measuring range		approx. 15 mm	approx. 25 mm	approx. 35 mm
Resolution	Static [1]	< 12 nm	< 36 nm	< 80 nm
	Dynamic [2]	< 50 nm	< 125 nm	< 250 nm
Measuring rate		Continuously adjustable from 100 Hz to 8 kHz		
Linearity [3]	Displacement and distance	< ±0.5 µm	< ±1,5 µm	< ±3,0 µm
	Thickness	< ±1.0 µm	< ±3,0 µm	< ±6,0 µm
Multi-peak measurement		1 layer		
Light source		Internal white LED		
Permissible ambient light		30.000 lx		
Light spot diameter [4]		12 µm	18 µm	24 µm

[1] All data at constant ambient temperature (24 ±2 °C). Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat

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

[3] Maximum deviation from reference system over the entire measuring range, measured on front surface of ND filter

Model		IFD2410-1	IFD2410-3	IFD2410-6
Measuring angle [5]		±25°	±19°	±10°
Numerical aperture (NA)		0.45	0.35	0.18
Min. target thickness				
Target material		Reflective, diffuse as well as transparent surfaces (e.g. glass)		
Supply voltage		24 VDC ±10 %		
Power consumption		< 5.3 W (24V)		
Signal input		2x encoders (A+, A-, B+, B-, index); 3x encoders (A+, A-, B+, B-) 2x HTL/TTL multi-function inputs: trigger in, slave in, zero setting, mastering, teach-in; 1x RS422 synchronization input: trigger in, sync in, master/slave, master/slave alternating		
Digital interface		EtherCAT / PROFINET / EtherNet/IP / RS422 / Ethernet (for parameter setting)		
Analog output		4 … 20 mA / 0 … 5 V / 0 ... 10 V (16 bit D/A converter)		
Switching output		Error1-Out, Error2-Out		
Digital output		Sync out		
Connection		12-pin M12 connector for supply, encoder, EtherCAT, PROFINET, EtherNet/IP, RS422 and Sync 17-pin M12 connector for I/O analog and encoder optional extension to 3 m / 6 m / 9 m / 15 m possible (see accessories for suitable connection cables)		
Mounting		Radial clamping (see accessories for mounting adapter), threaded holes		
Temperature range	Storage	-20 … +70 °C		
	Operation	+5 ... +50 °C		
Shock (DIN EN 60068-2-27)		15 g / 6 ms on XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2 g / 20 … 500 Hz in XY axis, 10 cycles each		
Protection class (DIN EN 60529)	Sensor	IP64 (front)		
	Controller	IP65		
Material		Aluminum housing, passive cooling		
Weight		approx. 490 g	approx. 490 g	approx. 490 g
Control and indicator elements		Correct button: interface selection, two adjustable functions and reset to factory setting after 10 s; 4x color LEDs for Intensity, Range, Data connections (2x)		

2.5 Technical data confocalDT IFD2415

Model		IFD2415-1	IFD2415-15	IFD2415-10
Measuring range		1 mm	3 mm	10 mm
Start of measuring range		approx. 10 mm	approx. 20 mm	approx. 50 mm
Resolution	Static [1]	< 8 nm	< 15 nm	< 36 nm
	Dynamic [2]	< 38 nm	< 80 nm	< 204 nm
Measuring rate		Continuously adjustable from 100 Hz to 25 kHz		
Linearity [3]	Displacement and distance	< ±0.25 µm	< ±0.75 µm	< ±2.5 µm
	Thickness	< ±0.5 µm	< ±1.5 µm	< ±5.0 µm
Multi-peak measurement		5 layers		
Light source		Internal white LED		

[4] In the mid of the measuring range

[5] Maximum sensor tilt angle that produces a usable signal on polished glass (n = 1.5) in the mid of the measuring range. The accuracy decreases when approaching the limit values.

[1] All data at constant ambient temperature (24 ±2 °C). Average from 512 values at 1 kHz, in the mid of the measuring range onto optical flat

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

[3] Maximum deviation from reference system over the entire measuring range, measured on front surface of ND filter

Model		IFD2415-1	IFD2415-15	IFD2415-10
Permissible ambient light		30.000 lx		
Light spot diameter [4]		8 µm	9 µm	16 µm
Measuring angle [5]		±30°	±24°	±17°
Numerical aperture (NA)		0.55	0.45	0.30
Min. target thickness		0.05 mm	0.15 mm	0.5 mm
Target material		Reflective, diffuse as well as transparent surfaces (e.g. glass)		
Supply voltage		24 VDC ±10 %		
Power consumption		< 7 W (24V)		
Signal input		2x encoders (A+, A-, B+, B-, index); 3x encoders (A+, A-, B+, B-) 2x HTL/TTL multi-function inputs: trigger in, slave in, zero setting, mastering, teach-in; 1x RS422 synchronization input: trigger in, sync in, master/slave, master/slave alternating		
Digital interface		EtherCAT / PROFINET / EtherNet/IP / RS422 / Ethernet (for parameter setting)		
Analog output		4 … 20 mA / 0 … 5 V / 0 ... 10 V (16 bit D/A converter)		
Switching output		Error1-Out, Error2-Out		
Digital output		Sync out		
Connection		12-pin M12 connector for supply, encoder, EtherCAT, PROFINET, EtherNet/IP, RS422 and Sync 17-pin M12 connector for I/O analog and encoder optional extension to 3 m / 6 m / 9 m / 15 m possible (see accessories for suitable connection cables)		
Mounting		Radial clamping (see accessories for mounting adapter), threaded holes		
Temperature range	Storage	-20 … +70 °C		
	Operation	+5 ... +50 °C		
Shock (DIN EN 60068-2-27)		15 g / 6 ms on XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2 g / 20 … 500 Hz in XY axis, 10 cycles each		
Protection class (DIN EN 60529)	Sensor	IP64 (front)		
	Controller	IP65		
Material		Aluminum housing, passive cooling		
Weight		approx. 500 g	approx. 600 g	approx. 800 g
Control and indicator elements		Correct button: interface selection, two adjustable functions and reset to factory setting after 10 s; 4x color LEDs for Intensity, Range, Data connections (2x)		

2.6 Technical data confocalDT IFD2411

Model		IFC2411	IFC2411/IE
Resolution	Ethernet	2 nm	-
	Industrial Ethernet	-	2 nm
	RS422	18 bit	
	Analog	16 bits (teachable)	
Measuring rate		Continuously adjustable from 100 Hz to 8 kHz	
Linearity [6]		typ. < ±0.02 % FSO (depends on sensor)	
Multi-peak measurement		1 layer	
Light source		Internal white LED	
No. of characteristic curves		up to 10 characteristic curves for different sensors per channel, selection via table in the menu	

[4] In the mid of the measuring range

[5] Maximum sensor tilt angle that produces a usable signal on polished glass (n = 1.5) in the mid of the measuring range. The accuracy decreases when approaching the limit values.

[6] FSO = Full Scale Output

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

Model		IFS2404-1	IFS2404-3	IFS2404-6
Measuring range		1 mm	3 mm	6 mm
Start of measuring range	approx.	15 mm	25 mm	35 mm
Resolution	Static [9]	< 12 nm	< 40 nm	< 80 nm
	Dynamic [2]	< 50 nm	< 125 nm	< 250 nm
Linearity [10]	Displacement and distance	< ±0.3 µm	< ±0.9 µm	< ±1.8 µm
	Thickness	< ±0.6 µm	< ±1.8 µm	< ±3.6 µm
Light spot diameter		12 µm	18 µm	24 µm
Maximum measuring angle [11]		±25°	±19°	±10°

[7] Illuminant: light bulb

[8] The controller can also be parameterized via Ethernet

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

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

[10] All data at constant ambient temperature (25±1 °C). Measurement on plane-parallel test glass. Acceptance report is enclosed with delivery

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

Model		IFS2404-1	IFS2404-3	IFS2404-6
Numerical aperture (NA)		0.45	0.35	0.18
Min. target thickness [12]		0.05 mm	0.15 mm	0.3 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)		
Connection		Pluggable fiber optic cable via FC socket; cable type see accessories; standard length 2 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm		
Mounting		Radial clamping (mounting adapter see accessories)		
Temperature range	Storage	-20 ... +70 °C		
	Operation	5 ... 70 °C		
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each		
Vibration (DIN EN 60068-2-6)		2g/ 20 ... 500 Hz on XY axis, 10 cycles each		
Protection class (DIN EN 60529)		IP64		
Material		Aluminum housing, glass lenses		
Weight [13]		approx. 100 g	approx. 100 g	approx. 100 g

Model		IFS2404-2	IFS2404/90-2	IFS2404-2(001)	IFS2404/90-2(001)
Measuring range		2 mm	2 mm	2 mm	2 mm
Start of measuring range	approx.	14 mm	9.6 mm [14]	14 mm	9.6 mm [1]
Resolution	Static [9]	40 nm	40 nm	40 nm	40 nm
	Dynamic [2]	125 nm	125 nm	125 nm	125 nm
Linearity [10]	Displacement and distance	< ±0,6 µm	< ±0,6 µm	< ±0,6 µm	< ±0,6 µm
	Thickness	< ±1,2 µm	< ±1,2 µm	< ±1,2 µm	< ±1,2 µm
Light spot diameter		10 µm	10 µm	10 µm	10 µm
Maximum measuring angle [11]		±12°	±12°	±12°	±12°
Numerical aperture (NA)		0.25	0.25	0.25	0.25
Min. target thickness [12]		0.1 mm	0.1 mm	0.1 mm	0.1 mm
Target material		reflective, diffuse as well as transparent surfaces (e.g. glass)			
Connection		Pluggable fiber optic cable via FC socket; cable type see accessories; standard length 2 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm		Pluggable fiber optic cable via FC socket; cable type see accessories; standard length 3 m; extension up to 50 m; bending radius: static 30 mm, dynamic 40 mm	
Mounting		Radial clamping (mounting adapter see accessories)			
Temperature range	Storage	-20 °C ... +70 °C			
	Operation	+5 °C ... +70 °C			
Shock (DIN EN 60068-2-27)		15 g/ 6 ms in XY axis, 1000 shocks each			

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

[13] Sensor weight without optical fiber

[14] Start of measuring range measured from sensor axis

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

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

[10] All data at constant ambient temperature (25±1 °C). Measurement on plane-parallel test glass. Acceptance report is enclosed with delivery

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

Model	IFS2404-2	IFS2404/90-2	IFS2404-2(001)	IFS2404/90-2(001)
Vibration (DIN EN 60068-2-6)	2g/ 20 ... 500 Hz on XY axis, 10 cycles each			
Protection class (DIN EN 60529)	IP64			
Material	Stainless steel housing, glass lenses			
Weight [13]	Approx. 20 g	Approx. 30 g	Approx. 40 g	Approx. 40 g

[13] Sensor weight without optical fiber

3 Delivery

3.1 Scope of delivery confocalDT IFD2410/2415

1 Sensor	IFD241x-x
1 PC2415-1/Y	Length 1 m
1 acceptance report	
1 quick manual	

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

3.2 Scope of supply confocalDT IFD2411

1 Controller	IFC2411
1 Sensor	IFS2404-x
1 RJ patch cable Cat5	2 m
1 acceptance report	
1 quick manual	

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

3.3 Rücknahme Verpackung

Micro-Epsilon Messtechnik GmbH & Co. KG offers customers the opportunity to return the packaging of products purchased from Micro-Epsilon by prior arrangement so that it can be reused or recycled.

To arrange the return of packaging, for questions about the costs and / or the exact return procedure, please contact us directly at

info@micro-epsilon.de

3.4 Storage

Temperature range:	-20 ... +70 °C
Humidity:	5 ... 95 % RH (non-condensing)

i Protect the sensor lens against contamination.
Protect the ends of the sensor cable (optical fiber) against contamination (applies for the IFD2411).

4 Installation

4.1 Preliminary remarks

The optical sensors/measuring systems of the confocalDT IFD2410/2411/2415 series measure in the nanometer range. Observe the maximum tilt between sensor and target.

i Ensure careful handling during installation and operation.

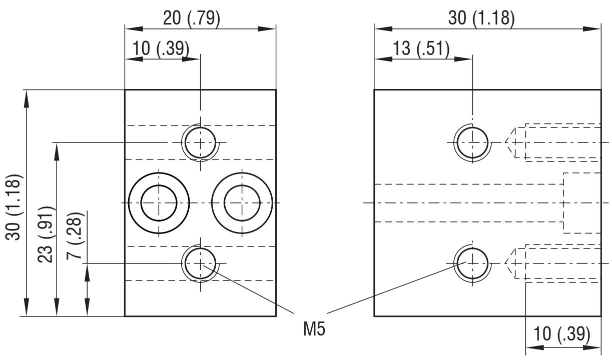
4.2 confocalDT IFD2410/2415

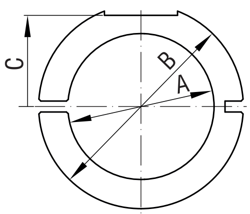
4.2.1 Circumferential clamping

► Mount the IFD241x using a mounting adapter.

Fig. 4.1: Circumferential clamping with MA240x mounting ring, consisting of mounting block and mounting ring

i Micro-Epsilon recommends using the circumferential clamping.



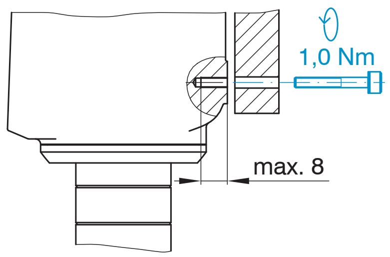


Mounting ring	Dimension A	Dimension B	Dimension C
MA2400-27	ø27	ø46	19.75
MA2405-34	ø34	ø50	22
MA2405-54	ø54	ø70	32

Tab. 4.1: Mounting block and mounting ring MA240x

4.2.2 Direct screw connection

► Mount the IFD241x using three M3 screws.



Screwing depth		Screw	Tightening torque Screw
Minimum	Maximum	ISO 4762	
mm	mm	3 pieces	Nm
6	8	M3	1.0

Tab. 4.2: Mounting conditions IFD2410 / IFD2415

IFD2410-	1	3	6
MR	1	3	6
SMR	15	25	35
A	56		
B	33		
C	150		
D	27		

IFD2415-	1	3	10
MR	1	3	10
SMR	10	20	50
A	82	85	118
B	59	62	---
C	176	179	212
D	27	34	54

Dimension in millimeters

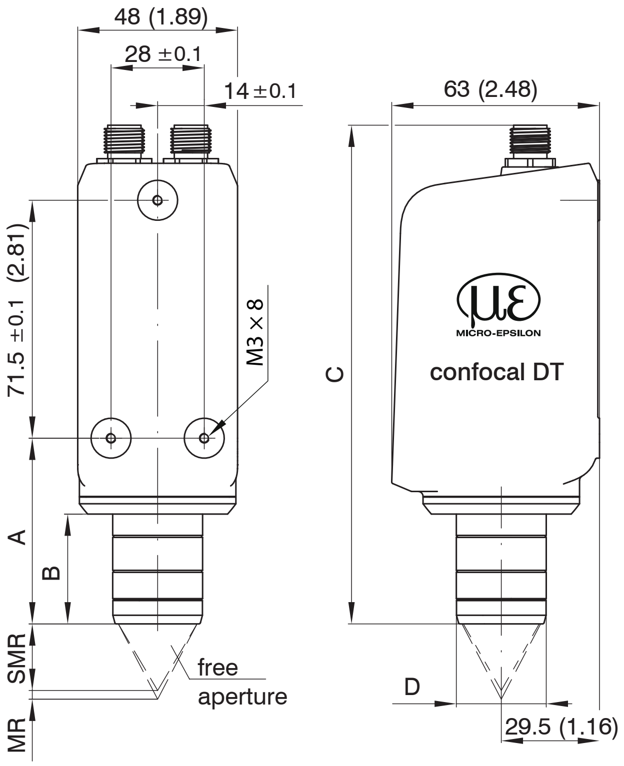
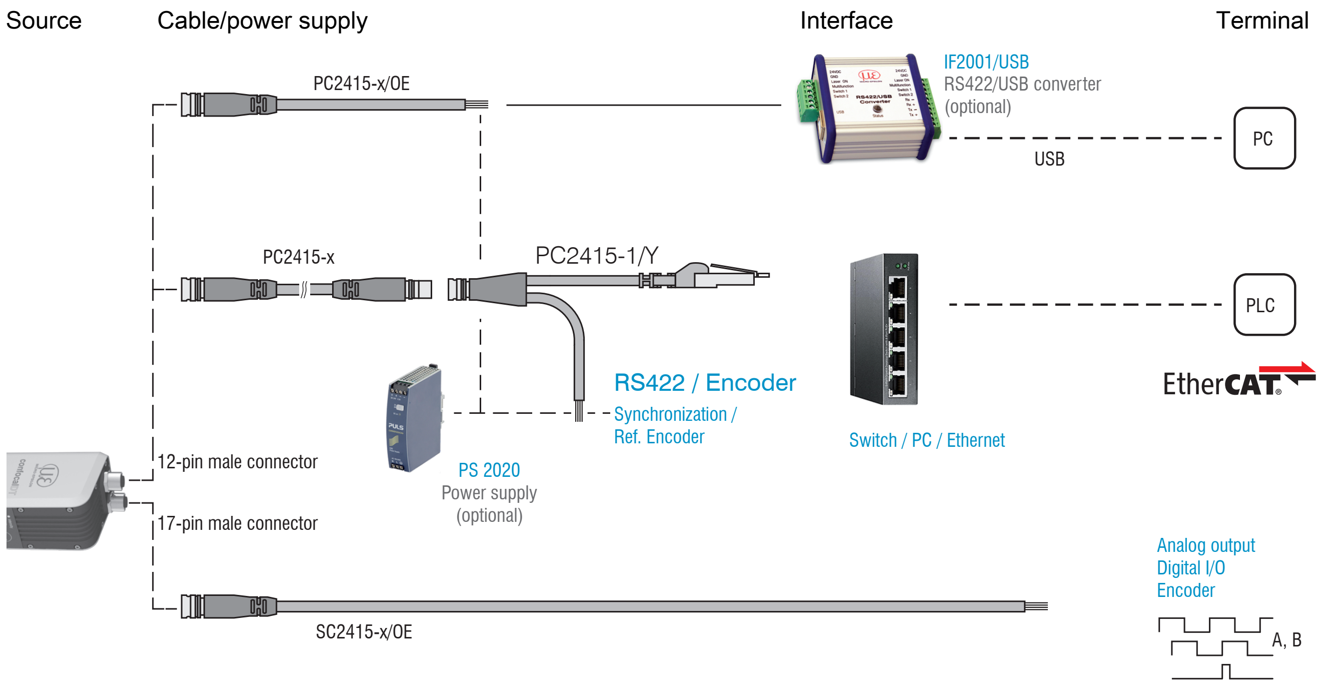


Fig. 4.2: Dimensional drawing IFD2410 / IFD2415, dimensions in mm

The support surfaces around the fastening holes are slightly raised.

4.2.3 Electrical connections, pin assignment



Tab. 4.3: Connection examples with confocalDT IFD2410/2415

IFD2410/2415, 12-pin connector			PC2415-x/OE	PC2415-1/Y		IF2001
Signal		Pin	Wire color	Wire color	RJ45, pin	Signal
V_+		1	Red	Red	---	24VDC
Supply GND		2	Blue	Blue	---	GND
Data Rx+	Encoder 2A + [15]	3	Brown	Brown	---	Tx +
Data Rx -	Encoder 2A -	4	White	White	---	Tx -
Data Tx +	Encoder 2B +	5	Green	Green	---	Rx +
Data Tx -	Encoder 2B +	6	Yellow	Yellow	---	Rx -
SYNC +	Encoder 2Ref +	7	Gray	Gray	---	---
SYNC -	Encoder 2Ref -	8	Pink	Pink	---	---
Shield		Housing	Black	Black	---	---
Industrial Ethernet		9	White/green	---	3	---
		10	Green	---	6	---
		11	White/orange	---	1	---
		12	Orange	---	2	---

Tab. 4.4: Pin assignment for 12-pin sensor connector

[15] You can use the pins for
- serial communication (TIA/EIA-422-B) and synchronization or
- encoder signals.

The PC2415-1/Y cable is included in the scope of delivery.

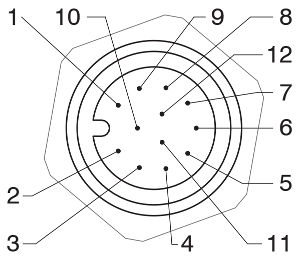


Fig. 4.3: 12-pin sensor connector, pin side

IFD2410/2415, 17-pin connector		SC2415-x/OE
Signal	Pin	Wire color
Analog output	1	White, inside
Analog GND	2	Black
Switching output 2 GND	3	Black
Switching output 2	13	Purple
Multifunction input 1	5	Red
Multifunction input 2	14	Blue
Encoder 1B +	8	Gray
Encoder 1B -	15	Pink
Encoder 1Ref +	9	Green
Encoder 1Ref -	16	Yellow
Switching output 1 GND	10	Brown
Switching output 1	11	White
Encoder 1A -	12	Red/ blue
Encoder 1A +	17	Gray/pink
Shield	Housing	Black

Tab. 4.5: Pin assignment 17-pin sensor connector

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

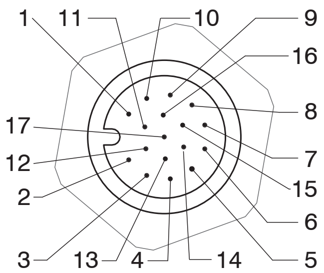


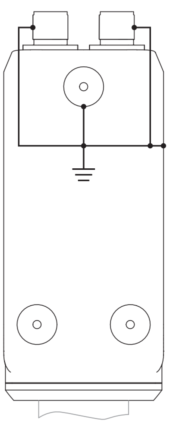
Fig. 4.4: 17-pin sensor connector, pin side

4.2.4 Grounding concept, shielding

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

The ground connections `(supply GND, switching output GND and analog GND)` of each connection group are galvanically connected internally via filters.

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

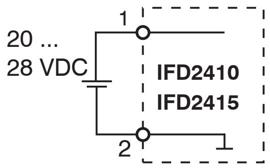


i For reasons of electromagnetic immunity, use the corresponding GND connection for the analog output and the two switching outputs.
Only use screened cables shorter than 30 m and connect the cable screen to the Shield or the connector housing.

4.2.5 Supply voltage (power)

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

The sensor is supplied via cable PC2415-1/Y or PC2415-x/OE.



IFD2410/2415 12-pin connector	Power supply	PC2415-1/Y PC2415-x/OE
1	V_+	Red
2	GND	Blue

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

► Connect the inputs Pin 1 and Pin 2 at the sensor with a 24V power supply.

i Voltage supply only for measuring devices, not to be used for drives or similar sources of impulse interference at the same time. Micro-Epsilon recommends using an optional available power supply unit PS2020 for the sensor.

4.2.6 RS422

In addition to Industrial Ethernet, the IFD2410/2415 also supports serial communication via RS422. The PC2415-1/Y or PC2415-x/OE cables enable serial communication. The IF2001/USB RS422-to-USB converter is available as an optional accessory.

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

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

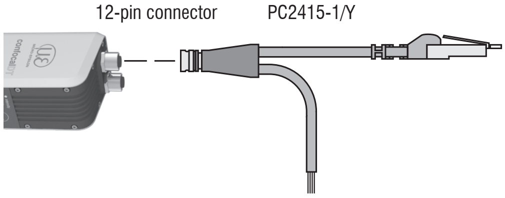
► Connect the ground connections.

IFD2410/2415 12-pin connector	Signal	PC2415-1/Y PC2415-x/OE	IF2001/USB
3	RX +	Brown	TX +
4	RX -	White	TX -
2	Supply GND (blue)		GND
5	TX +	Green	RX +
6	TX -	Yellow	RX -
Housing	Shield	Cable shield	---

4.2.7 Ethernet, EtherCAT

Connection

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



IFD2410/2415, 12-pin connector		PC2415-x/OE	PC2415-1/Y
Signal	Pin	Wire color	RJ45, pin
Industrial Ethernet	9	GND	3
	10	White/green	6
	11	White/orange	1
	12	Orange	2

- Connect the IFD2410/2415 and network with a shielded Ethernet cable (Cat5E, patch cable 2 m from the scope of delivery, total cable length less than 100 m).

The two LEDs `RUN` and `ERR` indicate that the connection was successful and is active.

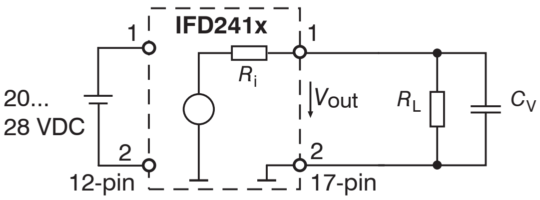
The measuring device can be configured via SDOs (EtherCAT), the web interface or by ASCII commands at command level (e.g. Telnet).

4.2.8 Analog output

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

IFD2410/2415, 17-pin connector		SC2415-x/OE
Signal	Pin	Wire color
Analog output	1	White, inside
Analog GND	2	Black [16]

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

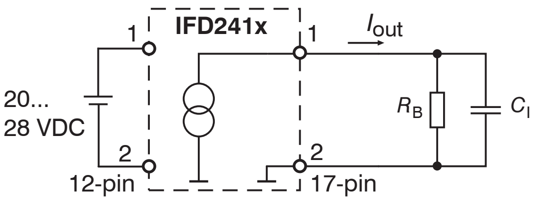


R_i approx. 50 Ohm, R_L > 10 MOhm

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

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

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



$R_B \leq$ 500 Ohm

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

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

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

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

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

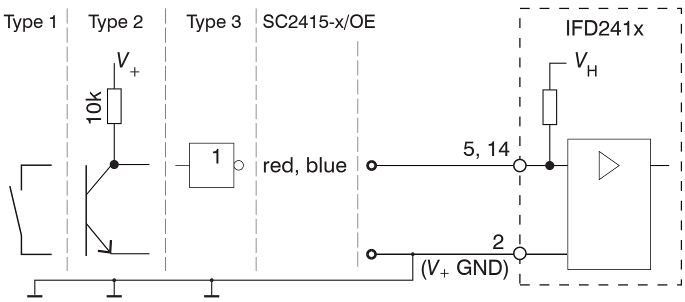
Current: 4 ... 20 mA.

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

4.2.9 Multifunction inputs

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

[16] Analog output in shielded cable area



The inputs are not electrically separated.
24V logic (HTL): Low ≤ 3 V; High ≥ 8 V (max 30 V),
5V logic (TTL): Low ≤ 0.8 V; High ≥ 2 V
Minimal pulse width 50 µs
Internal pull-up resistor, an open input is detected as High.
Maximum switching frequency 25 kHz

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

4.2.10 Switching outputs (digital I/O)

The GND connections of the switching outputs are separated from the supply GND by filters.

The switching behavior (NPN, PNP, push-pull) is programmable, I_{max} 100 mA.

The maximum auxiliary voltage for a switching output with NPN switching behavior is 28 V.

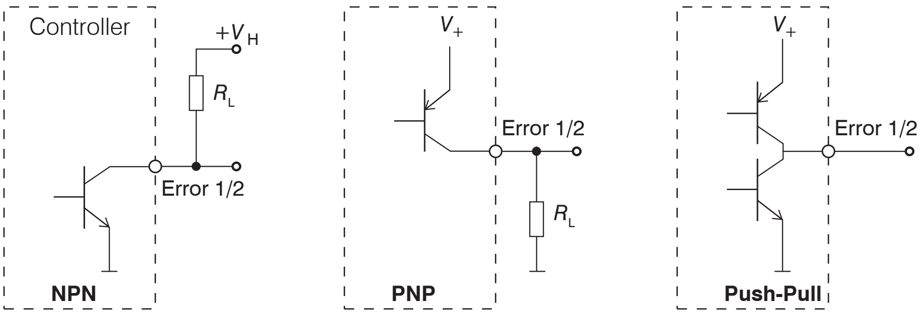


Fig. 4.5: Output behavior and wiring of the TTL switching outputs `Error 1/2`

IFD2410/2415, 17-pin connector		SC2415-x/OE
Signal	Pin	Wire color
Switching output 2 GND	3	Black
Switching output 2	13	Purple
Switching output 1 GND	10	Brown
Switching output 1	11	White

All GND conductors are interconnected with one another and to the supply ground.

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

Output level (without load resistor) at a supply voltage of 24 VDC	Low < 1 V; High > 23 V
	Low < 2.5 V (output - GND)
Saturation voltage with I_{max} = 100 mA	High < 2.5 V (output - V+)

The saturation voltage is measured

- between output and GND, at output = Low, or
- between output and V+ , with output = High.

Name	Output active (error)	Output passive (no error)
NPN (Low side)	GND	*V*+
PNP (High side)	*V*+	GND
Push-pull	*V*+	GND
Push-pull, negative	GND	*V*+

Tab. 4.6: Switching behavior of the switching outputs

i The load resistor R_L can be dimensioned according to the limit values (I_{max} = 100 mA, V_{Hmax}= 28 V). When connecting inductive loads, e.g. a relay, the parallel protective diode must not be missing.

4.2.11 Synchronization (in-/outputs)

4.2.11.1 General

- The `SYNC+` and `Sync-` pins on the 12-pin sensor connector: Symmetrical output/input for synchronization of two or more sensors
- The pins `Multifunction input 1` or `Multifunction input 2` on the 17-pin sensor connector: Input for synchronizing a sensor with an external synchronous source, e.g. function generator
- The termination resistor R_T (120 Ohm) can be switched on or off via software.

4.2.11.2 Internal synchronization

An IFD2410/2415 (master) synchronizes one or more sensors (slaves).

IFD2410/2415, 12-pin connector			PC2415-x/OE	PC2415-1/Y
Signal	Pin	Level	Wire color	Wire color
Supply GND	2		Blue	Blue
SYNC +	7	RS422 (EIA422)	Gray	Gray
SYNC -	8		Pink	Pink

Tab. 4.7: Connections and signal level internal synchronization

► Activate the termination resistor (120 ohm) in the last sensor (slave n) in the chain.

Star synchronization

► Connect the `Sync+` and `Sync-` pins of sensor 1 (master) in a star configuration with the `Sync+` and `Sync-` pins of sensor 2 (slave) to sensor n in order to synchronize two or more sensors with each other, see Tab. 4.8

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

Chain synchronization

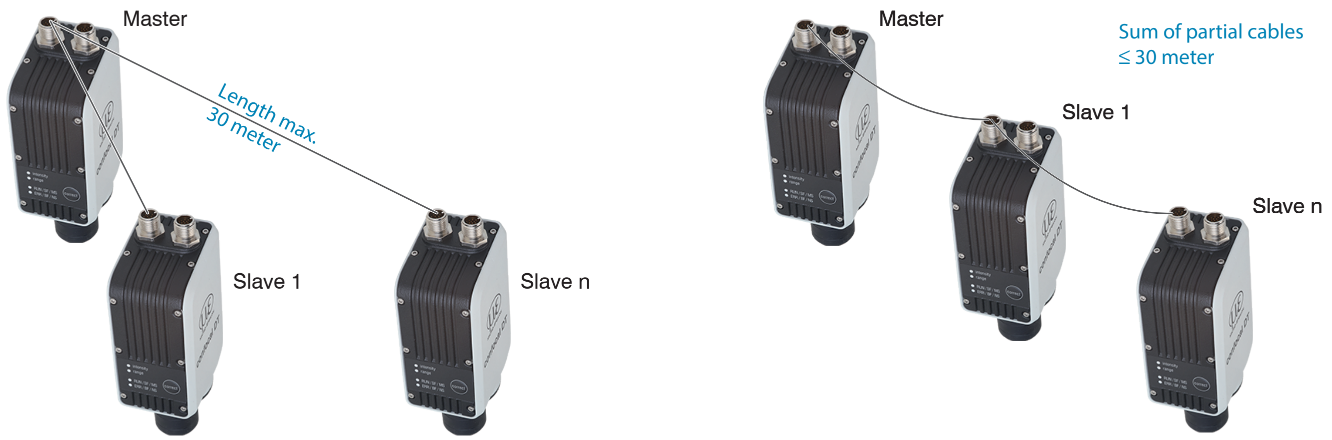
► Connect the `Sync+` and `Sync-` pins of sensor 1 (master) to the `Sync+` and `Sync-` pins of sensor 2 (slave 1). Connect the pins of the following sensors to synchronize two or more sensors with each other, see Tab. 4.8

- Total line length less than 30 m in chain synchronization

► Use shielded cables with twisted wires.

► Connect the cable shield to the housing.

► Program sensor 1 to `Master` and all other sensors to `Slave`.



Tab. 4.8: Synchronization of multiple sensors, star-shaped on the left, daisy-chained on the right

► Connect all GND connections of the supply to each other if the sensors are not supplied by a common power supply.

4.2.11.3 External synchronization

An external synchronous source synchronizes one or more IFD2410/2415 (slaves).

IFD2410/2415, 17-pin connector				SC2415-x/OE
Signal	Pin	Level		Wire color
Multifunction input 1	5	TTL Low level ≤ 0.8 V; High level ≥ 2 V Minimal pulse width 50 µs	HTL Low level ≤ 3 V; High level ≥ 8 V (max. 30 V) Minimal pulse width 50 µs	Red
Multifunction input 2	14			Blue

IFD2410/2415, 12-pin connector		PC2415-x/OE	PC2415-1/Y
Signal	Pin	Wire color	Wire color
Supply GND	2	Blue	Blue

Tab. 4.9: Connections and signal level external synchronization

► Activate the termination resistor (120 ohm) in the last sensor (slave n) in the chain.

Star synchronization

► Connect the pin `Multifunction input 1` or `2` of slave 1 to the external synchronous source.
► Connect the `Supply GND` of the sensor to the ground connection of the synchronization source.

Further sensors can be synchronized in the same schematic.

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

► Use shielded cables with twisted wires.
► Connect the cable shield to the housing.
► Program all sensors to `Slave`.

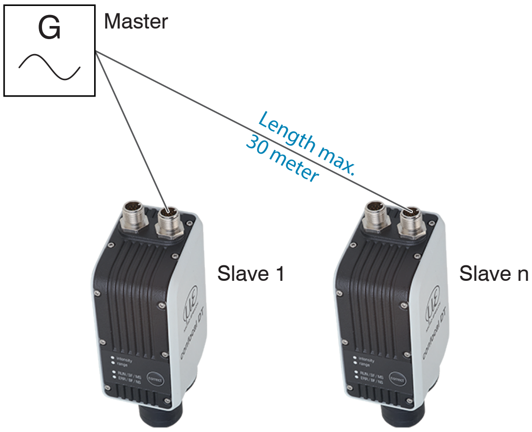


Fig. 4.6: Synchronization of multiple sensors, star-shaped

► Connect all GND connections of the supply to each other if the sensors are not supplied by a common power supply.

4.2.12 Triggering

4.2.12.1 General

Data acquisition or output can be triggered with:

- multifunction inputs 1/2,
- synchronization inputs Sync+ and Sync-,
- encoder 1.

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

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

4.2.12.2 Triggering with multifunction input

IFD2410/2415, 17-pin connector				SC2415-x/OE
Signal	Pin	Level		Wire color
Multifunction input 1	5	TTL Low level ≤ 0.8 V; High level ≥ 2 V Minimal pulse width 50 µs	HTL Low level ≤ 3 V; High level ≥ 8 V (max. 30 V) Minimal pulse width 50 µs	Red
Multifunction input 2	14			Blue

► Connect the `Multifunction input pin 1` or `2` to the external trigger source.

► Connect the `Supply GND` of the sensor to the ground connection of the external trigger source.

Program the sensor’s `multifunction input` connections to the trigger input function.

4.2.12.3 Triggering with synchronization input

IFD2410/2415, 12-pin connector			PC2415-x/OE	PC2415-1/Y
Signal	Pin	Level	Wire color	Wire color
SYNC +	7	RS422 (EIA422)	Gray	Gray
SYNC -	8		Pink	Pink

► Connect the `Sync+` and `Sync-` pins to the external trigger source.

Program the sensor’s sync connections to the trigger input function.

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

4.2.12.4 Triggering with Input Encoder 1

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

IFD2410/2415, 17-pin connector			PC2415-x/OE
Signal	Pin	Level	Wire color
Encoder 1B +	8	RS422 (EIA422)	Gray
Encoder 1B -	15		Pink
Encoder 1A -	12		Red/ blue
Encoder 1A +	17		Gray/pink

Program the encoder’s sync connections to the trigger input function.

4.2.13 Encoder inputs

The measuring system supports up to three encoders.

Two encoder inputs:

- Incremental signals A, B
- Reference pulse

The maximum pulse frequency is 1 MHz.

RS422 level (symmetrical) for A, B, Ref

IFD2410/2415, 12-pin connector		PC2415-x/OE	PC2415-1/Y	IFD2410/2415, 17-pin connector		SC2415-x/OE
Signal	Pin	Wire color		Signal	Pin	Wire color
Supply GND	2	Blue	Blue	Encoder 1B +	8	Gray
Encoder 2A + [17]	3	Brown	Brown	Encoder 1B -	15	Pink
Encoder 2A -	4	White	White	Encoder 1Ref +	9	Green
Encoder 2B +	5	Green	Green	Encoder 1Ref -	16	Yellow
Encoder 2B +	6	Yellow	Yellow	Encoder 1A -	12	Red/ blue
Encoder 2Ref +	7	Gray	Gray	Encoder 1A +	17	Gray/pink
Encoder 2Ref -	8	Pink	Pink			

Tab. 4.10: Pin assignment for two encoder inputs

Three encoder inputs:

- Incremental signals A, B

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

RS422 level (symmetrical) for A, B

IFD2410/2415, 12-pin connector		PC2415-x/OE	PC2415-1/Y	IFD2410/2415, 17-pin connector		SC2415-x/OE
Signal	Pin	Wire color		Signal	Pin	Wire color
Supply GND	2	Blue	Blue	Encoder 1B +	8	Gray
Encoder 2A + [17]	3	Brown	Brown	Encoder 1B -	15	Pink
Encoder 2A -	4	White	White	Encoder 3A +	9	Green

[17] If encoders 2 and 3 are used, neither serial communication via RS422 and nor synchronization of the IFD2410/2415 is possible.

IFD2410/2415, 12-pin connector		PC2415-x/OE	PC2415-1/Y	IFD2410/2415, 17-pin connector		SC2415-x/OE
Encoder 2B +	5	Green	Green	Encoder 3A -	16	Yellow
Encoder 2B +	6	Yellow	Yellow	Encoder 1A -	12	Red/ blue
Encoder 3B +	7	Gray	Gray	Encoder 1A +	17	Gray/pink
Encoder 3B -	8	Pink	Pink			

Tab. 4.11: Pin assignment for three encoder inputs

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

Connection conditions

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

4.3 confocalDT 2411

4.3.1 IFC2411 Controller

The IFC2411 controller can be placed on a flat surface or mounted with a TH 35 top-hat rail according to DIN EN 60715, e.g. in a control cabinet. The minimum distance between neighboring controllers is 10 mm.

i	Position the controller so that the connections, control and display elements are not concealed.

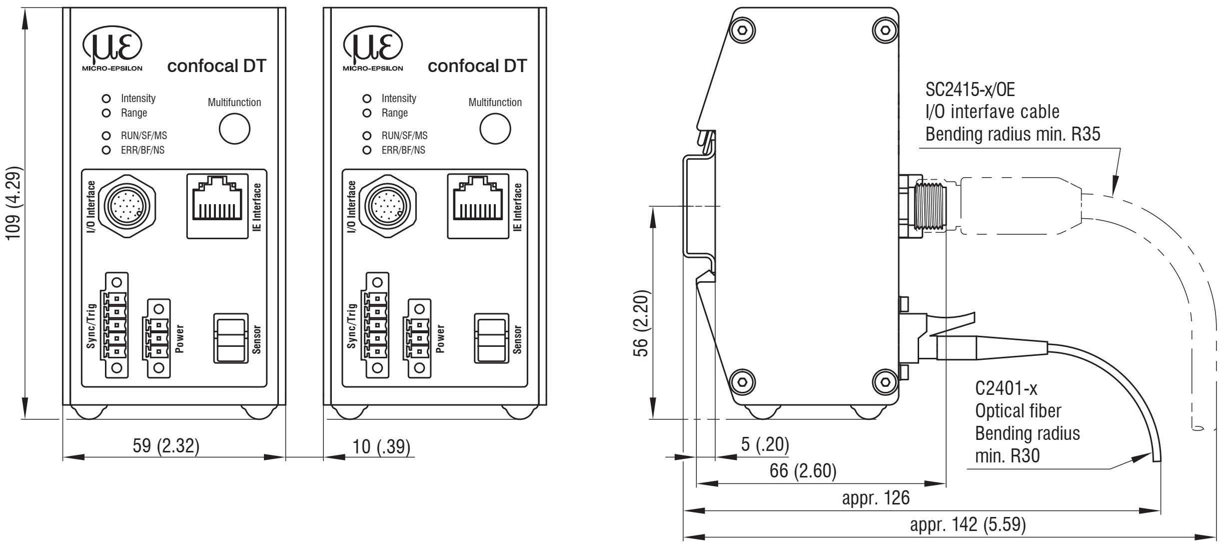


Fig. 4.7: Dimensional drawing IFC2411, dimensions in mm

4.3.2 Sensor cable, optical fiber

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

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

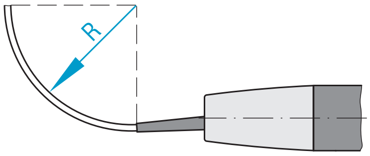
The connector must not be dirty under any circumstances, as this will cause particles to build up in the controller and severe loss of light. The plugs may only be cleaned by persons with the appropriate expertise using a fiber microscope for control.

General rules

Do not

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

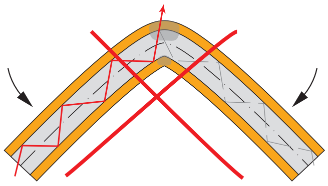
Never bend the sensor cable more tightly than the permitted bending radius.



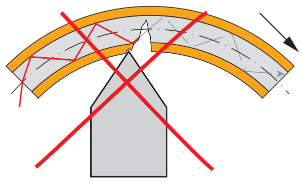
Fixed installation:
R = 30 mm or more

Movably routed:
R = 40 mm or more

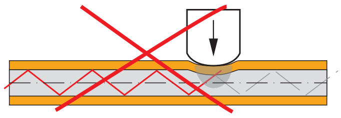
Do not kink the sensor cable.



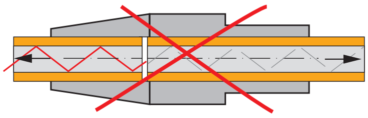
Do not pull the sensor cable over sharp edges.



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



Do not pull on the sensor cable.



Connect sensor cable to controller

- ► Remove the dummy plug from the green `Sensor` optical fiber socket on the controller.
- ► Insert the sensor cable with green plug (E2000/APC) into the optical fiber socket, ensuring that the sensor plug is correctly aligned.
- ► Insert the sensor plug until it locks into place.

Connect sensor cable to controller

- ► Press the release lever on the sensor plug downwards and pull the sensor plug out of the socket.
- ► Plug the dummy plug back in.

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

Connect sensor cable to sensor

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

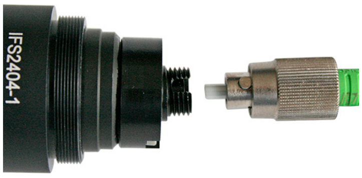


Fig. 4.8: Groove of the socket on the sensor (left) and guide lug of an FC sensor plug (right)

i	Note the orientation of the socket and the guiding peg.

Connect sensor cable to sensor

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

4.3.3 Dimensional drawing of sensors

The dimensional drawings for sensors IFS2404-1; IFS2404-2(001); IFS2404/90-2(001); IFS2404-3; IFS2404-6 are compiled in a separate document. You can find these online at:

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

4.3.4 Mounting, mounting adapter

4.3.4.1 General

The sensors measure in the nanometer range. Observe the maximum tilt between sensor and target.

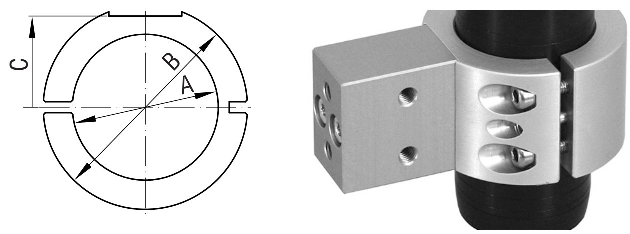
i	Ensure careful handling during installation and operation.

Fasten the sensors with a circumferential clamp. This type of sensor mounting ensures the highest level of reliability because the sensor’s cylindrical housing is clamped over a relatively large area. It is essential to have in difficult installation situations, such as on machines, production lines, etc.

4.3.4.2 Circumferential clamping

- Mount the IFS2404-1 (IFD2411-1), IFD2404-3 (IFD2411-3) and IFD2404-6 (IFD2411-6) sensors using a MA240x mounting adapter.

Mounting ring	Dimension A	Dimension B	Dimension C
MA2400-27	ø27	ø46	19.75



Tab. 4.12: Mounting ring MA2400-27

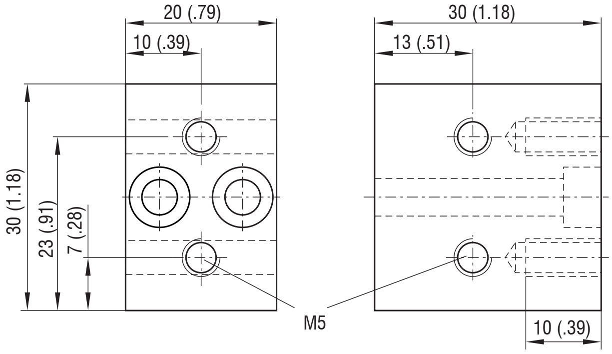
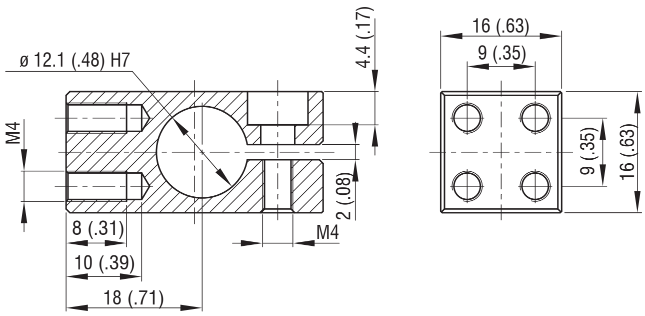


Fig. 4.9: Mounting block MA240x

- Mount the IFS2404-2 (IFD2411-2) sensors using a MA2404-12 mounting adapter.



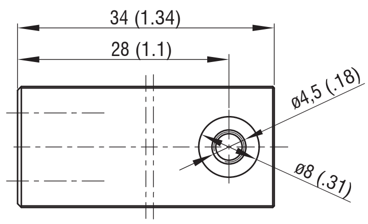
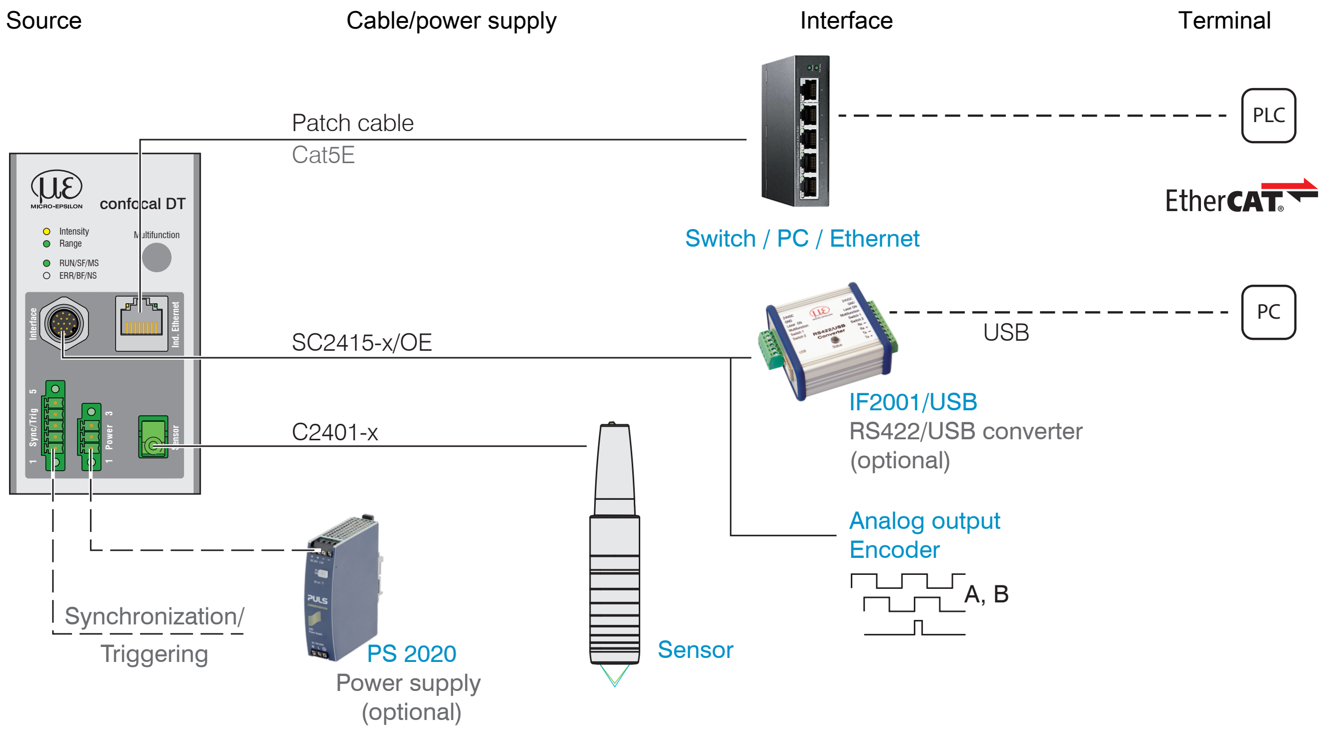


Fig. 4.10: Mounting block MA2404-12

4.3.5 Electrical connections, pin assignment



Tab. 4.13: Connection examples with the confocalDT IFD2411

IFC2411, 17-pin connector		SC2415-x/OE
Signal	Pin	Wire color
Analog output	1	White, inside
Analog GND	2	Black [18]
Data Tx-	3	Black
Data Tx+	13	Purple
n.c.	5	Red
n.c.	14	Blue
Encoder 1B+	8	Gray
Encoder 1B-	15	Pink
Encoder 1Ref+	9	Green
Encoder 1Ref-	16	Yellow
Data Rx+	10	Brown
Data Rx-	11	White
Encoder 1A-	12	Red/ blue
Encoder 1A+	17	Gray/pink
Shield	Housing	Black

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

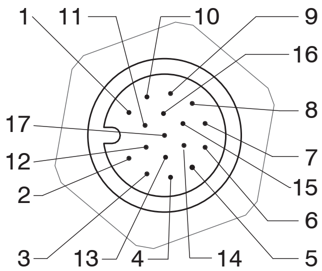


Fig. 4.11: 17-pin sensor connector, pin side

Tab. 4.14: Pin assignment for 17-pin controller connector, pin side

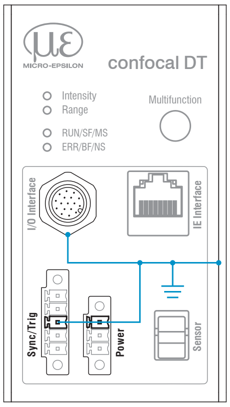
4.3.6 Ground concept, shielding

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

The ground connections (`supply GND` and `analog GND`) of each connection group are galvanically connected internally via filters.

[18] Analog output in the shielded cable area

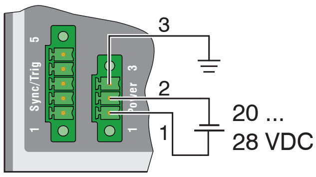
The shield connections of each connection group are only connected to the controller housing. They are used to connect the cable shieldings for individual connections (power, analog output, switching outputs, synchronization and trigger input).



i For reasons of electromagnetic immunity, use the corresponding GND connection for the analog output.
Only use screened cables shorter than 30 m and connect the cable screen to the Shield or the connector housing.

4.3.7 Supply voltage (power)

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



IFC2411 3-pin terminal socket	Power supply
1	V_+
2	GND
3	Shield

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

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

i Voltage supply only for measuring devices, not to be used for drives or similar sources of impulse interference at the same time. Micro-Epsilon recommends using an optional available power supply unit PS2020 for the sensor.

4.3.8 RS422

In addition to Industrial Ethernet, the IFC2411 also supports serial communication via RS422. The SC2415-x/OE cable enables serial communication. The IF2001/USB RS422-to-USB converter is available as an optional accessory.

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

► Use a shielded cable with twisted wires. Cable length less than 30 m.
► Connect the ground connections.

IFC2411 17-pin connector	Signal	SC2415-x/OE	IF2001/USB
3	Tx -	Black	Rx -
13	Tx +	Purple	Rx +
10	Rx +	Brown	Tx +
11	Rx -	White	Tx -
Housing	Shield	Cable shield	---

4.3.9 Ethernet, EtherCAT

Connection

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

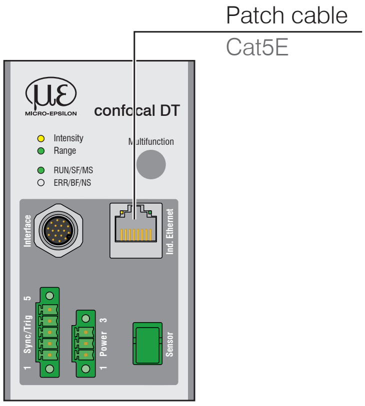


Fig. 4.12: confocalDT 2411 patch cable connection

► Connect the IFC2411 and network with a shielded Ethernet cable (Cat5E, patch cable 2 m from the scope of delivery, total cable length less than 100 m).

The two LEDs `RUN` and `ERR` indicate that the connection was successful and is active.

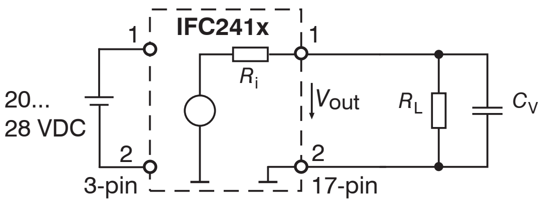
The measuring device can be configured via SDOs (EtherCAT), the web interface or by ASCII commands at command level (e.g. Telnet).

4.3.10 Analog output

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

IFC2411, 17-pin connector		SC2415-x/OE
Signal	Pin	Wire color
Analog output	1	White, inside
Analog GND	2	Black [16]
Shield	Housing	Black

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



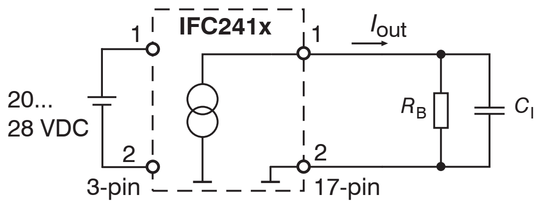
R_i approx. 50 Ohm, R_L > 10 MOhm

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

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

[16] Analog output in shielded cable area

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



$R_B \leq$ 500 Ohm

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

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

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

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

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

Current: 4 ... 20 mA.

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

4.3.11 Multifunction input

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

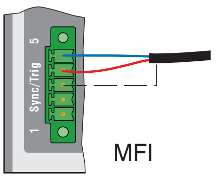
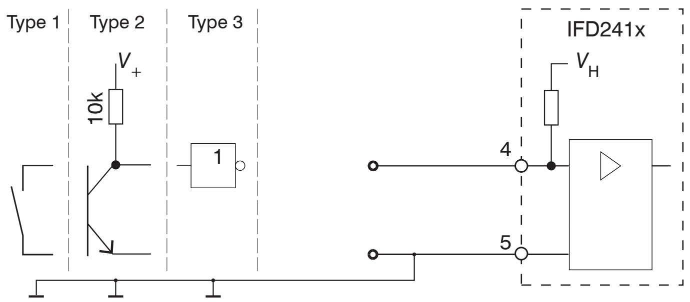


Fig. 4.13: Connections multifunction input



24V logic (HTL): Low ≤ 3 V; High ≥ 8 V (max 30 V),
5V logic (TTL): Low ≤ 0.8 V; High ≥ 2 V
Minimal pulse width 50 µs
Internal pull-up resistor, an open input is detected as High.
Maximum switching frequency 25 kHz

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

4.3.12 Synchronization (in-/outputs)

4.3.12.1 General

- The `SYNC+` and `Sync-` pins on the 5-pin clamping sleeve: Symmetrical output/input for synchronization of two or more controllers
- The `Multifunction input 1` pin on the 5-pin terminal socket: Input for synchronizing a controller with an external synchronous source, e.g. function generator
- The termination resistor R_T (120 Ohm) can be switched on or off via software.

4.3.12.2 Internal synchronization

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

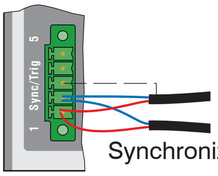


Fig. 4.14: Connections internal synchronization

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

Tab. 4.15: Signal level internal synchronization

► Activate the terminating resistor 120 ohm in the last controller (slave n) in the chain.

Star synchronization

► Connect the `Sync+` and `Sync-` pins of Controller 1 (master) in a star configuration with the `Sync+` and `Sync-` pins of Controller 2 (slave) to controller n in order to synchronize two or more controllers with each other, see Tab. 4.16

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

Chain synchronization

► Connect the `Sync+` and `Sync-` pins of Controller 1 (master) to the `Sync+` and `Sync-` pins of Controller 2 (slave 1). Connect the pins of downstream controllers in order to synchronize two or more sensors, see Tab. 4.16

- Total line length less than 30 m in chain synchronization

► Use shielded cables with twisted wires.

► Connect the cable shield to Pin 3 of the 5-pin terminal block.

► Program Controller 1 to `Master` and all other sensors to `Slave`.

Tab. 4.16: Synchronization of several controllers, star-shaped on the left, daisy-chained on the right

► Connect all GND connections of the supply to each other if the sensors are not supplied by a common power supply.

i	If the sensors are operated via the EtherCAT interface, synchronization can also be implemented without the sync cable.

4.3.12.3 External synchronization controller

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

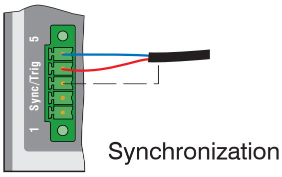


Fig. 4.15: Connections external synchronization

IFC241x 5-pin clamping sleeve	Signal	Level	
4	Multifunction	TTL Low level ≤ 0.8 V; High level ≥ 2 V Minimal pulse width 50 µs	HTL Low level ≤ 3 V; High level ≥ 8 V (max. 30 V) Minimal pulse width 50 µs
3	Cable shield		
5	GND		

Tab. 4.17: Signal level external synchronization

► Activate the terminating resistor 120 ohm in the last controller (slave n) in the chain.

Star synchronization

► Connect the `Multifunction` pin of slave 1 to the external synchronization source.

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

Further controllers can be synchronized in the same schematic.

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

► Use shielded cables with twisted wires.

► Connect the cable shield to Pin 3 or 5-pin terminal block.

► Program all sensors to `Slave`.

Fig. 4.16: Synchronization of multiple controllers, star-shaped

► Connect all GND connections of the supply to each other if the controllers are not supplied by a common power supply.

i	If the controllers are operated via the EtherCAT interface, synchronization can also be implemented without the synchronization cable.

4.3.13 Triggering

4.3.13.1 General

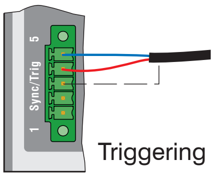
Data acquisition or output can be triggered with:

- the multifunction input,
- synchronization inputs Sync+ and Sync-,
- encoder 1.

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

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

4.3.13.2 Triggering with multifunction input



<table>
<tr><th>IFC241x
5-pin clamping sleeve</th><th>Signal</th><th colspan="2">Level</th></tr>
<tr><td>4</td><td>Multifunction</td><td rowspan="3">TTL
Low level ≤ 0.8 V;
High level ≥ 2 V
Minimal pulse width 50 µs</td><td rowspan="3">HTL
Low level ≤ 3 V;
High level ≥ 8 V (max. 30 V)
Minimal pulse width 50 µs</td></tr>
<tr><td>3</td><td>Cable shield</td></tr>
<tr><td>5</td><td>GND</td></tr>
</table>

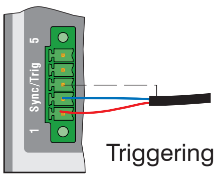
► Connect the `Multifunction` pin to the external trigger source.

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

► Connect the shielding of the trigger cable to Pin 3.

Program the controller’s `Multifunction` connection to the trigger input function.

4.3.13.3 Triggering with synchronization input



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

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

► Connect the shielding of the trigger cable to Pin 3.

Configure the controller’s `multifunction` connection to the trigger input operation.

► Connect the `Sync+` and `Sync-` pins to the external trigger source.

Program the sensor’s sync connections to the trigger input function.

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

4.3.13.4 Triggering with input encoder 1

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

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

The encoder connections of the controller must be programmed to the trigger input function.

4.3.14 Encoder input IFC2411

The measuring system supports one encoder.

Encoder input:

- Incremental signals A, B
- Reference pulse

The maximum pulse frequency is 1 MHz.

RS422 level (symmetrical) for A, B, Ref

The encoder supply is not provided.

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

Tab. 4.18: Pin assignment for encoder input

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

Connection conditions

- The encoders must supply signals with TTL level.

4.3.15 Handling of the plug-in screw terminals

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

► Remove the insulation from the connecting wires (0.14 ... 1.5 mm²) over a length of 7 mm.

► Connect the connection wires.

i The screw terminals can be fixed with two captive screws.

4.3.16 Dark correction IFC2411/IFC2416

A dark correction must be carried out after the sensor or sensor cable is changed. Details can be found in the Initial operation, see Chap. 5 section.

4.4 LEDs

LED	Color	Status	Meaning
Intensity	Red	flashes	Dark signal acquisition in progress
	Red	illuminated	Signal saturated
	Yellow	illuminated	Signal too low
	Green	illuminated	Signal OK
Range	Red	flashes	Dark signal acquisition in progress
	Red	illuminated	No target present, outside of measuring range
	Yellow	illuminated	Target close to mid of measuring range
	Green	illuminated	Target within the measuring range
RUN	Green	Off	Slave is in “Init” status
	Green	flashes evenly	Slave is in “Pre-Operational” status
	Green	flashes briefly	Slave is in “Safe-Operational” status
	Green	flashes quickly	Slave is in “Initialization” or “Bootstrap” status
	Green	illuminated	Slave is in “Operational” status
ERR	Red	Off	no error
	Red	flashes evenly	invalid configuration
	Red	flashes briefly	Unwanted status change
	Red	flashes twice	Timeout of the Application watchdog
	Red	flickers	Boot error
	Red	illuminated	PDI watchdog timeout
	Green	flashes evenly	Ethernet setup mode is active

Tab. 4.19: Meaning of LEDs on measuring system

4.5 Correct and multifunction buttons

The `Correct` keys on the IFD241x or `Multifunction` keys on the IFC2411 are assigned for multiple functions. The buttons are assigned the `Dark referencing` function at the factory.

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

Tab. 4.20:

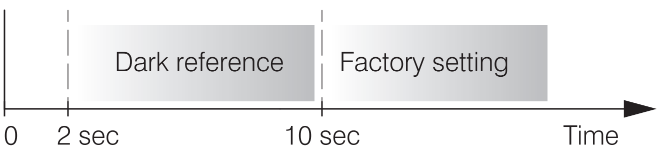


Fig. 4.17: Actuation time of `Correct button`

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

The key can also be used to switch the operating mode. You can find more details on this in the sections `Initial operation` or `Switch between EtherCAT and Ethernet setup mode`, see Chap. 19.

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

5 Initial operation

5.1 Communication options

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

The measuring system starts with the last saved operating mode. EtherCAT is standard.

Standard

EtherCAT

Integrate the device description file (EtherCAT® slave information) into your PLC development environment, e.g. TwinCAT:

- `Micro-Epsilon_IFC241x.xml` for IFD2411
- `Micro-Epsilon_IFD241x.xml` for IFD2410/2415

You can find the files online at https://www.micro-epsilon.de/download/software.
Further information on EtherCAT operation can be found here, see Chap. 8.

Ethernet over EtherCAT (EoE)

- Parameterization via web interface,
- Parameterization at command level, e.g. with Telnet,
- Parallel parameterization and measurement

Activate EoE in your PLC software.
`Virtual Ethernet Port` is a name in TwinCAT®.
Assign a MAC address and an IP address to the slave.
Continue with chapter `Access via web interface`.

Alternative communication

Ethernet setup mode

- Parameterization via web interface,
- no EtherCAT

Switch to the Ethernet setup mode.
Details can be found in section `Switch between EtherCAT and Ethernet setup mode`, see Chap. 19.
Connect the measuring system and PC with a LAN cable.
Start your web browser and type the standard IP address 169.254.168.150 of the sensor into the address bar.
Continue with chapter `Access via web interface`.

RS422 communication

- Parameterization via web interface,
- Parameterization at command level, e.g. with Telnet,
- Parallel output of measurement data not possible via EtherCAT and RS422

Connect the measuring system, e.g. via an IF2001/USB RS422 converter from Micro-Epsilon, via USB to a PC.
Start the `sensorTOOL` program.
Download at https://www.micro-epsilon.de/download/software/sensor-TOOL.exe.
Click on the `Sensor` button.
The program searches for connected measuring systems.
Select the desired measuring system. Click the `Open Website` button.

Saved settings are retained permanently in the measuring system across all interfaces.

5.2 Access via web interface

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

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

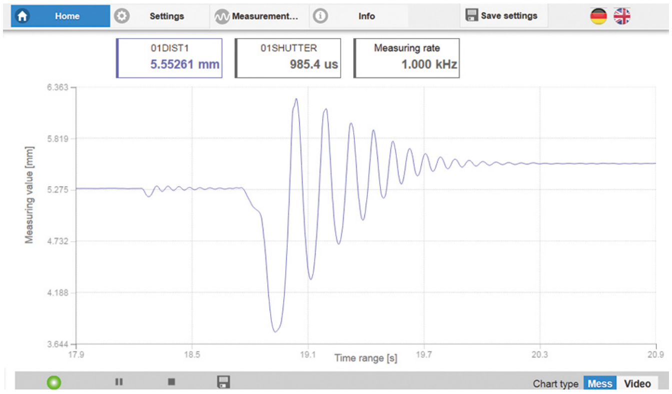


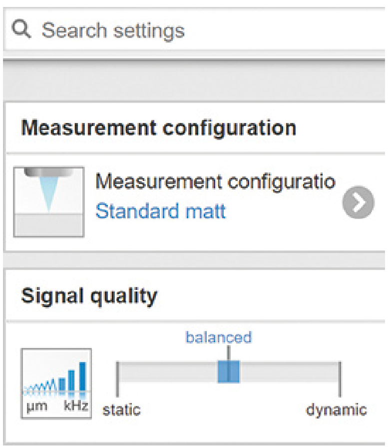
Fig. 5.1: Start page after accessing the web interface in Ethernet mode

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

i	Depending on the selected measuring rate and the PC used, measured values may be reduced dynamically in the display. This means that not all measured values are sent to the web interface for display and saving.

Horizontal navigation includes the following functions:

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

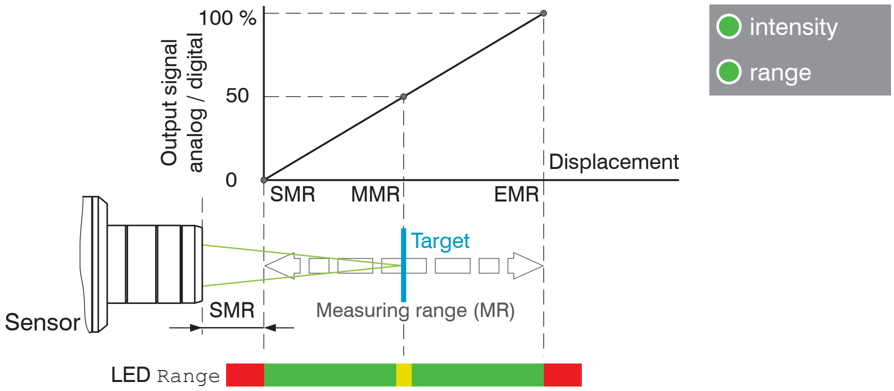


The vertical navigation is related to the context of the selection in the horizontal navigation and contains the following functions for the `Home` menu:

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

5.3 Positioning the target

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



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

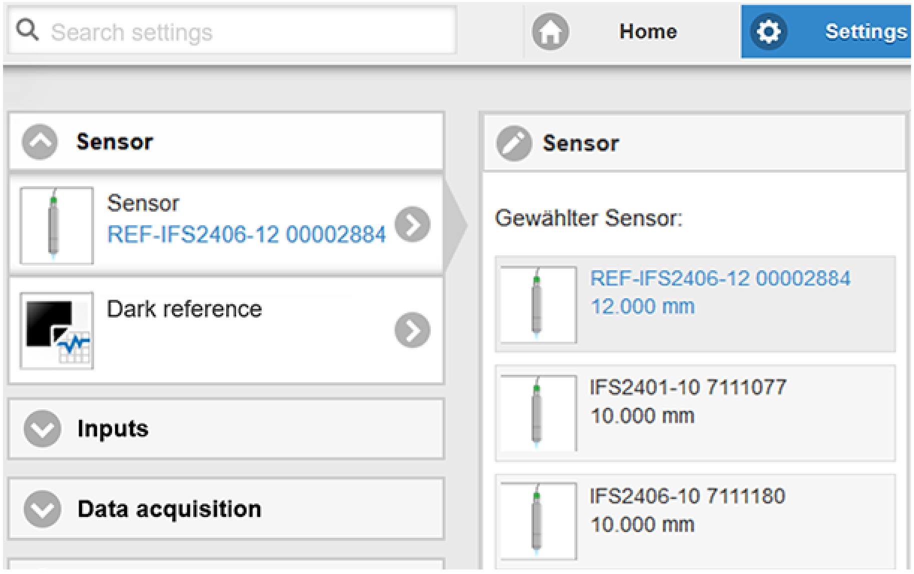
The Range LED on the front of the measuring system indicates the position of the target relative to the sensor.

5.4 Select sensor

The function is valid for the IFD2411 measuring system.

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

- Go to the Settings > Sensor menu.
- Select the required sensor from the list.

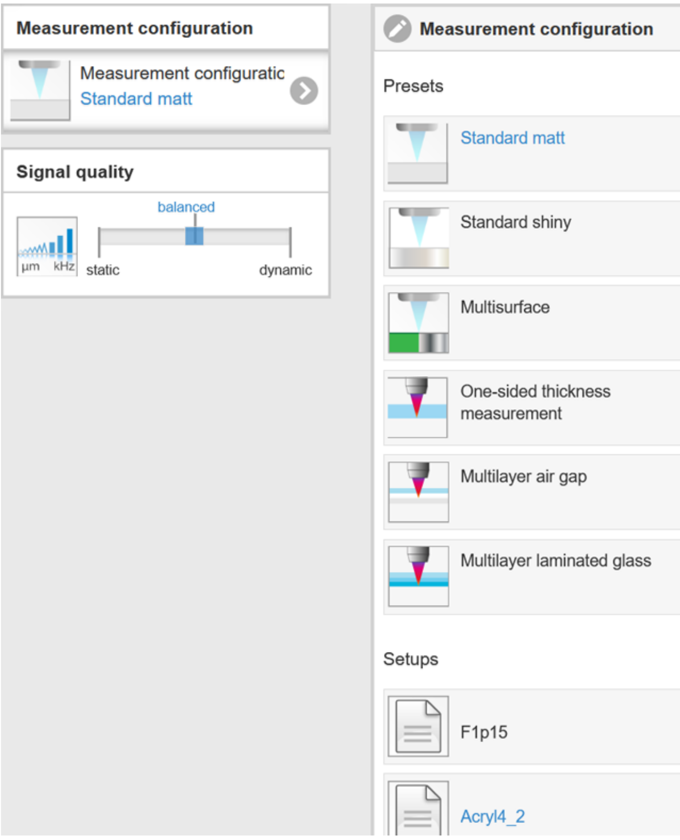


The calibration data of up to 20 different sensors can be saved in the controller. Calibration is only possible by Micro-Epsilon.

5.5 Presets, setup, selection of measurement configuration

Definition

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



Upon delivery of the measuring system from the factory:

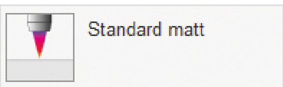
- the presets `Standard matt, Standard shiny, Multisurface` and `One-sided thickness measurement` are available.
- for the IFD2415 sensor, the presets `Multi-layer air gap` and `Multilayer laminated glass` are also available,
- no setup is available.

You can select a preset in the `Home > Measurement configuration` tab.

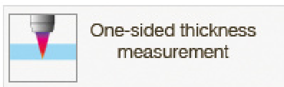
You can select a setup in the menu `Home > Measurement configuration` tab or `Settings` in the `System settings > Load & save`.

A setup can be permanently saved in the measuring system.

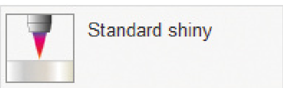
These presets allow for a quick start in the individual measuring task. Basic features to suit the target surface, such as peak and material selection and the calculation functions are already set in the preset.



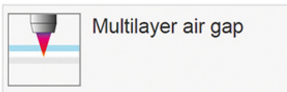
Distance measurement e.g. for ceramic material, non-transparent plastics. Highest peak, averaging, distance calculation.



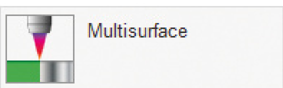
One-sided thickness measurement, e.g., for glass, BK7 material. First and second peak, averaging, thickness calculation.



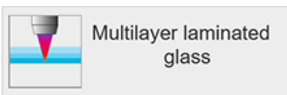
Distance measurement e.g. for metal, polished surfaces. Highest peak, median over 5 values, distance calculation.



One-sided thickness measurement[19] against glass, 1st layer BK7, 2nd layer vacuum, first and second peak, 3 measured values, median over 5 values, moving averaging over 16 values, thickness calculation.



Distance measurement e.g. for PCBs, hybrid materials. Highest peak, median over 9 values, distance calculation.



Layer thickness measurement[19] against laminated glass, e.g. windshield, 1st layer BK7, 2nd layer PC, 3rd layer BK7, 1st and 2nd peak, 4 measured values, thickness calculation, moving average over 16 values.

5.6 Video signal

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

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

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

[19] Only possible with IFD2415.

The diagram starts automatically when the website is accessed.

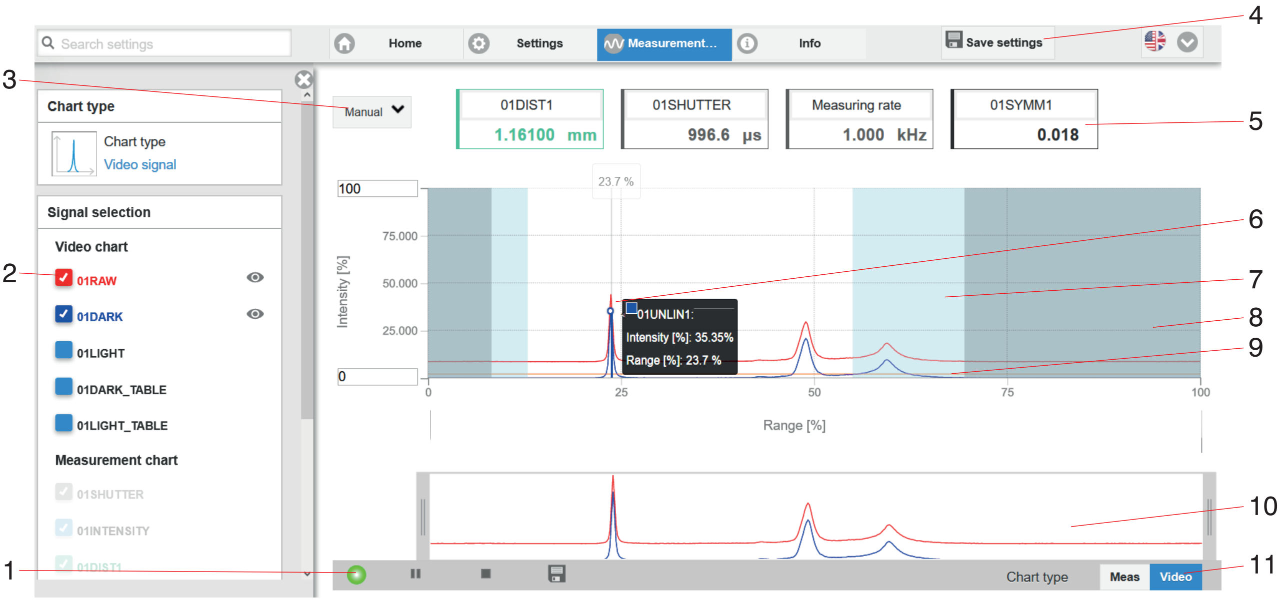


Fig. 5.2: `Video signal` *web page*

The `Video signal` website contains the following functions:

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

The data query is controlled with the `Play/Pause/Stop/Save` buttons of the measured values that were transmitted. `Stop` halts the diagram; data selection and the zoom function are still possible. `Pause` pauses the recording. `Save` opens the Windows selection dialog for the file name and the save location to save the selected video signals to a CSV file. This contains all pixels, their (selected) intensity in % and other parameters.
Click on the ► button (Start) to display the measurement results.

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

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

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

5 The current values of the exposure time and the selected measuring rate are also displayed above the graphic.

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

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

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

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

10 X axis scaling: The diagram shown above can be enlarged (zoomed in on) with the two sliders on the right and left in the lower entire signal. The overall signal can also be moved to the side using the mouse in the center of the zoom window (arrow cross).

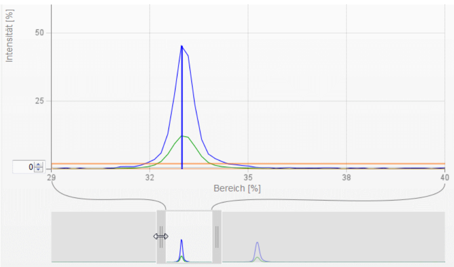


Fig. 5.3: Zooming with slider: one-sided with arrow cross

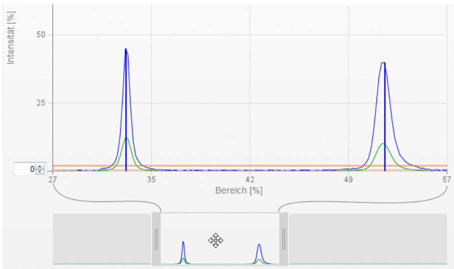


Fig. 5.4: Zooming with slider: range shift with arrow cross

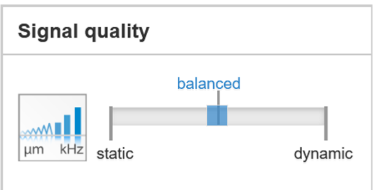
11 The two buttons allow you to switch between the display of the video signal and the measured value.

5.7 Signal quality

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

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

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



	Measuring rate	Averaging[20]
`Static`	200 Hz	Moving, 128 values
`Balanced`	1 kHz	Moving, 16 values
`Dynamic`	5 kHz	Moving, 4 values

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

5.8 Distance measurement with website display

- ► Align the sensor perpendicularly to the object to be measured.
- ► Then move the sensor (or the measuring object) closer and closer from a distance until the start of the measuring range corresponding to the sensor used is approximately reached.

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

[20] Applies for the presets Standard and One-sided thickness measurement.

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

Tab. 5.1: Meaning of LEDs during distance measurement

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

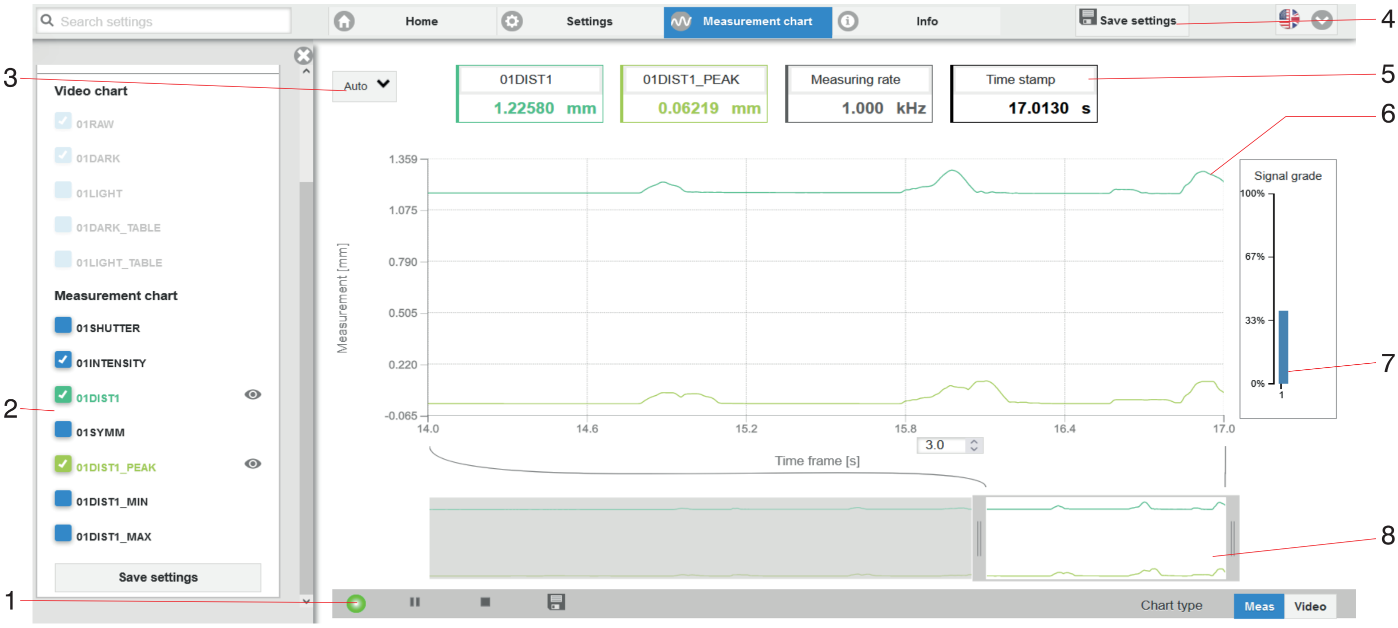


Fig. 5.5: Website `Meas` (distance measurement)

1 The LED visualizes the state of measured value transmission.

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

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

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

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

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

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

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

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

7 Peak intensity is displayed as a bar chart.

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

5.9 Save/load settings

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

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

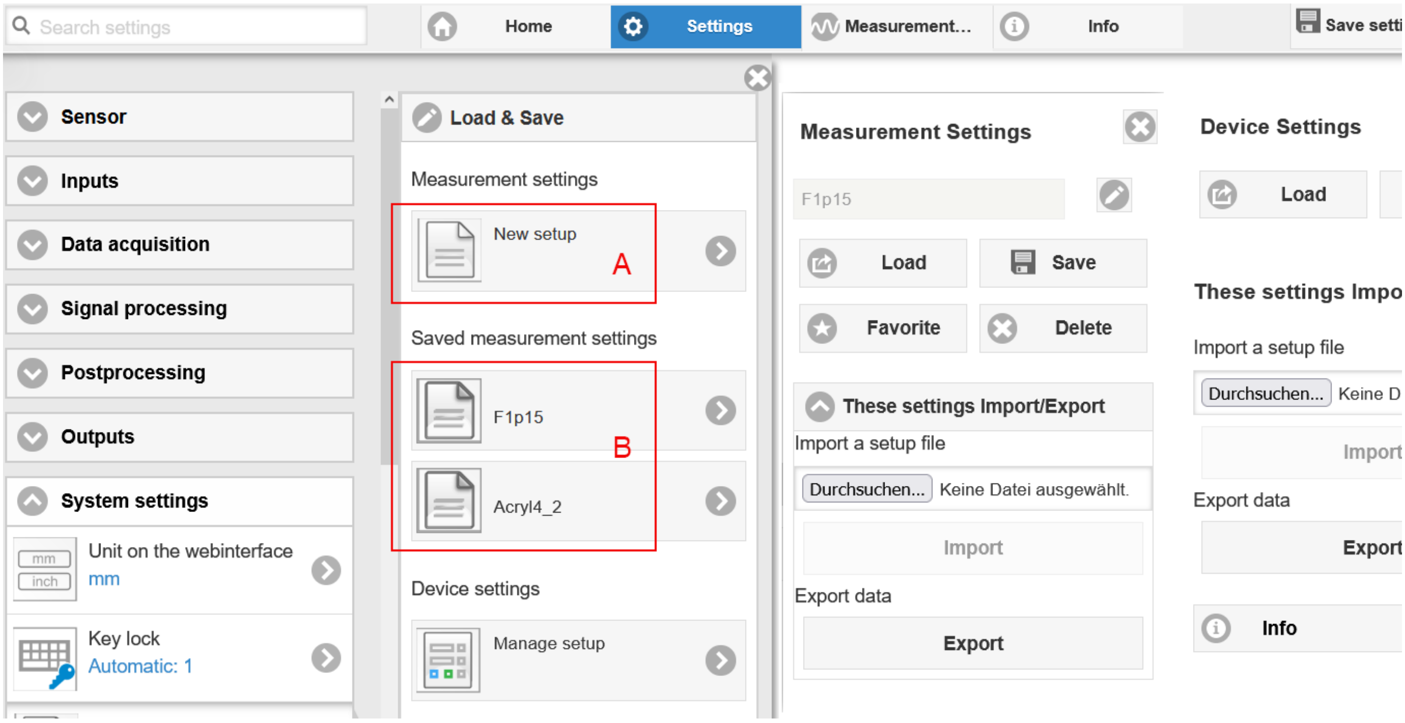


Fig. 5.6: Manage user programs

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

Manage setups in the controller, options and sequence			
Save settings	Activate existing setup	Save changes in the active setup	Determine setup after booting
Menu `New setup`, see A	Menu `Load & Save`	Menu bar	Menu `Load & Save`
Enter the name for the setup, e.g. F1p15 and confirm the entry with the `Save` button.	Click on the desired setup with the left mouse button, see B. The `Measurement settings` dialog opens. Click the `Load` button.	Click on the `Save settings` button	Click on the desired setup with the left mouse button, see B. The `Measurement settings` dialog opens. Click the `Favorite` button.

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

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

i When switching on, the last parameter set saved in the controller is loaded.

Switch setups with PC/notebook, options	
Save setup on PC	Load setup from PC
Load & Save menu	Load & Save menu
Click on the desired setup with the left mouse button, area B. The Measurement settings dialog opens. Click on the button Export.	Left-click on New setup. The Measurement settings dialog opens. Click on the button Search. A Windows dialog for file selection opens. Select the desired file and click the Open button. Click on the Import button.

5.10 Dark correction

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

Dark correction is required after:

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

The dark correction depends on the sensor and is saved separately in the controller for each measuring system. For that reason, the desired sensor must be connected before correction. For the IFD2411/2416, the sensor must be selected in the Settings > Sensor menu.

Work steps:

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

i During the dark correction, no object may be within the measuring range under any circumstances, nor may ambient light enter the sensor.

Correction using the button		Correction via software/web interface
IFD2410/2415	IFD2411/2416	Switch to the Settings > Sensor > Dark reference menu. Click on the Start button to start the correction.
Press the correct button on the IFD2410/2415 for approx. 4 s[21], to start the correction.	Press the Multifunction button on the IFC2411/2416 for approx. 4 s in order to start the correction.	

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

The dark-corrected video signal after referencing is characterized by a signal curve that is almost smooth and located directly along the X-axis.

[21] If you press this button for more than 10 seconds, the factory setting is loaded.

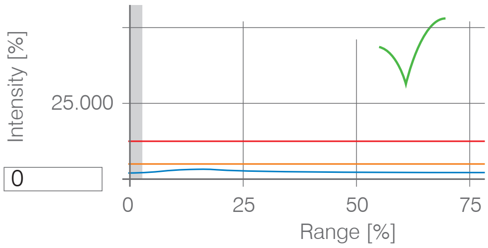
<table>
<tr><th>IFD2410/2415</th><th>Dark signal evaluation</th><th>IFD2411/2416</th></tr>
<tr><td>Remove the covering paper from the sensor. This sensor can be used normally again.</td><td>

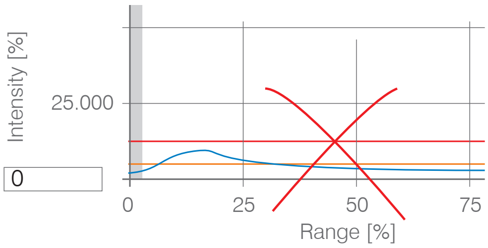
Fig. 5.7: Dark signal OK</td><td>Remove the covering paper from the sensor. This sensor can be used normally again.</td></tr>
<tr><td>Carefully clean the glass surface on the sensor.
Repeat the dark correction.</td><td>

Fig. 5.8: Dark signal too high</td><td>Carefully clean the front of the E2000 plug of the sensor cable and the socket on the controller, see Chap. 17.
Repeat the dark correction.</td></tr>
</table>

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

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

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

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

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

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

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

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

6 Setting sensor parameters, web interface

6.1 Inputs

6.1.1 Synchronization

Legend of the menu structure:

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

► In the `Settings` tab, switch to the `Inputs` menu.

Synchronization	*Master / Slave / Multifunction input 1 / Multifunction input 2*	*If multiple measuring systems are to measure the same target at the same time, the controllers can be synchronized with one another. The synchronization output of the first controller (master) controls the controllers (slaves) connected at the synchronization inputs*, see Chap. 4.2.11.1, see Chap. 4.3.12.1.
	Inactive	

If the controllers are operated by way of an EtherCAT interface, then synchronization can also be achieved without the synchronization line. You can find more details on this in the Distributed Clocks, see Chap. 8.8.2 section.

6.1.2 Encoder inputs

6.1.2.1 Overview, menu

The IFD2410/2415 and IFD 2416 support up to three encoders, see Chap. 4.2.13.

A maximum of three encoder values can be assigned to the measuring data exactly, output and also used as triggering condition. This precise assignment to the measured values is ensured by outputting exactly the encoder values that were present halfway through the exposure time of the measured value (the exposure time may vary due to the control). Tracks A and B enable direction recognition.

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

6.1.2.2 Number of encoders

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

6.1.2.3 Interpolation

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

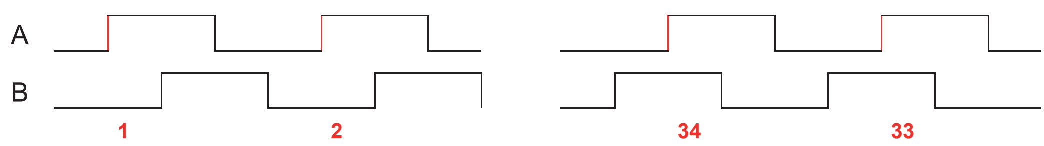


Fig. 6.1: Pulse image encoder signal, simple resolution, add (left), reduce (right)

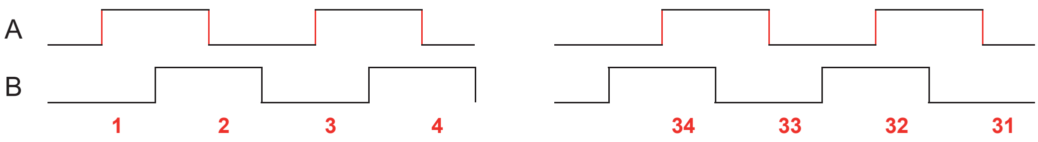


Fig. 6.2: Pulse image encoder signal, double resolution, add (left), reduce (right)

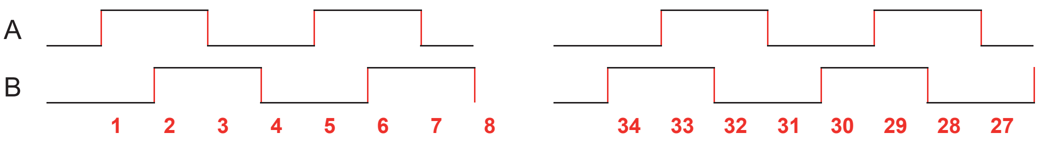


Fig. 6.3: Pulse image encoder signal, quadruple resolution, add (left), reduce (right)

6.1.2.4 Maximum value

If the encoder exceeds this maximum value, the encoder counter restarts the count at zero. This could be the pulse count of an encoder without zero pulse (reference track). The maximum counter reading before an overflow is 4294967295 (2^32-1).

6.1.2.5 Effect of reference track

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

`Set to value once for mark`. Sets the encoder counter to the defined value when the first reference marker is reached. The applicable mark is the first one after sensor/controller switch-on.

`Set for all marks`. Sets the encoder counter to the start value in the case of all marks.

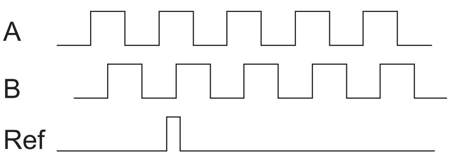


Fig. 6.4: Reference signal of an encoder

The reference track is not available when using a third encoder.

6.1.2.6 Set to value

This function sets the encoders to this value

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

The starting value must be lower than the maximum value and should not exceed 4.294.967.294 (2^32-2).

6.1.2.7 Reset reference marker

Resets the reference marker detection.

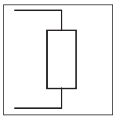
6.1.3 Level function inputs

The level must be selected for the inputs:

- Synchronization
- Multifunction

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

6.1.4 Terminating resistor



The terminating resistor at the Sync/Trig synchronization input is switched on or off to avoid reflections.
ON: with terminating resistor
OFF: no terminating resistor

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

6.2 Data recording

6.2.1 Measuring rate

IFD2410/2411: The measuring rate can be set continuously in a range from 0.1 kHz to 8 kHz. The increment is 1 Hz.

IFD2415/2416: The measuring rate can be set continuously in a range from 0.1 kHz to 25 kHz. The increment is 1 Hz.

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

► Select the required measuring rate.

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

Procedure:

► Position the target in the mid of the measuring range, see Fig. 6.5. Keep adjusting the measuring rate until you get a high signal intensity that is not saturated.

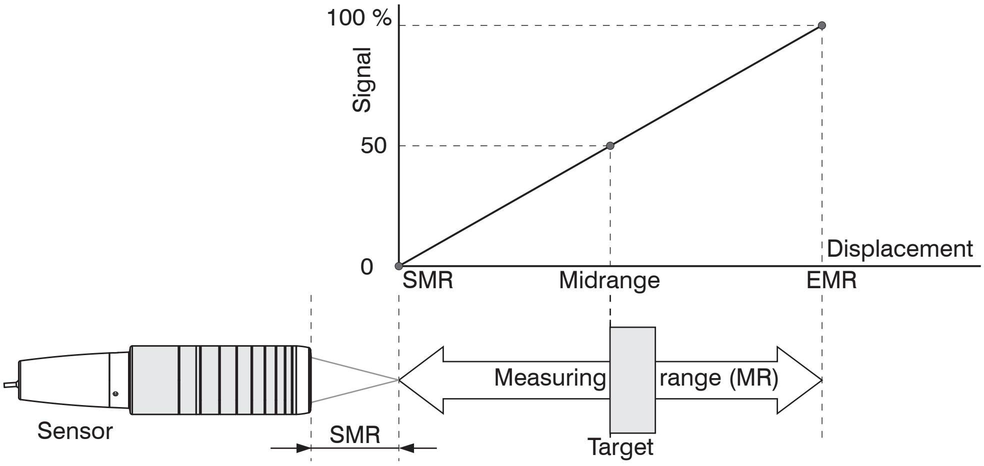


Fig. 6.5: Definition of measuring range and output signal

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

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

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

► Select the measuring rate so that the `Intensity` LED lights up green.

► If necessary, change the exposure mode, use the `Manual mode`, see Chap. 6.2.5.

► Use the required measuring rate and adjust the exposure time. Otherwise, the exposure time defines the possible measuring rate.

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

6.2.2 Triggering for Data Acquisition

6.2.2.1 General

The data recording on the confocalDT IFD241x can be controlled using an external electrical trigger signal or commands.

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

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

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

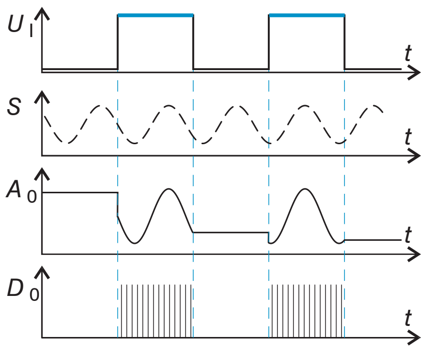


Fig. 6.6: Triggering with active high level (U_I), associated analog signal (A_O) and digital signal (D_O)

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

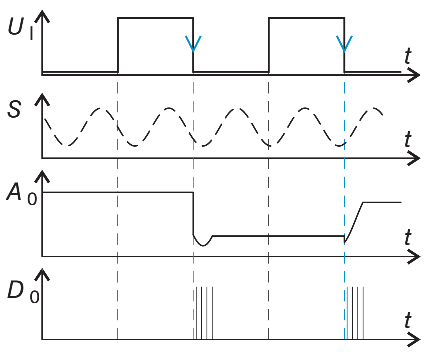


Fig. 6.7: Triggering with falling edge (U_I), associated analog signal (A_O) and digital signal (D_O)

`Software triggering`. Starts the data acquisition as soon as a software command is issued (instead of using the trigger input) or the `Initiate trigger` button is pressed.

`Encoder triggering`. Starts the data acquisition with Encoder 1.

6.2.2.2 Triggering data acquisition

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

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

6.2.2.3 Trigger time difference

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

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

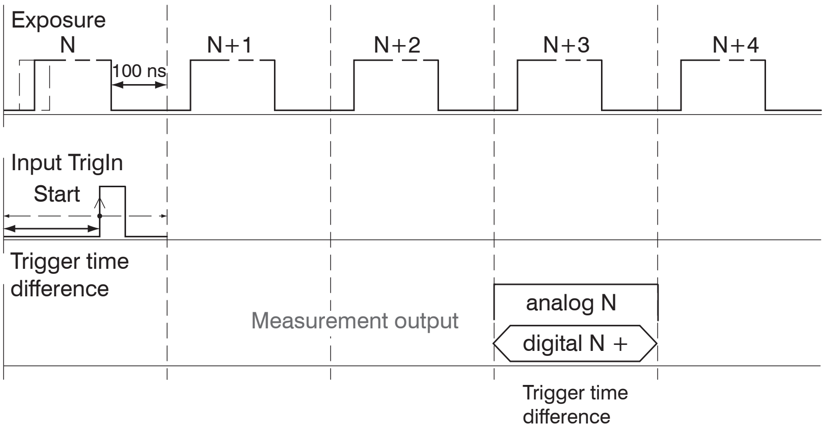


Fig. 6.8: Definition of the trigger time difference

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

6.2.3 Reset measurement counter

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

6.2.4 Masking the region of interest

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, a peak is detected only if it is completely within the masked area, i. e., above the threshold. This can reduce the measuring range.

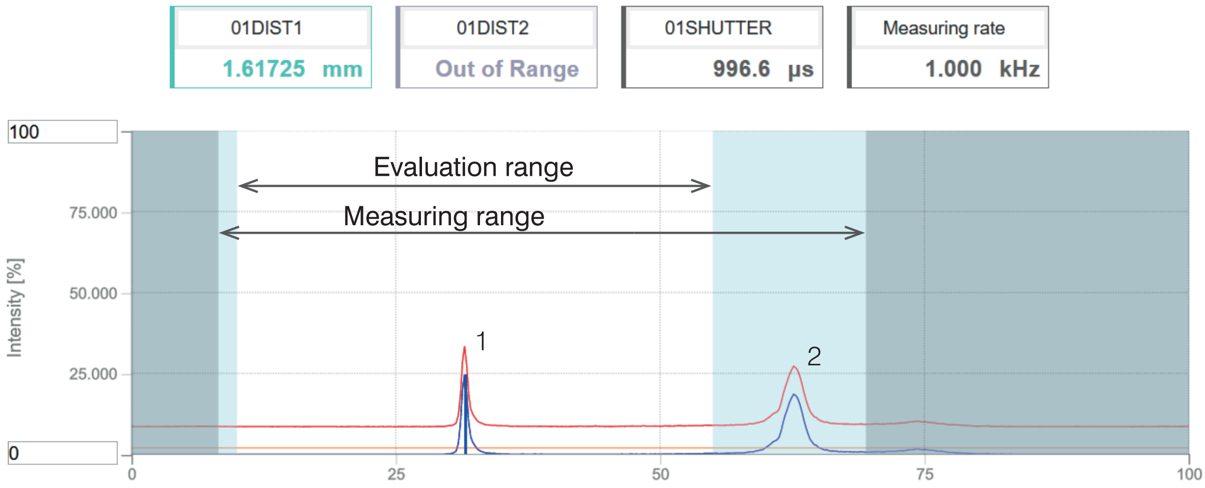


Fig. 6.9: Limiting the video signal used

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

6.2.5 Exposure mode

Measurement mode		
Manual mode	Exposure time 1 in µs	*IFD2410/2411: Value (3 µs ... 10,000 µs)* *IFD2415/2416: Value (3 µs ... 10,000 µs)*
Alternating two-time mode	Exposure time 1 in µs	*IFD2410/2411: Value (3 µs ... 10,000 µs)* *IFD2415/2416: Value (3 µs ... 10,000 µs)*
	Exposure time 2 (shorter) in µs	*Value (value is lower than exposure time 1)*
Automatic two-time mode	Exposure time 1 in µs	*IFD2410/2411: Value (3 µs ... 10,000 µs)* *IFD2415/2416: Value (3 µs ... 10,000 µs)*
	Exposure time 2 (shorter) in µs	*Value (value is lower than exposure time 1)*

► Select the desired exposure type.

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

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

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

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

6.2.6 Peak separation

6.2.6.1 Peak modulation

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

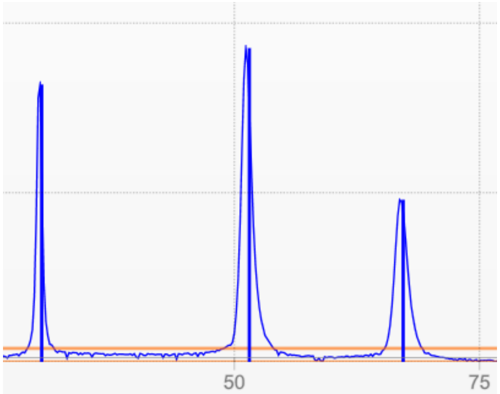


Fig. 6.10: Separated peaks: measurement possible

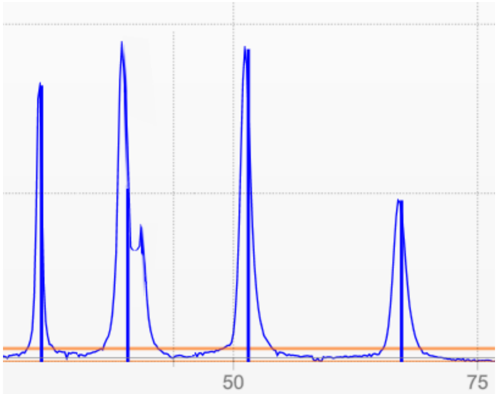


Fig. 6.11: Peaks interlocking: probable measurement uncertainty

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

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

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

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

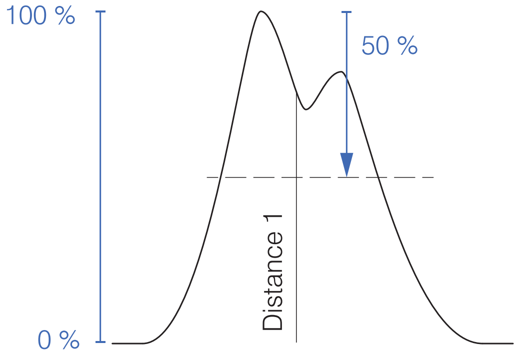


Fig. 6.12: Example 1 for peak modulation

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

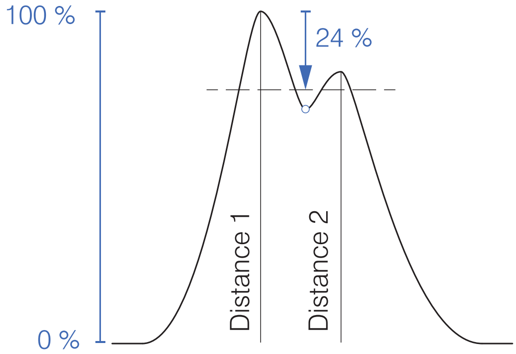


Fig. 6.13: Example 2 for peak modulation

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

6.2.6.2 Detection threshold

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

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

Defining the detection threshold.

- For very weak signals typical of extremely high measuring rates, choose a low detection threshold, as only signal parts above this threshold will be included in the calculation.

- In general, set the threshold high enough to prevent any interfering video signal peaks from being detected.

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

6.2.7 Number of peaks, peak selection

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

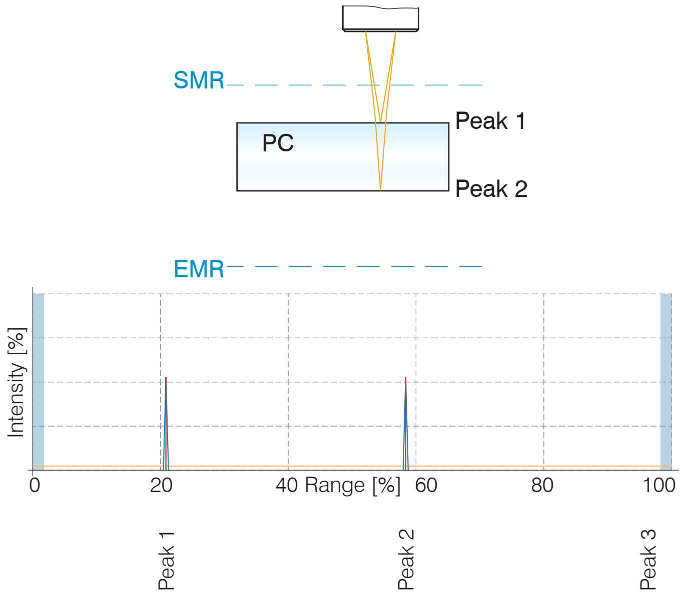


Fig. 6.14: Transparent measuring object with one layer

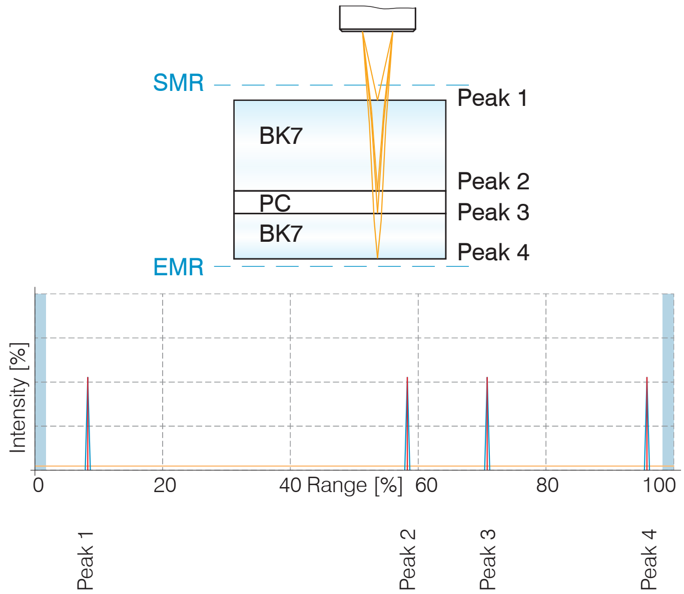
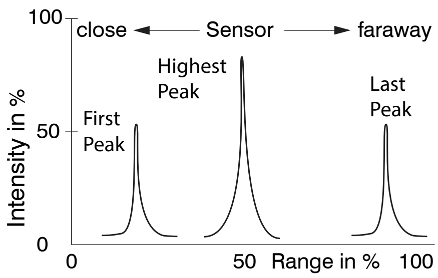


Fig. 6.15: Transparent measuring object with three layers

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

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

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

Peak selection	*First peak / Highest peak / Last peak*	*Defines which signal in the line signal is used for the evaluation.* *First peak: Nearest peak to sensor.* *Highest peak: Standard, peak with the highest intensity.* *Last peak: Peak furthest away from sensor.* 

IFD2410/2411	IFD2415/2416	Measurement values	Peak selection
•	•	1 measurement value	First peak / Highest peak / Last peak
•	•	2 measurement values	First and second peak / First and last peak / Highest and second highest peak / Last peak and second to last peak
	•	3 measurement values	Individual
	•	4 measurement values	Individual
	•	5 measurement values	Individual
	•	6 measurement values	Individual

Tab. 6.1: Options for peak selection

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

The refractive index correction is performed with the standard setting. However, if more than two peaks are within the measuring range, an exact refractive index correction is performed with the same amount of peaks only. If, for example, the first or last peak of 3 peaks sometimes leaves the measuring range, it is better to switch off the refractive index correction. Otherwise the refractive index correction would apply to the wrong layer and the material assignment becomes ambiguous.

6.2.8 Material selection

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

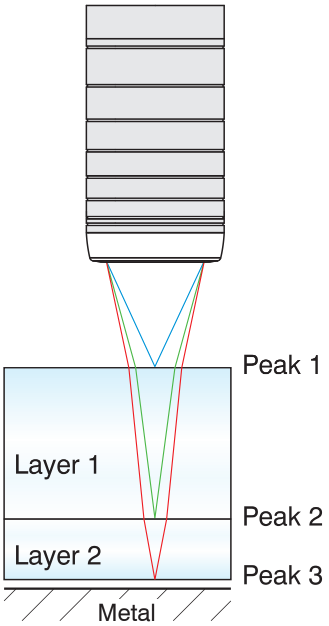
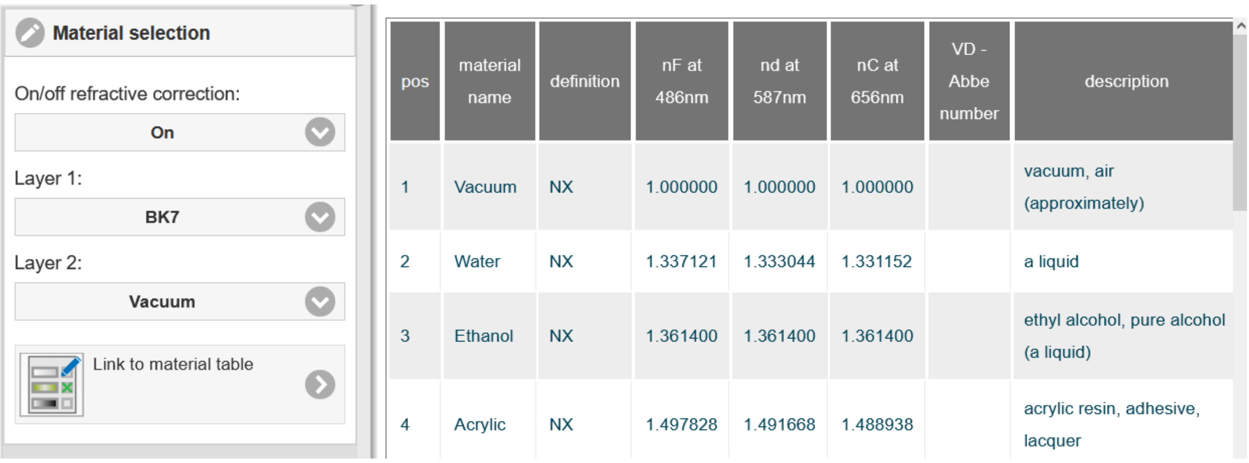


Fig. 6.16: Layer structure of a target

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

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

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



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

Fig. 6.17: Selection of material-specific refractive indices

6.3 Signal processing, calculation

6.3.1 Data source, parameters, calculation programs

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

`Thickness`	Calculating the difference	Two signals or results, Signal distance B < Signal distance A
`Formula`	Distance A - Distance B	

`Calculation`	Summation	Two signals or results
`Formula`	Factor 1 * Distance A + Factor 2 * Distance B + Offset	

`Median`	Sorts the measurement values and outputs the mean value as the median.

`Moving average`	Forms the arithmetic average

`Recursive average`	Each new measured value is weighted and added to the sum of the previous average values

`Duplicate`	Creates a copy of a signal

Sequence for creating a calculation block.

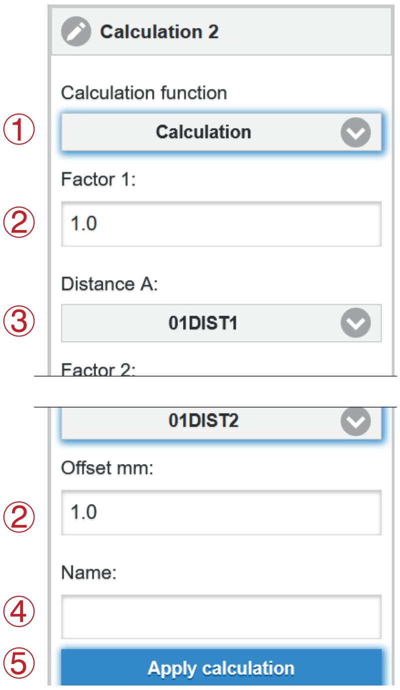


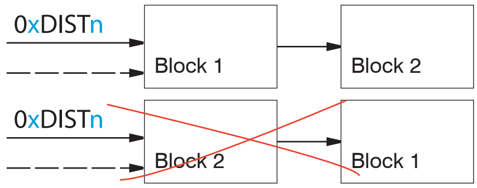
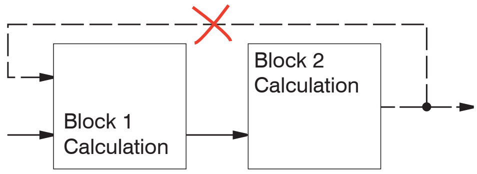
Fig. 6.18: Sequence for the program selection

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

The programs Calculation and Thickness have two data sources. The Averaging and Duplicate programs each have one data source.

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

6.3.2 Definitions

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

6.3.3 Averaging

6.3.3.1 Allgemein

Die Messwertmittelung erfolgt nach der Berechnung der Messwerte und vor der Ausgabe über die Schnittstellen oder deren Weiterverarbeitung.

Durch die Messwertmittelung wird

- die Auflösung verbessert,
- das Ausblenden einzelner Störstellen ermöglicht oder
- das Messergebnis „geglättet“.

i	Das Linearitätsverhalten wird mit einer Mittelung nicht beeinflusst. Die Mittelung hat keinen Einfluss auf die Messrate bzw. Ausgaberate. Der eingestellte Mittelwerttyp und die Anzahl der Werte müssen im Controller gespeichert werden, damit sie nach dem Ausschalten erhalten bleiben.

Der Controller wird ab Werk mit der Voreinstellung „gleitende Mittelung, Mittelwerttiefe = 16“, d. h. mit Mittelwertbildung ausgeliefert.

Messwertmittelung definieren

► Wechseln Sie in den Reiter `Einstellungen` > `Signalverarbeitung` > `Rechnung`.

► Make the desired settings and confirm them by pressing `Save settings`.

6.3.3.2 Moving mean

Moving mean

The arithmetic average M_{mov} is calculated and output using the selectable filter width N of consecutive measurement values. Each new measured value is added, and the first (oldest) value is removed from the averaging (from the window).

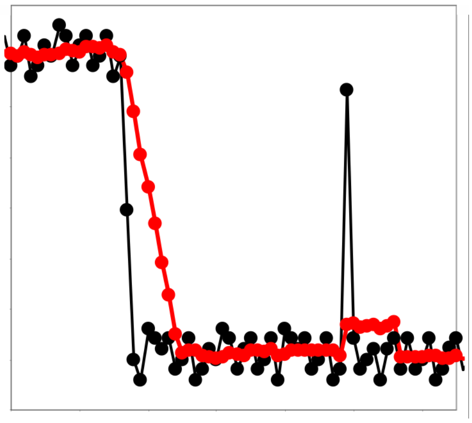
$$M_{mov} = \frac{\sum_{k=1}^{N} MV(k)}{N}$$	*MW* = measured value
	N = averaging value
	k = continuous index (in the window)
	M_{mov} = average value or output value

This produces short settling times in case of measurement jumps.

Example: N=4

... 0, 1, $\underbrace{2, 2, 1, 3}$	... 1, 2, $\underbrace{2, 1, 3, 4}$	Measured values
$\frac{2, 2, 1, 3}{4} = M_{mov}(n)$	$\frac{2, 1, 3, 4}{4} = M_{mov}(n+1)$	Output value

Note	For the moving average, only powers of 2 are permitted for the averaging number *N*. The highest averaging value is 1024.



Application tips

- Smoothing of measured values
- In contrast to recursive averaging, the effect can be finely controlled.
- With uniform noise of the measured values without spikes
- In the case of a slightly rough surface whose roughness is to be eliminated.
- Also suitable for measured value jumps with relatively short settling times

Signal without averaging

Signal with averaging

Tab. 6.2: Moving average, N = 8

6.3.3.3 Recursive average

Recursive average

Each new measured value *MW*(n) is weighted and added to (n-1) times the previous average value.

Formula:

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

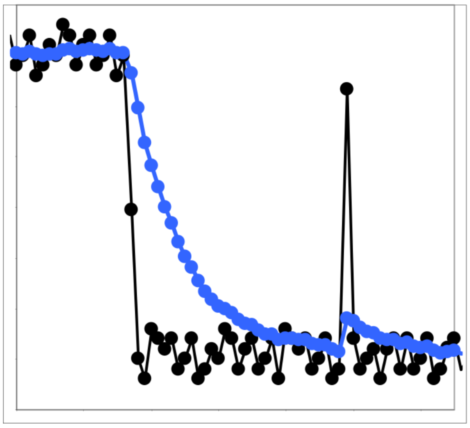
N = averaging number, *N* = 1 ... 32767

n = measured value index

MW = measurement value

M_{rec} = mean value or output value

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



Application tips

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

—— Signal without averaging

—— Signal with averaging

Tab. 6.3: Recursive average, N = 8

6.3.3.4 Median

Median

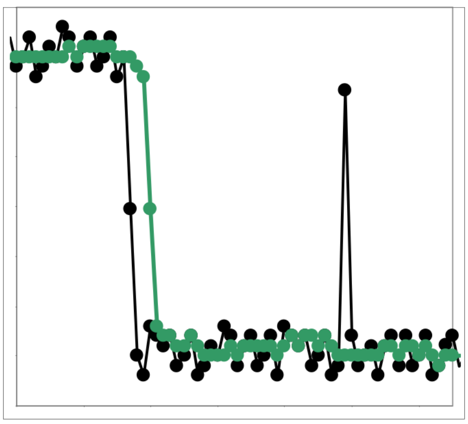
A median value is formed from a preselected number of measured values.

When creating a median value for the controller, incoming measured values are sorted after each measurement. The middle value is then output as the median.

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 from measurement values

... 0 1 $\underline{2\ 4\ 5\ 1\ 3}$ → Sorted measurements: 1 2 $\boxed{3}$ 4 5 Median$_{(n)}$ = 3
... 1 2 $\underline{4\ 5\ 1\ 3\ 5}$ → Sorted measurements: 1 3 $\boxed{4}$ 5 5 Median$_{(n+1)}$ = 4



Application tips

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

—— Signal without averaging

—— Signal with averaging

Tab. 6.4: Median, N = 7

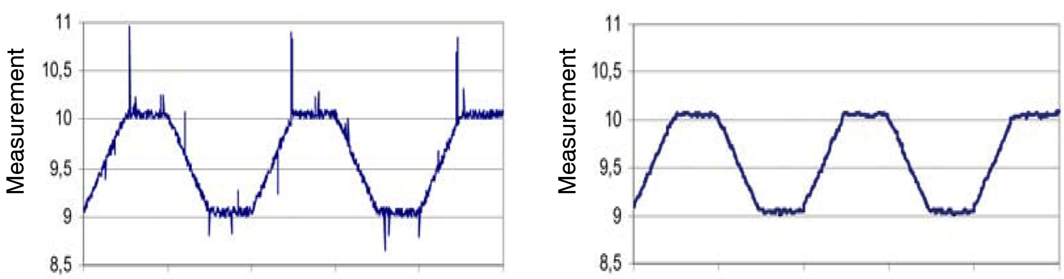


Fig. 6.19: Signal profile without median (left), with median N = 9 (right)

6.4 Post-Processing

6.4.1 Zeroing, mastering

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

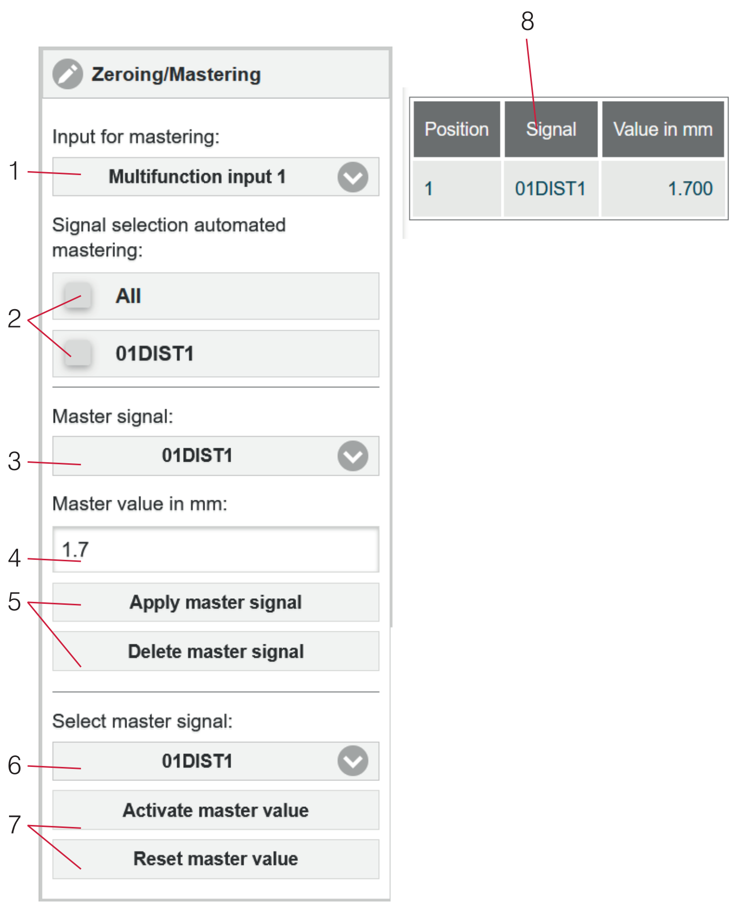
Master value in mm	*Value*	*Specify the thickness (or other parameter) of a master object.* *Value range: -2147.0 ... +2147.0 mm*

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

The measured value provided at the controller output when measuring a master object is the `Master value`. Zeroing is a special feature of mastering, since the master value is “0” here.

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

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



1 Trigger or undo mastering via multifunction inputs MFI 1/2 through an external source.
2 Selection of signals to be mastered via the multifunction inputs (1).
3 Overview of all existing signals for the function. Selection of a signal to assign the master value with (4) and (5).
4 Enter master value.
5 Button for saving or deleting a signal (3).
6 Apply selection of a specific signal or master to all defined signals (8).
7 Start or stop function for signal (6) via software.
8 Overview of all existing signals and their master value for the function.

Fig. 6.20: Mastering dialog, overview of individual master values

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

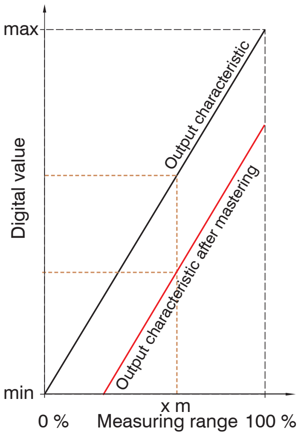


Fig. 6.21: Moving the characteristic during mastering

Mastering / zeroing:

- Place measuring object and sensor into their desired positions to one another.
- Define the `Master value`, web interface/ASCII.

After setting the master, the controller will issue new readings that relate to the master value. By resetting with the `Reset master value` button, the status before mastering is restored.

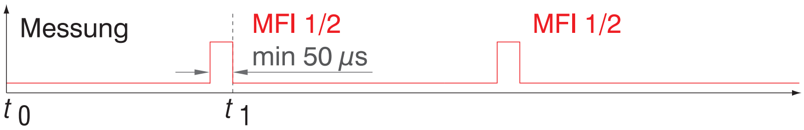


Fig. 6.22: Flowchart for zeroing, mastering (Multifunction key)

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

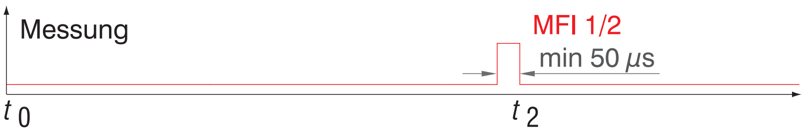


Fig. 6.23: Flowchart for resetting zeroing, mastering

6.4.2 Statistics

The measuring system derives the following statistical values from the result of the measurement:

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

Statistical values are calculated from measured values within the region of interest. The region of interest is reset for each new measured value. The statistical values are displayed via the web interface in the `Measurement chart`, or are output via the interfaces.

The statistical values are not channel-specific. The controller can manage up to 3 statistic signals. These 3 signals can be applied to any internally determined value, including calculated values.

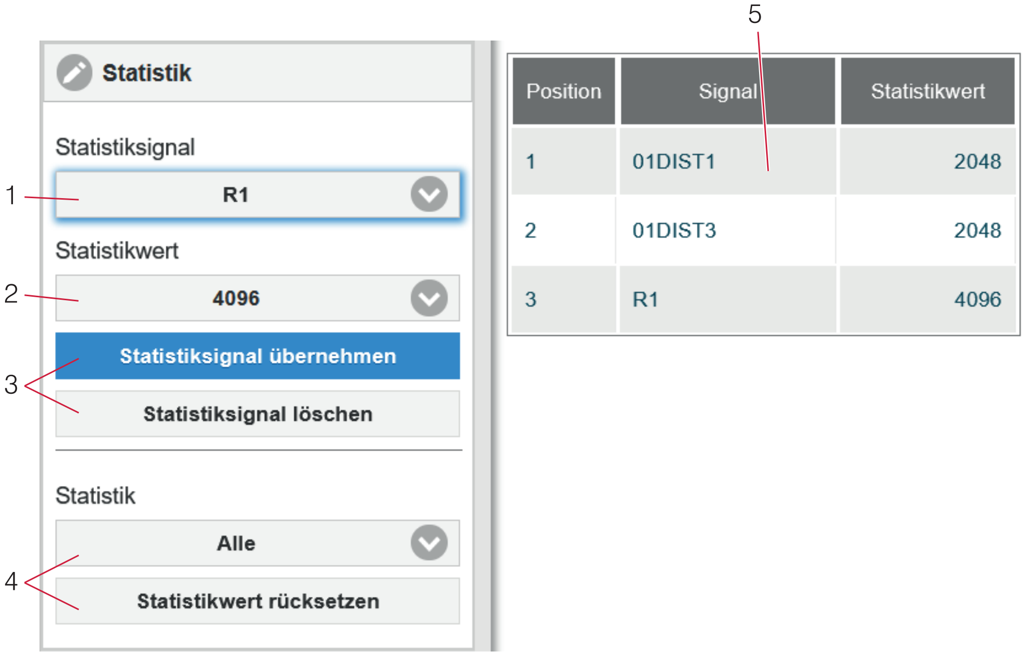


Fig. 6.24: Statistics dialog, overview of the individual statistic signals

1 The `Reset statistic value` button can be used to reset a specific signal or all statistics signals and thus initiate a new evaluation cycle (storage period). When a new cycle starts, previous statistical values are deleted.

2 Deletes a signal

3 Number of measurement values based on which minimum, maximum and peak-to-peak are determined for a signal. The range of values used for calculation can be between 2 and 8192 (in powers of 2) or include all measured values.

4 Selects a signal for the function

5 Overview of all existing signals for the function.

Sequence for creating a statistical evaluation:

- ► Change to the tab `Settings` > `Postprocessing` > `Statistics`.
- ► Choose a signal (4) for which the statistical values should be calculated.
- ► Define the region of interest via the `Statistic value`.

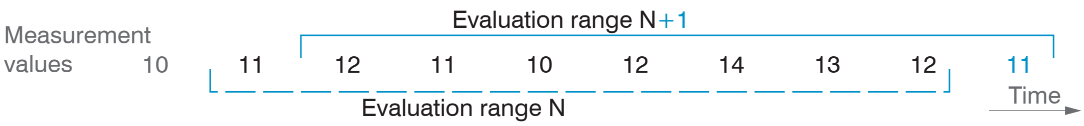


Fig. 6.25: Dynamic updating of the region of interest via the measured values, statistical value = 8

6.4.3 Data reduction, output data rate

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

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

6.4.4 Error handling (hold last value)

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

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

6.5 Outputs

6.5.1 Interface RS422

The RS422 interface has a maximum baud rate of 4000 kBaud. The baud rate is set to 115.2 kBaud when the interface is delivered. Use ASCII commands or the web interface to configure.

Transfer settings for controller and PC must match.

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

The RS422 interface transmits 18 bits per output value.

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

Parallel output of measuring data is not possible via RS422 and EtherCAT.

6.5.2 Ethernet setup mode

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

In Ethernet setup mode

- EtherCAT communication is not possible,
- RS422-communication and data transmission are possible.

Ethernet setup mode is used to configure the IFD241x via web interface.

6.5.3 RS422

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

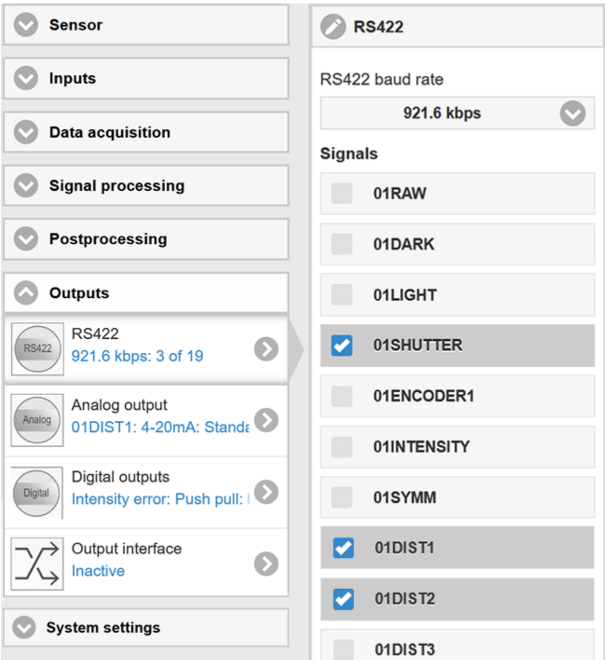


Fig. 6.26: Interface selection

6.5.4 Analog output

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

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

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

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

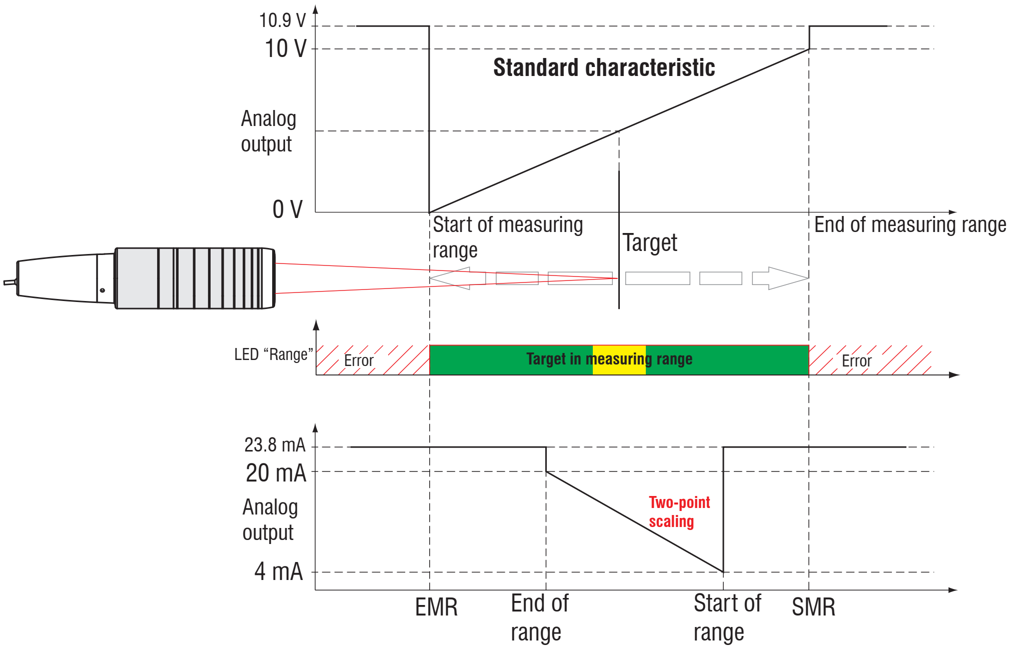


Fig. 6.27: Scaling the analog signal

6.5.4.1 Calculating measured value from current output

Current output (without mastering, without two-point scaling)		
Variables	**Value range**	**Formula**
I_{OUT} = Current [mA]	[3.8; <4] SMR reserve [4; 20] Measuring range [>20; 20.2] EMR reserve	$d\,[\mathrm{mm}] = \dfrac{(I_{OUT}\,[\mathrm{mA}] - 4)}{16} * MR\,[\mathrm{mm}]$
MR = Measuring range [mm]	{1/2/3/6/10}	
d = Distance [mm]	[-0.01MR; 1.01MR]	

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

6.5.4.2 Calculating measured value from voltage output

Voltage output (without mastering, without two-point scaling)		
Variables	**Value range**	**Formula**
V_{OUT} = voltage [V]	[-0.05; <0] SMR reserve [0; 5] Measuring range [>5; 5.05] EMR reserve	$d = \dfrac{V_{OUT}}{5} * MR$
	[-0.1; <0] SMR reserve [0; 10] Measuring range [>10; 10.1] EMR reserve	$d = \dfrac{V_{OUT}}{10} * MR$
MR = Measuring range [mm]	{1/2/3/6/10}	
d = Distance [mm]	[-0.01*MR*; 1.01*MR*]	

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

6.5.5 Data output

Output interfaces	RS422 / analog output / switching output	Specifies the interface used for outputting the measured value. The measured values are output in parallel via the interfaces selected.

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

6.6 System Settings

6.6.1 Web interface unit

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

6.6.2 Key lock

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

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

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

6.6.3 Loading and Saving

This chapter describes how to save a setup with either measurement settings or with device settings. Here you can also find the functions for setup import and setup export, see Chap. 5.9.

6.6.4 Access authorization, login, logout

Assigning passwords prevents unauthorized changes to settings. The password protection is disabled in the delivery condition and the `Professional` level is active. When the configuration has been completed, you should enable password protection. The standard password for the Professional level is “000”.

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

Users have the following functions available:

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

Tab. 6.5: Rights in the user hierarchy

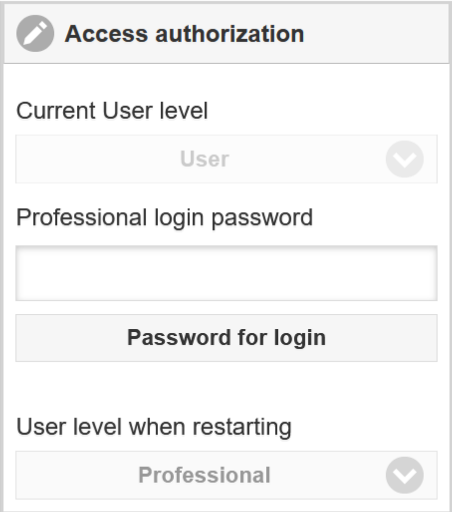


Fig. 6.28: Changing to Professional level

Changing to Professional level

- Switch to the tab `Settings` > `System settings` > `Access authorization`.
- Enter the standard password “000” or a custom password into the `Professional login password` box, and click `Password for login`.

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

Password	*Value*	*All passwords are case-sensitive; numbers are allowed. Special characters are not permitted.*
User level on re-start	*User / Professional*	Defines the user level that is enabled after restart. Micro-Epsilon recommends the selection Professional here.

6.6.5 Reset System

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

Device settings	*The settings for the following commands are reset to the factory settings:* *ANALOGRANGE, BAUDRATE, ECHO, KEYLOCK, LED.* *The operating mode is not affected by the device settings.*
Measurement settings	*Resets the preset to* `Standard matt` *and all parameters, except for interface settings, to the factory setting.*
Reset material database	*All settings for the materials table are set to factory setting.*
Reset all	*Resets the device and measurement settings to factory settings.*
Reboot sensor	*Starts the system with the last saved settings.*

6.6.6 Light source

You can switch the light source for the system on or off. You can switch the light source for the system on or off. This can be done via software or with the multifunctional inputs MFI1/2.

6.6.7 Boot mode

This setting determines the connection protocol when the system is started. EtherCAT is standard. To parameterize the measuring system via web interface, the IFD241x can optionally be operated in Ethernet setup mode. Save the current settings before switching to EtherCAT. The switch only becomes active after the system has been restarted.

Switching between Ethernet setup mode and EtherCAT is also possible via an ASCII command, see Chap. 18.3.16.2. The selected operating mode is loaded, then the IFD241x is automatically restarted. The measuring system must not be disconnected from the power supply during this time. If the selected boot mode is already active, no action will be executed.

The RS422 interface for sending an ASCII command is available both in Ethernet setup mode and in EtherCAT mode.

7 Thickness measurement, one-sided transparent measuring object

7.1 Requirement

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

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

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

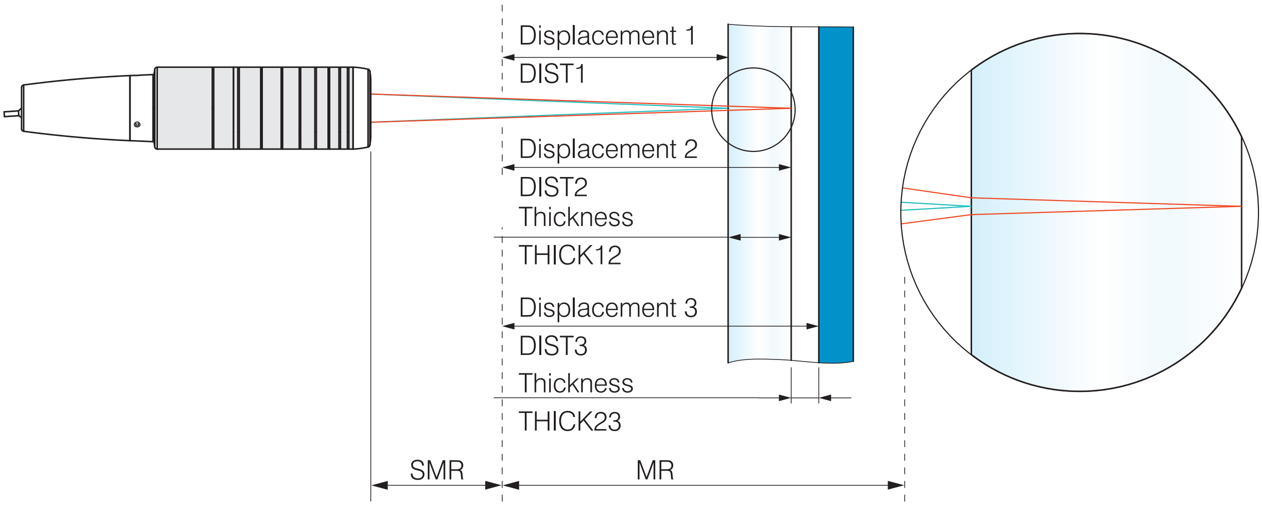


Fig. 7.1: One-sided thickness measurement on a transparent target

SMR	Start of measuring range
MR	Measuring range
Minimum target thickness	Technical data confocalDT IFD2410/2415 and Technical data confocalDT IFD2411
Maximum target thickness	

7.2 Preset

confocalDT IFD2415/2416	confocalDT IFD2410/2411
Switch to the `Home` menu.	
Choose `Multilayer airgap` in the configuration selection.	Choose `One-sided thickness measurement` in the configuration selection.

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

`Calculation 1` in controller: `thickness` Difference between `DIST2` and `DIST1`	`Calculation 1` in controller: `thickness` Difference between `DIST2` and `DIST1`

`Calculation 2` in controller: `thickness` Difference between `DIST3` and `DIST2`	---

7.3 Material selection

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

- Switch to the menu `Settings` > `Data acquisition` >`Material selection`.
- Select the material of the measuring object for `Layer 1` and possibly `Layer 2`.

7.4 Video signal

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

Two boundary surfaces are active when the thickness of a transparent material is measured. As a result, two peaks are visible in the video signal, see Fig. 7.2.

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

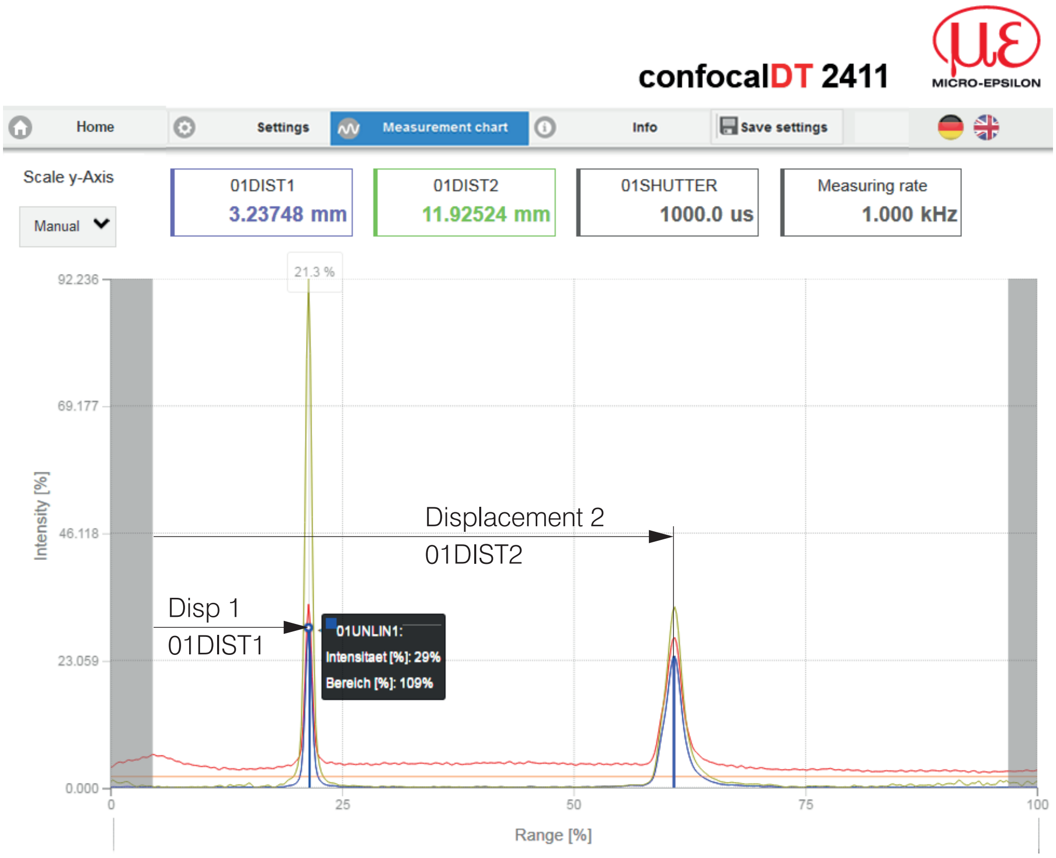


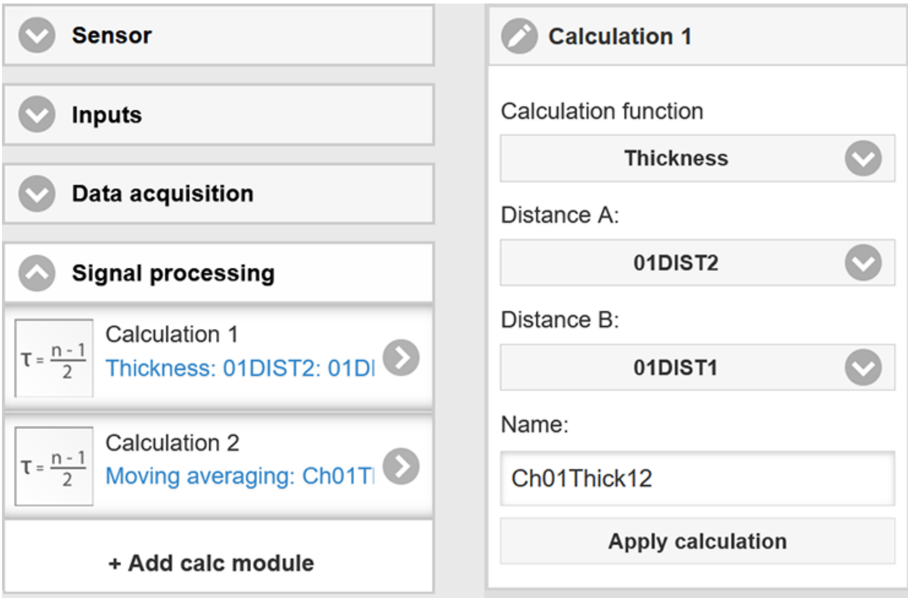
Fig. 7.2: Video signal website, one-sided thickness measurement

7.5 Signal processing

The configuration selection `One-sided thickness measurement` also contains presettings for the thickness calculation from the two distance signals `Displacement1` and `Displacement2`, see Fig. 7.2.

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

- Adapt the signal processing to your measurement task.



7.6 Measurement chart

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

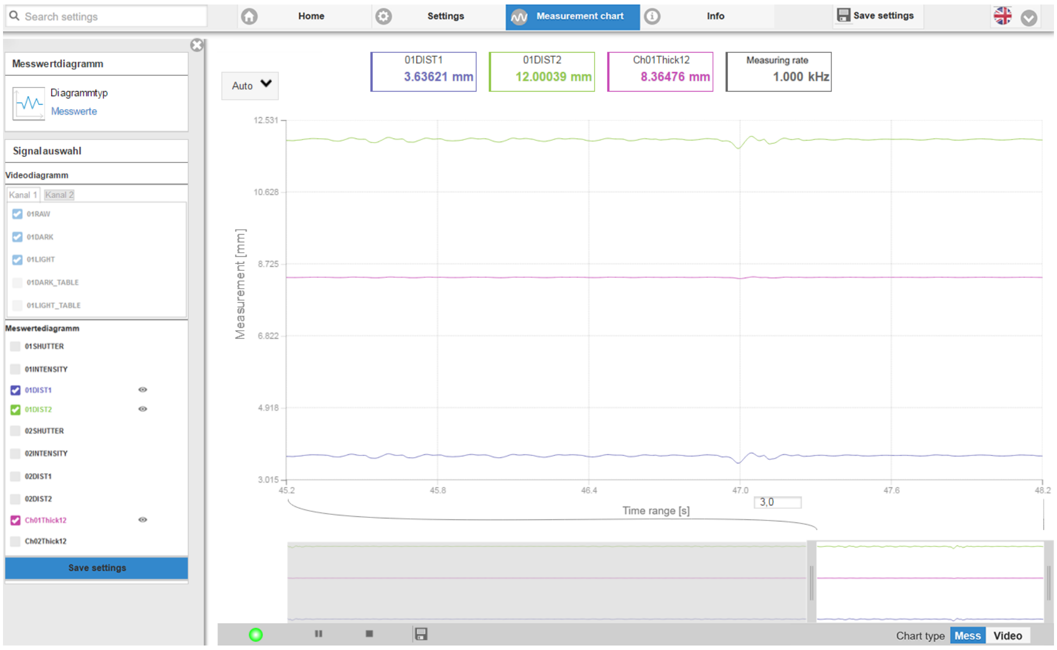


Fig. 7.3: Measured thickness results based on a one-sided thickness measurement with one sensor

The two distances and the thickness (difference between `01DIST2` and `01DIST1`) are shown graphically and numerically on the website, and the intensities for both peaks (Peak 1 = near, Peak 2 = far) can also be displayed as an option.

8 EtherCAT documentation

8.1 General

From an Ethernet point of view, EtherCAT® is an individual large Ethernet device that sends and receives Ethernet telegrams. An EtherCAT system like this consists of an EtherCAT master and up to 65535 EtherCAT slaves.

Master and slaves communicate via standard Ethernet cabling. On-the-fly processing hardware is used in each slave. The incoming Ethernet frames are processed by the hardware directly. The relevant data is extracted from the frame or inserted. The frame is then sent on to the next EtherCAT® slave device. The fully processed frame is returned from the last slave device. Various protocols can be used at the application level. CANopen over EtherCAT technology (CoE) is supported here. An object dictionary structure with service data objects (SDO) and process data objects (PDO) is used to manage the data in the CANopen protocol. Further information can be obtained from ® Technology Group (www.ethercat.org) or Beckhoff GmbH, (www.beckhoff.com).

8.2 Introduction

8.2.1 Structure of EtherCAT® Frames

The data in Ethernet frames is transmitted with a special Ether type (0x88A4). An EtherCAT® frame like this consists of one or more EtherCAT® telegrams, each of which is addressed to individual slaves / storage areas. The telegrams are transmitted either 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 has exchanged the associated data.

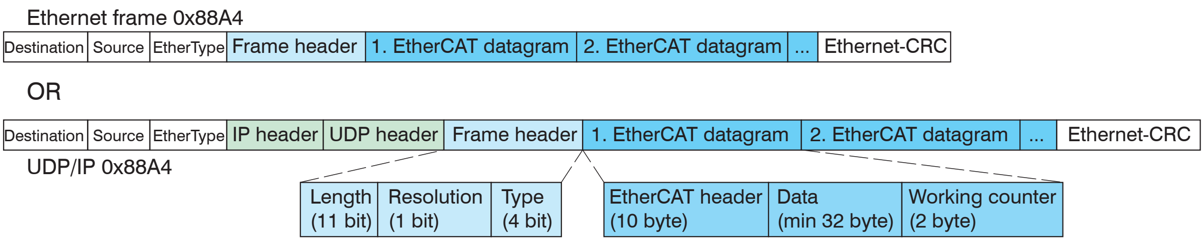


Fig. 8.1: Structure of EtherCAT frames

8.2.2 EtherCAT® services

In EtherCAT®, services are specified for reading and writing data in the physical memory within 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 (Auto-Increment Physical Write, writing of a physical area with auto-increment addressing)
- APRW (Auto-Increment 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)

8.2.3 Adressierverfahren und FMMUs

Um einen Slave im EtherCAT®-System zu adressieren, können vom Master verschiedene Verfahren angewendet werden. Der Sensor/Controller unterstützt als Full-Slave:

- Positionsadressierung

  Das Slave-Gerät wird über seine physikalische Position im EtherCAT®-Segment adressiert. Die verwendeten Dienste hierfür sind APRD, APWR, APRW.
- Knotenadressierung

  Das Slave-Gerät wird über eine konfigurierte Knotenadresse adressiert, die vom Master während der Inbetriebnahmephase zugewiesen wurde. Die verwendeten Dienste hierfür sind FPRD, FPWR und FPRW.
- Logische Adressierung

  Die Slaves werden nicht einzeln adressiert; stattdessen wird ein Abschnitt der segmentweiten logischen 4-GB-Adresse adressiert. Dieser Abschnitt kann von einer Reihe von Slaves verwendet werden. Die verwendeten Dienste hierfür sind LRD, LWR und LRW.

Die lokale Zuordnung von physikalischen Slave-Speicheradressen und logischen segmentweiten Adressen wird durch die Fieldbus Memory Management Units (FMMUs) vorgenommen. Die Konfiguration der Slave-FMMU's wird vom Master durchgeführt. Die FMMU Konfiguration enthält eine Startadresse des physikalischen Speichers im Slave, eine logische Startadresse im globalen Adressraum, Länge und Typ der Daten, sowie die Richtung (Eingang oder Ausgang) der Prozessdaten.

8.2.4 Sync Manager

Sync-Manager dienen der Datenkonsistenz beim Datenaustausch zwischen EtherCAT®-Master und Slave. Jeder Sync-Manager-Kanal definiert einen Bereich des Anwendungsspeichers. Der Sensor/Controller besitzt vier Kanäle:

- Sync-Manager-Kanal 0: Sync Manager 0 wird für Mailbox-Schreibübertragungen verwendet (Mailbox vom Master zum Slave).
- Sync-Manager-Kanal 1: Sync Manager 1 wird für Mailbox-Leseübertragungen verwendet (Mailbox vom Slave zum Master).
- Sync-Manager-Kanal 2: Sync Manager 2 wird normalerweise für Prozess-Ausgangsdaten verwendet. Wird nicht benutzt.
- Sync-Manager-Kanal 3: Sync Manager 3 wird für Prozess-Eingangsdaten verwendet. Er enthält die Tx PDOs, die vom PDO-Zuweisungsobjekt 0x1C13 (hex.) spezifiziert werden.

8.2.5 EtherCAT-Zustandsmaschine

In jedem EtherCAT®-Slave ist die EtherCAT®-Zustandsmaschine implementiert. Direkt nach dem Einschalten des Sensors/Controllers befindet sich die Zustandsmaschine im Zustand "Initialization". In diesem Zustand hat der Master Zugriff auf die DLL-Information Register der Slave Hardware. Die Mailbox ist noch nicht initialisiert, d.h. eine Kommunikation mit der Applikation (Controllersoftware) ist noch nicht möglich. Beim Übergang in den Pre-Operational-Zustand werden die Sync-Manager-Kanäle für die Mailboxkommunikation konfiguriert. Im Zustand „Pre-Operational" ist die Kommunikation über die Mailbox möglich und es kann auf das Objektverzeichnis und seine Objekte zugegriffen werden. In diesem Zustand findet noch keine Prozessdatenkommunikation statt. Beim Übergang in den „Safe-Operational"-Zustand wird vom Master das Prozessdaten-Mapping, der Sync-Manager- Kanal der Prozesseingänge und die zugehörige FMMU konfiguriert. Im „Safe-Operational"-Zustand ist weiterhin die Mailboxkommunikation möglich. Die Prozessdatenkommunikation läuft für die Eingänge. Die Ausgänge befinden sich im „sicheren" Zustand. Im „Operational"-Zustand läuft die Prozessdatenkommunikation sowohl für die Eingänge als auch für die Ausgänge.

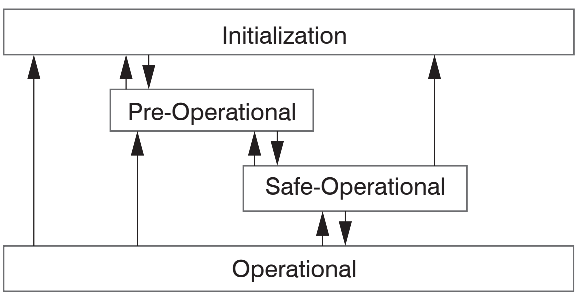


Fig. 8.2: EtherCAT State Machine

8.2.6 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 IFD241x, as well as the communication objects for the exchange of process data and acyclic messages. The IFD241x 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.

8.2.7 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 IFD241x. The PDO mapping defines which application objects (measurement data) are transmitted into a PDO.

With the confocalDT IFD2410/2411, you can choose from a range of TxPDO map objects, see Chap. 8.3.1.7

With the confocalDT IFD2415, you can choose from a range of TxPDO map objects, see Chap. 8.3.1.8

In EtherCAT, the PDOs are transported in objects of the Sync Manager channel. The IFD241x 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.

Note: Sub-index 0h of the object 0x1A00 contains the number of valid entries within the mapping report. This number also stands for the number of application variables (parameters) that are to be transmitted/received with the corresponding PDO. The sub-indices from 1h to the number of objects contain information about the mapped 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. 0x6000 (16 bit)	Sub-index e.g. 0x01	Object length in bits, e.g. 20h = 32 bits

Tab. 8.1: Entry structure of the PDO mapping, example

8.2.8 Service data SDO service

Service Data Objects (SDOs) are primarily used for the transmission of data that is not time critical, e.g. parameter values.

EtherCAT specifies

- SDO services: these 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.

8.3 CoE – Object Directory

The CoE object directory (CANopen over EtherCAT) contains all the configuration data of the IFD241x. The objects in CoE object directory can be accessed using the SDO services. Each object is addressed using a 16-bit index.

8.3.1 Communication-specific standard objects

8.3.1.1 Overview

Index (h)	Name	Description
1000	Device type	Device type
1008	Device name	Manufacturer device name
1009	Hardware version	Hardware version
100 A	Software version	Software version
1018	Identity	Device identification
10F8	Timestamp	EtherCAT stack predefined object, not to be confused with the timestamp of the process data
1A00 ... 1B5B		TxPDO mapping, see Chap. 8.3.1.7 In some cases, several process data (mappable objects - process data) are combined in the PDO map objects.
1C00	Sync. manager type	Synchronous manager type
1C12	RxPDO assign	Not used with the IFD241x
1C13	TxPDO assign	TxPDO assign
1C32	Sync manager output parameter	Synchronous mode parameter (DC)
1C33	Sync manager input parameter	

Tab. 8.2: Overview standard objects

8.3.1.2 Object 1000h: Device type

1000	VAR	Device type	0x00000000	Uint32	ro

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

8.3.1.3 Object 1008h: Manufacturer device name

1008	VAR	Device name	IFC24xx	Visible string	ro

8.3.1.4 Object 1009h: Hardware version

1009	VAR	Hardware version	xx	Visible string	ro

8.3.1.5 Object 100Ah: Software version

100 A	VAR	Software version	xxx.xxx	Visible string	ro

8.3.1.6 Object 1018h: Device identification

1018	RECORD	Identity			

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	Vendor ID	0x00000607	Uint32	ro
2	VAR	Product code	0x0024E555	Uint32	ro
3	VAR	Revision	0x00010000	Uint32Uint32	ro
4	VAR	Serial number	0x009A4435		ro

The product code identifies an EtherCAT device in the network. This identification is made up of vendor ID, product code and revision. Serial number contains the serial number of the IFD241x.

8.3.1.7 TxPDO mapping IDF2410, 2411

0x1A00	Ch01Dist1 TxPDOMap OV1			
	:001 0x6000: 001Ch01Dist1_OV00			
0x1A01	Ch01Dist1 TxPDOMap OV2			
	:001 0x6000:001 Ch01Dist1_OV00	**:002** 0x6000: 002Ch01Dist1_OV01		
0x1A02	Ch01Dist1 TxPDOMap OV4			
	:001 0x6000:001 Ch01Dist1_OV00	**:002** 0x6000: 002Ch01Dist1_OV01	**:003** 0x6000:003 Ch01Dist1_OV02	**:004** 0x6000: 004Ch01Dist1_OV03
0x1A03	Ch01Dist1 TxPDOMap OV8			
	:001 0x6000:001 Ch01Dist1_OV00	**:002** 0x6000:002 Ch01Dist1_OV01	**:003** 0x6000:003 Ch01Dist1_OV02	**:004** 0x6000: 004Ch01Dist1_OV03
	:005 0x6000:005 Ch01Dist1_OV04	**:006** 0x6000:006 Ch01Dist1_OV05	**:007** 0x6000:007 Ch01Dist1_OV06	**:008** 0x6000: 008Ch01Dist1_OV07

Tab. 8.3: Mapping for the distance value DIST1

0x1A10	Ch01Dist2 TxPDOMap OV1			
	:001 0x6001: 001Ch01Dist2_OV00			
0x1A11	Ch01Dist2 TxPDOMap OV2			
	:001 0x6001:001 Ch01Dist2_OV00	**:002** 0x6001:002 Ch01Dist2_OV01		
0x1A12	Ch01Dist2 TxPDOMap OV4			
	:001 0x6001:001 Ch01Dist2_OV00	**:002** 0x6001:002 Ch01Dist2_OV01	**:003** 0x6001:003 Ch01Dist2_OV02	**:004** 0x6001:004 Ch01Dist2_OV03
0x1A13	Ch01Dist2 TxPDOMap OV8			
	:001 0x6001:001 Ch01Dist2_OV00	**:002** 0x6001:002 Ch01Dist2_OV01	**:003** 0x6001:003 Ch01Dist2_OV02	**:004** 0x6001:004 Ch01Dist2_OV03
	:005 0x6001:005 Ch01Dist2_OV04	**:006** 0x6001:006 Ch01Dist2_OV05	**:007** 0x6001:007 Ch01Dist2_OV06	**:008** 0x6001:008 Ch01Dist2_OV07

Tab. 8.4: Mapping for distance value DIST2

0x1A30	Ch01Intensity1 TxPDOMap OV1			
	:001 0x6010:001 Ch01Intensi- ty1_OV00			
0x1A31	Ch01Intensity1 TxPDOMap OV2			
	:001 0x6010:001 Ch01Intensi- ty1_OV00	**:002** 0x6010:002 Ch01Intensi- ty1_OV01		

0x1A32	Ch01Intensity1 TxPDOMap OV4			
	:001 0x6010:001 Ch01Intensity1_OV00	**:002** 0x6010:002 Ch01Intensity1_OV01	**:003** 0x6010:003 Ch01Intensity1_OV02	**:004** 0x6010:004 Ch01Intensity1_OV03
0x1A33	Ch01Intensity1 TxPDOMap OV8			
	:001 0x6010:001 Ch01Intensity1_OV00	**:002** 0x6010:002 Ch01Intensity1_OV01	**:003** 0x6010:003 Ch01Intensity1_OV02	**:004** 0x6010:004 Ch01Intensity1_OV03
	:005 0x6010:005 Ch01Intensity1_OV04	**:006** 0x6010:006 Ch01Intensity1_OV05	**:007** 0x6010:007 Ch01Intensity1_OV06	**:008** 0x6010:008 Ch01Intensity1_OV07

Tab. 8.5: Mapping for intensity 1 of DIST1

0x1A40	Ch01Intensity2 TxPDOMap OV1			
	:001 0x6011:001 Ch01Intensity2_OV00			
0x1A41	Ch01Intensity2 TxPDOMap OV2			
	:001 0x6011:001 Ch01Intensity2_OV00	**:002** 0x6011:002 Ch01Intensity2_OV01		
0x1A42	Ch01Intensity2 TxPDOMap OV4			
	:001 0x6011:001 Ch01Intensity2_OV00	**:002** 0x6011:002 Ch01Intensity2_OV01	**:003** 0x6011:003 Ch01Intensity2_OV02	**:004** 0x6011:004 Ch01Intensity2_OV03
0x1A43	Ch01Intensity2 TxPDOMap OV8			
	:001 0x6011:001 Ch01Intensity2_OV00	**:002** 0x6011:002 Ch01Intensity2_OV01	**:003** 0x6011:003 Ch01Intensity2_OV02	**:004** 0x6011:004 Ch01Intensity2_OV03
	:005 0x6011:005 Ch01Intensity2_OV04	**:006** 0x6011:006 Ch01Intensity2_OV05	**:007** 0x6011:007 Ch01Intensity2_OV06	**:008** 0x6011:008 Ch01Intensity2_OV07

Tab. 8.6: Mapping for intensity 2 of DIST2

0x1A80	Ch01Shutter TxPDOMap OV1			
	:001 0x6030:001 Ch01Shutter_OV00			
0x1A81	Ch01Shutter TxPDOMap OV2			
	:001 0x6030:001 Ch01Shutter_OV00	**:002** 0x6030:002 Ch01Shutter_OV01		
0x1A82	Ch01Shutter TxPDOMap OV4			
	:001 0x6030:001 Ch01Shutter_OV00	**:002** 0x6030:002 Ch01Shutter_OV01	**:003** 0x6030:003 Ch01Shutter_OV02	**:004** 0x6030:004 Ch01Shutter_OV03
0x1A83	Ch01Shutter TxPDOMap OV8			
	:001 0x6030:001 Ch01Shutter_OV00	**:002** 0x6030:002 Ch01Shutter_OV01	**:003** 0x6030:003 Ch01Shutter_OV02	**:004** 0x6030:004 Ch01Shutter_OV03
	:005 0x6030:005 Ch01Shutter_OV04	**:006** 0x6030:006 Ch01Shutter_OV05	**:007** 0x6030:007 Ch01Shutter_OV06	**:008** 0x6030:008 Ch01Shutter_OV07

Tab. 8.7: Mapping for exposure time

0x1AC0	Ch01Encoder TxPDOMap OV1			
	:001 0x6050:001 Encoder1_OV00	:002 0x6051:001 Encoder2_OV00	:003 00x6052:001 Encoder3_OV00	
0x1AC1	Ch01Encoder TxPDOMap OV2			
	:001 0x6050:001 Encoder1_OV00	:003 0x6051:001 Encoder2_OV00	:005 0x6052:001 Encoder3_OV00	
	:002 0x6050:002 Encoder1_OV01	:004 0x6051:002 Encoder2_OV01	:006 0x6052:002 Encoder3_OV01	
0x1AC2	Ch01Encoder TxPDOMap OV4			
	:001 0x6050:001 Encoder1_OV00	:005 0x6051:001 Encoder2_OV00	:009 0x6052:001 Encoder3_OV00	
	:002 0x6050:002 Encoder1_OV01	:006 0x6051:002 Encoder2_OV01	:010 0x6052:002 Encoder3_OV01	
	:003 0x6050:003 Encoder1_OV02	:007 0x6051:003 Encoder2_OV02	:011 0x6052:003 Encoder3_OV02	
	:004 0x6050:004 Encoder1_OV03	:008 0x6051:004 Encoder2_OV03	:012 0x6052:004 Encoder3_OV03	
0x1AC3	Ch01Encoder TxPDOMap OV8			
	:001 0x6050:001 Encoder1_OV00	:009 0x6051:001 Encoder2_OV00	:017 0x6052:001 Encoder3_OV00	
	:002 0x6050:002 Encoder1_OV01	:010 0x6051:002 Encoder2_OV01	:018 0x6052:002Encoder3_OV01	
	:003 0x6050:003 Encoder1_OV02	:011 0x6051:003 Encoder2_OV02	:019 0x6052:003 Encoder3_OV02	
	:004 0x6050:004 Encoder1_OV03	:012 0x6051:004 Encoder2_OV03	:020 0x6052:004 Encoder3_OV03	
	:005 0x6050:005 Encoder1_OV04	:013 0x6051:005 Encoder2_OV04	:021 0x6052:005 Encoder3_OV04	
	:006 0x6050:006 Encoder1_OV05	:014 0x6051:006 Encoder2_OV05	:022 0x6052:006 Encoder3_OV05	
	:007 0x6050:007 Encoder1_OV06	:015 0x6051:007 Encoder2_OV06	:023 0x6052:007 Encoder3_OV06	
	:008 0x6050:008 Encoder1_OV07	:016 0x6051:008 Encoder2_OV07	:024 0x6052:008 Encoder3_OV07	

Tab. 8.8: Mapping for encoders 1 to 3

0x1AE0	Counter TxPDOMap OV1			
	:001 0x7000:001 Counter_OV00			
0x1AE2	Counter TxPDOMap OV2			
	:001 0x7000:001 Counter_OV00	**:002** 0x7000:002 Counter_OV01		
0x1AE2	Counter TxPDOMap OV4			
	:001 0x7000:001 Counter_OV00	**:002** 0x7000:002 Counter_OV01	**:003** 0x7000:003 Counter_OV02	**:004** 0x7000:004 Counter_OV03
0x1AE3	Counter TxPDOMap OV8			
	:001 0x7000:001 Counter_OV00	**:002** 0x7000:002 Counter_OV01	**:003** 0x7000:003 Counter_OV02	**:004** 0x7000:004 Counter_OV03
	:005 0x7000:005 Counter_OV04	**:006** 0x7000:006 Counter_OV05	**:007** 0x7000:007 Counter_OV06	**:008** 0x7000:008 Counter_OV07

Tab. 8.9: Mapping for measurement counter

0x1AE8	Time stamp TxPDOMap OV1			
	:001 0x7001:001 Time stamp_OV00			
0x1AE9	Time stamp TxPDOMap OV2			
	:001 0x7001:001 Time stamp_OV00	**:002** 0x7001:002 Time stamp_OV01		
0x1AEA	Time stamp TxPDOMap OV4			
	:001 0x7001:001 Time stamp_OV00	**:002** 0x7001:002 Time stamp_OV01	**:003** 0x7001:003 Time stamp_OV02	**:004** 0x7001:004 Time stamp_OV03
0x1AEB	Time stamp TxPDOMap OV8			
	:001 0x7001:001 Time stamp_OV00	**:002** 0x7001:002 Time stamp_OV01	**:003** 0x7001:003 Time stamp_OV02	**:004** 0x7001:004 Time stamp_OV03
	:005 0x7001:005 Time stamp_OV04	**:006** 0x7001:006 Time stamp_OV05	**:007** 0x7001:007 Time stamp_OV06	**:008** 0x7001:008 Time stamp_OV07

Tab. 8.10: Mapping for time information

0x1AF0	Frequency TxPDOMap OV1			
	:001 0x7002:001 Frequency_OV00			
0x1AF1	Frequency TxPDOMap OV2			
	:001 0x7002:001 Frequency_OV00	**:002** 0x7002:002 Frequency_OV01		

0x1AF2	Frequency TxPDOMap OV4			
	:001 0x7002:001 Frequency_OV00	**:002** 0x7002:002 Frequency_OV01	**:003** 0x7002:003 Frequency_OV02	**:004** 0x7002:004 Frequency_OV03
0x1AF3	Frequency TxPDOMap OV8			
	:001 0x7002:001 Frequency_OV00	**:002** 0x7002:002 Frequency_OV01	**:003** 0x7002:003 Frequency_OV02	**:004** 0x7002:004 Frequency_OV03
	:005 0x7002:005 Frequency_OV04	**:006** 0x7002:006 Frequency_OV05	**:007** 0x7002:007 Frequency_OV06	**:008** 0x7002:008 Frequency_OV07

Tab. 8.11: Mapping for measuring frequency

0x1B00	User calc output 01 TxPDOMap OV1			
	:001 0x7C00:001 User calc 01_OV00			
0x1B01	User calc output 01 TxPDOMap OV2			
	:001 0x7C00:001 User calc 01_OV00	**:002** 0x7C00:002 User calc 01_OV01		
0x1B02	User calc output 01 TxPDOMap OV4			
	:001 0x7C00:001User calc 01_OV00	**:002** 0x7C00:002 User calc 01_OV01	**:003** 0x7C00:003 User calc 01_OV02	**:004** 0x7C00:004 User calc 01_OV03
0x1B03	User calc output 01 TxPDOMap OV8			
	:001 0x7C00:001 User calc 01_OV00	**:002** 0x7C00:002 User calc 01_OV01	**:003** 0x7C00:003 User calc 01_OV02	**:004** 0x7C00:004 User calc 01_OV03
	:005 0x7C00:005 User calc 01_OV04	**:006** 0x7C00:006 User calc 01_OV05	**:007** 0x7C00:007 User calc 01_OV06	**:008** 0x7C00:008 User calc 01_OV07

Tab. 8.12: Mapping for calculation program 1

0x1B08	User calc output 02 TxPDOMap OV1			
	:001 0x7C01:001 User calc 02_OV00			
0x1B09	User calc output 02 TxPDOMap OV2			
	:001 0x7C01:001 User calc 02_OV00	**:002** 0x7C01:002 User calc 02_OV01		
0x1B0A	User calc output 01 TxPDOMap OV4			
	:001 0x7C01:001User calc 02_OV00	**:002** 0x7C01:002 User calc 02_OV01	**:003** 0x7C01:003 User calc 02_OV02	**:004** 0x7C01:004 User calc 02_OV03
0x1B0B	User calc output 02 TxPDOMap OV8			
	:001 0x7C01:001 User calc 02_OV00	**:002** 0x7C01:002 User calc 02_OV01	**:003** 0x7C01:003 User calc 02_OV02	**:004** 0x7C01:004 User calc 02_OV03
	:005 0x7C01:005 User calc 02_OV04	**:006** 0x7C01:006 User calc 02_OV05	**:007** 0x7C01:007 User calc 02_OV06	**:008** 0x7C01:008 User calc 02_OV07

Tab. 8.13: Mapping for calculation program 2

0x1B10	User calc output 03 TxPDOMap OV1			
	:001 0x7C02:001 User calc 03_OV00			
0x1B11	User calc output 03 TxPDOMap OV2			
	:001 0x7C02:001 User calc 03_OV00	**:002** 0x7C02:002 User calc 03_OV01		
0x1B12	User calc output 03 TxPDOMap OV4			
	:001 0x7C02:001User calc 03_OV00	**:002** 0x7C02:002 User calc 03_OV01	**:003** 0x7C02:003 User calc 03_OV02	**:004** 0x7C02:004 User calc 03_OV03
0x1B13	User calc output 03 TxPDOMap OV8			
	:001 0x7C02:001 User calc 03_OV00	**:002** 0x7C02:002 User calc 03_OV01	**:003** 0x7C02:003 User calc 03_OV02	**:004** 0x7C02:004 User calc 03_OV03
	:005 0x7C02:005 User calc 03_OV04	**:006** 0x7C02:006 User calc 03_OV05	**:007** 0x7C02:007 User calc 03_OV06	**:008** 0x7C02:008 User calc 03_OV07

Tab. 8.14: Mapping for calculation program 3

0x1B18	User calc output 04 TxPDOMap OV1			
	:001 0x7C03:001 User calc 04_OV00			
0x1B19	User calc output 04 TxPDOMap OV2			
	:001 0x7C03:001 User calc 04_OV00	**:002** 0x7C03:002 User calc 04_OV01		
0x1B1A	User calc output 04 TxPDOMap OV4			
	:001 0x7C03:001User calc 04_OV00	**:002** 0x7C03:002 User calc 04_OV01	**:003** 0x7C03:003 User calc 04_OV02	**:004** 0x7C03:004 User calc 04_OV03
0x1B1B	User calc output 04 TxPDOMap OV8			
	:001 0x7C03:001 User calc 04_OV00	**:002** 0x7C03:002 User calc 04_OV01	**:003** 0x7C03:003 User calc 04_OV02	**:004** 0x7C03:004 User calc 04_OV03
	:005 0x7C03:005 User calc 04_OV04	**:006** 0x7C03:006 User calc 04_OV05	**:007** 0x7C03:007 User calc 04_OV06	**:008** 0x7C03:008 User calc 04_OV07

Tab. 8.15: Mapping for calculation program 4

0x1B20	User calc output 05 TxPDOMap OV1			
	:001 0x7C04:001 User calc 05_OV00			
0x1B21	User calc output 05 TxPDOMap OV2			
	:001 0x7C04:001 User calc 05_OV00	**:002** 0x7C04:002 User calc 05_OV01		

0x1B22	User calc output 05 TxPDOMap OV4			
	:001 0x7C04:001User calc 05_OV00	**:002** 0x7C04:002 User calc 05_OV01	**:003** 0x7C04:003 User calc 05_OV02	**:004** 0x7C04:004 User calc 05_OV03
0x1B23	User calc output 05 TxPDOMap OV8			
	:001 0x7C04:001 User calc 05_OV00	**:002** 0x7C04:002 User calc 05_OV01	**:003** 0x7C04:003 User calc 05_OV02	**:004** 0x7C04:004 User calc 05_OV03
	:005 0x7C04:005 User calc 05_OV04	**:006** 0x7C04:006 User calc 05_OV05	**:007** 0x7C04:007 User calc 05_OV06	**:008** 0x7C04:008 User calc 05_OV07

Tab. 8.16: Mapping for calculation program 5

0x1B28	User calc output 06 and 07 TxPDOMap OV1			
	:001 0x7C05:001 User calc 06_OV00			
	:002 0x7C06:001 User calc 07_OV00			
0x1B29	User calc output 06 and 07 TxPDOMap OV2			
	:001 0x7C05:001 User calc 06_OV00	**:002** 0x7C05:002 User calc 06_OV01		
	:003 0x7C06:001 User calc 07_OV00	**:004** 0x7C06:002 User calc 07_OV01		
0x1B2A	User calc output 06 and 07 TxPDOMap OV4			
	:001 0x7C05:001 User calc 06_OV00	**:002** 0x7C05:002 User calc 06_OV01	**:003** 0x7C05:003 User calc 06_OV02	**:004** 0x7C05:004 User calc 06_OV03
	:005 0x7C06:001 User calc 07_OV00	**:006** 0x7C06:002 User calc 07_OV01	**:007** 0x7C06:003 User calc 07_OV02	**:008** 0x7C06:004 User calc 07_OV03
0x1B2B	User calc output 06 and 07 TxPDOMap OV8			
	:001 0x7C05:001 User calc 06_OV00	**:002** 0x7C05:002 User calc 06_OV01	**:003** 0x7C05:003 User calc 06_OV02	**:004** 0x7C05:004 User calc 06_OV03
	:005 0x7C05:005 User calc 06_OV04	**:006** 0x7C05:006 User calc 06_OV05	**:007** 0x7C05:007 User calc 06_OV06	**:008** 0x7C05:008 User calc 06_OV07
	:009 0x7C06:001 User calc 07_OV00	**:010** 0x7C06:002 User calc 07_OV01	**:011** 0x7C06:003 User calc 07_OV02	**:012** 0x7C06:004 User calc 07_OV03
	:013 0x7C06:005 User calc 07_OV04	**:014** 0x7C06:006 User calc 07_OV05	**:015** 0x7C06:007 User calc 07_OV06	**:016** 0x7C06:008 User calc 07_OV07

Tab. 8.17: Mapping for calculation programs 6 and 7

0x1B30	User calc output 08 and 09 TxPDOMap OV1			
	:001 0x7C07:001 User calc 08_OV00			
	:002 0x7C08:001 User calc 09_OV00			
0x1B31	User calc output 08 and 09 TxPDOMap OV2			
	:001 0x7C07:001 User calc 08_OV00	**:002** 0x7C07:002 User calc 08_OV01		
	:003 0x7C08:001 User calc 09_OV00	**:004** 0x7C08:002 User calc 09_OV01		
0x1B32	User calc output 08 and 09 TxPDOMap OV4			
	:001 0x7C07:001 User calc 08_OV00	**:002** 0x7C07:002 User calc 08_OV01	**:003** 0x7C07:003 User calc 08_OV02	**:004** 0x7C07:004 User calc 08_OV03
	:005 0x7C08:001 User calc 09_OV00	**:006** 0x7C08:002 User calc 09_OV01	**:007** 0x7C08:003 User calc 09_OV02	**:008** 0x7C08:004 User calc 09_OV03
0x1B33	User calc output 08 and 09 TxPDOMap OV8			
	:001 0x7C07:001 User calc 08_OV00	**:002** 0x7C07:002 User calc 08_OV01	**:003** 0x7C07:003 User calc 08_OV02	**:004** 0x7C07:004 User calc 08_OV03
	:005 0x7C07:005 User calc 08_OV04	**:006** 0x7C07:006 User calc 08_OV05	**:007** 0x7C07:007 User calc 08_OV06	**:008** 0x7C07:008 User calc 08_OV07
	:009 0x7C08:001 User calc 09_OV00	**:010** 0x7C08:002 User calc 09_OV01	**:011** 0x7C08:003 User calc 09_OV02	**:012** 0x7C08:004 User calc 09_OV03
	:013 0x7C08:005 User calc 09_OV04	**:014** 0x7C08:006 User calc 09_OV05	**:015** 0x7C08:007 User calc 09_OV06	**:016** 0x7C08:008 User calc 09_OV07

Tab. 8.18: Mapping for calculation programs 8 and 9

0x1B38	User calc output 10 and 11 TxPDOMap OV1			
	:001 0x7C09:001 User calc 10_OV00			
	:002 0x7C0A:001 User calc 11_OV00			
0x1B39	User calc output 10 and 11 TxPDOMap OV2			
	:001 0x7C09:001 User calc 10_OV00	**:002** 0x7C09:002 User calc 10_OV01		
	:003 0x7C0A:001 User calc 11_OV00	**:004** 0x7C0A:002 User calc 11_OV01		

0x1B3A	User calc output 10 and 11 TxPDOMap OV4			
	:001 0x7C09:001 User calc 10_OV00	:002 0x7C09:002 User calc 10_OV01	:003 0x7C09:003 User calc 10_OV02	:004 0x7C09:004 User calc 10_OV03
	:005 0x7C0A:001 User calc 11_OV00	:006 0x7C0A:002 User calc 11_OV01	:007 0x7C0A:003 User calc 11_OV02	:008 0x7C0A:004 User calc 11_OV03
0x1B3B	User calc output 10 and 11 TxPDOMap OV8			
	:001 0x7C09:001 User calc 10_OV00	:002 0x7C09:002 User calc 10_OV01	:003 0x7C09:003 User calc 10_OV02	:004 0x7C09:004 User calc 10_OV03
	:005 0x7C09:005 User calc 10_OV004	:006 0x7C09:006 User calc 10_OV05	:007 0x7C09:007 User calc 10_OV06	:008 0x7C09:008 User calc 10_OV07
	:009 0x7C0A:001 User calc 11_OV00	:010 0x7C0A:002 User calc 11_OV01	:011 0x7C0A:003 User calc 11_OV02	:012 0x7C0A:004 User calc 11_OV03
	:013 0x7C0A:005 User calc 11_OV04	:014 0x7C0A:006 User calc 11_OV05	:015 0x7C0A:007 User calc 11_OV06	:016 0x7C0A:008 User calc 11_OV07

Tab. 8.19: Mapping for calculation programs 10 and 11

0x1B40	User calc output 12 and 13 TxPDOMap OV1			
	:001 0x7C0B:001 User calc 12_OV00			
	:002 0x7C0C:001 User calc 13_OV00			
0x1B41	User calc output 12 and 13 TxPDOMap OV2			
	:001 0x7C0B:001 User calc 12_OV00	:002 0x7C0B:002 User calc 12_OV01		
	:003 0x7C0C:001 User calc 13_OV00	:004 0x7C0C:002 User calc 13_OV01		
0x1B42	User calc output 12 and 13 TxPDOMap OV4			
	:001 0x7C0B:001 User calc 12_OV00	:002 0x7C0B:002 User calc 12_OV01	:003 0x7C0B:003 User calc 12_OV02	:004 0x7C0B:004 User calc 12_OV03
	:005 0x7C0C:001 User calc 13_OV00	:006 0x7C0C:002 User calc 13_OV01	:007 0x7C0C:003 User calc 13_OV02	:008 0x7C0C:004 User calc 13_OV03

0x1B43	User calc output 12 and 13 TxPDOMap OV8			
	:001 0x7C0B:001 User calc 12_OV00	:002 0x7C0B:002 User calc 12_OV01	:003 0x7C0B:003 User calc 12_OV02	:004 0x7C0B:004 User calc 12_OV03
	:005 0x7C0B:005 User calc 12_OV004	:006 0x7C0B:006 User calc 12_OV05	:007 0x7C0B:007 User calc 12_OV06	:008 0x7C0B:008 User calc 12_OV07
	:009 0x7C0C:001 User calc 13_OV00	:010 0x7C0C:002 User calc 13_OV01	:011 0x7C0C:003 User calc 13_OV02	:012 0x7C0C:004 User calc 13_OV03
	:013 0x7C0C:005 User calc 13_OV04	:014 0x7C0C:006 User calc 13_OV05	:015 0x7C0C:007 User calc 13_OV06	:016 0x7C0C:008 User calc 13_OV07

Tab. 8.20: Mapping for calculation programs 12 and 13

0x1B48	User calc output 14 and 15 TxPDOMap OV1			
	:001 0x7C0D:001 User calc 14_OV00			
	:002 0x7C0E:001 User calc 15_OV00			
0x1B49	User calc output 14 and 15 TxPDOMap OV2			
	:001 0x7C0D:001 User calc 14_OV00	:002 0x7C0D:002 User calc 14_OV01		
	:003 0x7C0E:001 User calc 15_OV00	:004 0x7C0E:002 User calc 15_OV01		
0x1B4A	User calc output 14 and 15 TxPDOMap OV4			
	:001 0x7C0D:001 User calc 14_OV00	:002 0x7C0D:002 User calc 14_OV01	:003 0x7C0D:003 User calc 14_OV02	:004 0x7C0D:004 User calc 14_OV03
	:005 0x7C0E:001 User calc 15_OV00	:006 0x7C0E:002 User calc 15_OV01	:007 0x7C0E:003 User calc 15_OV02	:008 0x7C0E:004 User calc 15_OV03
0x1B4B	User calc output 14 and 15 TxPDOMap OV8			
	:001 0x7C0D:001 User calc 14_OV00	:002 0x7C0D:002 User calc 14_OV01	:003 0x7C0D:003 User calc 14_OV02	:004 0x7C0D:004 User calc 14_OV03
	:005 0x7C0D:005User calc 14_OV004	:006 0x7C0D:006 User calc 14_OV05	:007 0x7C0D:007 User calc 14_OV06	:008 0x7C0D:008 User calc 14_OV07
	:009 0x7C0E:001 User calc 15_OV00	:010 0x7C0E:002 User calc 15_OV01	:011 0x7C0E:003 User calc 15_OV02	:012 0x7C0E:004User calc 15_OV03
	:013 0x7C0E:005 User calc 15_OV04	:014 0x7C0E:006 User calc 15_OV05	:015 0x7C0E:007 User calc 15_OV06	:016 0x7C0E:008 User calc 15_OV07

Tab. 8.21: Mapping for calculation programs 14 and 15

0x1B50	User calc output 16 and 17 TxPDOMap OV1			
	:001 0x7C0F:001 User calc 16_OV00			
	:002 0x7C10:001 User calc 17_OV00			
0x1B51	User calc output 16 and 17 TxPDOMap OV2			
	:001 0x7C0F:001 User calc 16_OV00	**:002** 0x7C0F:002 User calc 16_OV01		
	:003 0x7C10:001 User calc 17_OV00	**:004** 0x7C10:002 User calc 17_OV01		
0x1B52	User calc output 16 and 17 TxPDOMap OV4			
	:001 0x7C0F:001 User calc 16_OV00	**:002** 0x7C0F:002 User calc 16_OV01	**:003** 0x7C0F:003 User calc 16_OV02	**:004** 0x7C0F:004 User calc 16_OV03
	:005 0x7C10:001 User calc 17_OV00	**:006** 0x7C10:002 User calc 17_OV01	**:007** 0x7C10:003 User calc 17_OV02	**:008** 0x7C10:004 User calc 17_OV03
0x1B53	User calc output 16 and 17 TxPDOMap OV8			
	:001 0x7C0F:001 User calc 16_OV00	**:002** 0x7C0F:002 User calc 16_OV01	**:003** 0x7C0F:003 User calc 16_OV02	**:004** 0x7C0F:004 User calc 16_OV03
	:005 0x7C0F:005User calc 16_OV004	**:006** 0x7C0F:006 User calc 16_OV05	**:007** 0x7C0F:007 User calc 16_OV06	**:008** 0x7C0F:008 User calc 16_OV07
	:009 0x7C10:001 User calc 17_OV00	**:010** 0x7C10:002 User calc 17_OV01	**:011** 0x7C10:003 User calc 17_OV02	**:012** 0x7C10:004User calc 17_OV03
	:013 0x7C10:005 User calc 17_OV04	**:014** 0x7C10:006 User calc 17_OV05	**:015** 0x7C10:007 User calc 17_OV06	**:016** 0x7C10:008 User calc 17_OV07

Tab. 8.22: Mapping for calculation programs 16 and 17

0x1B58	User calc output 18 and 19 TxPDOMap OV1			
	:001 0x7C11:001 User calc 18_OV00			
	:002 0x7C12:001 User calc 19_OV00			
0x1B59	User calc output 18 and 19 TxPDOMap OV2			
	:001 0x7C11:001 User calc 18_OV00	**:002** 0x7C11:002 User calc 18_OV01		
	:003 0x7C12:001 User calc 19_OV00	**:004** 0x7C12:002 User calc 19_OV01		

0x1B5A	User calc output 18 and 19 TxPDOMap OV4			
	:001 0x7C11:001 User calc 18_OV00	:002 0x7C11:002 User calc 18_OV01	:003 0x7C11:003 User calc 18_OV02	:004 0x7C11:004 User calc 16_OV03
	:005 0x7C12:001 User calc 19_OV00	:006 0x7C12:002 User calc 19_OV01	:007 0x7C12:003 User calc 19_OV02	:008 0x7C12:004 User calc 17_OV03
0x1B5B	User calc output 18 and 19 TxPDOMap OV8			
	:001 0x7C11F:001 User calc 18_OV00	:002 0x7C11:002 User calc 18_OV01	:003 0x7C11:003 User calc 18_OV02	:004 0x7C11:004 User calc 18_OV03
	:005 0x7C11:005User calc 18_OV004	:006 0x7C11:006 User calc 18_OV05	:007 0x7C11:007 User calc 18_OV06	:008 0x7C11:008 User calc 18_OV07
	:009 0x7C12:001 User calc 19_OV00	:010 0x7C12:002 User calc 19_OV01	:011 0x7C12:003 User calc 19_OV02	:012 0x7C12:004User calc 19_OV03
	:013 0x7C12:005 User calc 19_OV04	:014 0x7C12:006 User calc 19_OV05	:015 0x7C12:007 User calc 19_OV06	:016 0x7C12:008 User calc 19_OV07

Tab. 8.23: Mapping for calculation programs 18 and 19

8.3.1.8 TxPDO mapping IFD2415

0x1A00	Ch01Dist1 TxPDOMap OV1			
	:001 0x6000: 001Ch01Dist1_OV00			
0x1A01	Ch01Dist1 TxPDOMap OV2			
	:001 0x6000:001 Ch01Dist1_OV00	:002 0x6000: 002Ch01Dist1_OV01		
0x1A02	Ch01Dist1 TxPDOMap OV4			
	:001 0x6000:001 Ch01Dist1_OV00	:002 0x6000: 002Ch01Dist1_OV01	:003 0x6000:003 Ch01Dist1_OV02	:004 0x6000: 004Ch01Dist1_OV03
0x1A03	Ch01Dist1 TxPDOMap OV8			
	:001 0x6000:001 Ch01Dist1_OV00	:002 0x6000:002 Ch01Dist1_OV01	:003 0x6000:003 Ch01Dist1_OV02	:004 0x6000: 004Ch01Dist1_OV03
	:005 0x6000:005 Ch01Dist1_OV04	:006 0x6000:006 Ch01Dist1_OV05	:007 0x6000:007 Ch01Dist1_OV06	:008 0x6000: 008Ch01Dist1_OV07

Tab. 8.24: Mapping for the distance value DIST1

0x1A10	Ch01Dist2 TxPDOMap OV1			
	:001 0x6001: 001Ch01Dist2_OV00			
0x1A11	Ch01Dist2 TxPDOMap OV2			
	:001 0x6001:001 Ch01Dist2_OV00	:002 0x6001:002 Ch01Dist2_OV01		

0x1A12	Ch01Dist2 TxPDOMap OV4			
	:001 0x6001:001 Ch01Dist2_OV00	**:002** 0x6001:002 Ch01Dist2_OV01	**:003** 0x6001:003 Ch01Dist2_OV02	**:004** 0x6001:004 Ch01Dist2_OV03
0x1A13	Ch01Dist2 TxPDOMap OV8			
	:001 0x6001:001 Ch01Dist2_OV00	**:002** 0x6001:002 Ch01Dist2_OV01	**:003** 0x6001:003 Ch01Dist2_OV02	**:004** 0x6001:004 Ch01Dist2_OV03
	:005 0x6001:005 Ch01Dist2_OV04	**:006** 0x6001:006 Ch01Dist2_OV05	**:007** 0x6001:007 Ch01Dist2_OV06	**:008** 0x6001:008 Ch01Dist2_OV07

Tab. 8.25: Mapping for distance value DIST2

0x1A20	Ch01Dist3 bis Dist6 TxPDOMap OV1			
	:001 0x6002: 001Ch01Dist3_OV00	**:002** 0x6003: 001Ch01Dist4_OV00	**:003** 0x6004:001 Ch01Dist5_OV00	**:004** 0x6005: 001Ch01Dist6_OV00
0x1A21	Ch01Dist3 bis Dist6 TxPDOMap OV2			
	:001 0x6002:001 Ch01Dist3_OV00	**:003** 0x6003: 001Ch01Dist4_OV00	**:005** 0x6004:001 Ch01Dist5_OV00	**:007** 0x6005: 001Ch01Dist6_OV00
	:002 0x6002:002 Ch01Dist3_OV01	**:004** 0x6003:002 Ch01Dist4_OV01	**:006** 0x6004:002 Ch01Dist5_OV01	**:008** 0x6005:002 Ch01Dist6_OV01
0x1A22	Ch01Dist3 bis Dist6 TxPDOMap OV4			
	:001 0x6002: 001Ch01Dist3_OV00	**:005** 0x6003: 001Ch01Dist4_OV00	**:009** 0x6004: 001Ch01Dist5_OV00	**:013** 0x6005: 001Ch01Dist6_OV00
	:002 0x6002:002 Ch01Dist3_OV01	**:006** 0x6003:002 Ch01Dist4_OV01	**:010** 0x6004:002 Ch01Dist5_OV01	**:014** 0x6005:002 Ch01Dist6_OV01
	:003 0x6002:003 Ch01Dist3_OV02	**:007** 0x6003:003 Ch01Dist4_OV02	**:011** 0x6004:003 Ch01Dist5_OV02	**:015** 0x6005:003 Ch01Dist6_OV02
	:004 0x6002:004 Ch01Dist3_OV03	**:008** 0x6003:004 Ch01Dist4_OV03	**:012** 0x6004:004 Ch01Dist5_OV03	**:016** 0x6005:004 Ch01Dist6_OV03

0x1A23	Ch01Dist3 bis Dist6 TxPDOMap OV8			
	:001 0x6002:001 Ch01Dist3_OV00	**:009** 0x6003:001 Ch01Dist4_OV00	**:017** 0x6004:001 Ch01Dist5_OV00	**:025** 0x6005: 001Ch01Dist6_OV00
	:002 0x6002:002 Ch01Dist3_OV01	**:010** 0x6003:002 Ch01Dist4_OV01	**:018** 0x6004:002 Ch01Dist5_OV01	**:026** 0x6005:002 Ch01Dist6_OV01
	:003 0x6002:003 Ch01Dist3_OV02	**:011** 0x6003:003 Ch01Dist4_OV02	**:019** 0x6004:003 Ch01Dist5_OV02	**:027** 0x6005:003 Ch01Dist6_OV02
	:004 0x6002:004 Ch01Dist3_OV03	**:012** 0x6003:004 Ch01Dist4_OV03	**:020** 0x6004:004 Ch01Dist5_OV03	**:028** 0x6005:004 Ch01Dist6_OV03
	:005 0x6002:005 Ch01Dist3_OV04	**:013** 0x6003:005 Ch01Dist4_OV04	**:021** 0x6004:005 Ch01Dist5_OV04	**:029** 0x6005:005 Ch01Dist6_OV04
	:006 0x6002:006 Ch01Dist3_OV05	**:014** 0x6003:006 Ch01Dist4_OV05	**:022** 0x6004:006 Ch01Dist5_OV05	**:030** 0x6005:006 Ch01Dist6_OV05
	:007 0x6002:007 Ch01Dist3_OV06	**:015** 0x6003:007 Ch01Dist4_OV06	**:023** 0x6004:007 Ch01Dist5_OV06	**:031** 0x6005:007 Ch01Dist6_OV06
	:008 0x6002:008 Ch01Dist3_OV07	**:016** 0x6003:008 Ch01Dist4_OV07	**:024** 0x6004:008 Ch01Dist5_OV07	**:032** 0x6005:008 Ch01Dist6_OV07

Tab. 8.26: Mapping for distance values DIST3 to DIST6

0x1A30	Ch01Intensity1 TxPDOMap OV1			
	:001 0x6010:001 Ch01Intensi-ty1_OV00			
0x1A31	Ch01Intensity1 TxPDOMap OV2			
	:001 0x6010:001 Ch01Intensi-ty1_OV00	**:002** 0x6010:002 Ch01Intensi-ty1_OV01		
0x1A32	Ch01Intensity1 TxPDOMap OV4			
	:001 0x6010:001 Ch01Intensi-ty1_OV00	**:002** 0x6010:002 Ch01Intensi-ty1_OV01	**:003** 0x6010:003 Ch01Intensi-ty1_OV02	**:004** 0x6010:004 Ch01Intensi-ty1_OV03
0x1A33	Ch01Intensity1 TxPDOMap OV8			
	:001 0x6010:001 Ch01Intensi-ty1_OV00	**:002** 0x6010:002 Ch01Intensi-ty1_OV01	**:003** 0x6010:003 Ch01Intensi-ty1_OV02	**:004** 0x6010:004 Ch01Intensi-ty1_OV03
	:005 0x6010:005 Ch01Intensi-ty1_OV04	**:006** 0x6010:006 Ch01Intensi-ty1_OV05	**:007** 0x6010:007 Ch01Intensi-ty1_OV06	**:008** 0x6010:008 Ch01Intensi-ty1_OV07

Tab. 8.27: Mapping for intensity 1 of DIST1

0x1A40	Ch01Intensity2 TxPDOMap OV1			
	:001 0x6011:001 Ch01Intensity2_OV00			
0x1A41	Ch01Intensity2 TxPDOMap OV2			
	:001 0x6011:001 Ch01Intensity2_OV00	:002 0x6011:002 Ch01Intensity2_OV01		
0x1A42	Ch01Intensity2 TxPDOMap OV4			
	:001 0x6011:001 Ch01Intensity2_OV00	:002 0x6011:002 Ch01Intensity2_OV01	:003 0x6011:003 Ch01Intensity2_OV02	:004 0x6011:004 Ch01Intensity2_OV03
0x1A43	Ch01Intensity2 TxPDOMap OV8			
	:001 0x6011:001 Ch01Intensity2_OV00	:002 0x6011:002 Ch01Intensity2_OV01	:003 0x6011:003 Ch01Intensity2_OV02	:004 0x6011:004 Ch01Intensity2_OV03
	:005 0x6011:005 Ch01Intensity2_OV04	:006 0x6011:006 Ch01Intensity2_OV05	:007 0x6011:007 Ch01Intensity2_OV06	:008 0x6011:008 Ch01Intensity2_OV07

Tab. 8.28: Mapping for intensity 2 of DIST2

0x1A50	Channel 1 intensity 3 bis 6 TxPDOMap OV1			
	:001 0x6012:001 Intensity3_OV00	:002 0x6013:001 Intensity4_OV00	:003 0x6014:001 Intensity5_OV00	:004 0x6015:001 Intensity6_OV00
0x1A51	Channel 1 intensity 3 bis 6 OV2			
	:001 0x6012:001 Intensity3_OV00	:003 0x6013:001 Intensity4_OV00	:005 0x6014:001 Intensity5_OV00	:007 0x6015:001 Intensity6_OV00
	:002 0x6012:002 Intensity3_OV01	:004 0x6013:002 Intensity4_OV01	:006 0x6014:002 Intensity5_OV01	:008 0x6015:002 Intensity6_OV01
0x1A52	Channel 1 intensity 3 bis 6 OV4			
	:001 0x6012:001 Intensity3_OV00	:005 0x6013:001 Intensity4_OV00	:009 0x6014:001 Intensity5_OV00	:013 0x6015:001 Intensity6_OV00
	:002 0x6012:002 Intensity3_OV01	:006 0x6013:002 Intensity4_OV01	:010 0x6014:002 Intensity5_OV01	:014 0x6015:002 Intensity6_OV01
	:003 0x6012:003 Intensity3_OV02	:007 0x6013:003 Intensity4_OV02	:011 0x6014:003 Intensity5_OV02	:015 0x6015:003 Intensity6_OV02
	:004 0x6012:004 Intensity3_OV03	:008 0x6013:004 Intensity4_OV03	:012 0x6014:004 Intensity5_OV03	:016 0x6015:004 Intensity6_OV03

0x1A53	Channel 1 intensity 3 bis 6 OV8			
	:001 0x6012:001 Intensity3_OV00	**:009** 0x6013:001 Intensity4_OV00	**:017** 0x6014:001 Intensity5_OV00	**:025** 0x6015:001 Intensity6_OV00
	:002 0x6012:002 Intensity3_OV01	**:010** 0x6013:002 Intensity4_OV01	**:018** 0x6014:002 Intensity5_OV01	**:026** 0x6015:002 Intensity6_OV01
	:003 0x6012:003 Intensity3_OV02	**:011** 0x6013:003 Intensity4_OV02	**:019** 0x6014:003 Intensity5_OV02	**:027** 0x6015:003 Intensity6_OV02
	:004 0x6012:004 Intensity3_OV03	**:012** 0x6013:004 Intensity4_OV03	**:020** 0x6014:004 Intensity5_OV03	**:028** 0x6015:004 Intensity6_OV03
	:005 0x6012:005 Intensity3_OV04	**:013** 0x6013:005 Intensity4_OV04	**:021** 0x6014:005 Intensity5_OV04	**:029** 0x6015:005 Intensity6_OV04
	:006 0x6012:006 Intensity3_OV05	**:014** 0x6013:006 Intensity4_OV05	**:022** 0x6014:006 Intensity5_OV05	**:030** 0x6015:006 Intensity6_OV05
	:007 0x6012:007 Intensity3_OV06	**:015** 0x6013:007 Intensity4_OV06	**:023** 0x6014:007 Intensity5_OV06	**:031** 0x6015:007 Intensity6_OV06
	:008 0x6012:008 Intensity3_OV07	**:016** 0x6013:008 Intensity4_OV07	**:024** 0x6014:008 Intensity5_OV07	**:032** 0x6015:008 Intensity6_OV07

Tab. 8.29: Mapping for intensities 3 to 6 from DIST3 to DIST6

0x1A80	Ch01Shutter TxPDOMap OV1			
	:001 0x6030:001 Ch01Shutter_OV00			
0x1A81	Ch01Shutter TxPDOMap OV2			
	:001 0x6030:001 Ch01Shutter_OV00	**:002** 0x6030:002 Ch01Shutter_OV01		
0x1A82	Ch01Shutter TxPDOMap OV4			
	:001 0x6030:001 Ch01Shutter_OV00	**:002** 0x6030:002 Ch01Shutter_OV01	**:003** 0x6030:003 Ch01Shutter_OV02	**:004** 0x6030:004 Ch01Shutter_OV03
0x1A83	Ch01Shutter TxPDOMap OV8			
	:001 0x6030:001 Ch01Shutter_OV00	**:002** 0x6030:002 Ch01Shutter_OV01	**:003** 0x6030:003 Ch01Shutter_OV02	**:004** 0x6030:004 Ch01Shutter_OV03
	:005 0x6030:005 Ch01Shutter_OV04	**:006** 0x6030:006 Ch01Shutter_OV05	**:007** 0x6030:007 Ch01Shutter_OV06	**:008** 0x6030:008 Ch01Shutter_OV07

Tab. 8.30: Mapping for exposure time

0x1A90	CH01 Peak symmetry 1 TxPDOMap OV1			
	:001 0x6060:001 Peak sym 1_OV00			
0x1A91	CH01 Peak symmetry 1 TxPDOMap OV2			
	:001 0x6060:001 Peak sym 1_OV00	**:002** 0x6060:002 Peak sym 1_OV01		
0x1A92	CH01 Peak symmetry 1 TxPDOMap OV4			
	:001 0x6060:001Peak sym 1_OV00	**:002** 0x6060:002 Peak sym 1_OV01	**:003** 0x6060:003 Peak sym 1_OV02	**:004** 0x6060:004 Peak sym 1_OV03
0x1A93	CH01 Peak symmetry 1 TxPDOMap OV8			
	:001 0x6060:001 Peak sym 1_OV00	**:002** 0x6060:002 Peak sym 1_OV01	**:003** 0x6060:003 Peak sym 1_OV02	**:004** 0x6060:004 Peak sym 1_OV03
	:005 0x6060:005 Peak sym 1_OV04	**:006** 0x6060:006 Peak sym 1_OV05	**:007** 0x6060:007 Peak sym 1_OV06	**:008** 0x6060:008 Peak sym 1_OV07

Tab. 8.31: Mapping for peak symmetry 1

0x1AA0	CH01 Peak symmetry 2 TxPDOMap OV1			
	:001 0x6061:001 Peak sym 2_OV00			
0x1AA1	CH01 Peak symmetry 2 TxPDOMap OV2			
	:001 0x6061:001 Peak sym 2_OV00	**:002** 0x6061:002 Peak sym 2_OV01		
0x1AA2	CH01 Peak symmetry 2 TxPDOMap OV4			
	:001 0x6061:001Peak sym 2_OV00	**:002** 0x6061:002 Peak sym 2_OV01	**:003** 0x6061:003 Peak sym 2_OV02	**:004** 0x6061:004 Peak sym 2_OV03
0x1AA3	CH01 Peak symmetry 2 TxPDOMap OV8			
	:001 0x6061:001 Peak sym 2_OV00	**:002** 0x6061:002 Peak sym 2_OV01	**:003** 0x6061:003 Peak sym 2_OV02	**:004** 0x6061:004 Peak sym 2_OV03
	:005 0x6061:005 Peak sym 2_OV04	**:006** 0x6061:006 Peak sym 2_OV05	**:007** 0x6061:007 Peak sym 2_OV06	**:008** 0x6061:008 Peak sym 2_OV07

Tab. 8.32: Mapping for peak symmetry 2

0x1AB0	CH01 Peak symmetry 3 bis 6 TxPDOMap OV1			
	:001 0x6062:001 Peak sym 3_OV00	**:002** 0x6063:001 Peak sym 4_OV00	**:003** 0x6064:001 Peak sym 5_OV00	**:004** 0x6065:001 Peak sym 6_OV00
0x1AB1	CH01 Peak symmetry 3 bis 6 OV2			
	:001 0x6062:001 Peak sym 3_OV00	**:003** 0x6063:001 Peak sym 4_OV00	**:005** 0x6064:001 IPeak sym 5_OV00	**:007** 0x6065:001 Peak sym 6_OV00
	:002 0x6062:002 Peak sym 3_OV01	**:004** 0x6063:002 Peak sym 4_OV01	**:006** 0x6064:002 IPeak sym 5_OV01	**:008** 0x6065:002 Peak sym 6_OV01

0x1AB2	CH01 Peak symmetry 3 to 6 OV4			
	:001 0x6062:001 Peak sym 3_OV00	:005 0x6063:001 Peak sym 4_OV00	:009 0x6064:001 Peak sym 5_OV00	:013 0x6065:001 Peak sym 6_OV00
	:002 0x6062:002 Peak sym 3_OV01	:006 0x6063:002 Peak sym 4_OV01	:010 0x6064:002 Peak sym 5_OV01	:014 0x6065:002 Peak sym 6_OV01
	:003 0x6062:003 Peak sym 3_OV02	:007 0x6063:003 Peak sym 4_OV02	:011 0x6064:003 Peak sym 5_OV02	:015 0x6065:003 Peak sym 6_OV02
	:004 0x6062:004 Peak sym 3_OV03	:008 0x6063:004 Peak sym 4_OV03	:012 0x6064:004 Peak sym 5_OV03	:016 0x6065:004 Peak sym 6_OV03
0x1AB3	CH01 Peak symmetry 3 to 6 OV8			
	:001 0x6062:001 Peak sym 3_OV00	:009 0x6063:001 Peak sym 4_OV00	:017 0x6064:001 Peak sym 5_OV00	:025 0x6065:001 Peak sym 6_OV00
	:002 0x6062:002 Peak sym 3_OV01	:010 0x6063:002 Peak sym 4_OV01	:018 0x6064:002 Peak sym 5_OV01	:026 0x6065:002 Peak sym 6_OV01
	:003 0x6062:003 Peak sym 3_OV02	:011 0x6063:003 Peak sym 4_OV02	:019 0x6064:003 Peak sym 5_OV02	:027 0x6065:003 Peak sym 6_OV02
	:004 0x6062:004 Peak sym 3_OV03	:012 0x6063:004 Peak sym 4_OV03	:020 0x6064:004 Peak sym 5_OV03	:028 0x6065:004 Peak sym 6_OV03
	:005 0x6062:005 Peak sym 3_OV04	:013 0x6063:005 Peak sym 4_OV04	:021 0x6064:005 Peak sym 5_OV04	:029 0x6065:005 Peak sym 6_OV04
	:006 0x6062:006 Peak sym 3_OV05	:014 0x6063:006 Peak sym 4_OV05	:022 0x6064:006 Peak sym 5_OV05	:030 0x6065:006 Peak sym 6_OV05
	:007 0x6062:007 Peak sym 3_OV06	:015 0x6063:007 Peak sym 4_OV06	:023 0x6064:007 Peak sym 5_OV06	:031 0x6065:007 Peak sym 6_OV06
	:008 0x6062:008 Peak sym 3_OV07	:016 0x6063:008 Peak sym 4_OV07	:024 0x6064:008 Peak sym 5_OV07	:032 0x6065:008 Peak sym 6_OV07

Tab. 8.33: Mapping for peak symmetries 3 to 6

0x1AC0	Ch01Encoder TxPDOMap OV1			
	:001 0x6050:001 Encoder1_OV00	:002 0x6051:001 Encoder2_OV00	:003 00x6052:001 Encoder3_OV00	
0x1AC1	Ch01Encoder TxPDOMap OV2			
	:001 0x6050:001 Encoder1_OV00	:003 0x6051:001 Encoder2_OV00	:005 0x6052:001 Encoder3_OV00	
	:002 0x6050:002 Encoder1_OV01	:004 0x6051:002 Encoder2_OV01	:006 0x6052:002 Encoder3_OV01	

0x1AC2	Ch01Encoder TxPDOMap OV4			
	:001 0x6050:001 Encod-er1_OV00	:005 0x6051:001 Encod-er2_OV00	:009 0x6052:001 Encod-er3_OV00	
	:002 0x6050:002 Encod-er1_OV01	:006 0x6051:002 Encod-er2_OV01	:010 0x6052:002 Encod-er3_OV01	
	:003 0x6050:003 Encod-er1_OV02	:007 0x6051:003 Encod-er2_OV02	:011 0x6052:003 Encod-er3_OV02	
	:004 0x6050:004 Encod-er1_OV03	:008 0x6051:004 Encod-er2_OV03	:012 0x6052:004 Encod-er3_OV03	
0x1AC3	Ch01Encoder TxPDOMap OV8			
	:001 0x6050:001 Encod-er1_OV00	:009 0x6051:001 Encod-er2_OV00	:017 0x6052:001 Encod-er3_OV00	
	:002 0x6050:002 Encod-er1_OV01	:010 0x6051:002 Encod-er2_OV01	:018 0x6052:002Encoder3_OV01	
	:003 0x6050:003 Encod-er1_OV02	:011 0x6051:003 Encod-er2_OV02	:019 0x6052:003 Encod-er3_OV02	
	:004 0x6050:004 Encod-er1_OV03	:012 0x6051:004 Encod-er2_OV03	:020 0x6052:004 Encod-er3_OV03	
	:005 0x6050:005 Encod-er1_OV04	:013 0x6051:005 Encod-er2_OV04	:021 0x6052:005 Encod-er3_OV04	
	:006 0x6050:006 Encod-er1_OV05	:014 0x6051:006 Encod-er2_OV05	:022 0x6052:006 Encod-er3_OV05	
	:007 0x6050:007 Encod-er1_OV06	:015 0x6051:007 Encod-er2_OV06	:023 0x6052:007 Encod-er3_OV06	
	:008 0x6050:008 Encod-er1_OV07	:016 0x6051:008 Encod-er2_OV07	:024 0x6052:008 Encod-er3_OV07	

Tab. 8.34: Mapping for encoders 1 to 3

0x1AE0	Counter TxPDOMap OV1			
	:001 0x7000:001 Counter_OV00			
0x1AE2	Counter TxPDOMap OV2			
	:001 0x7000:001 Counter_OV00	:002 0x7000:002 Counter_OV01		
0x1AE2	Counter TxPDOMap OV4			
	:001 0x7000:001 Counter_OV00	:002 0x7000:002 Counter_OV01	:003 0x7000:003 Counter_OV02	:004 0x7000:004 Counter_OV03
0x1AE3	Counter TxPDOMap OV8			
	:001 0x7000:001 Counter_OV00	:002 0x7000:002 Counter_OV01	:003 0x7000:003 Counter_OV02	:004 0x7000:004 Counter_OV03
	:005 0x7000:005 Counter_OV04	:006 0x7000:006 Counter_OV05	:007 0x7000:007 Counter_OV06	:008 0x7000:008 Counter_OV07

Tab. 8.35: Mapping for measurement counter

0x1AE8	Time stamp TxPDOMap OV1			
	:001 0x7001:001 Time stamp_OV00			
0x1AE9	Time stamp TxPDOMap OV2			
	:001 0x7001:001 Time stamp_OV00	**:002** 0x7001:002 Time stamp_OV01		
0x1AEA	Time stamp TxPDOMap OV4			
	:001 0x7001:001 Time stamp_OV00	**:002** 0x7001:002 Time stamp_OV01	**:003** 0x7001:003 Time stamp_OV02	**:004** 0x7001:004 Time stamp_OV03
0x1AEB	Time stamp TxPDOMap OV8			
	:001 0x7001:001 Time stamp_OV00	**:002** 0x7001:002 Time stamp_OV01	**:003** 0x7001:003 Time stamp_OV02	**:004** 0x7001:004 Time stamp_OV03
	:005 0x7001:005 Time stamp_OV04	**:006** 0x7001:006 Time stamp_OV05	**:007** 0x7001:007 Time stamp_OV06	**:008** 0x7001:008 Time stamp_OV07

Tab. 8.36: Mapping for time information

0x1AF0	Frequency TxPDOMap OV1			
	:001 0x7002:001 Frequen-cy_OV00			
0x1AF1	Frequency TxPDOMap OV2			
	:001 0x7002:001 Frequen-cy_OV00	**:002** 0x7002:002 Frequen-cy_OV01		
0x1AF2	Frequency TxPDOMap OV4			
	:001 0x7002:001 Frequen-cy_OV00	**:002** 0x7002:002 Frequen-cy_OV01	**:003** 0x7002:003 Frequen-cy_OV02	**:004** 0x7002:004 Frequen-cy_OV03
0x1AF3	Frequency TxPDOMap OV8			
	:001 0x7002:001 Frequen-cy_OV00	**:002** 0x7002:002 Frequen-cy_OV01	**:003** 0x7002:003 Frequen-cy_OV02	**:004** 0x7002:004 Frequen-cy_OV03
	:005 0x7002:005 Frequen-cy_OV04	**:006** 0x7002:006 Frequen-cy_OV05	**:007** 0x7002:007 Frequen-cy_OV06	**:008** 0x7002:008 Frequen-cy_OV07

Tab. 8.37: Mapping for measuring frequency

0x1B00	User calc output 01 TxPDOMap OV1			
	:001 0x7C00:001 User calc 01_OV00			
0x1B01	User calc output 01 TxPDOMap OV2			
	:001 0x7C00:001 User calc 01_OV00	**:002** 0x7C00:002 User calc 01_OV01		

0x1B02	User calc output 01 TxPDOMap OV4			
	:001 0x7C00:001User calc 01_OV00	:002 0x7C00:002 User calc 01_OV01	:003 0x7C00:003 User calc 01_OV02	:004 0x7C00:004 User calc 01_OV03
0x1B03	User calc output 01 TxPDOMap OV8			
	:001 0x7C00:001 User calc 01_OV00	:002 0x7C00:002 User calc 01_OV01	:003 0x7C00:003 User calc 01_OV02	:004 0x7C00:004 User calc 01_OV03
	:005 0x7C00:005 User calc 01_OV04	:006 0x7C00:006 User calc 01_OV05	:007 0x7C00:007 User calc 01_OV06	:008 0x7C00:008 User calc 01_OV07

Tab. 8.38: Mapping for calculation program 1

0x1B08	User calc output 02 TxPDOMap OV1			
	:001 0x7C01:001 User calc 02_OV00			
0x1B09	User calc output 02 TxPDOMap OV2			
	:001 0x7C01:001 User calc 02_OV00	:002 0x7C01:002 User calc 02_OV01		
0x1B0A	User calc output 01 TxPDOMap OV4			
	:001 0x7C01:001User calc 02_OV00	:002 0x7C01:002 User calc 02_OV01	:003 0x7C01:003 User calc 02_OV02	:004 0x7C01:004 User calc 02_OV03
0x1B0B	User calc output 02 TxPDOMap OV8			
	:001 0x7C01:001 User calc 02_OV00	:002 0x7C01:002 User calc 02_OV01	:003 0x7C01:003 User calc 02_OV02	:004 0x7C01:004 User calc 02_OV03
	:005 0x7C01:005 User calc 02_OV04	:006 0x7C01:006 User calc 02_OV05	:007 0x7C01:007 User calc 02_OV06	:008 0x7C01:008 User calc 02_OV07

Tab. 8.39: Mapping for calculation program 2

0x1B10	User calc output 03 TxPDOMap OV1			
	:001 0x7C02:001 User calc 03_OV00			
0x1B11	User calc output 03 TxPDOMap OV2			
	:001 0x7C02:001 User calc 03_OV00	:002 0x7C02:002 User calc 03_OV01		
0x1B12	User calc output 03 TxPDOMap OV4			
	:001 0x7C02:001User calc 03_OV00	:002 0x7C02:002 User calc 03_OV01	:003 0x7C02:003 User calc 03_OV02	:004 0x7C02:004 User calc 03_OV03
0x1B13	User calc output 03 TxPDOMap OV8			
	:001 0x7C02:001 User calc 03_OV00	:002 0x7C02:002 User calc 03_OV01	:003 0x7C02:003 User calc 03_OV02	:004 0x7C02:004 User calc 03_OV03
	:005 0x7C02:005 User calc 03_OV04	:006 0x7C02:006 User calc 03_OV05	:007 0x7C02:007 User calc 03_OV06	:008 0x7C02:008 User calc 03_OV07

Tab. 8.40: Mapping for calculation program 3

0x1B18	User calc output 04 TxPDOMap OV1			
	:001 0x7C03:001 User calc 04_OV00			
0x1B19	User calc output 04 TxPDOMap OV2			
	:001 0x7C03:001 User calc 04_OV00	**:002** 0x7C03:002 User calc 04_OV01		
0x1B1A	User calc output 04 TxPDOMap OV4			
	:001 0x7C03:001User calc 04_OV00	**:002** 0x7C03:002 User calc 04_OV01	**:003** 0x7C03:003 User calc 04_OV02	**:004** 0x7C03:004 User calc 04_OV03
0x1B1B	User calc output 04 TxPDOMap OV8			
	:001 0x7C03:001 User calc 04_OV00	**:002** 0x7C03:002 User calc 04_OV01	**:003** 0x7C03:003 User calc 04_OV02	**:004** 0x7C03:004 User calc 04_OV03
	:005 0x7C03:005 User calc 04_OV04	**:006** 0x7C03:006 User calc 04_OV05	**:007** 0x7C03:007 User calc 04_OV06	**:008** 0x7C03:008 User calc 04_OV07

Tab. 8.41: Mapping for calculation program 4

0x1B20	User calc output 05 TxPDOMap OV1			
	:001 0x7C04:001 User calc 05_OV00			
0x1B21	User calc output 05 TxPDOMap OV2			
	:001 0x7C04:001 User calc 05_OV00	**:002** 0x7C04:002 User calc 05_OV01		
0x1B22	User calc output 05 TxPDOMap OV4			
	:001 0x7C04:001User calc 05_OV00	**:002** 0x7C04:002 User calc 05_OV01	**:003** 0x7C04:003 User calc 05_OV02	**:004** 0x7C04:004 User calc 05_OV03
0x1B23	User calc output 05 TxPDOMap OV8			
	:001 0x7C04:001 User calc 05_OV00	**:002** 0x7C04:002 User calc 05_OV01	**:003** 0x7C04:003 User calc 05_OV02	**:004** 0x7C04:004 User calc 05_OV03
	:005 0x7C04:005 User calc 05_OV04	**:006** 0x7C04:006 User calc 05_OV05	**:007** 0x7C04:007 User calc 05_OV06	**:008** 0x7C04:008 User calc 05_OV07

Tab. 8.42: Mapping for calculation program 5

0x1B28	User calc output 06 and 07 TxPDOMap OV1			
	:001 0x7C05:001 User calc 06_OV00			
	:002 0x7C06:001 User calc 07_OV00			
0x1B29	User calc output 06 and 07 TxPDOMap OV2			
	:001 0x7C05:001 User calc 06_OV00	**:002** 0x7C05:002 User calc 06_OV01		
	:003 0x7C06:001 User calc 07_OV00	**:004** 0x7C06:002 User calc 07_OV01		
0x1B2A	User calc output 06 and 07 TxPDOMap OV4			
	:001 0x7C05:001 User calc 06_OV00	**:002** 0x7C05:002 User calc 06_OV01	**:003** 0x7C05:003 User calc 06_OV02	**:004** 0x7C05:004 User calc 06_OV03
	:005 0x7C06:001 User calc 07_OV00	**:006** 0x7C06:002 User calc 07_OV01	**:007** 0x7C06:003 User calc 07_OV02	**:008** 0x7C06:004 User calc 07_OV03
0x1B2B	User calc output 06 and 07 TxPDOMap OV8			
	:001 0x7C05:001 User calc 06_OV00	**:002** 0x7C05:002 User calc 06_OV01	**:003** 0x7C05:003 User calc 06_OV02	**:004** 0x7C05:004 User calc 06_OV03
	:005 0x7C05:005 User calc 06_OV04	**:006** 0x7C05:006 User calc 06_OV05	**:007** 0x7C05:007 User calc 06_OV06	**:008** 0x7C05:008 User calc 06_OV07
	:009 0x7C06:001 User calc 07_OV00	**:010** 0x7C06:002 User calc 07_OV01	**:011** 0x7C06:003 User calc 07_OV02	**:012** 0x7C06:004 User calc 07_OV03
	:013 0x7C06:005 User calc 07_OV04	**:014** 0x7C06:006 User calc 07_OV05	**:015** 0x7C06:007 User calc 07_OV06	**:016** 0x7C06:008 User calc 07_OV07

Tab. 8.43: Mapping for calculation programs 6 and 7

0x1B30	User calc output 08 and 09 TxPDOMap OV1			
	:001 0x7C07:001 User calc 08_OV00			
	:002 0x7C08:001 User calc 09_OV00			
0x1B31	User calc output 08 and 09 TxPDOMap OV2			
	:001 0x7C07:001 User calc 08_OV00	**:002** 0x7C07:002 User calc 08_OV01		
	:003 0x7C08:001 User calc 09_OV00	**:004** 0x7C08:002 User calc 09_OV01		

0x1B32	User calc output 08 and 09 TxPDOMap OV4			
	:001 0x7C07:001 User calc 08_OV00	**:002** 0x7C07:002 User calc 08_OV01	**:003** 0x7C07:003 User calc 08_OV02	**:004** 0x7C07:004 User calc 08_OV03
	:005 0x7C08:001 User calc 09_OV00	**:006** 0x7C08:002 User calc 09_OV01	**:007** 0x7C08:003 User calc 09_OV02	**:008** 0x7C08:004 User calc 09_OV03
0x1B33	User calc output 08 and 09 TxPDOMap OV8			
	:001 0x7C07:001 User calc 08_OV00	**:002** 0x7C07:002 User calc 08_OV01	**:003** 0x7C07:003 User calc 08_OV02	**:004** 0x7C07:004 User calc 08_OV03
	:005 0x7C07:005 User calc 08_OV04	**:006** 0x7C07:006 User calc 08_OV05	**:007** 0x7C07:007 User calc 08_OV06	**:008** 0x7C07:008 User calc 08_OV07
	:009 0x7C08:001 User calc 09_OV00	**:010** 0x7C08:002 User calc 09_OV01	**:011** 0x7C08:003 User calc 09_OV02	**:012** 0x7C08:004 User calc 09_OV03
	:013 0x7C08:005 User calc 09_OV04	**:014** 0x7C08:006 User calc 09_OV05	**:015** 0x7C08:007 User calc 09_OV06	**:016** 0x7C08:008 User calc 09_OV07

Tab. 8.44: Mapping for calculation programs 8 and 9

0x1B38	User calc output 10 and 11 TxPDOMap OV1			
	:001 0x7C09:001 User calc 10_OV00			
	:002 0x7C0A:001 User calc 11_OV00			
0x1B39	User calc output 10 and 11 TxPDOMap OV2			
	:001 0x7C09:001 User calc 10_OV00	**:002** 0x7C09:002 User calc 10_OV01		
	:003 0x7C0A:001 User calc 11_OV00	**:004** 0x7C0A:002 User calc 11_OV01		
0x1B3A	User calc output 10 and 11 TxPDOMap OV4			
	:001 0x7C09:001 User calc 10_OV00	**:002** 0x7C09:002 User calc 10_OV01	**:003** 0x7C09:003 User calc 10_OV02	**:004** 0x7C09:004 User calc 10_OV03
	:005 0x7C0A:001 User calc 11_OV00	**:006** 0x7C0A:002 User calc 11_OV01	**:007** 0x7C0A:003 User calc 11_OV02	**:008** 0x7C0A:004 User calc 11_OV03

0x1B3B	User calc output 10 and 11 TxPDOMap OV8			
	:001 0x7C09:001 User calc 10_OV00	:002 0x7C09:002 User calc 10_OV01	:003 0x7C09:003 User calc 10_OV02	:004 0x7C09:004 User calc 10_OV03
	:005 0x7C09:005 User calc 10_OV004	:006 0x7C09:006 User calc 10_OV05	:007 0x7C09:007 User calc 10_OV06	:008 0x7C09:008 User calc 10_OV07
	:009 0x7C0A:001 User calc 11_OV00	:010 0x7C0A:002 User calc 11_OV01	:011 0x7C0A:003 User calc 11_OV02	:012 0x7C0A:004 User calc 11_OV03
	:013 0x7C0A:005 User calc 11_OV04	:014 0x7C0A:006 User calc 11_OV05	:015 0x7C0A:007 User calc 11_OV06	:016 0x7C0A:008 User calc 11_OV07

Tab. 8.45: Mapping for calculation programs 10 and 11

0x1B40	User calc output 12 and 13 TxPDOMap OV1			
	:001 0x7C0B:001 User calc 12_OV00			
	:002 0x7C0C:001 User calc 13_OV00			
0x1B41	User calc output 12 and 13 TxPDOMap OV2			
	:001 0x7C0B:001 User calc 12_OV00	:002 0x7C0B:002 User calc 12_OV01		
	:003 0x7C0C:001 User calc 13_OV00	:004 0x7C0C:002 User calc 13_OV01		
0x1B42	User calc output 12 and 13 TxPDOMap OV4			
	:001 0x7C0B:001 User calc 12_OV00	:002 0x7C0B:002 User calc 12_OV01	:003 0x7C0B:003 User calc 12_OV02	:004 0x7C0B:004 User calc 12_OV03
	:005 0x7C0C:001 User calc 13_OV00	:006 0x7C0C:002 User calc 13_OV01	:007 0x7C0C:003 User calc 13_OV02	:008 0x7C0C:004 User calc 13_OV03
0x1B43	User calc output 12 and 13 TxPDOMap OV8			
	:001 0x7C0B:001 User calc 12_OV00	:002 0x7C0B:002 User calc 12_OV01	:003 0x7C0B:003 User calc 12_OV02	:004 0x7C0B:004 User calc 12_OV03
	:005 0x7C0B:005 User calc 12_OV004	:006 0x7C0B:006 User calc 12_OV05	:007 0x7C0B:007 User calc 12_OV06	:008 0x7C0B:008 User calc 12_OV07
	:009 0x7C0C:001 User calc 13_OV00	:010 0x7C0C:002 User calc 13_OV01	:011 0x7C0C:003 User calc 13_OV02	:012 0x7C0C:004 User calc 13_OV03
	:013 0x7C0C:005 User calc 13_OV04	:014 0x7C0C:006 User calc 13_OV05	:015 0x7C0C:007 User calc 13_OV06	:016 0x7C0C:008 User calc 13_OV07

Tab. 8.46: Mapping for calculation programs 12 and 13

0x1B48	User calc output 14 and 15 TxPDOMap OV1			
	:001 0x7C0D:001 User calc 14_OV00			
	:002 0x7C0E:001 User calc 15_OV00			
0x1B49	User calc output 14 and 15 TxPDOMap OV2			
	:001 0x7C0D:001 User calc 14_OV00	**:002** 0x7C0D:002 User calc 14_OV01		
	:003 0x7C0E:001 User calc 15_OV00	**:004** 0x7C0E:002 User calc 15_OV01		
0x1B4A	User calc output 14 and 15 TxPDOMap OV4			
	:001 0x7C0D:001 User calc 14_OV00	**:002** 0x7C0D:002 User calc 14_OV01	**:003** 0x7C0D:003 User calc 14_OV02	**:004** 0x7C0D:004 User calc 14_OV03
	:005 0x7C0E:001 User calc 15_OV00	**:006** 0x7C0E:002 User calc 15_OV01	**:007** 0x7C0E:003 User calc 15_OV02	**:008** 0x7C0E:004 User calc 15_OV03
0x1B4B	User calc output 14 and 15 TxPDOMap OV8			
	:001 0x7C0D:001 User calc 14_OV00	**:002** 0x7C0D:002 User calc 14_OV01	**:003** 0x7C0D:003 User calc 14_OV02	**:004** 0x7C0D:004 User calc 14_OV03
	:005 0x7C0D:005User calc 14_OV004	**:006** 0x7C0D:006 User calc 14_OV05	**:007** 0x7C0D:007 User calc 14_OV06	**:008** 0x7C0D:008 User calc 14_OV07
	:009 0x7C0E:001 User calc 15_OV00	**:010** 0x7C0E:002 User calc 15_OV01	**:011** 0x7C0E:003 User calc 15_OV02	**:012** 0x7C0E:004User calc 15_OV03
	:013 0x7C0E:005 User calc 15_OV04	**:014** 0x7C0E:006 User calc 15_OV05	**:015** 0x7C0E:007 User calc 15_OV06	**:016** 0x7C0E:008 User calc 15_OV07

Tab. 8.47: Mapping for calculation programs 14 and 15

0x1B50	User calc output 16 and 17 TxPDOMap OV1			
	:001 0x7C0F:001 User calc 16_OV00			
	:002 0x7C10:001 User calc 17_OV00			
0x1B51	User calc output 16 and 17 TxPDOMap OV2			
	:001 0x7C0F:001 User calc 16_OV00	**:002** 0x7C0F:002 User calc 16_OV01		
	:003 0x7C10:001 User calc 17_OV00	**:004** 0x7C10:002 User calc 17_OV01		

0x1B52	User calc output 16 and 17 TxPDOMap OV4			
	:001 0x7C0F:001 User calc 16_OV00	**:002** 0x7C0F:002 User calc 16_OV01	**:003** 0x7C0F:003 User calc 16_OV02	**:004** 0x7C0F:004 User calc 16_OV03
	:005 0x7C10:001 User calc 17_OV00	**:006** 0x7C10:002 User calc 17_OV01	**:007** 0x7C10:003 User calc 17_OV02	**:008** 0x7C10:004 User calc 17_OV03
0x1B53	User calc output 16 and 17 TxPDOMap OV8			
	:001 0x7C0F:001 User calc 16_OV00	**:002** 0x7C0F:002 User calc 16_OV01	**:003** 0x7C0F:003 User calc 16_OV02	**:004** 0x7C0F:004 User calc 16_OV03
	:005 0x7C0F:005User calc 16_OV004	**:006** 0x7C0F:006 User calc 16_OV05	**:007** 0x7C0F:007 User calc 16_OV06	**:008** 0x7C0F:008 User calc 16_OV07
	:009 0x7C10:001 User calc 17_OV00	**:010** 0x7C10:002 User calc 17_OV01	**:011** 0x7C10:003 User calc 17_OV02	**:012** 0x7C10:004User calc 17_OV03
	:013 0x7C10:005 User calc 17_OV04	**:014** 0x7C10:006 User calc 17_OV05	**:015** 0x7C10:007 User calc 17_OV06	**:016** 0x7C10:008 User calc 17_OV07

Tab. 8.48: Mapping for calculation programs 16 and 17

0x1B58	User calc output 18 and 19 TxPDOMap OV1			
	:001 0x7C11:001 User calc 18_OV00			
	:002 0x7C12:001 User calc 19_OV00			
0x1B59	User calc output 18 and 19 TxPDOMap OV2			
	:001 0x7C11:001 User calc 18_OV00	**:002** 0x7C11:002 User calc 18_OV01		
	:003 0x7C12:001 User calc 19_OV00	**:004** 0x7C12:002 User calc 19_OV01		
0x1B5A	User calc output 18 and 19 TxPDOMap OV4			
	:001 0x7C11:001 User calc 18_OV00	**:002** 0x7C11:002 User calc 18_OV01	**:003** 0x7C11:003 User calc 18_OV02	**:004** 0x7C11:004 User calc 16_OV03
	:005 0x7C12:001 User calc 19_OV00	**:006** 0x7C12:002 User calc 19_OV01	**:007** 0x7C12:003 User calc 19_OV02	**:008** 0x7C12:004 User calc 17_OV03

0x1B5B	User calc output 18 and 19 TxPDOMap OV8			
	:001 0x7C11F:001 User calc 18_OV00	:002 0x7C11:002 User calc 18_OV01	:003 0x7C11:003 User calc 18_OV02	:004 0x7C11:004 User calc 18_OV03
	:005 0x7C11:005User calc 18_OV004	:006 0x7C11:006 User calc 18_OV05	:007 0x7C11:007 User calc 18_OV06	:008 0x7C11:008 User calc 18_OV07
	:009 0x7C12:001 User calc 19_OV00	:010 0x7C12:002 User calc 19_OV01	:011 0x7C12:003 User calc 19_OV02	:012 0x7C12:004User calc 19_OV03
	:013 0x7C12:005 User calc 19_OV04	:014 0x7C12:006 User calc 19_OV05	:015 0x7C12:007 User calc 19_OV06	:016 0x7C12:008 User calc 19_OV07

Tab. 8.49: Mapping for calculation programs 18 and 19

8.3.1.9 Example of TxPDO mapping

In object 0x1C13, it is selected which PDOs are to be transferred. The PDO mapping objects are selected. The selection process takes place before switching from PreOP to SafeOP mode.

Example 1: Startup procedure to output distance 1 from channel 1 (01DIST1).

- Distance 1 is expressed in 0x6000. In order to transfer 0x6000 in the PDO, the PDO mapping object 0x1A00 must be selected in 0x1C13.

Object	Value	Description
0x1C13:00	0x00	clear sm pdos (0x1C13)
0x1C13:01	0x1A00	download pdo 0x1C13:01 index
0x1C13:00	0x01	download pdo 0x1C13 count

Example 2: Startup procedure to output distance 1, the exposure time and the encoders.

- Distance 1 is expressed in 0x6000. In order to transfer 0x6000 in the PDO, the PDO mapping object 0x1A00 must be selected in 0x1C13.
- The shutter speed is expressed in 0x6030. In order to transfer 0x6030 in the PDO, PDO mapping object 0x1A80 must be selected in 0x1C13.
- Encoder 1 is output in 0x6050, encoder 2 in 0x6051 and encoder 3 in 0x6052. The process data is summarized in 0x1AC0, for transfer in the PDO, it must be selected in 0x1C13.

Object	Value	Description
0x1C13:00	0x00	clear sm pdos (0x1C13)
0x1C13:01	0x1A00	download pdo 0x1C13:01 index
0x1C13:02	0x080	download pdo 0x1C13:02 index
0x1C13:03	0x1AC0	download pdo 0x1C13:03 index
0x1C13:00	0x03 (3)	download pdo 0x1C13 count

8.3.1.10 Object 1C00h: Synchronous Manager Type

1C00	RECORD	Sync manager type			ro

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	Sync manager 1	0x01	Uint8	ro
2	VAR	Sync manager 2	0x02	Uint8	ro
3	VAR	Sync manager 3	0x03	Uint8	ro
4	VAR	Sync manager 4	0x04	Uint8	ro

8.3.1.11 Object 1C12h: RxPDO Assign

1C12	ARRAY	RxPDO assign			rw

Sub-indices

0	VAR	Number of entries	0	Uint8	ro

No RxPDOs can be selected because none are present. The object is implemented as a dummy to enable the EtherCAT master to set the RxPDOs to 0.

8.3.1.12 Object 1C13h: TxPDO Assign

1C13	ARRAY	TxPDO-Assign			rw

Sub-indices

0	VAR	Number of entries	n	Uint8	rw
1	VAR	Sub-index 001	0x1A00	Uint16	rw
2	VAR	Sub-index 002		Uint16	rw
...					rw
n	VAR	Sub-index n		Uint16	rw

Object for selecting the PDOs (TxPDO maps), see Chap. 8.3.1.7, see Chap. 8.3.1.8.

8.3.1.13 Object 1C32h: Sync manager output parameters

See description of input parameters, see Chap. 8.3.1.14.

8.3.1.14 Object 1C33h: Sync manager input parameters

1C33	RECORD	SM input parameter			ro

Sub-indices

0	VAR	Number of entries	9	Uint8	ro
1	VAR	Synchronization type	x	Uint16	ro
2	VAR	Cycle time	x	Uint32	ro
4	VAR	Synchronization types supported	0x4007	Uint16	ro
5	VAR	Minimum cycle time	1250000	Uint32	ro
6	VAR	Calc and copy time	x	Uint32	ro
8	VAR	Get cycle time	x	Uint16	rw
9	VAR	Delay time	x	Uint32	ro
0C	VAR	Cycle time too small counter	x	Uint16	ro
20	VAR	Sync error	x	BOOL	ro

- Synchronization type: currently specified synchronization type, see Tab. 8.50
- Cycle time: cycle time currently set in ns
  - Free run: cycle time derived from the measuring rate,
  - SM2, SM3: cycle time derived from the measuring rate,

- Sync0 synchronization: the Sync0 cycle time set by the master
- Supported synchronization types:
  - Freerun
  - SM2 / SM3
  - Sync0 Synchronization
- Minimum cycle time: The minimum cycle time is derived from the maximum measuring rate and is 125 µs for IFD2410 or IFD2411 and 40 µs for IFD2415.
- Calc and Copy Time: The Calc and Copy time is the time after the input latch (input data are available in the slave) until the input data is copied into the Sync-Manager-3 area (transfer of the data to Industrial Ethernet). The Calc and Copy Time from 0x1C33 is only calculated if the Distributed Clocks are enabled. The value is recalculated each time it is read. Since the sensor does not have output data, the Calc and copy time of 0x1C32 always returns to 0.
- Delay time: The delay time is the hardware-related delay until the input latch is reached.

The delay time from 0x1C33 is only calculated if the Distributed Clocks are activated. The value is recalculated each time it is read. Since the sensor does not have output data, the Delay time from 0x1C32 always returns to 0.

- Cycle Time Too Small Counter: This counter is incremented if the cycle time is too low, so that the input data could not be provided for the next SM event.
- Sync error
  - 0: No errors.
  - 1: A synchronization occurred. The Cycle Time Too Small Counter has been incremented.

The set synchronization depends on the combination of 0x1C33:001 and 0x1C32:001. The synchronization changes during a transition from the PreOP state to the SafeOP state. If the combination is invalid, an error message is displayed when the state is changed. Process data communication will then not be possible.

0x1C32 Synchronization Type	0x1C33 Synchronization Type	Synchronization
0x00	0x00	Free Run
0x01	0x22	SM2
0xyy	0x01	SM3
0x02	0x02	Sync0

Tab. 8.50: Example synchronization

An activation of the Distributed Clocks does not automatically change the Sync0 mode. The synchronization can only be changed by writing the objects 0x1C32 and 0x1C33.

8.3.2 Manufacturer-specific objects

8.3.2.1 Overview

Index (h)	Name	IFD2410	IFD2411	IFD2415	Description
3001	User level	•	•	•	Login, logout, change password
3005	Controller information	•	•	•	Information on the IFD241x (further)
3011	Correction ch 1	•	•	•	Dark referencing/dark correction
3020	Basic settings	•	•	•	Load, save, factory setting
3021	Preset settings	•	•	•	
3022	Measurement settings	•	•	•	Measurement settings
303F	Sensor error	•	•	•	Error IFD241x Channel 1
3101	Reset	•	•	•	Reboot IFD241x
3105	Factory reset	•	•	•	Factory Settings
3107	Counter reset	•	•	•	Counter reset
3133	LED on/off ch 1	•	•	•	LED light source channel 1
3150	Sensor ch 1	•	•	•	Error IFD241x channel 1
3152	Select sensor		•		Sensor selection

Index (h)	Name	IFD2410	IFD2411	IFD2415	Description
3153	Sensor table		•		Sensor table
3156	Multilayer options ch 1	•	•	•	
3161	Peak position ch 1	•	•	•	Peak selection channel 1
3162	Peak options ch 1	•	•	•	Peak options channel 1
31B0	Digital interfaces	•	•	•	Digital interfaces
31B1	Enable output	•	•	•	Interface selection
31B2	Outhold	•	•	•	Error handling
31B3	Outreduce settings	•	•	•	Data reduction
31D0	Analog output	•	•	•	Analog output, scaling
31F3	Switching output 1	•		•	Switching output 1/2
31F4	Switching output 2	•		•	
31F5	RS422 output	•	•	•	Data output with RS422
3250	Shutter mode ch 1	•	•	•	Exposure mode channel 1
3251	Measuring rate	•	•	•	Measuring rate
34A0	Keylock	•	•	•	Lock key on IFD241x
35A0	Encoder	•	•	•	Encoder settings
35B0	Trigger settings	•	•	•	Trigger settings
35B1	Synchronization	•	•	•	Synchronization, terminating resistor
3711	Region of interest ch 1	•	•	•	Masking the region of interest
3800	Material info and edit	•	•	•	Material information
3802	Materials table edit	•	•	•	Edit materials table
3803	Materials table	•	•	•	Materials present in the materials table
3804	Material selection ch 1	•	•	•	Select material
39FF-3A09	Mastering y	•	•	•	Master value, mastering
3A10-3A12	Statistic y	•	•	•	Statistics
3C00-3C09	Comp y ch 1	•	•	•	Measured value calculation Channel 1
3CBF	Sys signals	•	•	•	
3E00	User calc	•	•	•	

Note Reading and writing the manufacturer-specific objects can cause an error if invalid entries are made. These errors are listed in the SDO abort codes, see Chap. 8.5. If an error occurs while writing a value, you may be able to retrieve error details in object 303F.

8.3.2.2 Object 3001h: User level

3001	RECORD	User level			

Sub-indices

0	VAR	Number of entries	7	Uint8	ro
1	VAR	Actual user	x	Uint8	ro
2	VAR	Login		Visible string	wo
3	VAR	Logout	FALSE	BOOL	rw

4	VAR	User level when restarting	x	Uint8	rw
5	VAR	Password old		Visible string	wo
6	VAR	Password new		Visible string	wo
7	VAR	Password repeat		Visible string	wo

For more information, please refer to the Login section, see Chap. 6.6.4.

Actual user, standard user:

0 - Operator

1 - Professional

Modifying the user level will also change the access rights for objects. On the user level, once you `log out`, all RW objects change to read-only (= ro), and write-only objects (= wo) will no longer be available.

To change the password, you need to complete the three passwords fields (Old, New and Repeat) in this particular order. The maximum password length is 31 characters.

8.3.2.3 Object 3005h: Information on the IFD241x (further)

3005	RECORD	Controller info			ro

Sub-indices

0	VAR	Number of entries	8	Uint8	ro
1	VAR	Name	IFC24xx	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

Further details can be found in the Controller information, see Chap. 18.3.1.2 section.

8.3.2.4 Object 3011h: Correction, Channel 1

3011	RECORD	Correction channel 1			ro

Sub-indices

0	VAR	Number of entries	3	Uint8	ro
1	VAR	Dark correction start	FALSE	BOOL	wo
3	VAR	Dark correction state	x	Uint32	ro

Writing 1 (True) to subindex 1 triggers a dark correction. Sub-index 3 shows the state of the correction; the possible values are:

- 0: no correction active
- 1: Correction active
- 100: Error during the correction process

Once correction has been initiated, the status changes from 0 to 1. If no error occurs, the status changes back to 0 when correction is completed. No settings may be changed while a correction is active.

Further details can be found in the Dark correction information, , see Chap. 18.3.4.3.

8.3.2.5 Object 3020h: Load, save, factory setting

3020	RECORD	Basic settings			ro

Sub-indices

0	VAR	Number of entries	3	Uint8	ro
1	VAR	READ		BOOL	wo
2	VAR	STORE		BOOL	wo
3	VAR	SETDEFAULT		BOOL	wo

- READ: Loading the last basic settings saved
- STORE: Saves the current settings
- SETDEFAULT: Resets the basic settings to factory settings

8.3.2.6 Object 3021h: Preset

3021	RECORD	Preset			ro

Sub-indices

0	VAR	Number of entries	3	Uint8	ro
1	VAR	Mode	x	Uint8	wo
2	VAR	List		Visible string	ro
3	VAR	Named read		Visible string	wo

Mode:

- 0 – STATIC
- 1 – BALANCED
- 2 – DYNAMIC

Further details can be found in the Measurement settings, see Chap. 8.3.2.7 section

8.3.2.7 Object 3022h: Measurement settings

3022	RECORD	Measurement settings			ro

Sub-indices

0	VAR	Number of entries	7	Uint8	
1	VAR	Current		Visible string	ro
2	VAR	Named read		Visible string	wo
3	VAR	Named store		Visible string	wo
4	VAR	Named delete		Visible string	wo
5	VAR	Initial meassettings		Visible string	rw
6	VAR	List		Visible string	ro
7	VAR	Set default		BOOL	wo

- Current: Current measurement settings (MEASSETTINGS CURRENT)
- Named read: Loads a measurement setting from the `List`/sub-index 6 (MEASSETTINGS READ)
- Named store: Stores the current measurement setting. You can assign a name or number (MEASSETTINGS STORE
- Named delete: Deletes a measurement setting from the `List`/sub-index 6 (MEASSETTINGS DELETE)
- Initial meassettings: Measurement setting that is loaded first when the IFD241x is reset (MEASSETTINGS INITIAL)
- List: List with stored measurement settings (MEASSETTINGS LIST)
- Set default: Corresponds to the SETDEFAULT MEASSETTINGS command

Further details can be found in the Measurement settings, see Chap. 18.3.8.6 section.

8.3.2.8 Object 303F: Error IFD241x

303F	RECORD	Sensor error			ro

Sub-indices

0	VAR	Number of entries	7	Uint8	ro
1	VAR	Error number	x	Uint16	ro
2	VAR	Error description	x	Visible string	ro

For more information, please refer to the Error Messages section.

- Sensor error number: Outputs the error during communication
- Sensor error description: Error as plain text

8.3.2.9 Object 3101h: Reset

3101	VAR	Reset	FALSE	BOOL	rw

The IFD241x is restarted.

8.3.2.10 Object 3105h: Factory settings

3105	VAR	Factory reset		BOOL	wo

Complete reset to factory settings. Corresponds to the SETDEFAULT ALL command.

8.3.2.11 Object 3107h: Counter reset

3107	RECORD	Counter reset			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Reset timestamp		BOOL	wo
2	VAR	Reset counter		BOOL	wo

Setting sub-index 1 to 1 will reset the timestamp (0x7001). Setting sub-index 2 to 1 will reset the measurement counter (0x7000).

8.3.2.12 Object 3133h: LED light source Channel 1

3133	RECORD	LED on/off ch1			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	LED on/off	x	BOOL	rw
2	VAR	LED source	x	Uint8	rw

LED on/off:

- 0 – Off
- 1 – On

Permits switching the LED light source on or off and is equivalent to the LED command.

8.3.2.13 Object 3150h: Error IFD241x Channel 1

3150	RECORD	Sensor ch1			ro

Sub-indices

0	VAR	Number of entries	3	Uint8	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

Further details can be found in the Sensor, see Chap. 18.3.4 section.

8.3.2.14 Object 3152h: Sensor selection Channel 1

Object is valid for the IFD2411.

3152	RECORD	Select sensor ch1			ro

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	Select sensor		Uint8	rw
2	VAR	Sensor name	IFS24xx-xx	Visible string	ro
3	VAR	Measurement range	xx.xxxxxx	FLOAT32	ro
4	VAR	Sensor serial no.	xxxxxxxx	Visible string	ro

Further details can be found in the Select sensor, see Chap. 18.3.4 section.

8.3.2.15 Object 3153h: Sensor table

Object is valid for the IFD2411.

3153	RECORD	Select table ch1			ro

Sub-indices

0	VAR	Number of entries	6	Uint8	ro
1	VAR	Position		Uint8	rw
2	VAR	Get next position		BOOL	ro
3	VAR	Get previous position		BOOL	ro
4	VAR	Sensor name	IFS24xx-xx	Visible string	ro
5	VAR	Measurement range	xx.xxxxxx	FLOAT32	ro
6	VAR	Sensor serial no.	xxxxxxxx	Visible string	ro

8.3.2.16 Object 3156h: Multilayer options for Channel 1

3156	RECORD	Multilayer options ch1			ro

Sub-indices

0	VAR	Number of entries	6	Uint8	ro
1	VAR	Peak count		Uint32	rw
2	VAR	Disable refractivity correction	FALSE	BOOL	rw

Includes the options for thickness and multilayer measurements.

Sub-index 1 corresponds to the PEAKCOUNT command.

Sub-index 2 corresponds to the REFRACCORR command.

Disable refractivity correction: Disables the refractivity correction

8.3.2.17 Object 3161h: Peak selection Channel 1

3161	VAR	Peak position	0	Uint8	rw

The peak/peaks that is/are evaluated in distance/thickness measurement mode can be defined using this command.

Standard: first peak / first and second peak

In order to receive transparent measuring results, the standard setting should only be changed where absolutely required.

0	first and last peak
1	second-last and last peak
2	first and second peak
3	highest and second highest peak

8.3.2.18 Object 3162h: Peak options Channel 1

3162	RECORD	Peak options ch1			ro

Subindices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Min threshold		FLOAT32	rw
2	VAR	Peak modulation		FLOAT32	rw

Min threshold: Peak detection threshold, corresponds to the MIN_THRESHOLD command.

8.3.2.19 Object 31B0h: Digital interfaces

31B0	RECORD	Digital interfaces			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
2	VAR	RS422 baud rate	x	Uint32	rw

Sub-index 2 is equivalent to the BAUDRATE command. Only the preset baud rates can be specified:

RS422 baud rate: 9600, 115200, 230400, 460800, 691200, 921600, 1500000, 2000000, 3500000, 4000000

8.3.2.20 Object 31B1h: Interface selection

31B1	RECORD	Enable output			ro

Sub-indices

0	VAR	Number of entries	5	Uint8	ro
1	VAR	RS422	x	BOOL	rw
3	VAR	Analog out		BOOL	rw
4	VAR	Switching outputs		BOOL	rw
5	VAR	Industrial Ethernet		BOOL	rw

Corresponds to the OUTPUT command. Parallel output of measured values via the respective interface can be switched on and off.

8.3.2.21 Object 31B2h: troubleshooting

31B2	RECORD	Outhold			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Error handling type		Uint8	rw
2	VAR	Error handling values		Uint32	rw

8.3.2.22 Object 31B3h: Data reduction

31B3	RECORD	Outreduce settings			ro

Sub-indices

0	VAR	Number of entries	3	Uint8	ro
2	VAR	Reduction analog		BOOL	rw
3	VAR	Reduction RS422		BOOL	rw
4		Reduction factor		Uint32	rw

8.3.2.23 Object 31D0h: Analog output

31D0	RECORD	Analog output			ro

Sub-indices

0	VAR	Number of entries	55	Uint8	ro
1	VAR	Analog output	x	Uint8	rw
2	VAR	Analog signal	x	Uint32	rw
4	VAR	Type of scaling	x	Uint8	rw
5	VAR	Two-point-scaling start	x.x	FLOAT32	rw
6	VAR	Two-point-scaling end	x.x	FLOAT32	rw
50	VAR	Available signals part 0		Visible string	ro
51	VAR	Available signals part 1		Visible string	ro
52	VAR	Available signals part 2		Visible string	ro
53	VAR	Available signals part 3		Visible string	ro
54	VAR	Available signals part 4		Visible string	ro
55	VAR	Available signals part 5		Visible string	ro

Further details can be found in the Analog output, see Chap. 18.3.15 section.

Analog output:

- 0 - voltage 0 … 5 V
- 1 - voltage 0 … 10 V
- 7 - current 4 … 20 mA

Signal: Data can only be selected in accordance with the selected measuring program – for distance measurements, only distance 1 can be selected.

You can, for example, select 01DIST1. Available signals lists the available signals.

Type of scaling:

- 0 - Standard scaling
- 1 - Two-point scaling

8.3.2.24 Object 31F3h: Switching output 1

Object is valid for IFD2410/2415.

31F3	RECORD	Switching output			ro

Sub-indices

0	VAR	Number of entries	55	Uint8	ro
1	VAR	Output level		Uint8	rw
2	VAR	Error out		Uint8	rw
3	VAR	Limit signal		Visible string	rw
5	VAR	Lower limit value		FLOAT32	rw
6	VAR	Upper limit value		FLOAT32	rw
7	VAR	Compare to		Uint8	rw
8	VAR	Error hysteresis		FLOAT32	rw
50	VAR	Available signals part 0		Visible string	ro
51	VAR	Available signals part 1		Visible string	ro
52	VAR	Available signals part 2		Visible string	ro
53	VAR	Available signals part 3		Visible string	ro
54	VAR	Available signals part 4		Visible string	ro
55	VAR	Available signals part 5		Visible string	ro

Further details can be found in the Switching output section, see Chap. 18.3.14.

Output level:

- 0 - PNP
- 1 - NPN
- 2 - Push-pull
- 3 - Push-pull, negated

Error out:

- 1 - 01ER1
- 2 - 01ER2
- 3 - 01ER12
- 4 - 02ER1
- 5 - 02ER2
- 6 - 02ER12
- 7 - 0102ER12
- 8 - ERRORLIMIT

Use `Limit signal` to select a measured value signal that will be used for the comparison.

`Available signals` contains a list of the available signals.

Compare to:

- 1 - Lower
- 2 - Upper
- 3 - Both

Object 31F4h includes the settings for switching output 2.

8.3.2.25 Object 31F5h: RS422 output

31F5	RECORD	RS422 output			ro

Sub-indices

0	VAR	Number of entries	93	Uint8	ro
1	VAR	RS422 add output signal		Uint8	rw
2	VAR	RS422 remove output signal		Uint8	rw
3	VAR	RS422 reset output signals		Visible string	rw
50	VAR	RS422 available signals part 0		FLOAT32	ro

51	VAR	RS422 available signals part 1		FLOAT32	ro
...					
63	VAR	RS422 available signals part 12		FLOAT32	
81	VAR	Outputinfo RS422 part 0		Visible string	ro
82	VAR	Outputinfo RS422 part 1		Visible string	ro
...					
93	VAR	Outputinfo RS422 part 12		Visible string	ro

8.3.2.26 Object 3250h: Exposure mode Channel 1

3250	RECORD	Shutter mode ch1			

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	Shutter mode	x	Uint8	rw
3	VAR	Shutter time 1	x.xx	FLOAT32	rw
4	VAR	Shutter time 2	x.xx	FLOAT32	rw

Further details can be found in the Exposure mode, see Chap. 6.2.5, Exposure modes, see Chap. 18.3.9.4 and Exposure time sections, see Chap. 18.3.9.6.

Shutter mode:

- 1 - Measurement mode
- 2 - Manual mode
- 3 - Two-time mode alternating
- 4 - Two-time mode automatic

Object 3250h includes the exposure settings for channel 2.

8.3.2.27 Object 3251h: Measuring rate

3251	RECORD	Measuring rate		FLOAT32	rw

Further details can be found in the Measuring rate, see Chap. 18.3.9.5 section.

8.3.2.28 Object 34A0h: Keylock

34A0	RECORD	Keylock			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Mode	0	Uint8	rw
2	VAR	Key lock countdown [min]	0	Uint8	rw

Mode:

- 0 - Inactive
- 1 - Active
- 2 - Automatic mode / Active after delay

8.3.2.29 Object 35A0h: Encoder

Encoder 2/3 is possible with IFD2410/2415.

35A0	RECORD	RS422 output			ro

Sub-indices

0	VAR	Number of entries	17	Uint8	ro
1	VAR	Encoder 1 reference signal		Uint8	rw
2	VAR	Encoder 1 interpolation		Uint8	rw
3	VAR	Encoder 1 initial value		Uint32	rw
4	VAR	Encoder 1 maximum value		Uint32	rw
5	VAR	Encoder 1 set value		BOOL	wo
6	VAR	Encoder 2 reference signal		Uint8	rw
7	VAR	Encoder 2 interpolation		Uint8	rw
8	VAR	Encoder 2 initial value		Uint32	rw
9	VAR	Encoder 2 maximum value		Uint32	rw
10	VAR	Encoder 2 set value		BOOL	wo
11	VAR	Encoder 3 reference signal		Uint8	rw
12	VAR	Encoder 3 interpolation		Uint8	rw
13	VAR	Encoder 3 initial value		Uint32	rw
14	VAR	Encoder 3 maximum value		Uint32	rw
15	VAR	Encoder 3 set value		BOOL	wo
16	VAR	Set encoder		Uint8	wo
17	VAR	Reset encoder		Uint8	wo

Further details can be found in the section Encoder inputs, see Chap. 6.1.2 and Encoders, see Chap. 18.3.6.

Encoder reference signal:

- 0 - None, the encoder’s reference marker has no effect
- 1 - One, specified once
- 3 - Ever, set for all markers

Encoder interpolation:

- 1 - Single interpolation
- 2 - Dual interpolation
- 3 - Quadruple interpolation

Encoder initial value:

$0 \dots 2^{32}-1$

Encoder maximal value:

$0 \dots 2^{32}-1$

8.3.2.30 Object 35B0 triggering

35B0	RECORD	Trigger			ro

Sub-indices

0	VAR	Number of entries	11	Uint8	ro
1	VAR	Trigger at		Uint8	rw
2	VAR	Trigger source		Uint8	rw
3	VAR	Trigger mode		Uint8	rw
4	VAR	Trigger level		Uint8	rw
5	VAR	Trigger count type		Uint8	rw
6	VAR	Trigger count value		Uint16	rw
7	VAR	Trigger software		BOOL	ro

8	VAR	Trigger encoder minimum		Uint32	rw
9	VAR	Trigger encoder maximum		Uint32	rw
10	VAR	Trigger encoder step size		Uint32	rw
11	VAR	MFI level		Uint8	rw

8.3.2.31 Object 35B1 synchronization

35B1	RECORD	Synchronization			ro

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Sync mode		Uint8	rw
2	VAR	Termination		BOOL	rw

8.3.2.32 Object 3711h: Masking the region of interest Channel 1

3711	RECORD	Region of interest ch1			

Sub-indices

0	VAR	Number of entries	12	Uint8	ro
1	VAR	Region of interest start	x	Uint16	rw
2	VAR	Region of interest end	x	Uint16	rw

Further details can be found in the section Masking the region of interest, see Chap. 6.2.4, see Chap. 18.3.9.7.

8.3.2.33 Object 3800h: Material information

3800	RECORD	Material info and edit			

Sub-indices

0	VAR	Number of entries	7	Uint8	ro
1	VAR	Name	xxxxx	Visible string	rw
2	VAR	Description	xxxxxx	Visible string	rw
3	VAR	Type of refraction	xx	Uint8	rw
4	VAR	nd value	x.xxxx	FLOAT32	rw
5	VAR	nF value	x.xxxx	FLOAT32	rw
6	VAR	nC value	x.xxxx	FLOAT32	rw
7	VAR	Abbe number	x.xxxx	FLOAT32	rw

Further details can be found in the section Materials database, see Chap. 6.2.8, see Chap. 18.3.10.

Material name: Currently selected material for a thickness measurement

Material description: Description of the currently selected material

nd, nf and nC: Refractive index of the currently selected material at 587 nm, 486 nm and 656 nm

Abbe number: Abbe number for the currently selected material

In Professional mode, the current material can also be edited here. Specified settings are saved immediately.

8.3.2.34 Object 3802h: Edit materials table

3802	RECORD	Materials table edit			

Sub-indices

0	VAR	Number of entries	4	Uint8	ro
1	VAR	Material delete	x	Visible string	wo
2	VAR	Reset materials	x	BOOL	wo
3	VAR	New material	x	BOOL	wo
4	VAR	Select material for edit		Visible string	rw

Material delete: Specify the name of a material to be deleted from the materials table

Reset materials: Resets the materials table to the factory settings

New material: Creates a new material in the materials table. The newly created material ("New material") must then be edited in object 3800h "Material info".

Sub-index 4 selects the material that is to be edited in object 0x3800.

8.3.2.35 Object 3803h: Existing materials

3803	RECORD	Materials table			

Sub-indices

0	VAR	Number of entries	5	Uint8	ro
1	VAR	Existing materials part 0		Visible string	ro
2	VAR	Existing materials part 1		Visible string	ro
3	VAR	Existing materials part 2		Visible string	ro
4	VAR	Existing materials part 3		Visible string	ro
5	VAR	Existing materials part 4		Visible string	ro

Provides a list of all available materials.

8.3.2.36 Object 3804h: Select material for Channel 1

3804	RECORD	Material selection ch1			

Sub-indices

0	VAR	Number of entries	1	Uint8	ro
1	VAR	Material 1	xx	Visible string	rw

8.3.2.37 Object 3A00h: Mastering, Zeroing

3A00	RECORD	Master 1			

Sub-indices

0	VAR	Number of entries	55	Uint8	ro
1	VAR	Enable	xx	BOOL	rw
2	VAR	Signal	xx	Visible string	rw
4	VAR	Set/reset	xx	BOOL	rw
5	VAR	Value	xx	FLOAT32	rw
50	VAR	Available signals part 0		Visible string	ro
51	VAR	Available signals part 1		Visible string	ro
52	VAR	Available signals part 2		Visible string	ro
53	VAR	Available signals part 3		Visible string	ro
54	VAR	Available signals part 4		Visible string	ro
55	VAR	Available signals part 5		Visible string	ro

Mastering or zeroing a signal; there are 10 of these objects (3A00h and 3A09). Sub-index 2 specifies which signal is to be mastered. Sub-index 4 corresponds to the MASTER command.

8.3.2.38 Object 3A10h: Statistics

3A10	RECORD	Statistic 1			

Sub-indices

0	VAR	Number of entries	55	Uint8	ro
1	VAR	Enable		BOOL	rw
2	VAR	Signal		Visible string	rw
4	VAR	Infinite		BOOL	rw
5	VAR	Depth		Uint16	rw
6	VAR	Reset		BOOL	wo
50	VAR	Available signals part 0		Visible string	
51	VAR	Available signals part 1		Visible string	
52	VAR	Available signals part 2		Visible string	
53	VAR	Available signals part 3		Visible string	
54	VAR	Available signals part 4		Visible string	
55	VAR	Available signals part 5		Visible string	

The objects 3A10h to 3A12h generate three statistics signals.

Sub-index 50 ... 55 corresponds to the command META_STATISTICSIGNAL.

Subindex 6 corresponds to the STATISTIC command.

3 signals are generated for each activated statistics object. These signals are listed in object 0x3E00. The statistics function can also be applied to user signals.

Example: You want distance 1 (channel 1) to output the minimum and the maximum measured values using all previous distance values.

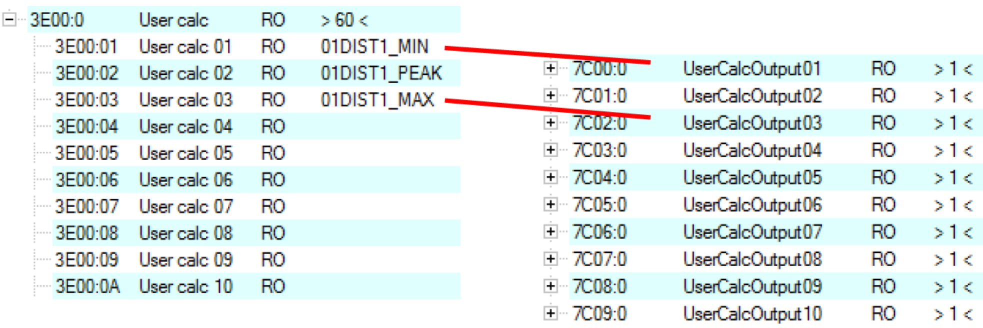
Activating a statistics object

3A10:01(Enable) to TRUE. Distance 1 (01DIST1) is selected as signal by default. If you would like to display statistics for a different signal, you will need to select the required signal in sub-index 2.

- Settings for all previous distance values 3A10:04 (Infinite) to True (STATISTICSIGNAL – INFINITE)

Assigning a user-defined signal to the PDO

The newly created signal names are listed in object 0x3E00h:



The minimum distance is output in 0x7C00h and the maximum distance is output in 0x7C02h.

Select PDO

UserCalcOutput01 – 0x7C00h is selected with object 1B00h, and 0x7C02h is output with object 1B10h

Extract from TxPDO mapping, see Chap. 8.3.1.7:

1B00	UserCalc01 TxPDOMap	
	UserCalcOutput01	0x7C00
1B08	UserCalc02 TxPDOMap	
	UserCalcOutput02	0x7C01
1B10	UserCalc03 TxPDOMap	
	UserCalcOutput03	0x7C02

Before the PreOp to SafeOp, 0x1C13h, 0x1B00h and 0x1B10h must therefore be selected:

0x00 (0)1B00	clear sm pdos (0x1C13)
0x1B00 (6912)	download pdo 0x1C13:01 index
0x1B10 (6928)	download pdo 0x1C13:02 index
0x02 (2)	download pdo 0x1C13 count

8.3.2.39 Object 3C00h: Measured value calculation Channel 1

3C00	RECORD	Comp y ch1			

Sub-indices

0	VAR	Number of entries	55	Uint8	ro
1	VAR	Type		Uint8	rw
2	VAR	Name1		Visible string	rw
4	VAR	Signal1		Visible string	rw
5	VAR	Signal2		Visible string	rw
13	VAR	Factor1		FLOAT32	rw
14	VAR	Factor2		FLOAT32	rw
17	VAR	Offset		FLOAT32	rw
18	VAR	Parameter		Uint32	rw
50	VAR	Available signals part 0		Visible string	ro
51	VAR	Available signals part 1		Visible string	ro
52	VAR	Available signals part 2		Visible string	ro
53	VAR	Available signals part 3		Visible string	ro
54	VAR	Available signals part 4		Visible string	ro
55	VAR	Available signals part 5		Visible string	ro

Objects 3C00h to 3C09 generate 10 calculation modules for channel 1.

Type:

- 1 - Moving average (MOVING)
- 2 - Recursive average (RECURSIVE)
- 3 - Median (MEDIAN)
- 4 - Calculating two signals (CALC)

As soon as the type is changed, default settings are loaded for the selected type. You can only select signals from the corresponding channel.

Depending on the type, all other object entries have different meanings:

- Moving average (MOVING):

4	Signal1	Signal to which the filter is to be applied (default 01DIST1)
18	Param1	Averaging value (default: 2)

Value range for Param1: 2|4|8|16|32|64|128|256|512|1024|2048|4096

- Recursive average (RECURSIVE):

4	Signal1	Signal to which the filter is to be applied (default 01DIST1)
18	Param1	Averaging value (default: 2)

Value range for Param1: 2 ... 32000

- Median (MEDIAN):

4	Signal1	Signal to which the filter is to be applied (default 01DIST1)
18	Param1	Averaging value (default: 3)

Value range for Param1: 3|5|7|9

- Calc / Calculation of two signals (CALC):

2	Name	Name of the generated signal
4	Signal1	(default chx: 01DIST1)
5	Signal2	(default chx: 01DIST2)
13	Factor1	(default chx/sys: -1.0)
14	Factor2	(default chx/sys: 1.0)
18	Offset	(default chx/sys: 0.0)

(<factor1> * <signal1>) + (<factor2> * <signal2>) + <offset>

Value range for offset (mm): -2147.0 ... 2147.0

> i The object index determines the order of processing and corresponds to the ID parameter of the ASCII command.

Example: Signal 01DIST1 is to be filtered using a median filter and an average value filter; the sequence is median filter first, then average value filter.

0x2C00:

1	Type	3 (median)
4	Signal1	01DIST1
18	Param1	<Averaging value>

0x2C01:

1	Type	2 (Recursive average)
4	Signal1	01DIST1
18	Param1	<Averaging value>

Filters can also be applied to user signals.

8.3.2.40 Object 3CBFh: Sys Signals

3CBF	RECORD	Sys signals			

Sub-indices

0	VAR	Number of entries	2	Uint8	ro
1	VAR	Range lower		FLOAT32	rw
2	VAR	Range upper		FLOAT32	rw

Reference to the `SYSSIGNALRANGE` command.

8.3.2.41 Object 3E00: User signals

3E00	RECORD	User calc			

Sub-indices

0	VAR	Number of entries	19	Uint8	ro
1	VAR	User calc 01		Visible string	ro
2	VAR	User calc 02		Visible string	ro
...					
13_{hex}	VAR	User calc 18		Visible string	ro

Names of the user signals that are output in the 0x7C0xh objects. The sequence specifies the order of the PDO data. The PDOs are selected via the 0x1B0xh objects.

8.4 Mappable objects - process data

Displays all individually available process data.

The objects 0x60xx, 0x700x and 0x7Cxx are structured as follows:

[INDEX]	[NAME]			
0	Sub-index 0		Uint8	Read
1	Sub-index 1		[DATA TYPE]	READ

Objects 0x60xx: Process data for channel 1.

Objects 0x700x: System process data (process data that are not available per channel).

Objects 0x7Cxx: Calculated process data.

i	After switching on, the process data for the objects is not yet available. Only a successful change of status from PreOP to SafeOP makes the process data available which were selected through object 0x1C13h or the mapping objects for the PDO output. If the status is changed from SafeOP to OP, all previously selected process data will still be available.

8.4.1 Object 6000, 6001: Distance value

6000	RECORD	Channel 1 Distance 1			

Sub-indices

0	Number of entries	8	Uint8	ro
1	Channel 1 distance 1_OV00		Uint32	ro
2	Channel 1 distance 1_OV01		Uint32	ro
3	Channel 1 distance 1_OV02		Uint32	ro
4	Channel 1 distance 1_OV03		Uint32	ro
5	Channel 1 distance 1_OV04		Uint32	ro
6	Channel 1 distance 1_OV05		Uint32	ro
7	Channel 1 distance 1_OV06		Uint32	ro
8	Channel 1 distance 1_OV07		Uint32	ro

Object 0x6001 contains the value for the second distance value Distance 2 (DIST2).

For IFD2415, there are the additional objects for additional distance values

- 0x6002 contains Distance 3 (DIST3),

- 0x6003 contains Distance 4 (DIST4),
- 0x6004 contains Distance 5 (DIST5) and
- 0x6005 contains Distance 6 (DIST6).

8.4.2 Object 6010, 6011: Intensity

6010	RECORD	Channel 1 Intensity 1			

Sub-indices

0	Number of entries	8	Uint8	ro
1	Channel 1 intensity 1_OV00		Uint32	ro
2	Channel 1 intensity 1_OV01		Uint32	ro
3	Channel 1 intensity 1_OV02		Uint32	ro
4	Channel 1 intensity 1_OV03		Uint32	ro
5	Channel 1 intensity 1_OV04		Uint32	ro
6	Channel 1 intensity 1_OV05		Uint32	ro
7	Channel 1 intensity 1_OV06		Uint32	ro
8	Channel 1 intensity 1_OV07		Uint32	ro

Object 0x6011 contains the value for the second intensity value Intensity 2 of DIST2.

For IFD2415, there are the additional objects for additional intensity values

- 0x6012 contains Intensity 3 (DIST3),
- 0x6013 contains Intensity 4 (DIST4),
- 0x6014 contains Intensity 5 (DIST5) and
- 0x6015 contains Intensity 6 (DIST6).

8.4.3 Object 6030: Exposure time

6030	RECORD	Channel 1 Shutter			

Sub-indices

0	Number of entries	8	Uint8	ro
1	Channel 1 shutter_OV00		Uint32	ro
2	Channel 1 shutter_OV01		Uint32	ro
3	Channel 1 shutter_OV02		Uint32	ro
4	Channel 1 shutter_OV03		Uint32	ro
5	Channel 1 shutter_OV04		Uint32	ro
6	Channel 1 shutter_OV05		Uint32	ro
7	Channel 1 shutter_OV06		Uint32	ro
8	Channel 1 shutter_OV07		Uint32	ro

8.4.4 Object 6050, 6051, 6052: Encoder

6050	RECORD	Channel 1 encoder 1			

Sub-indices

0	Number of entries	8	Uint8	ro
1	Channel 1 encoder 1_OV00		Uint32	ro
2	Channel 1 encoder 1_OV01		Uint32	ro
3	Channel 1 encoder 1_OV02		Uint32	ro
4	Channel 1 encoder 1_OV03		Uint32	ro
5	Channel 1 encoder 1_OV04		Uint32	ro
6	Channel 1 encoder 1_OV05		Uint32	ro
7	Channel 1 encoder 1_OV06		Uint32	ro
8	Channel 1 encoder 1_OV07		Uint32	ro

Object 0x6051 contains the values for encoder 2.

Object 0x6052 contains the values for encoder 3.

8.4.5 Object 6060: Peak symmetry

The object is valid for the IFD2415.

6060	RECORD	Channel 1 peak symmetry			

Sub-indices

0	Number of entries	8	Uint8	ro
1	Channel 1 peak symmetry 1_OV00		Uint32	ro
2	Channel 1 peak symmetry 1_OV01		Uint32	ro
3	Channel 1 peak symmetry 1_OV02		Uint32	ro
4	Channel 1 peak symmetry 1_OV03		Uint32	ro
5	Channel 1 peak symmetry 1_OV04		Uint32	ro
6	Channel 1 peak symmetry 1_OV05		Uint32	ro
7	Channel 1 peak symmetry 1_OV06		Uint32	ro
8	Channel 1 peak symmetry 1_OV07		Uint32	ro

Object 0x6060 contains the peak symmetry of DIST1.

The following objects contain additional symmetry values

- 0x6061 contains Peak symmetry 2 (DIST2),
- 0x6062 contains Peak symmetry 3 (DIST3),
- 0x6063 contains Peak symmetry 4 (DIST4),
- 0x6064 contains Peak symmetry 5 (DIST5),
- 0x6065 contains Peak symmetry 6 (DIST6).

8.4.6 Object 7000: Measurement counter

7000	RECORD	Counter			

Sub-indices

0	Number of entries	8	Uint8	ro
1	Counter_OV00		Uint32	ro
2	Counter_OV01		Uint32	ro
3	Counter_OV02		Uint32	ro
4	Counter_OV03		Uint32	ro

5	Counter_OV04		Uint32	ro
6	Counter_OV05		Uint32	ro
7	Counter_OV06		Uint32	ro
8	Counter_OV07		Uint32	ro

8.4.7 Object 7001: Timestamp

7001	RECORD	Time stamp			

Sub-indices

0	Number of entries	8	Uint8	ro
1	Time stamp_OV00		Uint32	ro
2	Time stamp_OV01		Uint32	ro
3	Time stamp_OV02		Uint32	ro
4	Time stamp_OV03		Uint32	ro
5	Time stamp_OV04		Uint32	ro
6	Time stamp_OV05		Uint32	ro
7	Time stamp_OV06		Uint32	ro
8	Time stamp_OV07		Uint32	ro

8.4.8 Object 7002: Measuring rate

7002	RECORD	Frequency			

Sub-indices

0	Number of entries	8	Uint8	ro
1	Frequency_OV00		Uint32	ro
2	Frequency_OV01		Uint32	ro
3	Frequency_OV02		Uint32	ro
4	Frequency_OV03		Uint32	ro
5	Frequency_OV04		Uint32	ro
6	Frequency_OV05		Uint32	ro
7	Frequency_OV06		Uint32	ro
8	Frequency_OV07		Uint32	ro

8.4.9 Object 7C00: Calculated Process Data

7C00	RECORD	User calc output			

Sub-indices

0	Number of entries	8	Uint8	ro
1	User calc output 01_OV00		Uint32	ro
2	User calc output 01_OV01		Uint32	ro
3	User calc output 01_OV02		Uint32	ro
4	User calc output 01_OV03		Uint32	ro
5	User calc output 01_OV04		Uint32	ro
6	User calc output 01_OV05		Uint32	ro
7	User calc output 01_OV06		Uint32	ro
8	User calc output 01_OV07		Uint32	ro

The following objects contain additional process data:

0x7C01 User calc output 02	0x7C02 User calc output 03	0x7C03 User calc output 04
0x7C04 User calc output 05	0x7C05 User calc output 06	0x7C06 User calc output 07
0x7C07 User calc output 08	0x7C08 User calc output 09	0x7C09 User calc output 10
0x7C0A User calc output 11	0x7C0B User calc output 12	0x7C0C User calc output 13
0x7C0D User calc output 14	0x7C0E User calc output 15	0x7C0F User calc output 16
0x7C10 User calc output 17	0x7C11 User calc output 18	0x7C12 User calc output 19

8.5 Error codes for SDO services

If an SDO requirement is evaluated as negative, a corresponding error code is added to the “Abort SDO Transfer Protocol”.

Error code hexadecimal	Meaning
0503 0000	Toggle bit did not change.
0504 0000	SDO protocol timeout expired
0504 0001	Invalid command entered
0504 0005	Insufficient memory
0601 0000	Access to object (parameter) not supported
0601 0001	Attempt to read a “write-only parameter”
0601 0002	Attempt to write a “read-only parameter”
0602 0000	Object (parameter) is not listed in the object directory
0604 0041	Object (parameter) cannot be mapped to PDO
0604 0042	Number or length of objects to be transmitted exceeds PDO length.
0604 0043	General parameter incompatibility
0604 0047	General internal device incompatibility
0606 0000	Access denied due to a hardware error
0607 0010	Incorrect data type or length of the service parameter does not match
0607 0012	Incorrect data type or the service parameter is too long
0607 0013	Incorrect data type or the service parameter is too short
0609 0011	Sub-index does not exist.
0609 0030	Invalid value for the parameter (only for write access)
0609 0031	Value of parameter too high
0609 0032	Value of parameter too low
0609 0036	Maximum value is below minimum value.
0800 0000	General error
0800 0020	Unable to transfer data to the application or unable to save data
0800 0021	Unable to transfer data to the application or unable to save data. Cause: local control
0800 0022	Data cannot be transferred or saved in application due to device status.
0800 0023	Dynamic generation of the object directory failed or no object directory available

8.6 Oversampling

In operation without oversampling, the last measured value data set is transferred to the EtherCAT master with each fieldbus cycle, see Chap. 8.3.1.7. Therefore, many data records with measured values are not available for long fieldbus cycle periods. Configurable oversampling ensures that all (or selected) measurement data records are gathered and transmitted together to the master during the next fieldbus cycle.

The oversampling factor specifies how many samples are transmitted per bus cycle. An oversampling factor of 2, for example, means that 2 samples are transmitted per bus cycle.

With TxPDO mapping, the base index of the PDO mapping objects is included with oversampling factor 1. Use the following list to determine the index for selecting a different oversampling factor: The following list is used to determine the index for selecting a different oversampling factor:

- Base index + 1: Oversampling factor 2
- Base index + 2: Oversampling factor 4
- Base index + 3: Oversampling factor 8

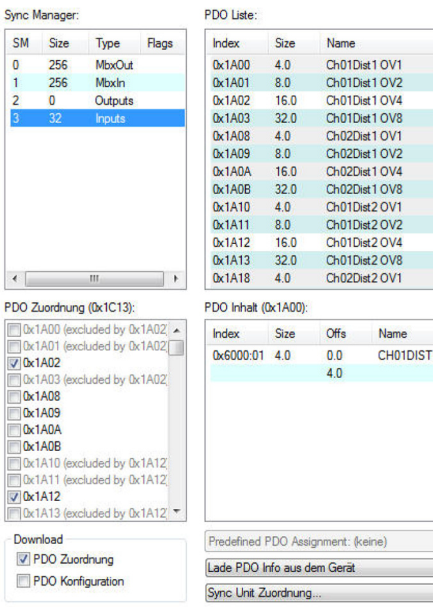
You can only select mapping objects with the same oversampling factor in 0x1C13h.

Example:

- The fieldbus/EtherCAT master operates at a cycle time of 1 ms because the higher-level PLC works with a cycle time of 1 ms. This means that an EtherCAT frame is sent to the IFD241x every 1 ms to retrieve the process data. If the measurement frequency in the IFD241x is set to 4 kHz, an oversampling of 4 must be set.
- Startup procedure to output distance 1 for channel 1 (01DIST1) and distance 2 for channel 1 (01DIST2) with an oversampling factor of 4.
  - Distance 1 for channel 1 is output in object 6000h. In order to transfer this object in the PDO, the PDO mapping object 0x1A00 must be selected in object 0x1C13:01h. However, 0x1A02 (base index 0x1A00 + 2) must be selected for the 4-fold oversampling.

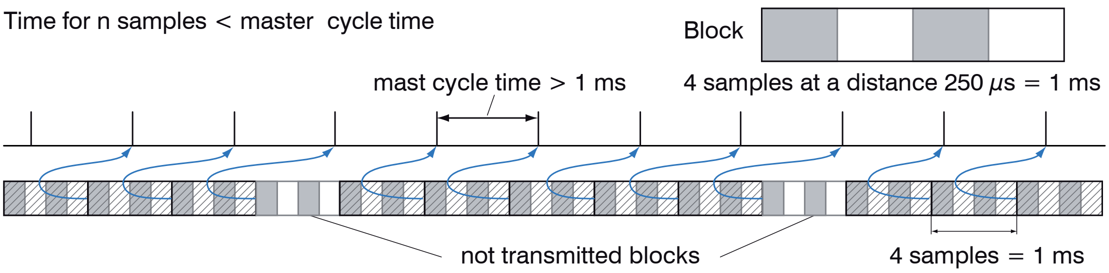
1A01:0	Ch01Dist1 TxPDOMap OV2	RO	> 2 <
1A02:0	Ch01Dist1 TxPDOMap OV4	RO	> 4 <
1A02:01	Subindex 001	RO	0x6000:01, 32
1A02:02	Subindex 002	RO	0x6000:01, 32
1A02:03	Subindex 003	RO	0x6000:01, 32
1A02:04	Subindex 004	RO	0x6000:01, 32
1A03:0	Ch01Dist1 TxPDOMap OV8	RO	> 8 <

  - Distance 2 for channel 1 is output in object 6001h. In order to transfer this object in the PDO, the PDO mapping object 0x1A10 must be selected in object 0x1C13:02h. However, 0x1A12 (base index 0x1A10 + 2) must be selected for the 4-fold oversampling.

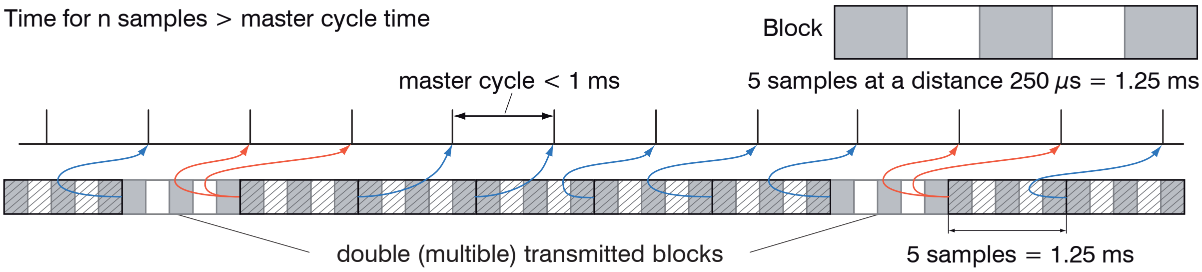


To ensure that no samples are lost due to the asynchronous nature between the master cycle and slave cycle, the master cycle time should always be less than the time for building a block from n samples.

An entire block with the specified samples is only made available to the EtherCAT side after all specified samples have been written to the block. If the time for filling a block is less than the master cycle time, individual blocks will not be transferred. It can indeed happen that the next block is already being filled with samples before the previously filled block is picked up in a master cycle.



But if you select a number of samples sufficiently large that the time for filling a block is greater than the master cycle time, each block will be picked up in a master cycle. However, individual blocks (and therefore samples) will be transferred two or more times. This can be detected on the master side by transferring the timestamp or counter (see object 0x7000).



8.7 Calculation

8.7.1 Setting a filter

The function for a average or median filter has already been explained, see Chap. 8.3.2.39.

8.7.2 Thickness calculation

Sequence for outputting a thickness (distance 1 to distance 2) in the PDO:

Steps 1 and 2 are not required when using the `Single side thickness` preset. To activate this preset, `Single side thickness` must be written to object 3022:01h, see Chap. 8.3.2.7. Please note that this also modifies other settings.

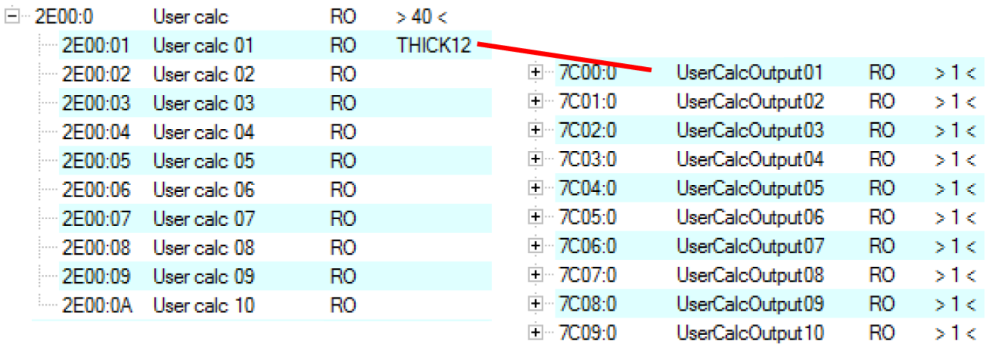
- Step 1: Set the number of expected peaks to 2.

2156:0	Multilayer options ch 1	RO	> 2 <
2156:01	Peak count	RW	0x02 (2)
2156:02	Disable refractivity correction	RW	FALSE

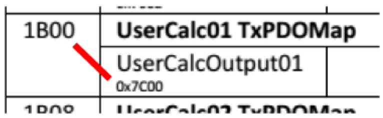
- Step 2: Set up the calculation for object 2C00:
  Set sub-index 1 to 4h. The name for the generated signal is `THICK12`.
  Formula for the calculation: THICK12 = -1.0 x 01DIST1 + 1.0 x 01DIST2 + 0.0
  The factors and the offset must be defined accordingly:

2C00:0	Comp 1 ch1	RO	> 25 <
2C00:01	Type	RW	0x0004 (4)
2C00:02	Name	RW	THICK12
2C00:03	Signal1	RW	01DIST1
2C00:04	Signal2	RW	01DIST2
2C00:0D	Factor1	RW	-1.000000 (-1.000000e+000)
2C00:0E	Factor2	RW	1.000000 (1.000000e+000)
2C00:17	Offset	RW	0.000000 (0.000000e+000)
2C00:18	Param1	RW	0x00000000 (0)

- Step 3: Assignment of user-defined signal to PDO
  The new signal name now appears in 2E00h (from sub-index 1 onwards, all user-defined signals are displayed).



- Step 4: Select the PDO.
  UserCalcOutput01 – 0x7C00h is selected with 0x1B00h:



Before PreOp is changed to SafeOp, the following must be selected in 0x1C13h and 0x1B00h:

0x1C13:00	0x00 (0)	clear sm pdos (0x1C13)
0x1C13:01	0x1B00 (6912)	download pdo 0x1C13:01 index
0x1C13:00	0x01 (1)	download pdo 0x1C13 count

8.8 Operational modes

8.8.1 Free run

There is no synchronization between the sensor and EtherCAT master. The PDOs are updated based on the internal measuring rate. The measuring rate is set using object 0x3251h. PDO frames may be lost or duplicated. The PDO frames can only be transmitted to the EtherCAT master without gaps if the oversampling and measuring rate are in the correct ratio to the bus cycle, see Chap. 8.6. You can use the measurement counter in 0x7000h or 0x1AE0h so that measured values are not evaluated twice because there is no synchronization.

8.8.2 Distributed clocks SYNC0 synchronization

Synchronization between the IFD241x and EtherCAT master takes place via the Sync0 cycle time. The PDOs are updated based on the Sync0 cycle time, which replaces the internal measuring rate. In this mode, an EtherCAT master can synchronize the data acquisition to the EtherCAT cycle time and synchronize the measurement data of multiple systems.

Please note that although the measurements in the IFD241x are synchronized to the Sync0 cycle time, the values are transmitted to the EtherCAT master asynchronously with the bus cycle. Synchronous transmission of the values to the EtherCAT master is only possible if oversampling and Sync0 cycle time are in the correct ratio to the bus cycle, see Chap. 8.6.

Predefined SYNC0 cycle times are available in the ESI-XML file. However, any desired cycle time can be set within the limits of

- 10000000 ns to 125000 ns for the IFD2410 and IFD2411
- 10000000 ns to 50000 ns for the IFD2415

this parameter.

8.8.3 SM2/SM3 synchronization

The sensor supplies current data to the EtherCAT master with every SM2 or SM3 event. Please note that the data of the PDOs are updated with the internal measuring rate independent of the bus cycle. This can cause PDO frames to be lost or duplicated. The PDO frames can only be transmitted to the EtherCAT master without gaps if the oversampling and measuring rate are in the correct ratio to the bus cycle, see Chap. 8.6.

8.9 Update

Two options are available to update the firmware of the IFD241x:

- Update via EoE (Ethernet over EtherCAT) or Telnet
- Update via FoE (File Access over EtherCAT)

8.9.1 Update via FoE

It is possible to perform an update of the IFD241x via FoE. For this purpose, a *.mef file is transferred to the sensor via FoE. To do so, the name and password of the file must correspond as follows:

Name:	`confocalDT241x.mef`
Password:	`0x00000000`

The IFD241x checks the beginning of the file during transmission. If the file is not in the correct format, the IFD241x will abort the transfer. After the file has been completely transferred, the IFD241x automatically starts the update, which disconnects the EtherCAT master.

8.9.2 Update via EoE

An update is performed via a *.meu file. The firmware update tool `Update_Sensor.exe` is required for this.

The current firmware is available at www.micro-epsilon.de/service/download/software/.

To execute an update, you have to check Ethernet in the firmware update tool and enter the IP address, which you have configured via the EtherCAT master. With `Refresh` you can check if the sensor can be found on this IP address. Then select the *.meu file via "..." and confirm with "Send update". First, the update is transmitted to the IFD241x. After transmission has been completed, the installation will start automatically. Do not disconnect the IFD241x from the power supply. Once the installation is complete, the message `All updates successful` is displayed. The IFD241x is ready for operation again.

8.10 Meaning of LEDs in EtherCAT operation

LED	Color	Status	Meaning
RUN	Green	Off	Slave is in “Init” status
	Green	flashes evenly	Slave is in “Pre-Operational” status
	Green	flashes briefly	Slave is in “Safe-Operational” status
	Green	flashes quickly	Slave is in the "initialization" or "bootstrap" status
	Green	illuminated	Slave is in “Operational” status
ERR	Red	Off	no error
	Red	flashes evenly	invalid configuration
	Red	flashes briefly	Unwanted status change
	Red	flashes twice	Application watchdog timeout
	Red	flickers	Boot error
	Red	illuminated	PDI watchdog timeout

8.11 EtherCAT configuration with the Beckhoff TwinCAT©-Manager

The Beckhoff TwinCAT Manager can be used as EtherCAT master on the PC.

The device description files (EtherCAT® Slave Information) can be found online at www.micro-epsilon.de/download/software/:

- `Micro-Epsilon_IFC241x.xml` for IFD2411
- `Micro-Epsilon_IFD241x.xml` for IFD2410/2415

► Copy the device description file into the directory `C:\TwinCAT\3.1\Config\Io\EtherCAT` before the measuring device can be configured using EtherCAT®.

► Delete any older files that may exist.

EtherCAT® slave information files are XML files which specify the characteristics of the slave device for the EtherCAT® Master and contain information on the communication objects supported.

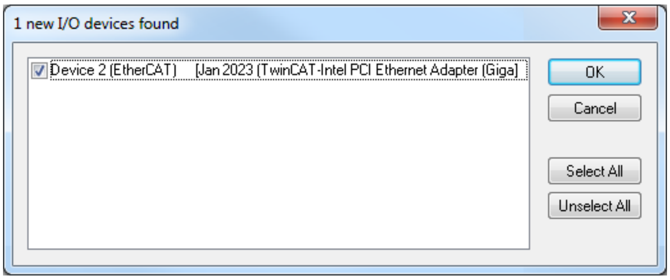
► Restart the TwinCAT Manager after copying.

Search for a device:

► Select the `I/O Devices` tab and then`Scan`.

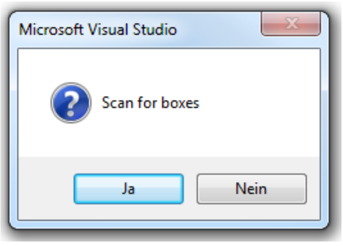
► Confirm with `OK`.

► Select a network card on which to search for EtherCAT® slaves.



► Confirm with `OK`.

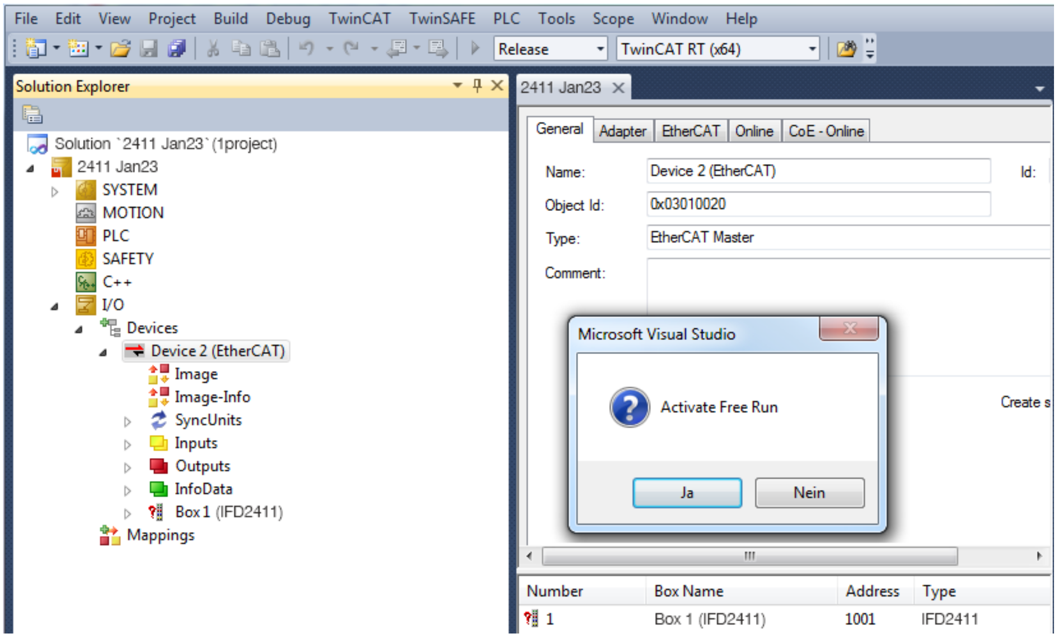
The “`Scan for boxes`”window appears (EtherCAT® slaves).



► Confirm with `Yes`.

The IFD241x is now listed in a list.

► Now confirm the `Activate Free Run` window with `Yes`.

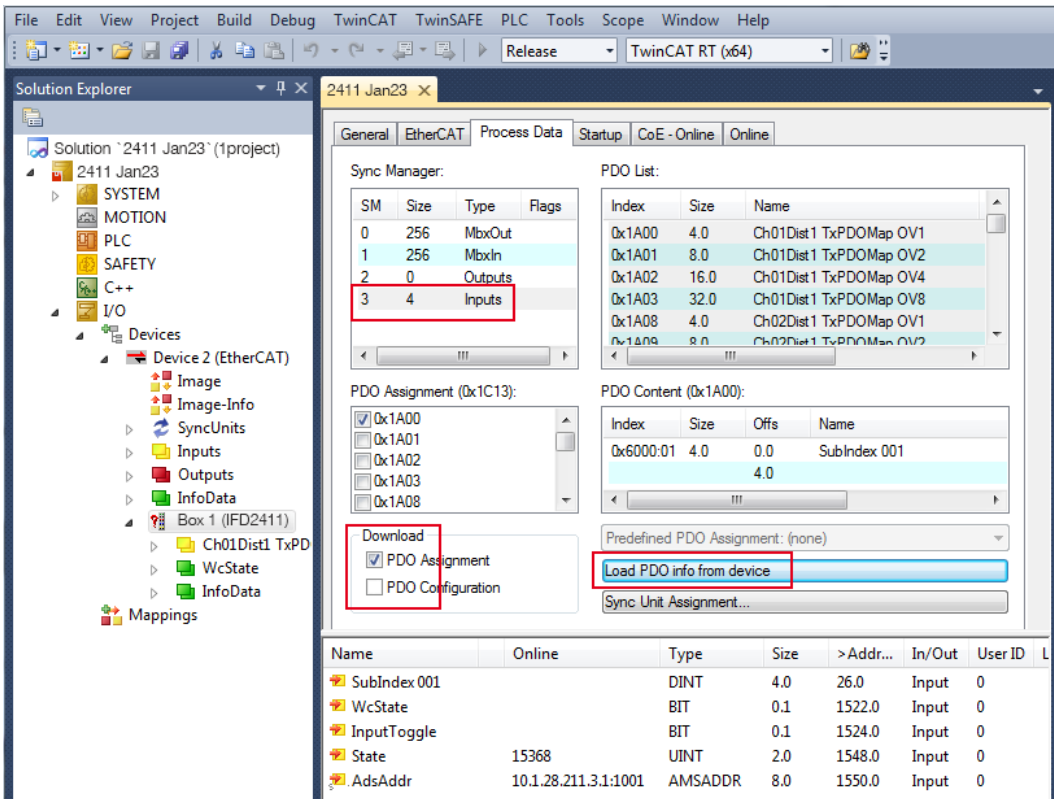


The current status should be at least `PREOP`, `SAFEOP` or `OP` on the `Online` page.

In the event that ERR PREOP appears in `Current State`, the cause is reported in the message window. This will be the case if the settings for the PDO mapping in the IFD241x are different from the settings in the ESI file (device description file).

In the delivery state for the measuring device, only one measured value (distance 1) is set as the output variable (both in the IFD241x and in the ESI file).

Further data can be selected in the Process Data tab.

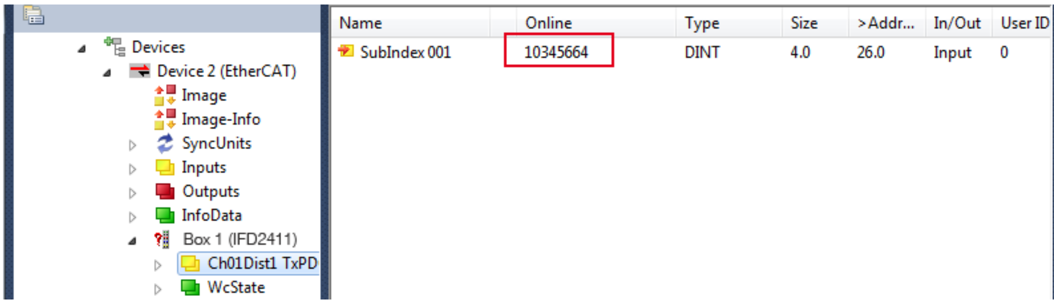


The scope of the process data provided and the assignment of the SyncManager can now be viewed.

► From the `TwinCAT` menu select the `Restart TwinCAT (Config Mode)` tab.

The configuration is now complete.

In `SAFEOP` and `OP` status, the selected measurement values are transferred as process data.



9 Errors, repair

9.1 Web interface communication

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

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

9.2 Changing the sensor cable on the sensors

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

► Feed the new sensor cable through the protective sleeve.

► Remove the protective cap from the sensor cable and keep it in a safe place.

► Insert the guide lug of the sensor plug into the groove of the socket.

► Screw the sensor plug and sensor socket together.

► Screw the protective sleeve back onto the sensor.

► Perform a dark correction, see Chap. 5.10.

9.3 Replacing the protective glass on the sensors

The protective glass must be replaced in case of:

- irreversible contamination,
- scratches.

i	The sensor must not be used without a protective screen, as this reduces the measuring accuracy.

► Loosen the front frame including the protective glass on the sensor.

- Remove the seal and insert the O-ring into the groove of the new protective glass.
- Screw the new frame including protective glass back onto the sensor.

10 Software support with MEDAQLib

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

Connection options:

- RS422/USB converter (optional accessories) and suitable PC2415-x/OE connection cable for IFD2410/2415 or SC2415-x/OE for IFC2411.

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

MEDAQLib

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

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

You can find the current driver routine including documents at:

www.micro-epsilon.de/download

www.micro-epsilon.de/link/software/medaqlib

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 or the firmware.

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

12 Service, repair

If the sensor, controller or sensor cable is defective:

- If possible, save the current sensor settings in a parameter set , see Chap. 5.9 to reload them into the controller after the repair.
- Please send us the affected parts for repair or exchange.

If the cause of a fault cannot be clearly identified, please send the entire measuring system 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/contact/worldwide/
https://www.micro-epsilon.com

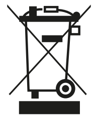
13 Decommissioning, disposal

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

- Remove all cables from the sensor and/or controller.
- Dispose of the sensor and/or the controller, its components and accessories, as well as the packaging materials in compliance with the applicable country-specific waste treatment and disposal regulations of the region of use.
- You are obliged to comply with all relevant national laws and regulations.

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

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



- A list of national laws and contacts in the EU member states can be found at https://ec.europa.eu/environment/topics/waste-and-recycling/waste-electrical-and-electronic-equipment-weee_en. Here you can inform yourself about the respective national collection and return points.

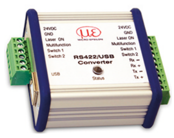
- Old devices can also be returned for disposal to Micro-Epsilon at the address given in the legal details at https://www.micro-epsilon.com/legal-details.

- We would like to point out that you are responsible for deleting the measurement-specific and personal data on the old devices to be disposed of.

- Under the registration number WEEE-Reg.-Nr. DE28605721, we are registered at the foundation Elektro-Altgeräte Register, Nordostpark 72, 90411 Nuremberg, as a manufacturer of electrical and/or electronic equipment.

14 Optional accessories

14.1 Optional accessories, confocalDT IFD2410/2415

SC2415-x/OE		Connection cable with 17-pole M12 socket and open ends for analog output, digital I/O and encoder; drag chain-compatible, cable length x = 3 m, 6 m, 9 m or 15 m
PC2415-x		Cable extension with 12-pin M12 socket and 12-pin M12 plug for power supply, RS422 or encoder, Industrial Ethernet; suitable for drag chains, cable length x = 3 m, 6 m, 9 m or 15 m
PC2415-x/OE		Connection cable with 12-pin M12 socket and open ends, suitable for PC2415-x, supply, RS422 or encoder, Industrial Ethernet; suitable for drag chains, cable length x = 3 m, 6 m, 9 m or 15 m
PC2415-1/Y		Supply/interface cable for IFD241x; with 12-pin M12 socket and open ends or RJ45 plug, cable length = 1 m
IF2001/USB		IF2001/USB 1-channel RS422/USB converter Connections: 1 x 10-pin socket strip (cable clamp) type: Würth 691361100010, 1 x 6-pin socket strip (cable clamp), type: Würth 691361100006
PS2020		Power supply unit for DIN rail mounting Input 230 VAC, output 24 VDC/2.5 A

14.2 Optional accessories, confocalDT IFD2411

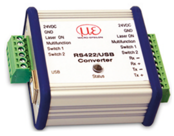
Cable C2401 with FC/APC and E2000/APC connector

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

Mounting adapter

MA2400-27	Mounting adapter for IFS2404-1 / IFS2404-3 / IFS2404-6 sensors
MA2404-12	Mounting adapter for IFS2404-2(001) / IFS2404/90-2(001) sensors
JMA-xx	Adjustable mounting adapter

Other accessories

SC2415-x/OE		Connection cable with 17-pole M12 socket and open ends for analog output, digital I/O and encoder; drag chain-compatible, cable length x = 3 m, 6 m, 9 m or 15 m
IF2001/USB		IF2001/USB 1-channel RS422/USB converter Connections: 1 x 10-pin socket strip (cable clamp) type: Würth 691361100010, 1 x 6-pin socket strip (cable clamp), type: Würth 691361100006
PS2020		Power supply unit for DIN rail mounting Input 230 VAC, output 24 VDC/2.5 A

Vacuum feedthrough

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

14.3 Services

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

15 Factory settings

15.1 confocalDT IFD2410/2415

Number of peaks	1 measurement value, highest peak
Region of interest	Start of range corresponds to 0% End of range corresponds to 100%:
Exposure mode	Measurement mode
User group	Professional, password “000”
Data reduction	Inactive
Detection threshold	2 %
Error handling	Error output, no measured value
Measuring program	Distance measurement, “Standard matt”
Measuring rate	1 kHz
Peak modulation	50 %

RS422	921.6 kBps
Switching output 1	Intensity error, switching level for error: Push Pull
Switching output 2	Error measuring range, switching level for error: Push Pull
Interface	EtherCAT
Signal processing	01DIST1, moving averaging, 16 values
Synchronization	no synchronization
Key function	Change operating mode, dark referencing, factory setting
Key lock	Inactive
Trigger mode	No trigger

15.2 confocalDT IFD2411

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

RS422	921.6 kBps
Interface	EtherCAT
Signal processing	01DIST1, moving averaging, 16 values
Synchronization	no synchronization
Key function	Change operating mode, dark referencing, factory setting
Key lock	Inactive
Trigger mode	No trigger

16 Adjustable mounting adapter JMA-xx

16.1 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

16.2 Sensor mounting, compatibility

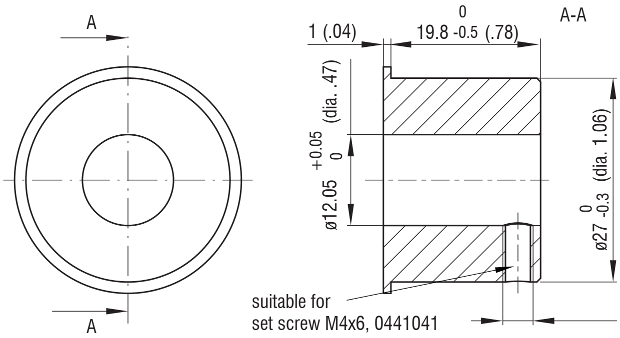
Radial clamping for sensors with

ø 12 mm

Reducing sleeve
Adapter D27-D12

Sensor

- IFD2411-2

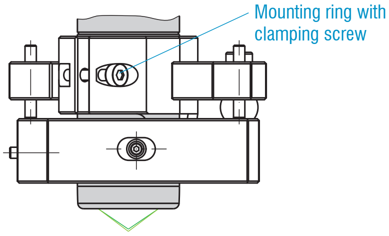


ø 27 mm

Sensor

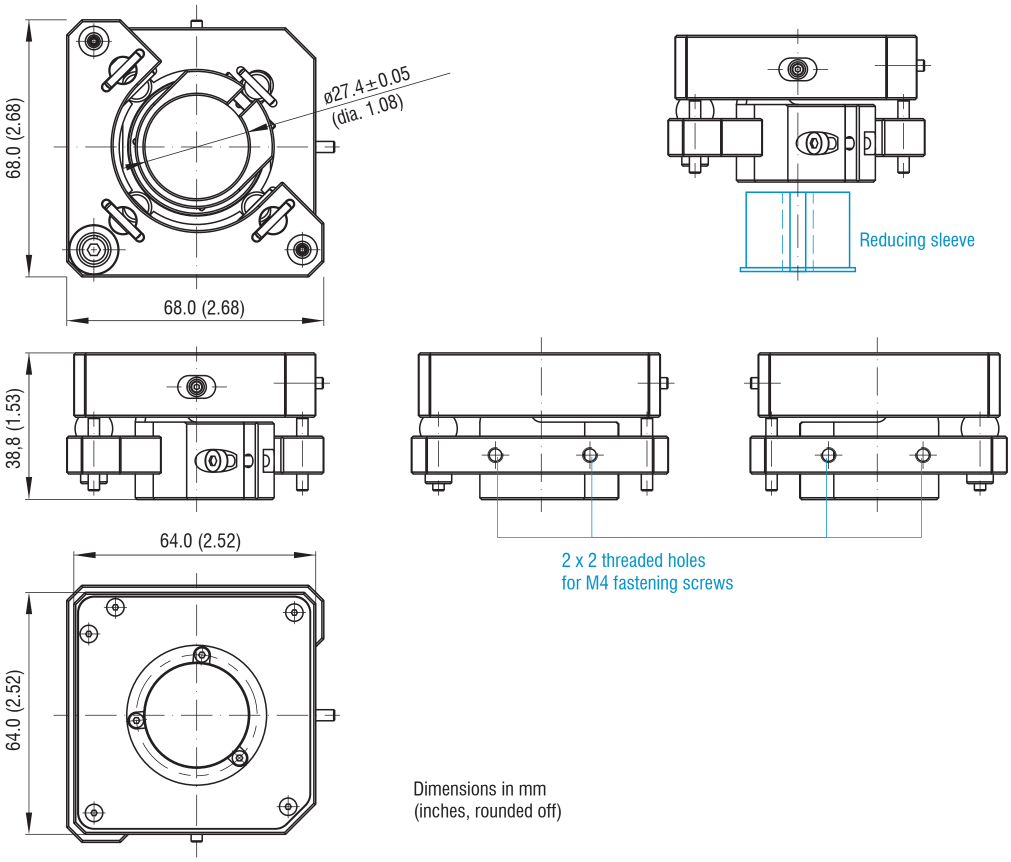
- IFD2411-1
- IFD2411-3
- IFD2411-6

16.3 Mounting



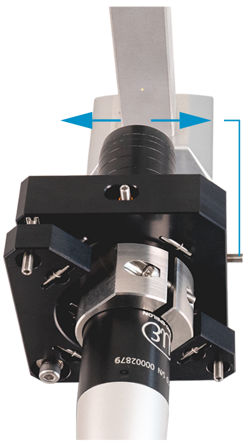
- ► Mount the sensor in the mounting ring, see figure.
- ► Use reducing sleeves for sensors with an outer diameter of less than 27 mm.
- ► Mount the mounting adapter with M4 screws, see dimensional drawing.

16.4 Dimensional drawing of mounting adapter

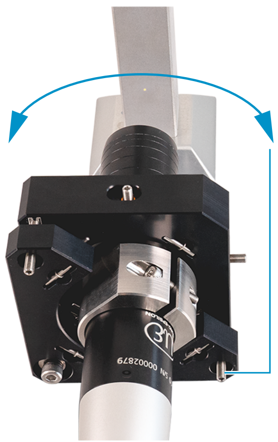


16.5 Orthogonal alignment of sensor

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

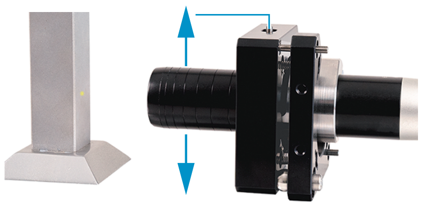


Horizontal shift, ±2 mm

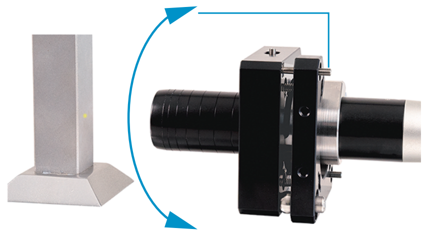


Horizontal tilt angle ±4°

- For horizontal shift or tilt to the left, turn the hexagon socket screw clockwise.
- For horizontal shift or tilt to the right, turn the hexagon socket screw counterclockwise.



Vertical shift, ±2 mm



Vertical tilt angle, ±4°

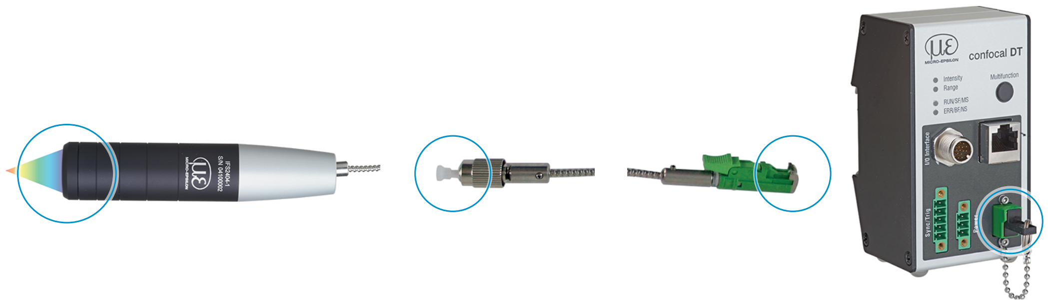
- For vertical upward shift or tilt, turn the hexagon socket screw clockwise.
- For vertical downward shift or tilt, turn the hexagon socket screw counterclockwise.

17 Cleaning optical components

17.1 Soiling

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

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



Sensor		Sensor cable		Controller
Protective glass	FC connector		E2000 connector	

Tab. 17.1: Optical boundary surfaces of a confocal measuring system

- Perform a dark correction, see Chap. 5.10.

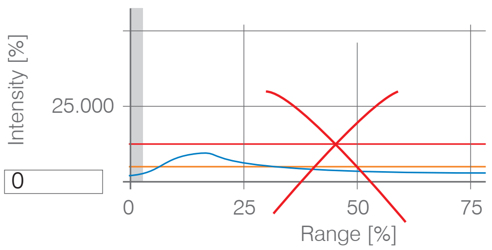


Fig. 17.1: Video signal before dark correction (high dark value, blue line)

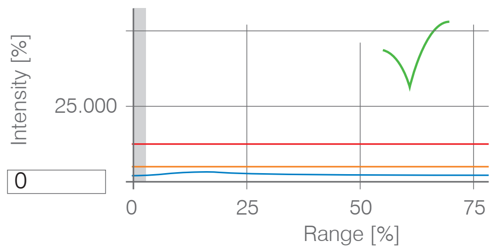


Fig. 17.2: Video signal after dark correction

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

- Continue with section `Protective glass of sensor`.

i	Check or clean the protective screen on 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.

17.2 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

17.3 Protective glass of sensor

Loose sticking particles:

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

Sticking particles:

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

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

► Soak a Q-tip in isopropanol. Slowly rub the Q-Tip with a circular motion on the protective glass.

Fig. 17.3: Cross-section of protective glass

► Perform a dark correction.

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

► Continue with section `Interface between controller and sensor cable`.

17.4 Interface between controller and sensor cable

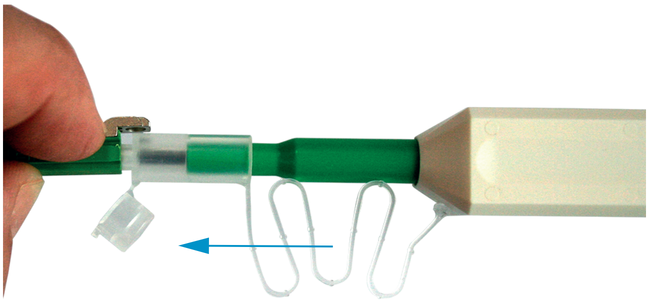
► Disconnect the sensor cable (optical fiber) from the controller.
► Remove the protective cap of the One-Click™ cleaner.
► Put the One-Click™ cleaner into the fiber optic connector of the controller, see figure.

- Press the outer sleeve of the One-Click™ Cleaner onto the fiber optic cable until a click noise signalizes the end of cleaning.

Fig. 17.4: One-Click™ Cleaner for cleaning E2000 optical fiber transitions

- Insert the protective cap on the controller into the fiber optic connection.

- Remove the front protective cap from the One-Click™ Cleaner.
- Place the One-Click™ Cleaner over the fiber optic cable, see illustration.
- Press the outer sleeve of the One-Click™ Cleaner onto the fiber optic cable until a click noise signalizes the end of cleaning.



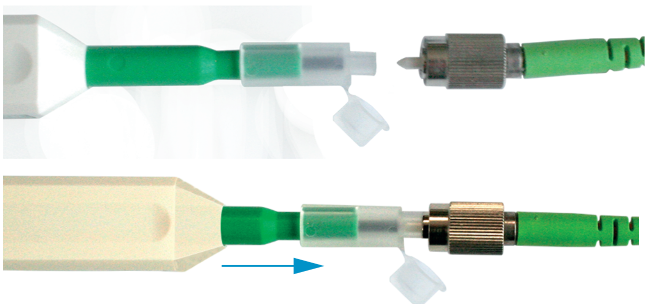
- Connect the sensor cable to the controller.
- Perform a dark correction.

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

- Continue with section `Interface between sensor cable and sensor`.

17.5 Interface between sensor cable and sensor

- Remove the sensor cable (optical fiber) from the sensor.
- Remove the front protective cap from the One-Click™ Cleaner.
- Place the One-Click™ Cleaner over the fiber optic cable, see illustration.
- Press the outer sleeve of the One-Click™ Cleaner onto the fiber optic cable until a click noise signalizes the end of cleaning.



- Place a protective cap on the optical fiber.

Sensor with optical fiber in the sensor:

- Remove the protective cap of the One-Click™ cleaner.
- Place the One-Click™ Cleaner over the sensor, see illustration.
- 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 a dark correction.

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

- Continue with section `Interface between controller and sensor cable`.

17.6 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.

- Close the fiber optic connections consistently and immediately when replacing sensors or disconnecting a sensor cable from the controller.

18 ASCII communication with controller

18.1 General

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

Example: Switching on output via RS422

OUTPUT RS422 <Enter>

Reference	<Enter>	Must include LF, but can also be CR LF
Explanation	<LF>	Line feed (hex 0A)
	<CR>	Carriage return (hex 0D)
	<Enter>	hex 0A or hex 0D0A depending on the system

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

The output format is:

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

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

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

18.2 Commands overview

Group	Command	Brief information
General		
	HELP	Help
	GETINFO	Controller information
	ECHO	Reply type
	PRINT	Parameter overview
	SYNC	Synchronization
	TERMINATION	Termination resistor
	RESET	Boot sensor
	RESETCNT	Reset counter
User level		
	LOGIN	Change user level
	LOGOUT	Change to user level
	GETUSERLEVEL	User level query
	STDUSER	Setting the standard user
	PASSWD	Change password
Inputs		
	MFILEVEL	Input level multifunction inputs
Sensor		

Group	Command	Brief information
	SENSORTABLE	Display available sensors
	SENSORINFO	Information on sensor
	DARKCORR	Start dark correction
	LED	LED on/off
	LEDSOURCE	Control input measurement light source
Triggering		
	TRIGGERSOURCE	Trigger source
	TRIGGERAT	Effect of trigger input
	TRIGGERMODE	Trigger type
	TRIGGERLEVEL	Active level of trigger input
	TRIGGERSW	Generates a software trigger pulse
	TRIGGERCOUNT	Number of measured values to be specified
	TRIGGERLEVEL	Level for the trigger input (TTL / HTL)
	TRIGGERENCSTEPSIZE	Step size encoder triggering
	TRIGGERENCMIN	Minimum encoder triggering
	TRIGGERENCMAX	Maximum encoder triggering
Encoder		
	META_ENCODERCOUNT	Number of available encoders
	ENCINTERPOLn	Setting interpolation depth
	ENCREFn	Setting the reference track
	ENCVALUEn	Setting encoder value
	ENCSET	Setting encoder
	ENCRESET	Reset encoder value
	ENCMAXn	Setting maximum encoder value
	ENCODERCOUNT	Number of active encoders
Interface		
	BAUDRATE	Setting RS422
Parameter management, load/save settings		
	BASICSETTINGS	Load connection settings
	CHANGESETTINGS	Show changed parameters
	EXPORT	Export parameter sets
	IMPORT	Import parameter sets
	SETDEFAULT	Set factory settings
	MEASSETTINGS	Edit measurement settings
Measurement		
	PEAKCOUNT	Number of measurement peaks
	MEASPEAK	Peak selection
	REFRACCORR	Refractivity correction
	SHUTTERMODE	Exposure mode
	MEASRATE	Measurement frequency
	SHUTTER	Exposure time
	ROI	Masking the region of interest
	MIN_THRESHOLD	Minimum threshold peak detection
	PEAK_MODULATION	Modulation of peaks
Material Database		

Group	Command	Brief information
	MATERIALTABLE	Materials table
	MATERIAL	Select material
	MATERIALINFO	Show material property
	META_MATERIAL	Existing materials, material names
	META_MATERIAL_PROTECT-ED	Protected materials
	MATERIALEDIT	Edit materials table
	MATERIALDELETE	Delete material
	MATERIALADD	Add material
Edit measured value		
	STATISTIC	Selection of signals for statistics
	META_STATISTIC	List of possible statistics signals
	STATISTICSIGNAL	Selection of statistics signal
	META_STATISTICSIGNAL	List of possible statistics signals to select
	META_MASTERSIGNAL	List of possible signals to be parameterized
	MASTERSIGNAL	Parameterization of master signals
	META_MASTER	List of possible signals for mastering
	MASTER	Trigger mastering
	MASTERSIGNALSELECT	Determine signal for mastering with external source
	MASTERSOURCE	Select external source for mastering
	COMP	Calculation in channel
	META_COMP	List of possible calculation signals
	SYSSIGNALRANGE	Two-point scaling data outputs
Data Output		
	OUTPUT	Digital output selection
	OUTREDUCEDEVICE	Output data rate
	OUTREDUCECOUNT	Reduction counter
	OUTHOLD	Error handling
Selection of measured values to be output via interfaces		
	OUT_RS422	Data selection for RS422
	META_OUT_RS422	List of possible signals RS422
	GETOUTINFO_RS422	List of selected signals, sequence via RS422
Switching Outputs		
	ERROROUTn	Selection of error signal for output
	META_ERRORLIMITSIGNAL	List of possible signals for error output
	ERRORLIMITSIGNALn	Set signal to be evaluated
	ERRORLIMITCOMPARETOn	Setting the limit values
	ERRORLIMITVALUESn	Set value
	ERRORLEVELOUTn	Switching behavior of switching outputs
	ERRORHYSTERESIS	Switching hysteresis of switching outputs
Analog Output		

Group	Command	Brief information
	ANALOGOUT	Data selection for analog output
	META_ANALOGOUT	List of possible signals for analog output
	ANALOGRANGE	Set current/voltage range of the digital-to-analog converter (DAC)
	ANALOGSCALEMODE	Set scaling for DAC
	ANALOGSCALERANGE	Set scaling range
System Settings for Key Functions		
	KEYLOCK	Selection of the key lock
	BOOTMODE	Switch EtherCAT to Ethernet setup mode

18.3 General commands

18.3.1 General

18.3.1.1 Help

`HELP [<Command>]`

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

18.3.1.2 Controller information

`GETINFO`

Request sensor information. Output see example below:

```
->GETINFO
Name:            IFD2415-3/IE
Serial:          12345678
Option:          000
Article:         1234567
MAC-Address:     00-0C-12-01-E2-0C
Version:         004.004
Hardware-rev:    01
Boot-version:    001.018
BuildID:         57
Output-variant:  IE-setup
->
```

Name:	Model name of controller / controller series
Serial:	Controller serial number
Option:	Controller option number
Article:	Controller article number
MAC address:	Address of network adapter
Version:	Version of the booted software
Hardware-rev:	Hardware revision used
Boot version:	Bootloader version
BuildID:	Identification number for generated software

Command is mapped in SDOs 0x3005, 0x1008, 0x1009 and 0x100A.

18.3.1.3 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.

18.3.1.4 Parameterübersicht

```
PRINT ALL
```

ohne Parameter:	Dieser Befehl gibt eine Liste aller Einstellparameter und deren Wert aus.
ALL :	Dieser Befehl gibt eine Liste aller Einstellparameter und deren Wert, als auch Informationen wie z. B. Sensortabelle oder GETINFO, aus.

18.3.1.5 Synchronisation

```
SYNC NONE | MASTER | SLAVE_SYNTRIG | SLAVE_TRIGIN
```

Einstellen der Synchronisationsart:

- NONE: Keine Synchronisation
- MASTER: Controller ist Master, d. h. er gibt Synchronisationsimpulse am Ausgang Sync/Trig aus
- SLAVE_SYNTRIG: Bei dieser Einstellung ist der Controller der Slave und erwartet Synchron-Impulse von z. B. einem anderen Controller oder einer ähnlichen Impulsquelle am Eingang Sync/Trig.
- SLAVE_TRIGIN: Controller ist Slave und erwartet Synchron-Impulse von einem Frequenzgenerator am Eingang TrigIn.

Eingang	Verhalten
Sync/Trig	Differenziell
TrigIn	TTL / HTL

Sync/Trig ist alternativ ein Ein- oder ein Ausgang, d. h. es ist darauf zu achten, dass immer einer der Controller auf Master und die anderen auf Slave geschaltet sind.

Außerdem dient der Eingang TrigIn ebenfalls als Triggereingang für die Triggerarten Flanken- und Pegeltriggerung.

Befehl ist in dem SDO 0x35B1 abgebildet.

18.3.1.6 Termination resistor at Sync/Trig

```
TERMINATION OFF | ON
```

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

Command is mapped in the SDO 0x35B1.

18.3.1.7 Boot sensor

```
RESET
```

The controller is restarted.

Command is mapped in the SDO 0x3101.

18.3.1.8 Reset counter

```
RESETCNT [TIMESTAMP] [MEASCNT]
```

The counter is reset after the selected trigger edge occurs.

TIMESTAMP:	resets the time stamp
MEASCNT:	resets the measurement counter

Command is mapped in the SDO 0x3107.

18.3.2 User level

18.3.2.1 Change user level

`LOGIN <Password>`

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

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

Command is mapped in the SDO 0x3001.

18.3.2.2 Switch to user level

`LOGOUT`

Set user level to USER.

Command is mapped in the SDO 0x3001.

18.3.2.3 User level query

`GETUSERLEVEL`

Queries the current user level.

Possible outputs, see Chap. 18.3.2.1, “Change User Level”.

18.3.2.4 Set standard user

`STDUSER USER|PROFESSIONAL`

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

18.3.2.5 Change password

`ASSWD <Old password> <New password> <New password>`

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

For this, the old password must be entered and the new password must be entered twice. If the new passwords do not match, an error message will be output. The password function is case-sensitive. A password may only contain the letters A to Z and numbers without umlauts/special characters. The maximum length is limited to 31 characters.

18.3.3 Level of multifunction inputs

`MFILEVEL HTL | TTL`

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

- HTL: HTL level
- TTL: TTL level

18.3.4 Sensor

18.3.4.1 Information on calibration tables

`SENSORTABLE`

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

Output of all available (taught-in) sensors.

The `SENSORTABLE` command is valid for the IFD2411.

Command is mapped in the SDO 0x3152.

18.3.4.2 Sensor information

`SENSORINFO`

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

```
->SENSORINFO
Position:                 0
Name:                     BG
Measurement range:        3.000 mm
Serial:                   12345678
->
```

18.3.4.3 Dark correction

`DARKCORR`

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

Command is mapped in the SDO 0x3011.

`DARKCORR_PRINT`

Lists the values of the dark correction table.

18.3.4.4 LED

`LED OFF | ON`

Switches the LED of the respective channel on or off.

18.3.4.5 Control input measurement light source

`LEDSOURCE [SOFTWAREONLY | MFI1 | MFI2]`

- SOFTWAREONLY: The measurement light source can only be controlled by software; via ASCII command `LED ON/OFF` or web interface
- MFI1: Control of the measurement light source via selected multifunction input MFI1
- MFI2: Control of the measurement light source via selected multifunction input MFI2

Command is mapped in the SDO 0x3133.

18.3.5 Triggering

18.3.5.1 Select trigger source

`TRIGGERSOURCE NONE | SYNCTRIG | TRIGIN | SOFTWARE | ENCODER1 | ENCODER2`

- NONE: No trigger source used
- SYNCTRIG: Use input `Sync/Trig`
- TRIGIN: Use the input `TrigIn`
- SOFTWARE: Triggering is initiated by the command `TRIGGERSW`.
- ENCODER1: Encoder triggering of encoder 1
- ENCODER2: Encoder triggering of encoder 2

Command is mapped in the SDO 0x35B0.

18.3.5.2 Output of triggered values, with/without averaging

`TRIGGERAT INPUT | OUTPUT`

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

Triggering of data acquisition is active as a factory setting.

Command is mapped in the SDO 0x35B0.

18.3.5.3 Trigger type

`TRIGGERMODE EDGE | PULSE`

Selection of trigger type.

- PULSE: Level triggering
- EDGE: Edge triggering

Command is mapped in the SDO 0x35B0.

18.3.5.4 Active level of trigger input

`TRIGGERLEVEL HIGH | LOW`

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

Command is mapped in the SDO 0x35B0.

18.3.5.5 Software trigger pulse

`TRIGGERSW`

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

Command is mapped in the SDO 0x35B0.

18.3.5.6 Number of measurement values to be output

`TRIGGERCOUNT NONE | INFINITE | <n>`

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

Command is mapped in the SDO 0x35B0.

18.3.5.7 Level selection trigger input TrigIn

`TRIGINLEVEL TTL | HTL`

The level selection only applies to the input `TrigIn`. The input `Sync/Trig` waits for a differential signal.

- TTL: Input waits for TTL signal.
- HTL: Input waits for HTL signal.

Command is mapped in the SDO 0x35B0.

18.3.5.8 Step size encoder triggering

`TRIGGERENCSTEPSIZE [value of step size]`

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

Command is mapped in the SDO 0x35B0.

18.3.5.9 Minimum encoder triggering

`TRIGGERENCMIN [minimum value]`

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

Command is mapped in the SDO 0x35B0.

18.3.5.10 Maximum encoder triggering

`TRIGGERENCMAX [maximum value]`

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

Command is mapped in the SDO 0x35B0.

18.3.6 Encoder

18.3.6.1 Number of available encoders

`META_ENCODERCOUNT`

Lists the number of available encoders that can be selected with `ENCODERCOUNT`.

18.3.6.2 Encoder interpolation depth

`ENCINTERPOL1 1 | 2 | 3`

`ENCINTERPOL2 1 | 2 | 3`

`ENCINTERPOL3 1 | 2 | 3`

Sets the interpolation depth of the respective encoder input.

- 1 - Single interpolation
- 2 - Dual interpolation
- 3 - Quadruple interpolation

Command is mapped in the SDO 0x35A0.

18.3.6.3 Effect of reference track

`ENCREF1 NONE | ONE | EVER`

`ENCREF2 NONE | ONE | EVER`

Sets the effect of the encoder reference track.

- ONE: One-time setting (the first time the reference marker is reached, the encoder value, see Chap. 18.3.6.4 will be adopted).
- EVER: Setting for all markers (every time the reference marker is reached, the encoder value, see Chap. 18.3.6.4 will be adopted).

Command is mapped in the SDO 0x35A0.

18.3.6.4 Encoder value

`ENCVALUE1 <encoder value>`

`ENCVALUE2 <encoder value>`

`ENCVALUE3 <encoder value>`

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

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

Setting the ENCVALUE automatically resets the algorithm for recognizing the first reference marker, see Chap. 18.3.6.3.

Command is mapped in the SDO 0x35A0.

18.3.6.5 Set encoder value via software

`ENCSET 1 | 2 | 3`

Set the encoder value, see Chap. 18.3.6.4, in the specified encoder via software (only possible with ENCREF NONE, otherwise the command immediately returns without an error message).

Command is mapped in the SDO 0x35A0.

18.3.6.6 Reset detection of first reference marker

`ENCRESET 1 | 2`

Reset the detection of the first reference mark, see Chap. 18.3.6.3 (only possible with ENCREF ONE, otherwise the command returns immediately without an error message).

Command is mapped in the SDO 0x35A0.

18.3.6.7 Maximum encoder value

`ENCMAX1 <encoder value>`

`ENCMAX2 <encoder value>`

`ENCMAX3 <encoder value>`

Indicates the maximum value of the encoder after which the encoder jumps back to 0. Can be used for rotary encoders without reference track. Can be used for rotary encoders without a reference track, for example.

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

Command is mapped in the SDO 0x35A0.

18.3.6.8 Number of active encoders

`ENCODERCOUNT 1 | 2 | 3`

- 1: Encoder 1 is active, encoders 2 and 3 are inactive
- 2: Encoders 1 and 2 are active, encoder 3 is inactive
- 3: Encoder 1 to 3 are active

Command is valid with the IFD2410/2415.

Command is mapped in the SDO 0x35A0.

18.3.7 Setting the RS422 baud rate

`BAUDRATE <Baudrate>`

Baud rates can be set in Bps for the RS422 interface:

9600, 115200, 230400, 460800, 691200, 921600, 2000000, 3000000, 4000000

Command is mapped in the SDO 0x31B0.

18.3.8 Parameter administration, load / save settings

18.3.8.1 Load / save connection settings

`BASICSETTINGS READ | STORE`

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

Command is mapped in the SDO 0x3020.

18.3.8.2 Show changed parameters

`CHANGESETTINGS`

Outputs all changed settings.

18.3.8.3 Export parameter sets to PC

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

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

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

- MEASSETTINGS <SetupName>: Exports the specified measurement settings. Nothing is deleted before importing.
- BASICSETTINGS: Export the currently saved basic settings. The basic settings are deleted before importing.

- MEASSETTINGS_ALL: Export all saved measurement settings, including the initial setting. All existing measurement settings are deleted before importing.
- MATERIALTABLE: Exports the saved materials table. The existing materials table is deleted before importing.
- ALL: Complete export of all saved settings (Basic and Meas), the materials table and all sensor data saved. Everything is deleted before importing.

18.3.8.4 Import parameter sets from PC

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

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

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

- FORCE: Overwriting `Meassettings` with the same name, otherwise an error message is returned when the name is the same. When importing `Meassettings` or `Basicsettings`, `Force` must always be specified.
- APPLY : Apply the settings after importing and reading the initial settings.

18.3.8.5 Factory settings

`SETDEFAULT ALL | MEASSETTINGS | BASICSETTINGS | MATERIAL`

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

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

Command is mapped in the SDOs 0x3020, 0x3022, 0x3105 and 0x3802.

18.3.8.6 Editing, storing, displaying, deleting measurement settings

`MEASSETTINGS <Subcommand> [<Name>]`

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

Subcommands:

`PRESETMODE <mode>`	Defines the preset dynamics.
`<mode> = NONE|STATIC|BALANCED|DYNAMIC`	With NONE, there is no selection for a preset.
`PRESETLIST`	Lists all existing presets (names): “Name1” “Name2” “…”
`READ <Name>`	Loads a basic setting or measurement setting/preset (specify name) from the controller flash.
`STORE <Name>`	Stores a basic setting or a measurement setting in the controller Flash. Enter name or it will be saved under the current name.
`DELETE <Name>`	Deletes the named measurement setting from the controller flash.
`RENAME <NameOld> <NameNew> [FORCE]`	Changes the name of a measurement setting in the controller flash. An existing measurement setting can be overwritten with FORCE.

Subcommands:

`LIST`	Lists all stored measurement settings (names) "Name1" "Name2" "…". The order is based on the internal slot numbers, that is, not the order of saving.
`CURRENT`	Outputs the current measurement setting / preset (name)
`INITIAL AUTO`	When starting the controller, the settings which were saved last or the first preset are loaded if no setups exist.
`INITIAL <Name>`	Loads a named measurement setting upon starting the controller. Presets cannot be entered.

Command is mapped in SDOs 0x3021 and 0x3022.

18.3.9 Measurement

18.3.9.1 Peak count

`PEAKCOUNT <n>`

Indicates the maximum number of peaks to be evaluated.

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

Command is mapped in the SDO 0x3156.

18.3.9.2 Peak selection

`MEASPEAK F_L|L_SL|F_S|H_SH`

Selection of the peaks used for the measurement

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

Command is mapped in the SDO 0x3161.

18.3.9.3 Number of peaks and switching on/off refractivity correction

`REFRACCORR on | off`

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

Command is mapped in the SDO 0x3156.

18.3.9.4 Exposure mode

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

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

Command is mapped in the SDO 0x3250.

18.3.9.5 Measuring rate

```
MEASRATE <measuring rate>
```

Selection of the measuring rate in kHz:

IFD2410, IFD2411: value range 0.100 … 8,000;

IFD2415: value range 0.100 … 25,000.

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

Command is mapped in the SDO 0x3156.

18.3.9.6 Exposure time

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

Indication of exposure times for manual and two-time exposure modes.

The exposure time is processed with three decimal places. The minimum step size is 0.1 µs.

Command is mapped in the SDO 0x3250.

18.3.9.7 Region of interest (ROI)

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

Sets the "Region of interest" for the respective channel. Start and end must be between 0 and 511. The entry is made in the unit pixels. The start value must be less than the end value.

Command is mapped in the SDO 0x3711.

18.3.9.8 Minimum threshold peak detection

```
MIN_THRESHOLD <n>
```

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

The entry is made in % and relates to the dark corrected signal.

Command is mapped in the SDO 0x3162.

18.3.9.9 Peak modulation

```
PEAK_MODULATION <n>
```

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

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

Command is mapped in the SDO 0x3162.

18.3.10 Materials database

18.3.10.1 Materials table

```
MATERIALTABLE
```

Output of the materials table saved in the controller.

```
->MATERIALTABLE
                                    Refraction index                Abbenumber
Pos,   Name,        nF at 486nm,     nd at 587nm,  nC at 656nm,       vd          Description
0      Vakuum,      1.000000,        1.000000,     1.000000,          0.000000    Vakuum; Luft(naeherungsweise)
1      Wasser,      1.337121,        1.333044,     1.331152,          0.000000
1      Ethannol,    1.361400,        1.361400,     1.361400,          0.000000
7      PC,          1.599439,        1.585470,     1.579864,          0.000000    Polycarbonat
8      Quarzglas,   1.463126,        1.458464,     1.456367,          0.000000    Siliziumdioxid, Fused Silica
9      BK7,         1.522380,        1.516800,     1.514320,          0.000000    Kronglas
->
```

18.3.10.2 Select material

`MATERIAL <Materialname>`

Change the material between distance 1 and 2 for the respective channel.

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

Command is mapped in SDOs 0x3802 and 0x3804.

18.3.10.3 Show material property

`MATERIALINFO`

Output of the material properties of the selected layer. Layer 1 is between distance 1 and 2, layer 2 is between distance 2 and 3 etc. If no parameters are specified, the data for layer 1 are output.

Example:

```
->MATERIALINFO
Name:                                     BK7
Description:                              Kronglas
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
->
```

Command is mapped in the SDO 0x3800.

18.3.10.4 Existing material in controller

`META_MATERIAL`

Lists the material names already saved in the controller.

18.3.10.5 Protected materials in controller

`META_MATERIAL_PROTECTED`

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

18.3.10.6 Edit materials table

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

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

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

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

There is a maximum of 20 materials.

18.3.10.7 Delete a material

`MATERIALDELETE <Name>`

Deletes a material.

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

Command is mapped in the SDO 0x3802.

18.3.10.8 Add material

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

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

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

18.3.11 Measurement value processing

18.3.11.1 Statistical calculations

`STATISTIC <signal> RESET`

Resets individual statistics.

- <signal>: Statistical data Minimum, Maximum or Peak-Peak

Command is mapped in SDOs 0x3A10, 0x3A11 and 0x3A12.

18.3.11.2 List of statistics signals

`META_STATISTIC`

Provides a list of the active statistics signals.

These signals were defined under `STATISTICSIGNAL`.

18.3.11.3 Selection of statistics signal

`STATISTICSIGNAL <signal>`

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

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

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

Command is mapped in SDOs 0x3A10, 0x3A11 and 0x3A12.

18.3.11.4 List of possible statistics signals to select

`META_STATISTICSIGNAL`

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

Command is mapped in SDOs 0x3A10, 0x3A11 and 0x3A12.

18.3.11.5 List of possible signals to be parameterized

`META_MASTERSIGNAL`

Lists all possible signals that can be used for mastering.

Command is mapped in SDOs 0x3A00, 0x3A01 ... 0x3A09.

18.3.11.6 Parameterization of master signals

`MASTERSIGNAL [<signal>]`

`MASTERSIGNAL <signal> <master value>`

`MASTERSIGNAL <signal> NONE`

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

- <signal>: Selecting a specific measured or calculated signal on which the master value should be set, see Chap. 18.3.11.5
- <master value> master value in mm, value range: -2147,0 ... 2147.0

Command is mapped in SDOs 0x3A00, 0x3A01 ... 0x3A09.

18.3.11.7 List of possible signals for mastering

`META_MASTER`

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

18.3.11.8 Mastering / zeroing

`MASTER [<signal>]`

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

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

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

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

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

The master command waits a maximum of 2 seconds for the next measured value and uses this as the master value. If no measured value was recorded within this time, in case of external triggering, for example, the command returns with the error “E32 Timeout”. The master value is processed with six decimal places.

Command is mapped in SDOs 0x3A00, 0x3A01 ... 0x3A09.

18.3.11.9 Signal for mastering with external source

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

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

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

18.3.11.10 Mastering with external source

`MASTERSOURCE [NONE|MFI1|MFI2]`

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

- NONE: No port selected. (Controlling by commands is possible.)
- MFI1: Use MFI1-port to control the mastering function.
- MFI2: Use MFI2-port to control the mastering function.

Command is mapped in the SDO 0x39FF.

18.3.11.11 Mastering example

For the example, the preset `Standard matt Opposite thickness measurement` was selected in the controller, the commands are executed with the Telnet program, no variables are defined.

->o 169.254.168.150	

->META_MASTERSIGNAL META_MASTERSIGNAL 01DIST1 01DIST1 FOIL	// List all variables that can be mastered to
->META_MASTER META_MASTER NONE	// List all variables that have been assigned a master value
->MASTERSIGNAL 01DIST1 1.0 ->MASTERSIGNAL FOIL 2.1	// Set variable 01DIST1 to the value 1.0 // Set variable FOIL to the value 2.1
->META_MASTER META_MASTER 01DIST1 FOIL	// List all variables that have been assigned a master value; the vari-able 01DIST1 has now been assigned
->MASTER ALL MASTER 01DIST1 INACTIVE MASTER FOIL INACTIVE MASTER NONE ... MASTER NONE MASTER NONE	// List all 10 possible variables and show their status 
->MASTER ALL SET	// Triggers a master measurement for all assigned variables 
->MASTER 01DIST1 RESET	// the offset (master value) is undone for the variable 01DIST1 
->MASTER ALL MASTER 01DIST1 INACTIVE MASTER FOIL ACTIVE MASTER NONE ... MASTER NONE MASTER NONE	
->MASTER FOIL RESET	// the offset (master value) is reset for the FOIL variable 
->MASTERSIGNAL 01DIST1 NONE ->MASTERSIGNAL FOIL NONE	// The variable 01DIST1 is deleted // The variable FOIL is deleted
->MASTER ALL MASTER NONE ... MASTER NONE	// No variable on which a master measurement could be applied

18.3.11.12 Calculation in channel

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

This command defines all channel-specific as well as controller-specific calculations.

<channel> CH01|CH02|SYS	*Channel selection*
<id> 1...10	*Calculation block number*
<signal>	*Measuring signal; you can query the available signals with the command META_COMP*
<median data count> 3|5|7|9	*Averaging depth Median*
<moving data count> 2|4|8|16|32|64| 128|256|512|1024|2048|4096	*Averaging depth Moving average*
<recursive data count> 2 ... 32000	*Averaging depth Recursive average*
<factor1>, <factor2> -32768,0 … 32767,0	*Multiplication factor*
<offset> -2147.0 ... 2147.0	*Correction value in mm*
<name>	*Name of calculation block; length min. 2 characters, max. 15 characters. Permitted characters a-zA-Z0-9, the name must start with a letter.* *Command names such as STATISTIC, MASTER, CALC, NONE, ALL are not permitted.*

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

Functions:

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

Command is mapped in SDOs 0x3C00, 0x3C01 ... 0x3C09.

18.3.11.13 List of possible calculation signals

```
META_COMP
```

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

Command is mapped in SDOs 0x3C00, 0x3C01 ... 0x3C09.

18.3.11.14 Two-point scaling data outputs

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

The values determined from the calculation can be greater than the values that the controller can display. The range of values is determined with this command.

Default is 0 to 10 mm.

Command is mapped in the SDO 0x3CBF.

18.3.12 Data output

18.3.12.1 Digital output selection

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

- NONE: No output of measured values
- RS422: Output of measured values via RS422
- IE: Output of measured values via Industrial Ethernet, not parallel with RS422[22].
- ANALOG: Output of measured values via analog output

[22] The controller issues an error if IE and RS422 are selected in parallel. IE is implicitly activated when the EtherCAT state machine starts up or during PDO mapping; if RS422 was previously active, it is implicitly removed.

- ERROROUT: Error or status information via the error outputs

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

18.3.12.2 Output data rate

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

Reduction of output of measured values via specified interfaces.

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

18.3.12.3 Reduction counter for output of measured values

`OUTREDUCECOUNT <count>`

Reduction counter for output of measured values.

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

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

Command is mapped in the SDO 0x31B3.

18.3.12.4 Error handling

`OUTHOLD NONE|INFINITE|<count>`

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

- NONE: Last measured value not held; error value output
- INFINITE: Last measured value held indefinitely
- Number: Holds the last measured value via measurement cycle count and then outputs the error value (maximum 1024)

Command is mapped in the SDO 0x31B2.

18.3.13 Selection of the measurement values to be output

18.3.13.1 General

Setting the values to be output via the RS422 interface.

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

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

18.3.13.2 Datenauswahl für RS422

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

Auswahl der Daten, die über diese Schnittstelle ausgegeben werden sollen.

18.3.13.3 List of possible signals for RS422

`META_OUT_RS422`

List of possible data for the RS422.

Command is mapped in the SDO 0x31F5.

18.3.13.4 List of selected signals, sequence via RS422

`GETOUTINFO_RS422`

Returns the order of the signals via this interface.

Command is mapped in the SDO 0x31F5.

18.3.14 Switching Outputs

18.3.14.1 General

The following commands apply to the IFD2410/2415 and the IFC2416.

18.3.14.2 Error-Schaltausgänge

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

`ERROROUT2 [01ER1|01ER2|01ER12|ERRORLIMIT]`

Einstellen der Fehler-Schaltausgänge.

- 01ER1: Schaltausgang wird bei einem Intensitätsfehler geschaltet
- 01ER2: Schaltausgang wird bei einem Messbereichsfehler geschaltet
- 01ER12: Schaltausgang wird bei einem Intensitätsfehler oder einem Messbereichsfehler geschaltet
- ERRORLIMIT: Schaltausgang wird bei Messwert außerhalb der Grenzwerte geschaltet; Basis sind die Einstellungen für ERRORLIMITSIGNAL1/2, ERRORLIMITCOMPARETO1/2 und ERRORLIMITVALUES1/2

18.3.14.3 List of possible signals for error output

`META_ERRORLIMITSIGNAL1`

`META_ERRORLIMITSIGNAL2`

List of all signals that are possible for the `ERRORLIMITSIGNALn` command.

18.3.14.4 Set signal to be evaluated

`ERRORLIMITSIGNAL1 [<signal>]`

`ERRORLIMITSIGNAL2 [<signal>]`

Selection of the signal to be used for the limit value analysis.

18.3.14.5 Set limit values

`ERRORLIMITCOMPARETO1 [LOWER | UPPER |BOTH]`

`ERRORLIMITCOMPARETO2 [LOWER | UPPER |BOTH]`

Specifies whether the output should activate upon

- LOWER --> shortfall
- UPPER --> exceedance
- BOTH --> undershot or exceeded

18.3.14.6 Set value

`ERRORLIMITVALUES1 [<lower limit [mm]> <upper limit [mm]>]`

`ERRORLIMITVALUES2 [<lower limit [mm]> <upper limit [mm]>]`

Sets the values for Lower and Upper limit values.

- <lower limit [mm]> = -2147,0 ... 2147,0
- <upper limit [mm]> = -2147,0 ... 2147,0

18.3.14.7 Switching behavior of error outputs

`ERRORLEVELOUT1 [PNP|NPN|PUSHPULL|PUSHPULLNEG]`

`ERRORLEVELOUT2 [PNP|NPN|PUSHPULL|PUSHPULLNEG]`

Switching behavior of error outputs Error 1 and Error 2.

- PNP: Switching output is High in the case of an error and open without error
- NPN: Switching output is Low in the case of an error and open without error
- PUSHPULL: Switching output is High in the case of an error and Low without error
- PUSHPULLNEG: Switching output is Low in the case of an error and High without error

18.3.14.8 Switching hysteresis of error outputs

`ERRORHYSTERESIS1 <hysteresis [mm]>`

`ERRORHYSTERESIS2 <hysteresis [mm]>`

Sets the hysteresis for the switching outputs, see also function ERRORLIMIT.

- <hysteresis [mm]> = (0..2) * measurement range [mm]

18.3.15 Analog output

18.3.15.1 Data selection

`ANALOGOUT signal`

Selection of the signal to be output via the analog output. The signal is specified as a parameter. A list with the possible signals can be shown with META_ANALOGOUT, see Chap. 18.3.15.2.

Command is mapped in the SDO 0x31D0.

18.3.15.2 List of possible signals for analog output

`META_ANALOGOUT`

Lists all signals that can be connected to the analog output.

Command is mapped in the SDO 0x31D0.

18.3.15.3 Output range

`ANALOGRANGE 0-5V | 0-10V | 4-20mA`

- 0-5 V: The analog output provides a voltage of 0 to 5 volts.
- 0-10 V: The analog output provides a voltage of 0 to 10 volts.
- 4-20mA: The analog output puts out a current of 4 to 20 milliamperes.

Command is mapped in the SDO 0x31D0.

18.3.15.4 Set scaling for DAC

`ANALOGSCALEMODE STANDARD | TWOPOINT`

Selects whether to use one-point or two-point scaling of the analog output.

- STANDARD --> One-point scaling
- TWOPOINT --> Two-point scaling

The standard scaling is designed for distances -MR/2 to MR/2 and for thickness measurement from 0 to 2 MR (MR = measuring range).

Minimum and maximum measured values must be specified in millimeters. The available output range of the analog output is then spread between the minimum and maximum measured values. The minimum and maximum measured values must be between -2147.0 and 2147.0.

The minimum and maximum measured values are processed with three decimal places.

Command is mapped in the SDO 0x31D0.

18.3.15.5 Set scaling range

`ANALOGSCALERANGE <limit 1> <limit 2>`

Two-point scaling requires the start and end of the range to be entered in millimeters.

- <limit 1> = (-2147,0 ... 2147,0) [mm], and different from <limit 2>.
- <limit 2> = (-2147,0 ... 2147,0) [mm], and different from <limit 1>.

The values cannot be identical.

Command is mapped in the SDO 0x31D0.

18.3.16 System Settings

18.3.16.1 Key lock

`KEYLOCK NONE | ACTIVE | (AUTO [<value>])`

Selection of the key lock.

- NONE: Key always functions; no key lock
- ACTIVE: Key lock is activated immediately after restart
- AUTO: Key lock is only activated <time> minutes after restart, value range 1 ... 60 min

Command is mapped in the SDO 0x34A0.

18.3.16.2 Switch EtherCAT to Ethernet setup mode

`BOOTMODE [FIELDBUS|RECOVERY]`

Switches firmware. No action is taken if the requested firmware is already active. Otherwise, the requested firmware is installed and a restart takes place. The switch takes approx. one minute. The power supply for the IFD must not be interrupted during this time.

- FIELDBUS: Start with EtherCAT
- RECOVERY: Start in Ethernet setup mode

18.4 Measurement value format

18.4.1 Setup

The structure of measured value frames depends on the selection of the measured values or on the selection of a preset. In the following overview, you will find a summary of commands which you can use to query the available measured values via RS422.

OUT_RS422	Data selection for RS422
META_OUT_RS422	List of possible signals RS422
GETOUTINFO_RS422	List of selected signals, sequence via RS422

Example for the structure of a data block, query via Telnet:

Preset `Standard matt`	Preset `Multisurface`
->META_OUT_RS422 META_OUT_RS422 01RAW 01DARK 01LIGHT 01SHUTTER 01ENCODER1 01INTENSITY 01SYMM 01DIST1 MEASRATE TRIGTIMEDIFF TIMESTAMP TIMESTAMP_HIGH TIMESTAMP_LOW COUNTER 01DIST1_MIN 01DIST1_PEAK 01DIST1_MAX ->	->META_OUT_RS422 META_OUT_RS422 01RAW 01DARK 01LIGHT 01SHUTTER 01ENCODER1 01INTENSITY 01SYMM 01DIST1 01DIST2 01DIST3 MEASRATE TRIGTIMEDIFF TIMESTAMP TIMESTAMP_HIGH TIMESTAMP_LOW COUNTER Ch01Thick12 Ch01Thick23 ->
->GETOUTINFO_RS422 GETOUTINFO_RS422 01SHUTTER 01INTENSITY1 01DIST1 ->	->GETOUTINFO_RS422 GETOUTINFO_RS422 01SHUTTER 01INTENSITY1 01DIST1 01INTENSITY2 01DIST2 01INTENSITY3 01DIST3 Ch01Thick12 Ch01Thick23 ->

A measured value frame is built dynamically, i.e., values not selected are not transmitted.

18.4.2 Video signal

The video signals that have been calculated in the signal processing process can be transmitted. A video signal comprises 512 pixels. One pixel is described by a 16-bit word. The value range used is 0...16383.

There are five accessible video signals:

- Raw signal
- Dark corrected signal
- Light corrected signal

The dark value table and light value table can be queried with the commands `DARKCORR_PRINT` or `LIGHTCORR_PRINT`.

Pixel 0	Pixel 1	...	Pixel 511
Raw signal, 16 bit Dark corrected signal, 16 Bit Light corrected signal, 16 Bit	Raw signal Dark corrected signal Light corrected signal	...	Raw signal Dark corrected signal Light corrected signal

Tab. 18.1: Data structure of the video signals

18.4.3 Exposure time

The output of the exposure time via the RS422 interface is done with a resolution of 100 ns. The data word is 18 bits wide.

18.4.4 Encoder

The encoder values for transmission can be selected individually. When transmitting via RS422, only the lower 18 bits of the encoder values are transmitted.

18.4.5 Measurement counter

Only the lower 18 bits of the profile counter are transmitted on the RS422 interface.

18.4.6 Timestamp

The system-internal resolution of the time stamp is 1 µs. For the transmission via RS422, two 18 bit data words are provided (`TIMESTAMP_LOW` and `TIMESTAMP_HIGH`).

18.4.7 Measurement data (distances and intensities)

One intensity (if selected) and one measured value are transmitted for each selected distance.

Bit position	Description
0-10	Intensity of the peak (100 % corresponds to 1024)

Tab. 18.2: Intensity table

When transmitting via RS422, `Intensity of the peak` is transmitted with 10 bits.

The intensity value is determined based on the calculation rule below:

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

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

Details for the format for RS422 can also be found in the Measurement Data Formats section, see Chap. 18.5.1.

18.4.8 Trigger time difference

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

Value range 0….100000

18.4.9 Differences (thicknesses)

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

The selected differences between distance 1 and the other distances are output first, then those of distance 2, ...

Details for the format for RS422 can also be found in the Measurement Data Formats section, see Chap. 18.5.1.

18.4.10 Statistic values

The statistical values have the same format as the distances.

Minimum is transmitted first (if selected), then maximum and finally peak-to-peak.

18.4.11 Peak symmetry

The peak symmetry value is output via RS422 as 18 bit (signed integer) with 4 bit decimal places.

18.5 Measurement data formats

18.5.1 Data format RS422 interface

18.5.1.1 Video data

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

Tab. 18.3: Structure of a video frame

Data structure, see Tab. 18.1

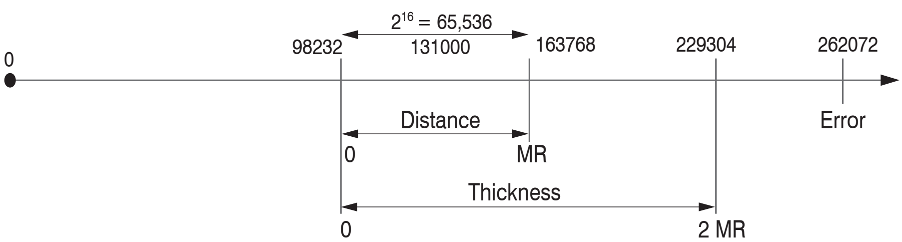
18.5.1.2 Measurement values

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

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

Output 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 distance and thickness measurement:



131000 = mid of measuring range for the distance measurement

MB = measuring range

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

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

x = distance / thickness in mm
d_{OUT} = digital output value
MR = Measuring range in mm

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

Error code	Description
262073	Scaling error RS422 interface underflow
262074	Scaling error RS422 interface overflow
262075	Data volume too large for selected baud rate [23]
262076	No peak is present
262077	Peak is before the measuring range (MR)
262078	Peak is behind the measuring range (MR)
262079	Measured value cannot be calculated

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

- Increase baud rate, see Chap. 18.3.7
- Decrease measuring frequency, see Chap. 18.3.9.5
- Reduce data volume; if 2 data words were selected, reduce to one data word, see Chap. 18.3.13
- Reduce output data rate, see Chap. 18.3.12.2

18.6 Warning and error messages

E200	I/O operation failed
E202	Access denied
E204	Received unsupported character
E205	Unexpected quotation mark
E210	Unknown command
E212	Command not available in current context
E214	Entered command is too long to be processed
E230	Unknown parameter
E231	Empty parameters are not allowed
E232	Wrong parameter count
E233	Command has too many parameters
E234	Wrong or unknown parameter type
E236	Value is out of range or the format is invalid
E262	Active signal transfer, please stop before
E270	No signals selected
E272	Invalid combination of signal parameters, please check measure mode and signal selection
E276	Given signal is not selected for output
E277	One or more values were unavailable. Please check output signal selection
E281	Not enough memory available
E282	Unknown output signal

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

E283	Output signal is unavailable with the current configuration
E284	No configuration entry was found for the given signal
E285	Name is too long
E286	Names must begin with an alphabetic character, and be 2 to 15 characters long. Permitted characters are: a-zA-Z0-9_
E320	Wrong info-data of the update
E321	Update file is too large
E322	Error during data transmission of the update
E323	Timeout during the update
E324	File is not valid for this sensor
E325	Invalid file type
E327	Invalid checksum
E331	Validation of import file failed
E332	Error during import
E333	No overwrite during import allowed
E340	Too many output values for RS422 selected
E350	The new passwords are not identical
E351	No password given
E360	Name already exists or not allowed
E361	Name begins or ends with spaces or is empty
E362	Storage region is full
E363	Setting name not found
E364	Setting is invalid
E500	Materials table is empty
E502	Materials table is full
E504	Material name not found
E600	ROI begin must be less than ROI end
E602	Master value is out of range
E603	One or more values were out of range
E610	Encoder: minimum is greater than maximum
E611	Encoder‘s start value must be less than the maximum value
E615	Synchronization as slave and triggering at level or edge are not possible at the same time
E616	Software triggering is not active
E618	Sensor head not available
E621	The entry already exists
E622	The requested dataset/table does not exist.
E623	Not available in EtherCAT mode
E624	Not allowed when EtherCAT SYNC0 synchronization is active
W505	Refractivity correction deactivated, vacuum is used as material
W526	Output signal selection modified by the system
W528	The shutter time has been changed to match the measurement rate and the system requirements.
W530	The IP settings has been changed.

19 Switch between EtherCAT and Ethernet setup mode

The IFD241x starts with the last saved operating mode. Factory setting is EtherCAT. Access via Ethernet is possible in Ethernet setup mode.

- Press and hold the `correct` button on the IFD2410/2415 or `Multifunction` button on the IFC2411 before switching on the power supply. Release the key as soon as the `Intensity` LED flashes yellow. Press the key again for approx. 10 to 15 seconds until the `Intensity` LED flashes red.

Within the time t_2 ... t_3, the red flashing starts at 8 Hz after 10 seconds. Release the key again after 15 seconds at the latest. When the `Correct` or `Multifunction` button is released at the latest at time t_3, the `Intensity` LED starts to flash yellow at 8 Hz.

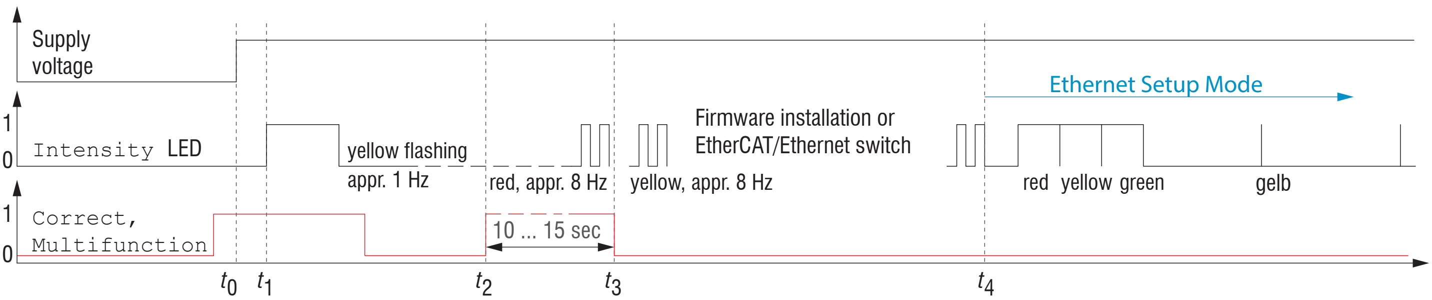


Fig. 19.1: Flowchart for starting an IFx241x in Ethernet setup mode

Once the firmware installation or change has been completed, the IFD241x restarts itself at time t_4.

t_0:	Supply voltage is applied
t_1:	The `Intensity` LED starts to flash yellow, the button can be released
t_2:	Press the button again within 15 seconds (t_2 - t_1) and hold it down for another 10 to 15 seconds (t_3 - t_2).
t_3... t_4:	The change from EtherCAT to Ethernet setup mode begins, duration max. 1 min.
t_4:	IFD241x starts in Ethernet setup mode, the `Intensity` LED lights up briefly at intervals of approx. 1 second.

In Ethernet setup mode, the ERR LED flashes green evenly.

20 Switching between Ethernet Setup Mode and EtherCAT

The IFD241x starts with the last saved operating mode. You can switch the sensor to EtherCAT mode with the `Correct` or `Multifunction` key.

► Press and hold the `Correct` button on the IFD2410/2415 or `Multifunction` button on the IFC2411 before switching on the power supply. Release the key as soon as the `Intensity` LED flashes yellow. Press the key again for approx. 10 to 15 seconds until the `Intensity` LED flashes red.

Within the time t_2 ... t_3, the red flashing starts at 8 Hz after 10 seconds. Release the key again after 15 seconds at the latest. When the `Correct` or `Multifunction` button is released at the latest at time t_3, the `Intensity` LED starts to flash yellow at 8 Hz.

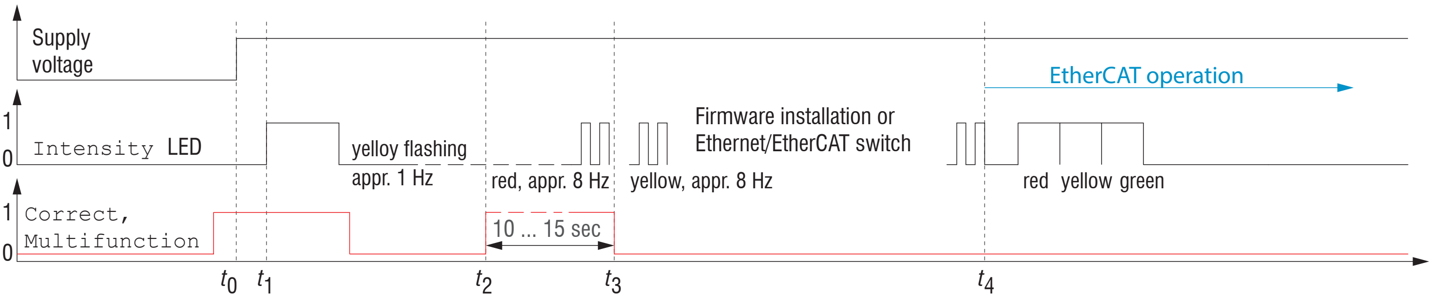


Fig. 20.1: Flowchart for starting an IFx241x in EtherCAT mode

Once the firmware installation or change has been completed, the IFD241x restarts itself at time t_4.

t_0:	Supply voltage is applied
t_1:	The `Intensity` LED starts to flash yellow, the button can be released
t_2:	Press the button again within 15 seconds (t_2 - t_1) and hold it down for another 10 to 15 sec. (t_3 - t_2)
t_3... t_4:	The change from EtherCAT to Ethernet setup mode begins, duration max. 1 min.
t_4:	IFD241x starts in EtherCAT operating mode.

21 Telnet

21.1 General

The Telnet service allows you to communicate with the IFD241x from your PC. To communicate with Telnet, you will need

- a connection between the IFD241x and your PC,
  - Ethernet Setup Mode
  - RS442 Communication
  - Ethernet over EtherCAT (EoE)
- the ASCII commands, see Chap. 18

21.2 Establishing the connection

- ► Start the `Telnet.exe` program via Start > Run.
- ► Enter the command `o 192.254.168.150` or the IP address of the controller.

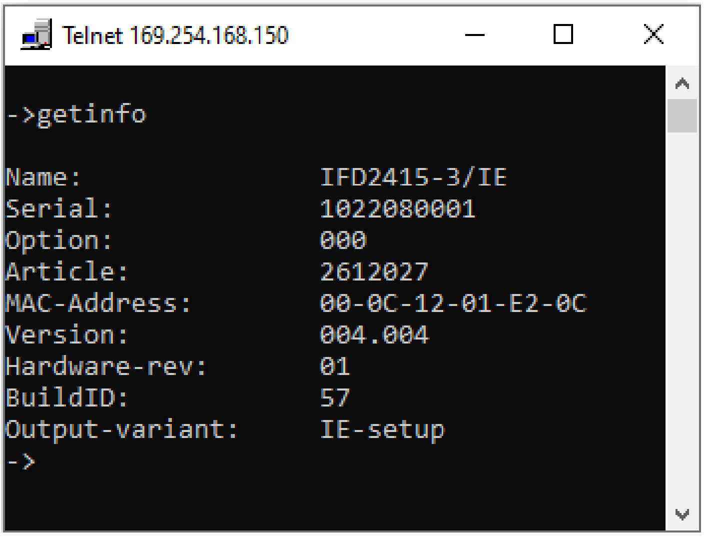


Fig. 21.1: Telnet start screen of IFD241x

A command always consists of the command name and zero or several parameters that are separated with a space. The currently set parameter value is reset if a command is invoked without parameters.

The output format is:

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

The returned command can be used again without changes for setting the password. After a command is processed, a line break and a prompt (“->”) is always returned. In the event of an error, an error message beginning with Exx, where xx stands for a unique error number, comes before the prompt.

i	If no connection is confirmed after sending the IP address, send a c to close the connection. Now send the command `o 192.254.168.150` again to establish the connection.

21.3 Help on a command

Telnet can output information about a command. For this, enter the sequence “HELP <command name>”.

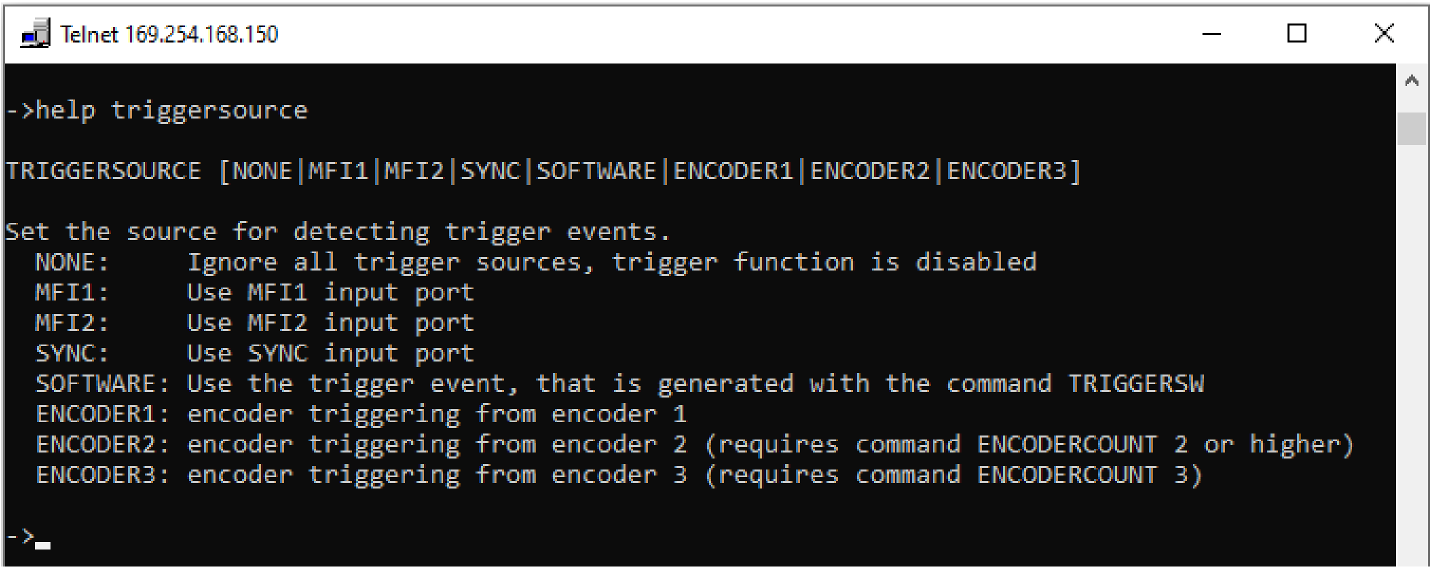


Fig. 21.2: Abruf der Information zu dem Befehl `TRIGGERSOURCE`

21.4 Fehlermeldungen

Folgende Fehlermeldungen können auftreten:

- E01 Unbekanntes Kommando: Es wurde eine unbekannte Parameter-ID übergeben.
- E06 Zugriff verweigert: Auf diesen Parameter kann momentan nicht zugegriffen werden. Eventuell ist der Controller nicht im Experten-Modus oder der Parameter ist durch andere Einstellungen nicht sichtbar.
- E08 Unbekannter Parameter: Es wurden zu wenig Parameter übergeben.
- E11 Der eingegebene Wert liegt außerhalb des Gültigkeitsbereichs, bzw. das Format ist ungültig: Der übergebene Wert liegt außerhalb des Gültigkeitsbereiches.

Der Text der Fehlermeldungen hängt von der eingestellten Sprache ab. Die Kennung der Fehlermeldung (Exx) ist für jede Sprache die gleiche.

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