MICRO-EPSILON

More Precision

colorSENSOR // Color sensors, LED Analyzers

Micro-Epsilon Eltrotec has more than 40 years' experience in the development and use of color recognition sensors and fiber optic technology.

In production and quality assurance, a number of very different types of color sensors are responsible for high productivity and cost reduction. The sensors record color values, intensities and functions on various surfaces and self-luminous objects.

The very latest color sensors and high quality fiber optics are combined in a comprehensive product range. They are used where high efficiency and effectiveness are called for.

Numerous renowned customers worldwide rely on accurate color recognition sensors from Micro-Epsilon Eltrotec and secure their advantage in cost efficiency and advanced knowledge of manufacturing.

The colorSENSOR CFO series provides opto-electronic sensor solutions where the electronics and the probe heads are coupled via fiber optics and therefore arranged separately.

Due to numerous sheathings and heads, these fiber optics can be adapted to any application, therefore being flexible in use.

Sophisticated, optical glass fibers stand out due to minimal installation dimensions and robust materials and are ideally suitable for harsh ambient conditions and high temperatures.

The colorSENSOR series includes a compact transmitter and receiver unit for color recognition with integrated signal evaluation. The light transmission to the object and back is based on high-quality, optical glass fibers according to the principle of total reflection. The received light intensity is used for evaluation.

These fiber optic sensors enable a wide variety of applications, from presence monitoring and color sorting of components in automatic assembly machines, feeding systems, test and inspection applications, through to high precision color inspection and production control.

Detection and inspection of small objects

High-speed processes

Integration in industrial environments

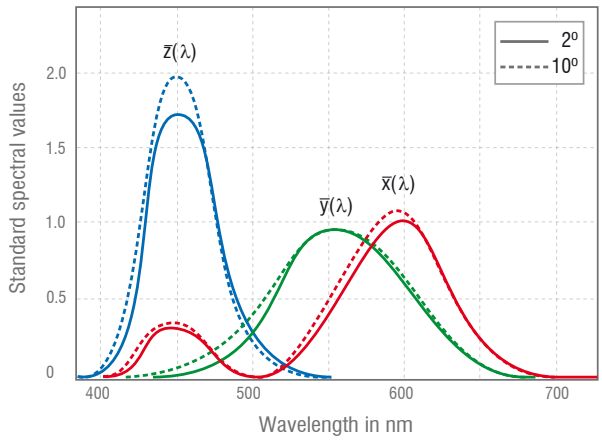
Color assessment based on:

Hue: Color differentiation, e.g., red, green, blue, yellow, etc.

Brightness: Intensity of light perception, color appears darker or brighter

Colorfulness: Intensity of the color compared with a gray color (not colored) with the same brightness

Saturation: Describes the relation between colorfulness and brightness



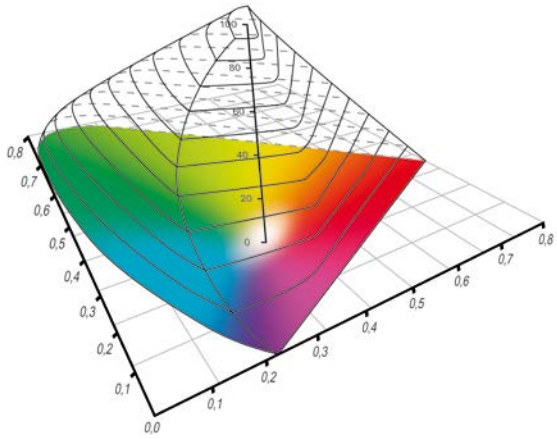
This is how each perceivable color can, due to its characteristics, be assigned an exact location in a color space and be communicated worldwide.

Color spaces

The human eye has three color receptors (L = long, M = middle, S = short). This is why 3D color models are used in order to clearly identify colors and to compare these with other colors (see color distance). In the industry, particularly the L*a*b* color space has become established.

Standard color space CIE 1931 (xyY color space)
This color space is based on perceived color in human color vision.
(very large green and small blue/red range).
x and y = color vectors describing hue and saturation
Y = value (brightness) scaled from 0 to 100
W = white point (x=y=z=1/3)
Spectral lines = "pure" colors
Black body curve = color as temperature of an ideal, black radiator

! *Suitable for testing green and white LEDs.*



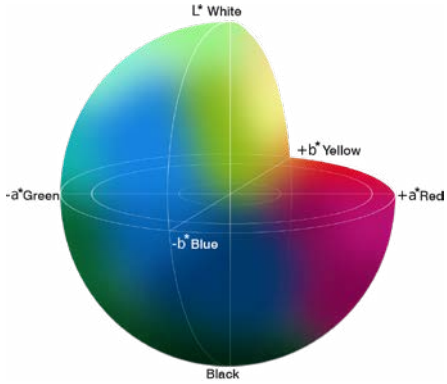
xyY color space

Standard color space CIELAB76

The L*a*b color space comprises all colors perceptible to the human eye. In this 3D color model, each hue is described with approximately the same volume of space. The L*a*b* color space has established itself in the industry and is used by device manufactures for color inspection.

Each color is described by the color location (L*; a*; b*).
L* = lightness (black = 0; white = 100)
a* = green/red colors (green = -100; red = +100)
b* = blue/yellow colors (blue = -100; yellow = +100)

! *Ideal color space for color test, as each color range is the same size.*

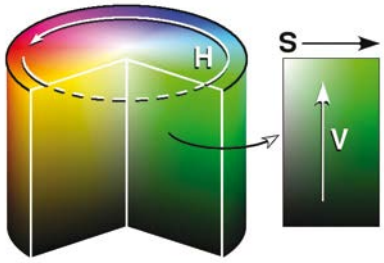


L*a*b* color space

HSV/ HSI color space

The colors in the HSV color space are defined by hue, saturation and brightness combining several color models such as HSV/HSL/HSI.
Each color is defined by the color coordinates (H, S, V)
H= Hue (red = 0°; green = 120°; blue = 240°)
S= (Saturation) Colorfulness (neutral gray = 0%; „pure" color = 100 %)
V= (Value) Brightness
I = (Intensity) Light intensity (dark = 0%; very bright = 100%)

! *Ideal color space for LED inspection (primarily used with the colorCONTROL MFA series)*



Color distance ΔE

The larger the difference between the colors within the color space, the more clearly the difference can be perceived with the human eye. This is defined as ΔE color distance.
Delta E; ΔE; dE = is a metric for the perceived color distance between colors (DIN 5033)

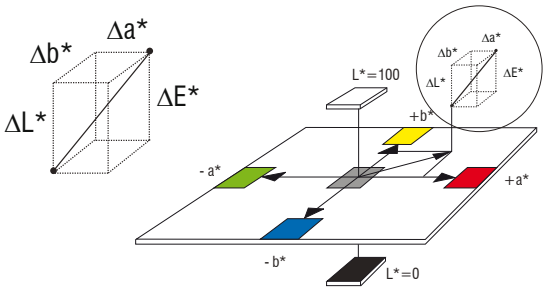
$$\Delta E = \sqrt{(L^*_p - L^*_v)^2 + (a^*_p - a^*_v)^2 + (b^*_p - b^*_v)^2}$$

ΔE of 11.61 corresponds to the difference between sample (p) and comparison (v)

$$\Delta E = \sqrt{(60^*_p - 55^*_v)^2 + (-38{,}6^*_p - (-30)^*_v)^2 + (-46^*_p - (-52)^*_v)^2} = 11{,}62$$

Interpretation:

ΔE > 5	Large color difference
ΔE 0.5 … 1	Limits of human perception
ΔE < 0.3	Required by the paper industry
ΔE < 0.1	Required by the automotive industry



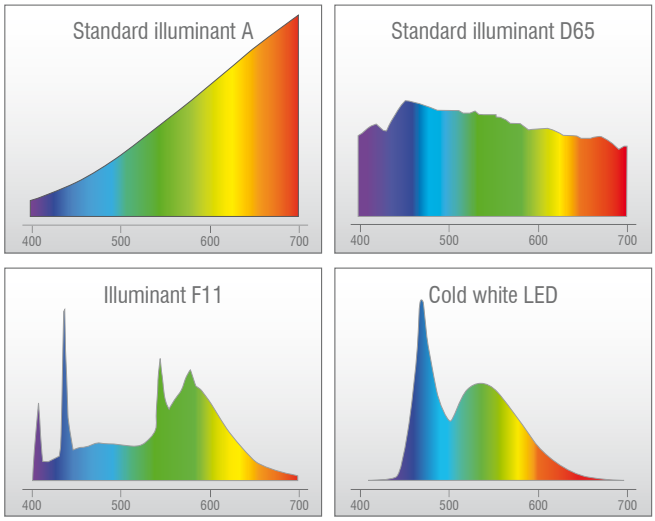
Sample (p)

Comparison (v)

Standard illuminants and light sources

Standard illuminants are defined from 380 to 780 nm.

- **Illuminant A** = light bulb with 2865 k
- **Illuminant D65** = medium daylight with approx. 6500 k
- **Illuminant F11** = fluorescent lamp
- **Cold white LED**



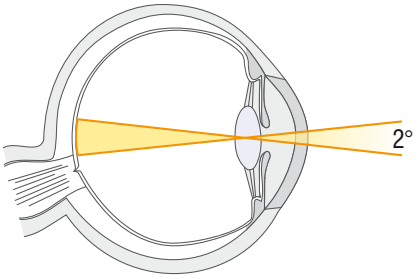
Standard observer

There are two different types defined by three cone sensitivity curves:

2° standard observer (1931)

- Distance 30 cm = 1 cm visual field
- Focus onto small area of retina (macula of retina)
- Hardly corresponds to visual perception

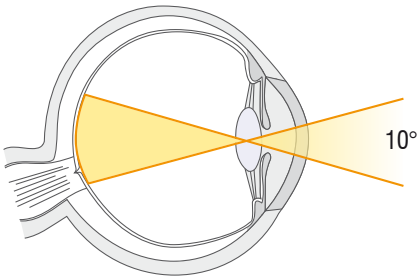
At the end of an outstretched arm, an object the size of a thumbnail has an aperture angle of approx. 2°.



10° standard observer (1964)

- Distance 30 cm = 5 cm visual field (standard practice)
- Focus onto large area of retina (macula of retina + edges)
- Corresponds to visual perception

At the end of an outstretched arm, this approximately corresponds to the palm without fingers. The sensitivity curves of the standard observers are standard spectral sensitivity curves/functions. The spectral values for $\bar{x}$ $\bar{y}$ $\bar{z}$ defined in DIN 5033 are the calculation basis for the chosen observer.



! **Standard observer**
People perceive colors differently. In order to achieve perceptual uniformity, the International Commission on Illumination (CIE) stipulates spectral weighting functions. These functions describe how people perceive colors. They are based on experimentally determined sensitivity curves of the long-wave L-cone (X), medium-wave M-cone (Y) and short-wave S-cone (Z).

Selection criteria

colorSENSOR with fiber optics		CFO100	CFO200	OT-3-LD
No. of color memories		6	254	31
Repeatability		ΔE ≤ 0.5	ΔE ≤ 0.3	ΔE ≤ 0.9
Detection distance		2 - 100 mm	2 - 200 mm	200 - 800 mm
Light spot Ø		0.6 - 20 mm	0.6 - 30 mm	20 - 80 mm
Fiber optics+ lens		•	•	
TEACH-IN		•	•	•
Teach-in via keys		6	254	31
Software		•	•	•
Software teach		6 (256)	254 (320)	31
RS232 interface		•	•	•
USB interface			•	
Ethernet interface		•	•	•
Application properties	mat surfaces	•	•	
	shiny surfaces	○ [1]	○ [1]	
	reflecting surfaces	○ [2]	○ [2]	
	textured surfaces	○ [2]	○ [2]	
	high temperatures up to 400 °C	•	•	
	large working distance			•
	LED test	•	○ [3]	•
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[1] Only with focus lens KL-D-XX or circular sensor
[2] Only with circular sensor
[3] Only with mountable lens

Recommended sensors:
colorSENSOR CFO200

Recognition of anti-reflection coating on lenses

Optical surfaces of many lenses have an anti-reflection coating which should reduce surface reflections. These anti-reflective layers must be applied evenly; otherwise undesired color gradients may occur which might impair the function of the lens. In order to inspect the visual color impression (green-blue for highly sophisticated coatings) and the coating quality, color sensors are used. With their sensor head, the sensors detect the color reflection of the lenses. Due to the high resolution, they detect even the slightest of color variations reliably.

Recommended sensors:
colorSENSOR CFO200

Comparing colors of parking sensor and car body

Car attachments such as parking sensors are painted separately. However, the colors of the parts must be identical during assembly. For color assignment, the colorSENSOR CFO sensors are used which ensure a direct color comparison between the parking sensor and the rear bumper.

Recommended sensors:
colorSENSOR CFO100

Distinction of shiny nuts

In modern machining centers, the automatic distinction of supplied parts is state of the art. To reliably distinguish shiny nuts made of aluminum and tin, color sensors are used. The measurement is performed with a fiber optics which can also be used in confined installation spaces. The high accuracy of the sensor then enables the reliable detection of the respective metal and transfers the measured value to the processing machine.

Color detection of kitchen fronts

Kitchens are available in many different styles and colors. In order to ensure consistent color of different front panels, color sensors from Micro-Epsilon are used. The sensors inspect the color of the kitchen fronts in the painting plant. Color sensors ensure that the color shade is within the specified tolerances. Even the smallest color deviations imperceptible to the human eye can be detected reliably. Furthermore, the sensors used inspect if the color is constant over several production batches. This ensures homogeneous colors of different components used for kitchen fronts.

Recommended sensors:
colorSENSOR CFO200

Recommended sensors:
colorSENSOR CFO200

Color inspection on front spoilers

Before installing front aprons, Micro-Epsilon color sensors check if the color of the attachment matches the body color. Different color groups can be defined to cover all coatings.

Color and intensity tests of vehicle lights

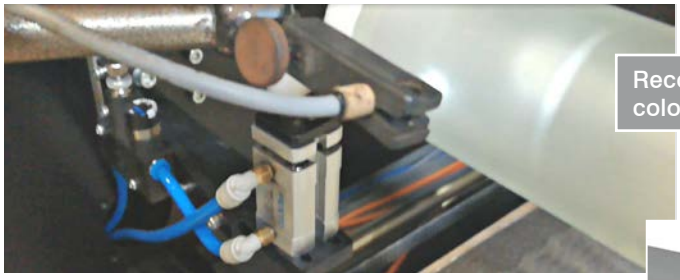
Color and intensity of vehicle lights must be reliably inspected prior to assembly and delivery. Homogeneous distribution of light should also be ensured with fluctuating LED batches. colorCONTROL MFA is designed to test inaccessible and widely spaced test specimens. Optical fibers enable simultaneous measurement of up to 20 measuring points.

Recommended sensors:
colorCONTROL MFA

Recommended sensors:
colorSENSOR CFO200

Inspection of the interior coating in aluminum cans

Aluminum cans are painted inside and outside. This transparent varnish protects the can from corrosion and reactions with the filling media. For presence monitoring of the interior varnish, colorSENSOR CFO200 color sensors are used which check the presence of the interior varnish using fiber optic sensors.



Recommended sensors:
colorSENSOR CFO100

Marking detection on cosmetics bottles

When automatically printing on semi-transparent glass ceramic bottles, it is necessary to determine the exact position for the printing. Before the printing process, a reference mark is embossed into the bottles. Due to the depression of the embossment, the color of the reference mark deviates slightly from the rest of the bottle surface. The color sensor detects this minimal color difference, which enables the exact determination of the printing position below the embossment. If the marking is missing, the bottle is considered as faulty and will be rejected immediately. Therefore at the same time, a good / bad evaluation can be carried out as part of a quality control.

colorSENSOR CFO100

- *256 colors can be saved*
- *Repeatability ≤ 0.5*
- *Easy key operation*
- *Automatic LED control*
- *Fiber optics with focus lenses*
- *Multi-teach function*

Features:

- Color memory: 256 colors in 6 color groups can be saved using keys
- Max. 3 color channels (6 with binary coding)
- Ethernet interface
- White light LED
- Color inspection in the L*a*b* / L*u*v* color space
- Different evaluation algorithms can be activated
- 6 color groups
- Adaptable fiber optics and focus lenses
- Robust aluminum housing
- Measurement frequency up to 10 kHz

Application examples:

- Detection of color rings on metal and plastic sleeves
- Color values can be read and statistically evaluated
- Color mark recognition in printing industry
- Color and gray-scale detection
- Packaging control
- Color sorting tasks (e.g., O-ring control, closures, crown caps, labels)
- Color recognition on interior parts (e.g., head supports)

The colorSENSOR CFO100 is a new sensor for precise color recognition in industrial measurement tasks. The controller is distinguished by high color accuracy, state-of-the-art interfaces and intuitive operation. Fiber optics which can be adapted for various measuring tasks, are connected to the controller.

Using a modulated high-power white light LED, a white light spot is projected via the fiber optics onto the surface to be detected. Part of the light that is back scattered from the target is directed onto a perceptive True Color detector via the same optical fiber, separated into long-, medium- and short-wave light components (X=long, Y=medium, Z=short) and transformed into L*a*b* color values.

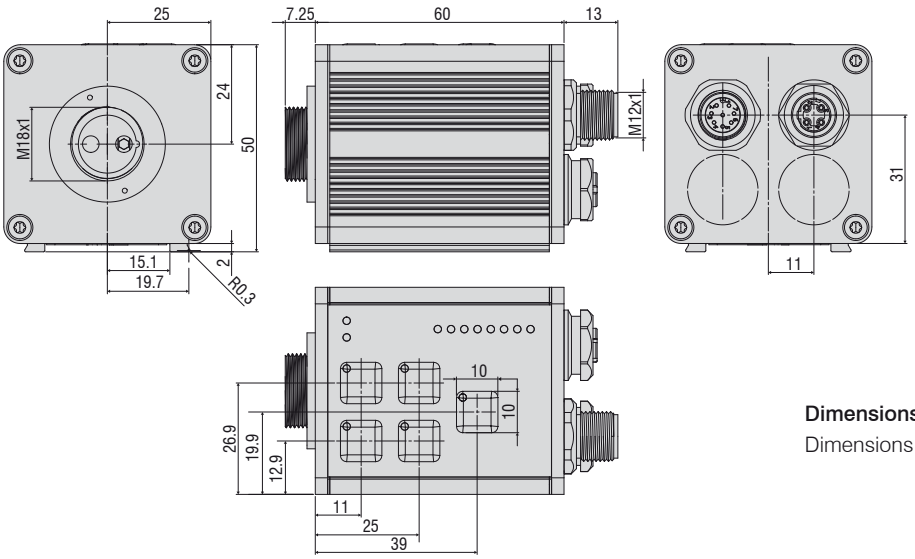
Intuitive key operation enables the user to easily teach-in up to 256 colors in 6 color groups. One function alone adapts the illumination, averaging and signal amplification to the current measurement situation. Furthermore, tolerance models and tolerance values can be adjusted individually.

If the sensor recognizes one of the taught colors, the switching state changes via three digital outputs. Binary output switching ensures reliable test performance in the face of a discontinuity while providing output of up to 6 color groups.

Equipped with optical fibers, the sensor can also be used in restricted areas as the sensor head requires a minimum of space.

Model	CFO100
Article number	10234670
Object distance	depends on the fiber optics and the ancillary lens used reflected-light optical fiber typ. 2 mm - 25 mm with lens typ. 5 mm - 100 mm [2]
Light spot diameter	depending on the fiber optics used as well as front lens attachment reflected-light optical fiber typ. dia. 0.6 mm - 20 mm [2]
Repeatability [1]	ΔE ≤ 0.5
Color distance	ΔE ≤ 1.0
Color spaces	XYZ, xyY, L*a*b*, L*u*v*, u'v'L*
Averaging	automatic adaption depending on the measurement frequency over max. 200 values
Size of color memory	max. 256 colors in non-volatile EEPROM with parameter sets
Measurement frequency	standard 1 kHz; max. 10 kHz (number of colors being taught and the setting for the averaging depend on this)
Temperature drift X,Y	0.1 % / K
Light source	white light LED, AC mode (adjustable or OFF for self-luminous objects, software-switchable)
Type of illumination	via fiber optics
Effect from illumination	automatically adjustable
Ambient light	up to 5000 lux
Alternating light operation	AC: typ. 1 kHz; max. 10 kHz
Power supply	+18 ... 28 VDC
Power consumption	typ. 500 mA
Max. switching current	100 mA
TEACH key/inputs	5 keys and IN0 for externally teaching color reference, tolerance stage and configuring sensor; triggering, key lock, clearing memory
Outputs	OUT0 - OUT2, digital (0V/+Ub), 100 mA max. switching current
Switching state display	Visualization with 13 white LEDs
Interface	Ethernet and RS232 process interface
Type of connector	to power/PLC: 8-pole flange connector (M12A) to PC: 4-pole flange socket (M12D) (Ethernet DHCP-capable)
Connection cable	to power/PLC: art. no. 11234717 / to PC: art. no. 11234735 (Ethernet)
Receiver	3-color filter detector (XYZ TRUE COLOR detector, color curve according to CIE1931)
Pulse extension	off by default, typ. 10ms, adjustable > 30 µs
Signal amplification	2 stages, automatic
Housing material	Aluminum, anodized black
Operating temperature	-10 ... +55 °C
Storage temperature	-10 ... +85 °C
Protection class	IP65

[1] Maximum color distance ΔE of 1000 successive measurements of the color value of a red and a dark gray reference tile (R = 5%), measured with sensor FAR-T-A2.0-2,5-1200-67° at 1000 Hz and brightness adjustment with a white standard (R=95%)
[2] Model: FAR - T - A 2.0 - 2,5 - 1200 - 67° Reflex; Model: FAD - T - A 2.0 - 2,5 - 1200 - 67° Transmitted light



Dimensions:
Dimensions in mm, not to scale

colorSENSOR CFO200

- *Up to 320 colors can be saved*
- *Repeatability ≤ 0.3*
- *Easy key operation*
- *Automatic LED control*
- *Fiber optics with focus lenses*
- *Multi-teach function*

Features:

- Color memory: 320 colors in 254 color groups can be saved using keys
- Max. 8 color channels (254 with binary coding)
- Ethernet interface
- White light LED
- Color inspection in the L*a*b* / L*u*v* color space
- Different evaluation algorithms can be activated
- 254 color groups
- Adaptable fiber optics and focus lenses
- Robust aluminum housing
- Measurement frequency up to 30 kHz

Application examples:

- Detection of color rings on metal and plastic sleeves
- Color values can be read and statistically evaluated
- Color mark recognition in printing industry
- Color and gray-scale detection
- Packaging control
- Color sorting tasks (e.g., O-ring control, closures, crown caps, labels)
- Color recognition on interior parts (e.g., head supports)
- Color recognition of exterior parts (e.g., parking sensors, exterior mirrors, etc.)
- Coloring of liquids (e.g., oil, apple juice, etc.)
- Gray shades of concrete blocks and paving stones
- Internal coating of cans
- Distinction of materials and coatings (stainless steel/tin or brass/gold)

The colorSENSOR CFO200 is a new sensor for precise color recognition in industrial measurement tasks. The controller is distinguished by high color accuracy, state-of-the-art interfaces and intuitive operation. Fiber optics which can be adapted for various measuring tasks, are connected to the controller.

Using a modulated high-power white light LED, a white light spot is projected via the fiber optics onto the surface to be detected. Part of the light that is back scattered from the target is directed onto a perceptive True Color detector via the same optical fiber, separated into long-, medium- and short-wave light components (X=long, Y=medium, Z=short) and transformed into L*a*b* color values.

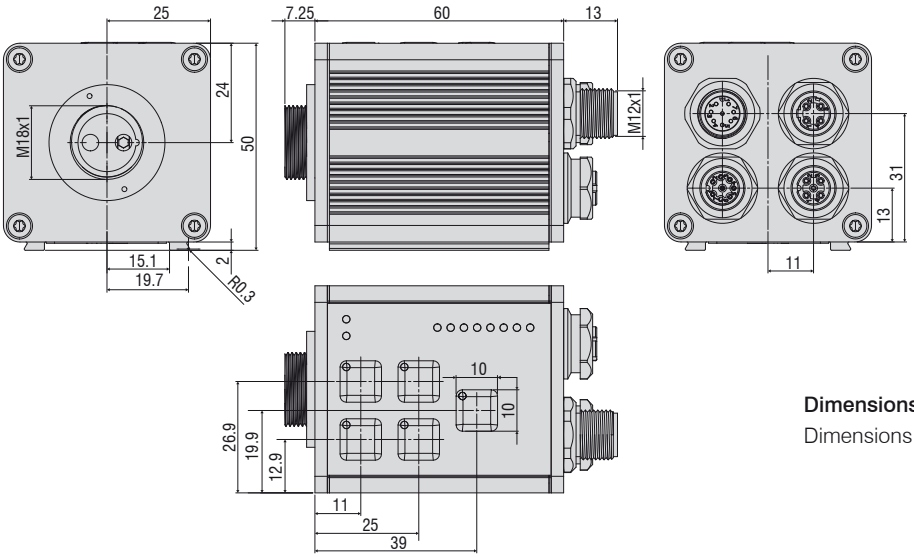
Intuitive key operation enables the user to easily teach-in 320 colors in 254 color groups. One function alone adapts the illumination, averaging and signal amplification to the current measurement situation. Furthermore, tolerance models and tolerance values can be adjusted individually.

If the sensor recognizes one of the taught colors, the switching state changes via 8 digital outputs. Binary output switching ensures reliable test performance in the face of a discontinuity while providing output of up to 254 color groups.

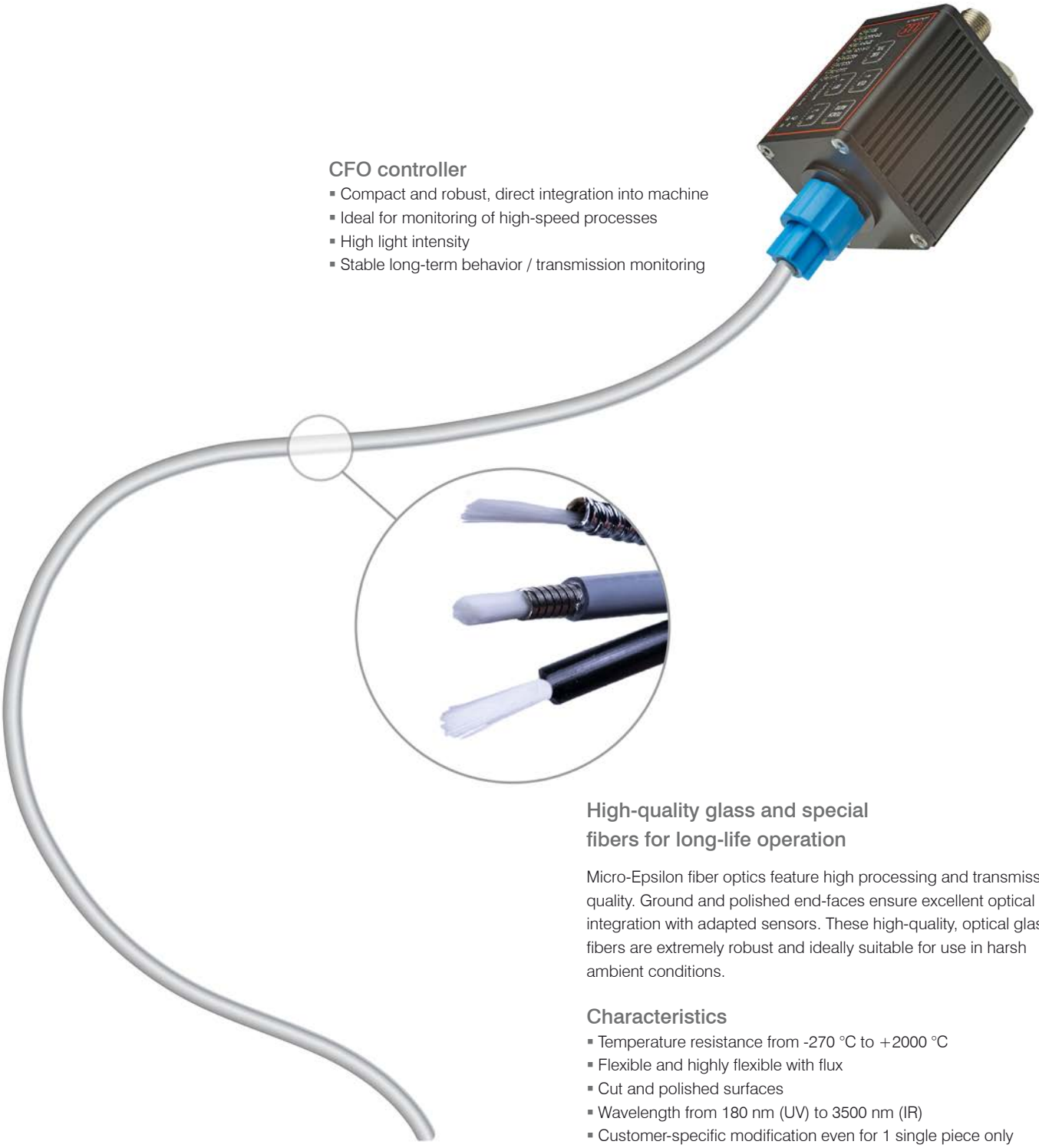
Equipped with optical fibers, the sensor can also be used in restricted areas as the sensor head requires a minimum of space.

Model	CFO200
Article number	10234671
Object distance	depends on the fiber optics and the ancillary lens used reflected-light optical fiber typ. 2 mm - 25 mm with lens typ. 5 mm- 200 mm [2]
Light spot diameter	depending on the fiber optics used as well as front lens attachment reflected-light optical fiber typ. dia. 0.6 mm - 20 mm [2]
Repeatability [1]	$\Delta E \leq 0.3$
Color distance	$\Delta E \leq 0.6$
Color spaces	XYZ, xyY, L*a*b*, L*u*v*, u'v'L*
Averaging	automatic adaption depending on the measurement frequency over max. 200 values
Size of color memory	320 colors in non-volatile EEPROM with parameter sets
Measurement frequency	standard 1 kHz; max. 30 kHz (number of colors being taught and the setting for the averaging depend on this)
Temperature drift X,Y	0.1 % / K
Light source	white light LED, AC mode (adjustable or OFF for self-luminous objects, software-switchable)
Type of illumination	via fiber optics
Effect from illumination	automatically adjustable
Ambient light	up to 5000 lux
Alternating light operation	AC: typ. 1 kHz; max. 30 kHz
Power supply	+18 ... 28 VDC
Power consumption	typ. 500 mA
Max. switching current	100 mA
TEACH key/inputs	5 keys and IN0 - IN3 for externally teaching color reference, tolerance stage and configuring sensor; triggering, key lock, clearing memory
Outputs	OUT0 - OUT7, digital (0V/+Ub), 100 mA max. switching current
Switching state display	Visualization with 13 white LEDs
Interface	Ethernet, RS232 and USB process interfaces
Type of connector	to power/PLC: 8-pole flange connector; PLC: 8-pole flange socket (M12A) to PC: 4-pole flange socket (M12D) (Ethernet DHCP-capable)
Connection cable	to power/PLC: art. no. 11234717 / 11234722; to PC: art. no. 11234735 (Ethernet)
Receiver	3-color filter detector (XYZ TRUE COLOR detector, color curve according to CIE1931)
Pulse extension	off by default, typ. 10 ms, adjustable > 30 μs
Signal amplification	5 stages, automatic
Housing material	Aluminum, anodized black
Operating temperature	-10 ... +55 °C
Storage temperature	-10 ... +85 °C
Protection class	IP65

[1] Maximum color distance ΔE of 1000 successive measurements of the color value of a red and a dark gray reference tile (R = 5%), measured with sensor FAR-T-A2.0-2,5-1200-67° at 1000 Hz and brightness adjustment with a white standard (R=95%)
[2] Model: FAR - T - A 2.0 - 2,5 - 1200 - 67° Reflex; Model: FAD - T - A 2.0 - 2,5 - 1200 - 67° Transmitted light



Dimensions:
Dimensions in mm, not to scale



CFO controller

- Compact and robust, direct integration into machine
- Ideal for monitoring of high-speed processes
- High light intensity
- Stable long-term behavior / transmission monitoring

High-quality glass and special fibers for long-life operation

Micro-Epsilon fiber optics feature high processing and transmission quality. Ground and polished end-faces ensure excellent optical integration with adapted sensors. These high-quality, optical glass fibers are extremely robust and ideally suitable for use in harsh ambient conditions.

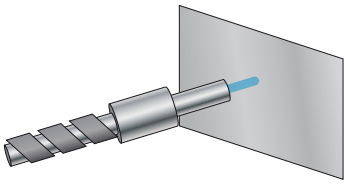
Characteristics

- Temperature resistance from -270 °C to +2000 °C
- Flexible and highly flexible with flux
- Cut and polished surfaces
- Wavelength from 180 nm (UV) to 3500 nm (IR)
- Customer-specific modification even for 1 single piece only

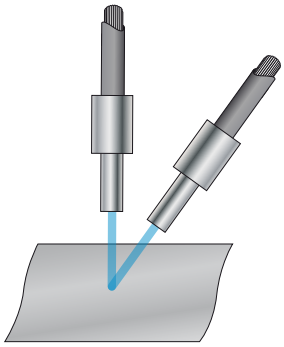
Heads for versatile applications

Functions of the fiber optics

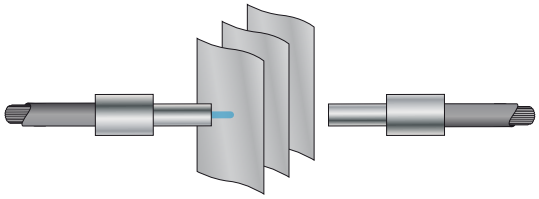
! Application instructions on selecting the appropriate function.



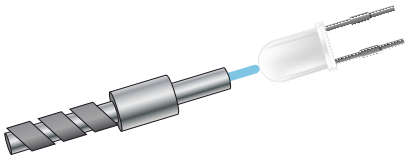
Reflex mode
- Max. measurement distance 200 mm
- Easy and fast installation
- Detection of smallest objects from 0.2 mm
- Color evaluation to determine color, gloss level, gray value, presence
- Ideal for part recognition, sorting tasks, presence monitoring, color tests



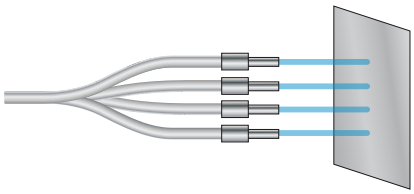
Reflex mode V arrangement
- Max. measurement distance 200 mm (with reflecting surfaces)
- Easy adjustment due to mounting accessories
- Very exact positioning of the detection point
- Immune to dust and particles in the beam path



Transmitted light mode
- Distance between receiving and transmission unit up to 50 mm
- Color recognition of transparent objects
- Arbitrary point of light transmission
- Ideal for part recognition, color tests, sorting tasks, presence monitoring



Receive mode with self-luminous objects
- Max. measurement distance 30 mm
- Recognition of slightest variations in color and intensity
- For color sensor with external illumination
- Ideal for testing LED illumination and self-luminous objects



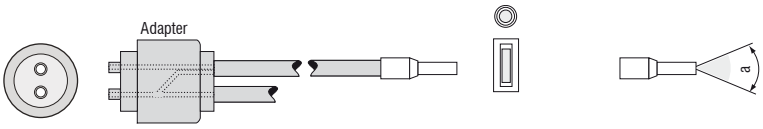
Available on request

Special types for multiple reflex mode
Transmission and receiving fibers are, statistically mixed, guided in two or more separated fiber optics. Therefore, several positions can be detected using only one sensor.

Available on request

Special types for multiple transmitted light mode
The light path of the axially opposing probe head ferrules is interrupted or damped by one or more objects.

Order code for fiber optics



	Function	Sheathing	Probe head	Fiber bundle øF	Total length	Aperture angle
Order code	FA D	T	A 2.0	2,5	1200	67°

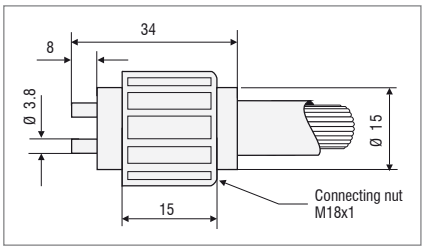
5 Aperture angle of the fiber, 67° (standard)

4 Total length, e.g., 1200 mm

3 Probe head type e.g., A2.0 with fiber bundle Ø 2.5 mm

2 Choose sheathing depending on the ambient conditions, e.g., silicone-metal sheath (T)

1 Function (D = transmitted light mode, R = reflex mode)

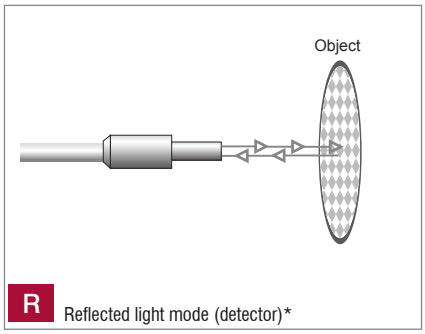


Adapter, FA System FASOP

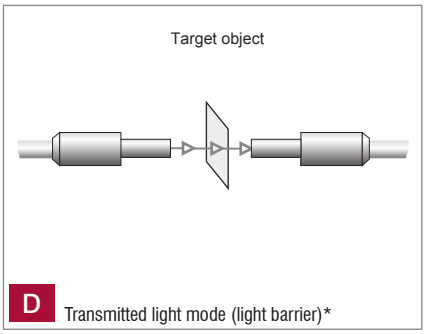
1 Function of the fiber optics

(D = transmitted light mode, R = reflex mode)

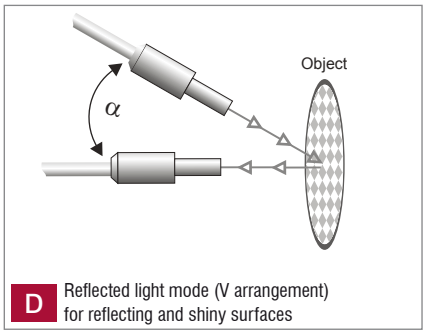
Please define the accessibility of the measuring site and the size of the measurement object in order to specify the function of the fiber optics and the diameter of the glass fiber bundle.



R Reflected light mode (detector)*



D Transmitted light mode (light barrier)*



D Reflected light mode (V arrangement) for reflecting and shiny surfaces

* All functions can also be performed as multiple reflex and transmitted light functions

2 Sheathing

! Please determine the sheathing and the bonding of the fiber optics based on the prevailing environmental conditions and mechanical stress. Please contact us in case of high temperature applications or extreme, mechanical stress.

Silicone-metal sheath
Metal wire-spiral-reinforced hose with glass-fiber braiding and silicone rubber sheathing [1]

Characteristics:
- Very flexible, ideal for frequent bending
- Highly resistant to bending, tension and torsion
- Temperature-stable from -60 °C to +180 °C
- Liquid-tight

T 

VA stainless-steel sheath
Flexible stainless steel wire-spiral-reinforced hose [1]

Characteristics:
- Flexible
- Protection against mechanical stress
- Temperature-stable to 400 °C
- Stainless

E 

Metal sheath
Flexible brass wire-spiral-reinforced hose, chrome-plated [1]

Characteristics:
- Flexible
- Protection against mechanical stress
- Temperature-stable to 300 °C

M 

PVC-metal sheath
Flexible brass spiral-reinforced hose coated with PVC sheathing [1]

Characteristics:
- Flexible
- Protection against mechanical stress such as pressure and tension
- Temperature-stable from -20 °C to +80 °C

Z 

PVC special sheath
Plastic hose [2]

Characteristics:
- For rigid installation
- Small sheath diameter
- Temperature-stable to 80 °C

P 

BOA special sheath
Corrugated tube with stainless steel braiding [2]

Characteristics:
- Protection against mechanical stress
- Ideal for drag-chain applications
- Temperature-stable from -270 °C to +600 °C

BOA 

Special models

Fiber optics with increased vibration protection - VS option

Fiber optics can be manufactured with increased vibration protection for use with mechanical loads such as shock, acceleration, and movement. This special treatment minimizes friction between fibers and reduces shocks. The fibers are embedded into a gel cushion.

Special models

Fiber optics with special bonding for high temperatures

Standard bonding is suitable for maximum temperatures up to 80 °C. Special adhesives allow for temperatures of up to 250 °C and even 400 °C. These higher temperature ranges require the use of Type E stainless steel sheathing. With quartz and sapphire fibers and appropriate adhesive, special fiber optics for use in environments up to 2000 °C can be produced.

[1] Bending radius corresponds to three times the external diameter of the sheath.
[2] Bending radius corresponds to twice the external diameter of the sheath.

Details about sheath diameters can be found in section 3: (probe head types)

3 Probe heads and fiber bundles

!

Please choose a probe head type and ensure that the probe head is compatible with the fiber bundle diameter øF (see 1) and the sheath (see 2).

Standard probe head bonding for -10 °C to +80 °C
Please refer to the technical data for special models (T250, T400).

All details in mm; tolerances: typ. ±0.1 mm
Alu ferrules, black anodized

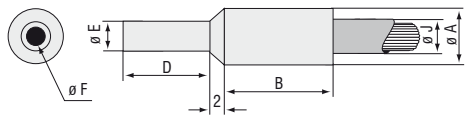
Please contact us if you require other dimensions.

Detection ranges of the probe heads

Fiber bundle ØF mm	Working distance mm	Light spot for 67° fiber approx. Ø mm	Light spot for 22° fiber approx. Ø mm
0.6	5	3	3
	10	5	4
	15	8[1)]	6
	20	12[1)]	8
1	5	3	3
	10	7	5
	15	11	8[1)]
	20	15[1)]	11[1)]
1.5	5	4	3
	10	7	5
	15	11	8
	20	19 [1)]	11
2.5	5	5	4
	10	10	8
	15	13	10
	20	19[1)]	13
3	5	8	5
	10	12	7
	15	15	10
	20	18[1)]	13

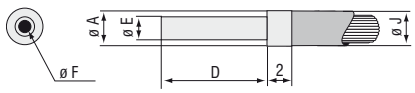
Typical values determined with colorSENSOR CFO200
[1)] Only under certain circumstances

A Type A ferrule, stainless steel



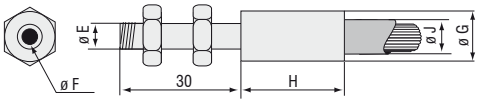
Ø F	Type	Ø A	B	D	Ø E	Ø J P	Ø J M	Ø J T
1.5	A 1.0	4.6	8	11	2.5	4	4	–
1.5	A 1.1	6.6	8	11	2.5	–	5	4.4
2.5	A 2.0	6.6	10	12	4.5	6	6	5.8
3	A 3.0	8.5	11	15	6	7	7	7.5

B Type B ferrule
(only suitable for PVC sheathing)



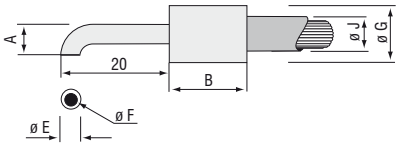
Ø F	Type	Ø A	D	Ø E	Ø J P	Ferrule
0.6	B 1.1	2	30	1	2	Stainless steel
0.6	B 1.2	2	10	1	2	Stainless steel
1	B 2.0	3	10	2	3	Alu
2.5	B 3.0	5	12	4	5	Alu
3	B 4.0	8	12	6	8	Alu

C Type C ferrule, stainless steel



Ø F	Type	E	Ø G	H	Ø J P	Ø J M	Ø J T
1.0	C 1.0	M4	6	13	5	5	4.4
2.5	C 2.0	M6	8	15	6	6	5.8
3	C 3.0	M10	11	12	7	7	7.5

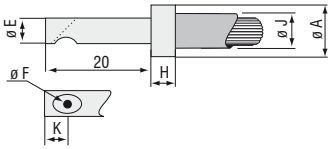
D Type D ferrule, stainless steel
With angular probe heads, a reduction in range can be expected compared to axially emerging versions.



Ø F	Model	Ø A	B	Ø E	Ø G	r	Ø J P	Ø J M	Ø J T
0.6	D 1.0	2.5	10	1	3	1.5	2	–	–
0.6	D 1.1	2.5	13	1	6	1.5	–	–	4.4
1.5	D 2.0	6	13	2	6	4	5	5	4.4
2.5	D 3.0	15	17	5	9	10	7	7	6.5

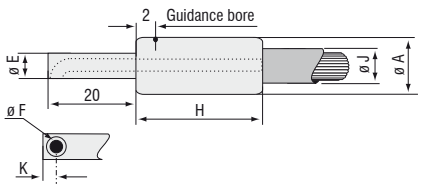
* D1.0 only suitable for PVC sheathing

E Type E ferrule, stainless steel
(* E1.0 only suitable for PVC sheathing)



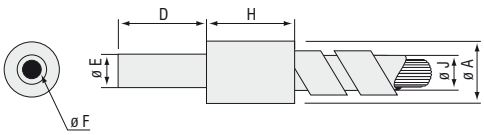
Ø F	Model	Ø A	Ø E	H	K	Ø J P	Ø J M	Ø J T
1.5	E 1.0	4	3	1.5	4	4	–	–
2.5	E 2.0	5	4	1.5	4	5	5	–
2.5	E 2.1	7	4	10	4	–	–	5.8
3	E 3.0	8	6	1.5	5	7	7	–

F Type F ferrule, stainless steel
With angular probe heads, a reduction in range can be expected compared to axially emerging versions.



Ø F	Model	Ø A	Ø E	H	K	Ø J P	Ø J M	Ø J T
1.5	F 1.0	8	6	9	3	5	5	5.8
2.5	F 2.0	10	8	10	4	6	6	6.5
3	F 3.0	12	10	10	5	7	7	7.5

M Type M ferrule, aluminum / stainless steel

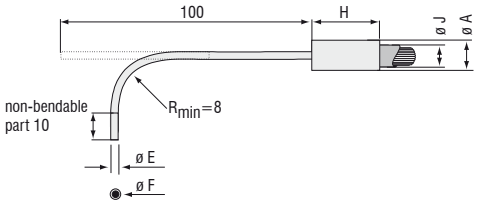


Ø F	Model	Ø A	D	Ø E	H	Ø J M	Ø J T	Ferrule
0.6	M 1.1	6	30	1	10	5	4.4	Stainless steel
0.6	M 1.2	6	10	1	10	5	4.4	Stainless steel
1	M 2.0	6	10	2	10	5	4.4	Alu
2.5	M 3.0	7	12	4	12	6	5.8	Alu
3.5	M 4.0	9	12	6	12	7	7.5	Alu

Larger fiber cross-sections are possible

O Type O ferrule, bendable to a certain extent

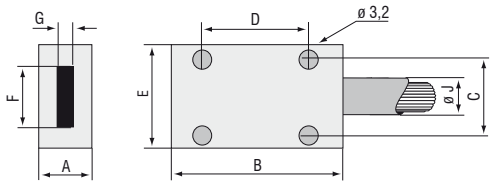
With angular probe heads, a reduction in range can be expected compared to axially emerging versions.



Ø F	Type	Ø A	Ø E	H	Ø J P	Ø J M	Ø J T
0.6	O 1.0	2	1	10	2	–	–
0.6	O 1.1	7	1	20	–	5	4.4
1	O 2.0	3	1.3	10	3	–	–
1	O 2.1	7	1.3	20	–	5	4.4

Q Type Q, aluminum

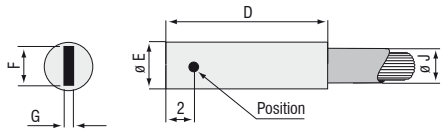
Also available in stainless steel



Model	A	B	C	D	E	F	G	Ø J
Q1	12	25	9	15	15	5	0.5	depends on fiber cross-section
Q2	12	30	14	20	20	10	0.3	
Q3	12	35	24	25	30	18	0.3	
Q4	12	55	34	40	40	28	0.2	
Q5	12	55	44	40	50	38	0.15	
Q6	12	55	54	40	60	48	0.15	
Q7	16	75	64	60	70	58	*	
Q8	16	75	74	60	80	68	*	
Q9	20	90	84	75	90	78	*	
Q10	20	90	94	75	100	88	*	

FxG max. 9.62 mm²
F=3.5 mm as special model
Q7 to Q10 only available as FAR special model

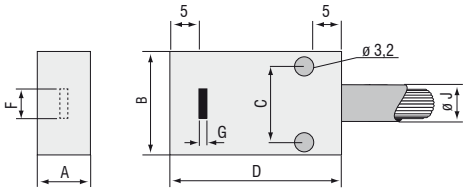
R Type R ferrule, aluminum



Model	D	Ø E	F	G max.	Ø J P	Ø J M	Ø J T
R 1.0*	25	4	3	0.5	3	–	–
R 1.1	30	7	3	0.5	6	6	5.8
R 2.0	25	7	6	1	6	6	5.8**
R 2.1	30	10	6	1	–	7	7.5

* R1.0 and R2.0 only suitable for PVC sheathing
** at 6x1 mm², can be made to a length of 1200

P Type P ferrule, aluminum

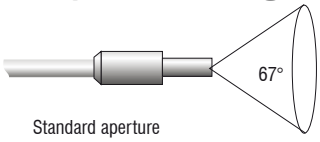


Model	A	B	C	D	F	G	Ø J P	Ø J M	Ø J T
P 1.0	8	15	9	25	3	0.1	4	5	4.4
P 2.1	8	17	11	30	6	0.3	4	6	6.5
P 3.1	12	17	11	30	10	0.5	6	6	6.5

4 Length

Standard lengths are: 600*, 1200*, 1800 and 2400 mm.
*Bearing types
Length tolerance typ.: ±4%
Cable lengths of up to 200 mm can be supplied on request.
The recommended max. cable length for color inspection 2,400 mm.

5 Aperture angle



Standard aperture angle 67°

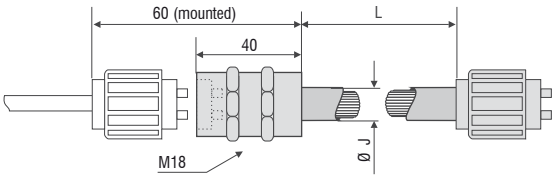
Technical data // Fiber optics		
Length	Standard lengths: 600, 1200, 1800 and 2400 mm, up to 30 m on request	
Aperture angle	Standard fiber	67° (NA 0.56)[1]
	Special fibers on request	22° (NA 0.21/ glass fibers) 80° (NA 0.64/glass fibers) 120° (NA 0.86/glass fibers) 25° (NA 0.22/UV-VIS and VIS-IR quartz fibers) 14° (NA 0.12/UV-VIS and VIS-IR quartz fibers)
Material	Optical glass; quartz glass or sapphire glass on request	
Dielectric strength	50 kV/m with PVC protective sheath	
Probe head Temperature range Fiber bonding	Standard	-10 °C to +80 °C
	T250	-40 °C to +250 °C
	T400	-40 °C to +400 °C
	T600 special model	0 °C to +600 °C
	T2000 special model	0 °C to +2000 °C
Permissible temperature range with sheathing that has appropriate fiber bonding	PVC (Type P / Type Z)	-20 °C to +80 °C
	Metal (type M)	-40 °C to +300 °C
	Metal with special bonding (Type E)	-40 °C to +400 °C
	Metal/silicone (Type T)	-60 °C to +180 °C
	Corrugated tube with stainless steel braiding (type BOA)	-270 °C to +600 °C
Fiber transmission	Different types for wavelengths from UV 180 nm to IR 3500 nm. We can provide the most suitable solution depending on your requirements. Transmission curves on request.	
Vibration protection	Increased vibration protection (VS option)	

[1] Fiber transmission with standard fiber 390 - 1390 nm

Extensions / feed-through

For extension or feed-through of the fiber optics please use the Type LV ferrule.

LV **Type LV ferrule**
Fiber optic extension / feed-through



Fiber bundle Ø	P	Ø J M	T	L
(3 mm)/ channel	12	13	13.5	variable

Available on request

Pressure-proof feed-through up to 10 bar [2] [3]
Housing feed-through
Adapter for optical fiber FA on FA
Suitable for use in vacuum
Suitable for use with drag cable
Vibration protection
Tomography
Single-channel
Multi-channel
Adaption for C-mount lenses
Special fiber optics according to customer requirements/drawing

[2] In combination with FAD-X-FAD adapter for optical fiber
[3] Also suitable for use in vacuum up to 10^{-5}

KL-xx/xx series

- Focusing of color and fiber optic sensors

- Improving the efficiency of the application

- Many possible applications

Features:

- Working distances from 8 mm to 200 mm
- Scratch-resistant glass lens
- Robust aluminum housing (black anodized)
- Bundling to a small light spot
- Extension of the range with C-mount lens to a distance > 300 mm
- Minimum color change when the distance is altered
- High luminous efficiency
- Special designs according to customer requirements
- Color measurement on small objects at a relatively large distance (Kl-3, KL-4)
- Recognition of highly absorbent objects (KL-5, KL-14, KL-17)

	Probe head type	Article number	Object distance (typ.)	Detection range (typ.)*	Dimensions
	KL-3-A2.0 [3]	10823012	8 mm - 20 mm	Ø 1 mm - 5 mm Ø 1 mm with 10 mm	L x Ø approx. 60 mm x 15 mm
	KL-M18-A2.0 [1]	10823020	20 mm - 50 mm	Ø 3 mm - 10 mm Ø 3 mm with 20 mm	L x Ø approx. 51 mm x M18 x 1
	KL-M18-XL-A2.0 [1]	10824358	Pos1 50 - 120 mm Pos2 10 - 180 mm Pos3 10 - 160 mm	Pos1 Ø 4-7 mm Ø 4 mm with 80 mm Pos2 Ø 7-11 mm Ø 7 mm with 110 mm Pos3 Ø 7-11 mm Ø 7 mm with 120 mm	L x Ø approx. 90 mm x M18x1 (L=50 mm)
	KL-M34-A2.0 [1]	10823278	100 mm - 180 mm	Ø 15 mm - 18 mm Ø 15 mm with 100 mm	L x Ø approx. 85 mm x M34 x 1.5
	KL-M34/62-A2.0 [1]	10824196	80 mm - 200 mm	Ø 3 mm - 5 mm Ø 3 mm with 120 mm	L x Ø approx. 170 mm x 62 mm
	KL-4-A1.1 [1]	10823262	8 mm - 20 mm	Ø 0.6 mm - 3 mm Ø 0.6 mm with 10 mm	L x Ø approx. 60 mm x 15 mm
	KL-M18-A1.1 [1]	10824140	10 mm - 50 mm	Ø 2 mm - 7 mm Ø 2 mm with 10 mm	L x Ø approx. 51 mm x M18 x 1
	KL-D-40-A2.0 [2]	10824143	15 mm - 25 mm	Ø 3 mm - 6 mm Ø 3 mm with 15 mm	L x W x H approx. 43.4 x 49.5 x 12 mm
	KL-D-28-A2.0 [2]	10824197	20 mm - 30 mm	Ø 5 mm - 8 mm Ø 5 mm with 20 mm	L x W x H approx. 31.7 x 40.5 x 15 mm
	KL-D-20-A2.0 [2]	10823021	10 mm - 50 mm	Ø 4 mm - 10 mm Ø 4 mm with 10 mm	L x W x H approx. 21.4 x 33 x 12 mm
	KL-D-17-A2.0 [2]	10823220	30 mm - 80 mm	Ø 8 mm - 25 mm Ø 8 mm with 30 mm	L x W x H approx. 36.5 x 25.5 x 15 mm
	KL-D-14-A2.0 [2]	10823022	60 mm - 120 mm	Ø 10 mm - 20 mm Ø 10 mm with 60 mm	L x W x H approx. 37 x 50 x 20 mm
	KL-D-6-A2.0 [2]	10823409	100 mm - 200 mm	Ø 15 mm - 30 mm Ø 15 mm with 100 mm	L x W x H approx. 31.1 x 45.1 x 20 mm
	KL-5-R1.1 [1]	10824198	8 mm - 20 mm	2 x 0.3 mm up to 15 x 3 mm 2 x 0.3 mm with 10 mm	L x Ø approx. 60 mm x 15 mm
	KL-8-R2.1 [1]	10823920	8 mm - 20 mm	4 x 0.7 mm up to 30 x 5 mm 4 x 0.7 mm with 10 mm	L x Ø approx. 60 mm x 15 mm

*The smallest figure in the table relates to the smallest typical optical diameter that is generated.
This corresponds roughly to the smallest detection area for color or fiber optic sensors.

[1] Reflected-light optical fiber (FAR)

[2] Transmitted-light optical fiber (FAD)

[3] Possible with FAR-X-A2.0-0,6-XXXX-67° reflected-light optical fiber (spot size of approx. 0.2 mm)

CFS2-Mxx Circular sensor

- *Color inspection from a large distance on inhomogeneous, strongly structured and shiny-metallic surfaces*
- *For colorSENSOR with FA connection*
- *Homogeneous ring illumination reduces glossy effects*
- *Recognition of color and gray scales*

Features:

- Transmission, homogeneous distribution and focusing of the white light LEDs of the colorSENSOR connected
- Object distance typ. 10 mm - 100 mm
- Very high color accuracy due to homogeneous illumination of the target
- Combination with CFO series for high performance ($\Delta E_{rel} \leq 0.5$ - CFO100 / $\Delta E_{rel} \leq 0.3$ - CFO200)
- External controller as space-saving benefit

Application examples:

- Improved color recognition on mat, structured and/ or shiny surfaces from a distance up to 100 mm
- Detection of color rings
- Color mark recognition in printing industry
- Packaging control
- Color sorting tasks
- Color control of self-luminous objects (LEDs, displays, etc.)
- Paper inspection
- Inspection of car attachments
- Paint inspection
- Inspection of wood/floor coverings

The circular sensor opens up new fields of application for the colorSENSOR CFO product series. Combined with the high performance of the CFO series, the ring illumination even more precision due to uniform illumination. This compact combination can be universally used but is also suitable for special solutions (customer-specific adaptions). The homogeneous illumination mainly offers advantages on strongly structured or shiny-metallic surfaces while providing highest precision when distinguishing colors such as white shades. Due to the standard FA connection, the fiber optics is also compatible with other controllers.

The circular sensor offers many advantages in terms of performance and installation possibilities. The external controller is a space-saving benefit here.

Model	CFS2-M11	CFS2-M20
Article number	10814900	10814895
Object distance	typ. 10 ... 100 mm ideal distance 30 mm	
Light spot diameter	Ø 12 … 114 mm	Ø 10 … 66 mm
Adjustment with 100 mm object distance [1) 2)]	10%	15%
Repeatability [1)]	ΔE ≤ 0.3	
Repeatability in rotation [1) 3)]	ΔE ≤ 0.95	ΔE ≤ 1.1
Color distance [1)]	ΔE ≤ 0.6	
Type of illumination	Ring illumination	
Length of fiber optics	standard 1.2 m - optionally all lengths (see catalog p. 20)	
Bending radius	> 30 mm	
Material	optical glass fiber bundle; quartz glass; housing: black anodized aluminum	
Dimensions of sensor head	Ø 11.5 mm x 33 mm	
Temperature range	Probe head: -10 … +80 °C; T-sheath: -20 … +80 °C; others available on request (see catalog from p. 18)	

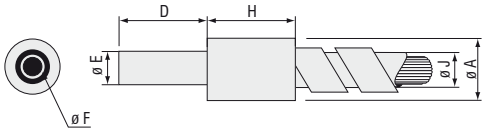
[1)] With CFO200
[2)] On white reference zenith
[3)] On titanium pearl mica from a distance of 30 mm

Detection ranges of the probe heads / Circular sensor

Fiber bundle ØF mm	Working distance in mm	Light spot for 67° fiber approx. Ø mm	Light spot for 22° fiber approx. Ø mm
1.5	10	12	-
	30	34	-
	60	68	-
	100	114 [1)]	-
2.5	10	-	10
	30	-	20
	60	-	38
	100	-	66 [1)]

[1)] Only possible under certain circumstances, received signal < 15 %

M Type M, aluminum



Ø F	Model	Ø A	D	Ø E	H	Ø J T	Aperture angle	Ferrule
1.5	M11	11.5	15.8	7	17	9	67°	Alu
2.5	M20	11.5	15.8	7	17	9	22°	Alu

Larger fiber cross-sections are possible

colorSENSOR OT-3-LD

- *Color sensor for large distances*
- *31 colors can be saved*
- *Coaxial lens for large working distances up to 900mm*
- *Color and gray scale evaluation*
- *PC programming via RS232*

Features:

- Object distance typ. 50 mm - 900 mm
- Integrated transmitter and receiving optics (coaxial)
- Color memory: 31 colors per Teach-in and software
- RS232 interface (optional USB adapter)
- Super bright white light LED
- Color, contrast and gray-scale detection
- Switchable brightness readjustment
- Max. switching frequency: 35 kHz
- Different evaluation algorithms can be activated e.g., "BEST HIT" mode
- Switching state display via 5 yellow LEDs
- Temperature compensation (<0.01% / K)
- Switchable averaging function
- Color control of self-luminous objects

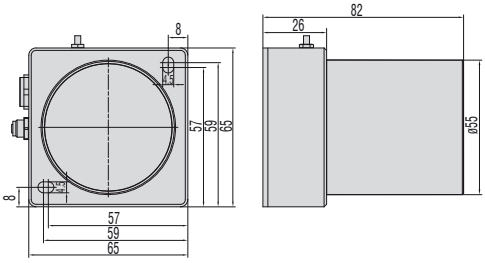
Application examples:

- Color recognition from a large distance up to 900 mm
- Correct product positioning in production machines
- Packaging control
- Color sorting tasks
- Color assignment with cars
- Detection of bottle crates
- Paper recycling recognition
- Illumination recognition as per color and intensity

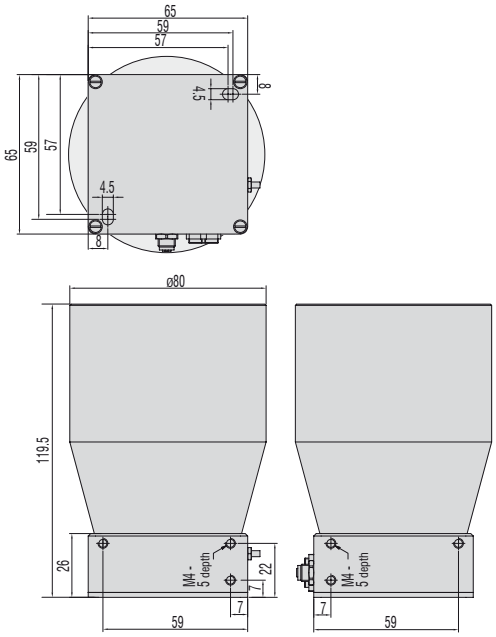
Dimensions:

Dimensions in mm, not to scale

OT-3-LD-200



OT-3-LD-500



Model	OT-3-LD-200-6	OT-3-LD-200-12	OT-3-LD-200-26	OT-3-LD-500-23	OT-3-LD-500-50
Article number	10234434	10234437	10234438	10234085	10234086
Object distance	typ. 100 - 700 mm ideal distance 200 mm	typ. 50 - 500 mm ideal distance 200 mm	typ. 50 - 500 mm ideal distance 200 mm	typ. 100 - 900 mm ideal distance 500 mm	typ. 100 - 900 mm ideal distance 500 mm
Light spot	Ø 4 - 28 mm	Ø 4 - 32 mm	Ø 6 - 70 mm	Ø 6 - 46 mm	Ø 8 - 105 mm
Light spot diameter	Ø 6 mm with 200 mm	Ø 12 mm with 200 mm	Ø 26 mm with 200 mm	Ø 25 mm with 500 mm	Ø 58 mm with 500 mm
Repeatability [1]	ΔE ≤ 0.9			ΔE ≤ 1.5	
Color distance	ΔE ≤ 1.8			ΔE ≤ 3.0	
Color spaces	X/Y INT; s/i M (Lab)				
Averaging	over a maximum of 32768 values				
Size of color memory	max. 31 colors in non-volatile EEPROM with parameter sets				
Switching frequency	max. 35 kHz (depending on number of colors learned and setting for averaging)				
Temperature drift X,Y	< 0.01 % / K				
Light source	ultra-bright white light LED, AC/DC/PULSE modes (adjustable or OFF for self-luminous objects, switchable via software) [2]				
Type of illumination	coaxial				
Effect from illumination	large object distance				
Ambient light	up to 5000 Lux (in AC and PULSE modes)				
Alternating light operation	AC: typ. up to 20 kHz (depending on amplification level AMP1 to AMP8) DC: typ. up to 35 kHz PULSE: typ. switchable by PC software up to 5 kHz				
Power supply	+24 VDC (± 10 %), reverse polarity protection, overload-proof				
Power consumption	typ. 160 mA				
Max. switching current	100 mA, short circuit proof				
TEACH key/inputs	1 key and IN0 for external teaching of the color references				
Outputs	OUT0 - OUT4, digital (0V/+Ub), short circuit proof, 100 mA max. switching current npn/pnp capable (switchable light/dark switching)				
Switching state display	visualization with 5 yellow LEDs				
Interface	RS232 (optional USB)				
Type of connector	to PLC: 8-pole flange socket (Binder series 712) to PC: 4-pole flange socket (Binder series 707)				
Connection cable	power/PLC: art.no. 11234091 / PC: art.no. 11234095 (RS232); 11234096 (USB)				
Receiver	3-color filter detector (XYZ TRUE COLOR Detector, color filter curve according to CIE1931)				
Software	colorCONTROL S				
Pulse extension	adjustable from 0ms to 100ms				
Signal amplification	8 stages (AMP1 - AMP8), adjustable				
Housing material	Aluminum, anodized black				
Operating temperature	-20 ... +55 °C				
Storage temperature	-20 ... +85 °C				
Protection class	IP67 (lens), IP64 (electronics)				
EMC test according to	DIN EN60947-5-2				

[1] Maximum color distance ΔE of 250 successive measurements of the color value of a light gray reference tile (R = 61%), measured with sensor FAR-T-A2.0-2,5-1200-67° at 1000 Hz and brightness adjustment with a white standard (R=95%)

[2] Suitable for illumination testing

colorCONTROL MFA

- Multipoint color recognition system

- Optionally with up to 495 channels

- Color inspection in HSI and RGB color spaces

- Color differentiation/intensity tests/ function tests

Features:
- Versatile coupling possibilities for fiber optics
- Individual configuration of fiber optics
- Each measuring position is freely configurable in terms of color, intensity and function
- Integration into testing process
- Good/bad evaluation
- Output of HSI, RGB and xy values via RS232 or USB
- External trigger
- Exchangeable adapter for fiber optics
- Suitable for POF (2 m) and optical glass fiber optics up to 5 m
- MFA-5 can be extended to 20 testing points using different assembly kits

Applications:
- Testing self-luminous objects
- LED tests (binning)
- Indication tests
- Display tests
- Seven-segment display tests
- Parallel and simultaneous inspection of up to 495 channels ≤ 1 s
- Front panel tests
- With external illumination, multipoint color testing is possible

Function:
The information about color, intensity and light are directly transmitted from the measuring object to the MFA sensor via single fiber bundles and evaluated at up to 20 points at the same time.
The inspection of inaccessible specimens and/or specimens situated far apart from one another can easily be achieved using the MFA series, as optical fibers transmit the information to the evaluation unit.

Using the colorCONTROL MFA-5-M expansion module, the colorCONTROL MFA-5 can be extended by 5 testing points to 20 testing points. Additionally, one of the assembly kits is required depending on the construction depths (see accessories). For example: 20 testing points require: 1x colorCONTROL MFA-5 + 3x colorCONTROL MFA-5-M + 1x assembly kit MFA-20.

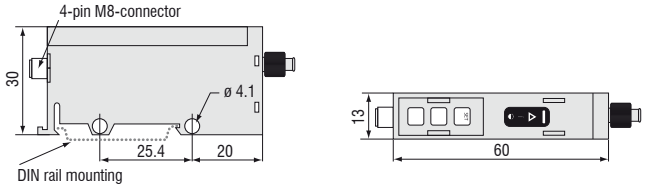
The colorCONTROL MFA-5-P board model is delivered without protection housing and can be interconnected with other MFA-5-P sensors. Here it is possible to switch up to 99 MFA-5-P sensors in series and to test 495 channels simultaneously.

Model	MFA-1	MFA-5	MFA-5-M [1]	MFA-5-P [2]
Article number	11094302	11094050	11094051	11094052
Detection points	1	5	extension of MFA-5 by 5 each	5
Test spectrum	480 – 1000 nm	450 – 650 nm		
Supply voltage	10 ... 30 VDC	24 V DC +/- 10 % residual ripple	24 VDC via MFA-5	5 VDC
Current consumption	100 mA	80 mA - 320 mA	160 - 320 mA	80 mA
Interface	-	RS232, USB, Daisy Chain	Daisy Chain	RS232, USB, Daisy Chain
Inputs	1 external teach input	-	-	-
Outputs	1 switching output NPN/PNP	-	-	-
	-	-	-	-
	-	-	-	-
Photo receiver	1 x b/w photodiode	5x True Color photo chip		
Accuracy	± 5 %	±4nm		
Resolution	-	9 - 81 pixels / detection point		
Data memory	EEPROM	-	-	-
Object distance	typ. 1 - 5 mm			
Optical fiber (length)	incl. POF ø2.2 mm [3] x 1 m; max. POF 2 m / glass 5 m	incl. POF ø2.2 mm [3] x 0.5 m; max. POF 2 m / glass 5 m		
Color space	-	HSI, RGB, xy + color temperature in K		
Dynamic range	200 lx - 4000 lx			
Testing frequency	≤ 5 Hz	≤ 1 Hz (100 detection points ≤1 s)		
Operating temperature	0 ... +60 °C	0 ... +50 °C		
Humidity	20% to 80% rel. humidity (non-condensing)			
Protection class	IP65	IP50	IP50	IP0

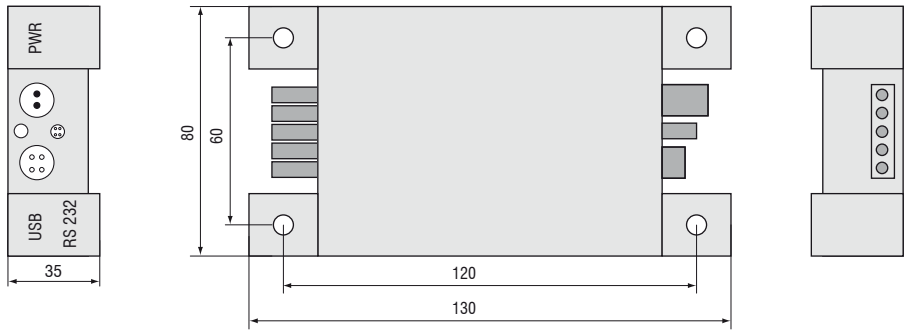
[1] Modular expansion to 10/15/20 measuring positions
[2] Modular expandable to 495 channels (99 pieces in series connection)
[3] Reduction to ø1.0 mm is possible with reducing adapter

Dimensions:
Dimensions in mm, not to scale

MFA-1



MFA-5

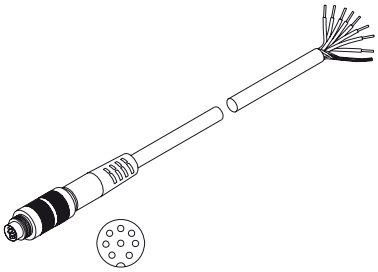


colorSENSOR Accessory		
Art. No.	Description	suitable for:
11234717	CAB-M12-8P-fm-co-straight; 2m-PUR; open ends	colorSENSOR CFO (SYS; power and PLC)
11234718	CAB-M12-8P-fm-co-straight; 5m-PUR; open ends	colorSENSOR CFO (SYS; power and PLC)
11234722	CAB-M12-8P-co-straight; 2m-PUR; open ends	colorSENSOR CFO200 (digital I/O; PLC)
11234723	CAB-M12-8P-co-straight; 5m-PUR; open ends	colorSENSOR CFO200 (digital I/O; PLC)
11234735	CAB-M12-4P-co-straight; 2m-PUR-Cat5e; RJ45-Eth	colorSENSOR CFO (Ethernet)
11234736	CAB-M12-4P-co-straight; 5m-PUR-Cat5e; RJ45-Eth	colorSENSOR CFO (Ethernet)
11234713	CFO mounting adapter	colorSENSOR CFO
11234762	CFO DIN rail mounting kit	colorSENSOR CFO
11234763	CFO DIN rail mounting adapter	colorSENSOR CFO
11234091	CAB-M9-8P-co-straight; 2m-PUR; open ends	colorSENSOR OT (power and PLC)
11234099	CAB-M9-8P-co-straight; 5m-PUR; open ends	colorSENSOR OT (power and PLC)
11234095	CAB-M5-4P-co-straight; 2m-PUR; RS232	colorSENSOR OT (RS232)
11234103	CAB-M5-4P-co-straight; 5m-PUR; RS232	colorSENSOR OT (RS232)
11234096	CAB-M5-4P-co-straight; 2m-PVC; USB	incl. RS232/USB converter suitable for: colorSENSOR OT (USB)
11234104	CAB-M5-4P-co-straight; 5m-PVC; USB	incl. RS232/USB converter suitable for: colorSENSOR OT (USB)
11234368	CAB-M5-4P-co-straight; 2m-PVC; RJ45-fm-Eth	incl. RS232/Ethernet converter suitable for: colorSENSOR OT (Ethernet)
11234694	White standard 30 mm zenith	colorSENSOR and colorCONTROL
11234695	White standard 30 mm zenith calibrated	colorSENSOR and colorCONTROL
2420065	PS2030 power supply 24V/24W/ 1A; 2m-PVC; terminal-2P-co-fm-straight	Power supply of all sensors with 24 VDC

colorCONTROL MFA Accessory		
Art. No.	Description	suitable for:
10814105	POF-2.2 mm fiber optics	colorCONTROL MFA
11251112	Fiber-optic thread fitting; M4	POF-2,2
11251113	Mountable lens 6 mm	Fiber-optic thread fitting; M4
11253931	Fiber-optic thread fitting; 3 mm lens; M4	POF-2,2
11254108	Fiber-optic thread fitting; 90° lens, M5	POF-2,2
11253959	Reducing adapter 2.2/1 mm POF; 2 pc.	colorCONTROL MFA for use of POF-1 mm
10813842	POF-1mm fiber optics	colorCONTROL MFA in connection with the reducing adapter 2.2/1 mm POF
11253906	Guide sleeve 1 mm	POF-1 mm
10824431	Guide sleeve 1 mm x 50 mm	POF-1 mm
11234305	CAB-M8-4P-fm-co-straight; 2m-PUR; open ends	colorCONTROL MFA-1 (power and PLC)
11234306	CAB-M8-4P-fm-co-straight; 5m-PUR; open ends	colorCONTROL MFA-1 (power and PLC)
11294205	CAB-M9-2P-fm-co-straight; 2m-PUR; open ends	colorCONTROL MFA-5 (power)
11294206	CAB-M9-2P-fm-co-straight; 5m-PUR; open ends	colorCONTROL MFA-5 (power)
11234094	CAB-M9-4P-co-straight; 2m-PVC; USB	colorCONTROL MFA-5 (USB)
11234102	CAB-M9-4P-co-straight; 5m-PVC; USB	colorCONTROL MFA-5 (USB)
11234095	CAB-M5-4P-co-straight; 2m-PUR; RS232	colorCONTROL MFA-5 (RS232)
11234103	CAB-M5-4P-co-straight; 5m-PUR; RS232	colorCONTROL MFA-5 (RS232)
11294243	Assembly kit MFA-10	colorCONTROL MFA-5 + MFA-5-M
11294244	Assembly kit MFA-15	colorCONTROL MFA-5 + 2 x MFA-5-M
11294245	Assembly kit MFA-20	colorCONTROL MFA-5 + 3 x MFA-5-M
11294203	CAB-socket board-6P-co-fm-straight; 2m-PVC; 2P-open ends	colorCONTROL MFA-5-P (power)
11294054	CAB-socket board-6P-co-fm-straight; 1m-PVC; USB	colorCONTROL MFA-5-P (USB and power)
11294204	CAB-socket board-4P-co-fm-straight; 2.5m-PVC; RS232	colorCONTROL MFA-5-P (RS232)

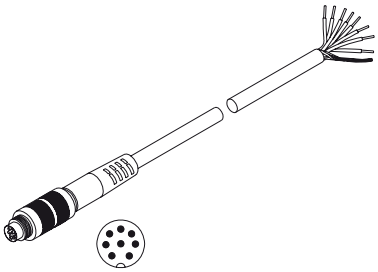
Pin assignment

CAB-M12-8P-co-fm-straight; Xm-PUR; open ends
(Art.-No.: 11234717; 11234718)
Connection cable SYS; Power and PLC
(max. length 10 m, PUR sheath)



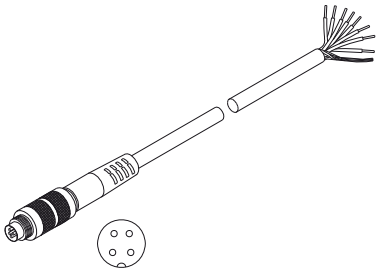
Pin	Color	CFO100/200
1	white	IN0
2	brown	+UB
3	green	TX
4	yellow	RX
5	gray	OUT0
6	pink	OUT1
7	blue	GND
8	red	OUT2

CAB-M9-8P-co-straight; Xm-PUR; open ends
(Art.-No.: 11234091; 11234098)
Connection cable to power/PLC or digital I/O
(max. length 10 m, PUR sheath)



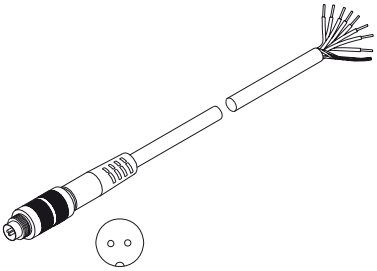
Pin	Color	OT-3-LD
1	white	GND (0V)
2	brown	+24 VDC (± 10%)
3	green	IN0
4	yellow	OUT0
5	gray	OUT1
6	pink	OUT2
7	blue	OUT3
8	red	OUT4

CAB-M8-4P-fm-co-straight; Xm-PUR; open ends
(Art.-No.: 11234305; 11234306)
Connection cable to Power/PLC
(max. length. 5 m, PUR sheath)



Pin	Color	MFA-1
1	brown	+ 24VDC
2	white	External Teach
3	blue	GND
4	black	NPN/PNP

CAB-M9-2P-co-fm-Straight; Xm-PUR; open ends
(Art.-No.: 11294205; 11294206)
Connection cable Power
(max. length 10 m, PUR sheath)



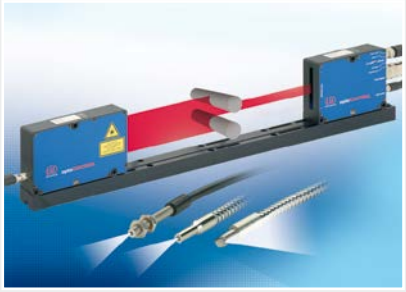
Pin	Color	MFA-5
1	white	+24 VDC
2	brown	GND

Sensors and Systems from Micro-Epsilon

Sensors and systems for displacement, distance and position

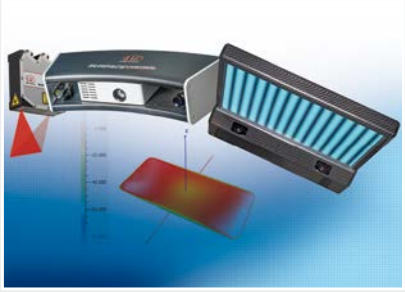
Sensors and measurement devices for non-contact temperature measurement

Measuring and inspection systems for metal strips, plastics and rubber



Optical micrometers and fiber optics, measuring and test amplifiers

Color recognition sensors, LED analyzers and inline color spectrometers



3D measurement technology for dimensional testing and surface inspection

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