



More Precision

colorSENSOR // Colors sensors, LED Analyzers





Micro-Epsilon Eltrotec has 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, and do so 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 and LT series provide 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

Basics and selection criteria

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Universal color sensors

Model	Teach-in via keys	Software teach	Repeatability	Page
colorSENSOR CFO100	6	6 colors	$\Delta E \leq 0.5$	8 - 9
colorSENSOR CFO200	254	254 colors	$\Delta E \leq 0.3$	10 - 11
colorSENSOR LT-2-DU	8	255 colors	$\Delta E \leq 0.8$	12 - 13

Color sensors for special targets

Modell	Description	Repeatability	Page
colorSENSOR OT-3-MA	Color control from a large distance for mat surfaces	$\Delta E \leq 0.9$	24 - 25
colorSENSOR OT-3-GL	Color control on non-homogeneous and shiny surfaces	$\Delta E \leq 0.9$	26 - 27
colorSENSOR OT-3-HR	Color control on reflective and textured surfaces	$\Delta E \leq 0.9$	28 - 29
colorSENSOR OT-3-LD	Color control from a very large distance	$\Delta E \leq 0.9$	30 - 31

Quality inspection of LEDs and illumination

Model	Description	Detection points	Page
colorSENSOR CFO100	LED tests of function, color and intensity	1	8 - 9
colorSENSOR LT-2-DU	LED tests of function, color and intensity	2	12 - 13
colorSENSOR OT-3-MA	Testing LED lamps and illumination acc. to function, color and intensity	1	24 - 25
colorSENSOR OT-3-LD	Testing LED lamps and illumination acc. to function, color and intensity from a large distance	1	30 - 31
colorCONTROL MFA	LED tests for function, color and intensity	1/5/10/15/20	32 - 33

Accessories

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Fiber optics
Cables
Pin assignment of cables (power supply)
14 - 21
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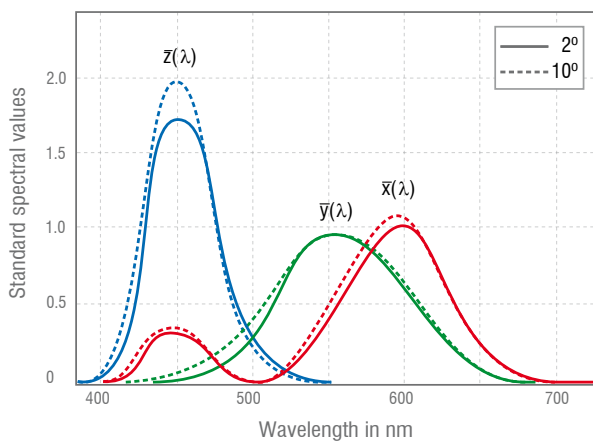
Color assessment based on:

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

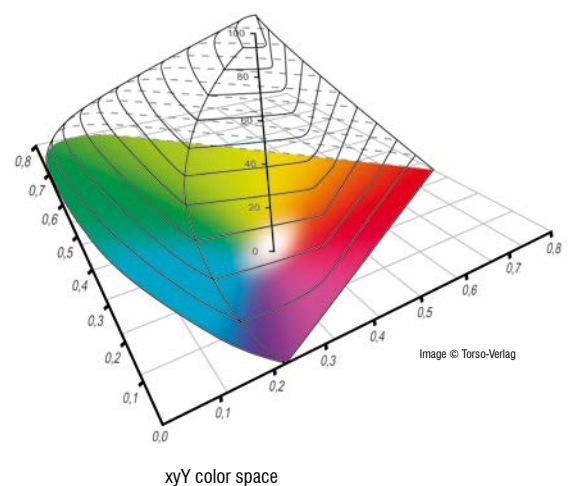
Y = value (brightness) scaled from 0 to 100

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.



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.

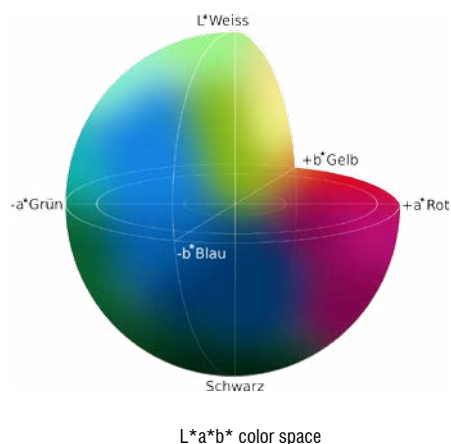
Each color is described by the color location (L*; a*; b*).

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.*



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)

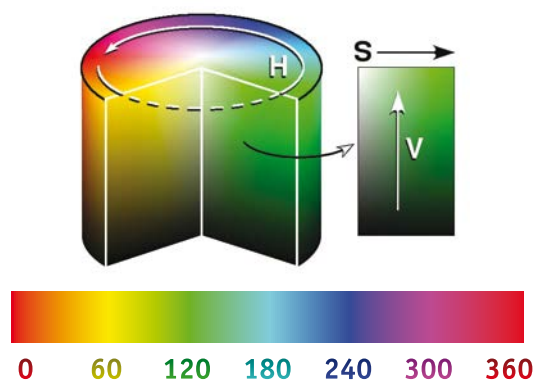
H = Hue (red = 0°; green = 120°; blue = 240°)

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)

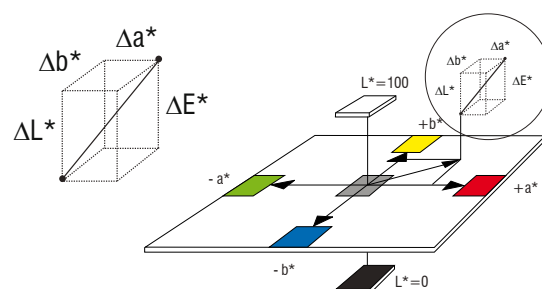
$$\Delta E = \sqrt{(L_p^* - L_v^*)^2 + (a_p^* - a_v^*)^2 + (b_p^* - b_v^*)^2}$$

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:

- $\Delta E > 5$ Large color difference
- $\Delta E 0.5 \dots 1$ Limits of human perception
- $\Delta E < 0.3$ Required by the paper industry
- $\Delta E < 0.1$ Required by the automotive industry



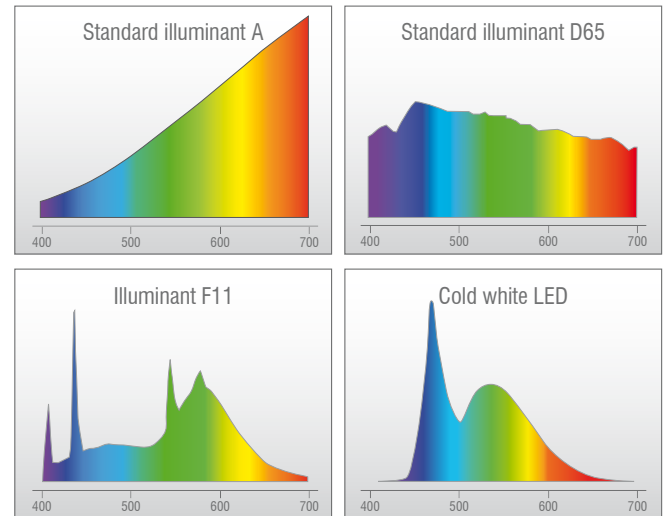
Sample (p)

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**



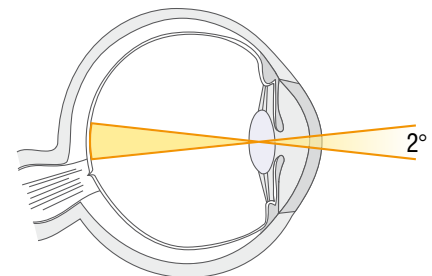
Standard observer

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

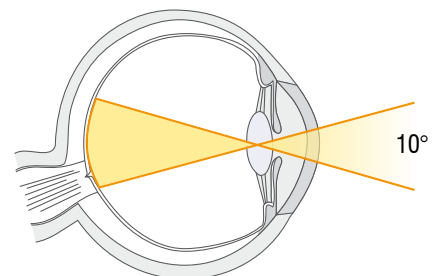
At the end of an outstretched arm, an object the size of a thumbnail has an aperture angle of approx. 2°.



10° standard observer (1964)

- Distance 30 cm = 5 cm visual field (standard practice)
- Focus onto large area of retina (macula of retina + edges)
- Good correspondence with 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	LT-2-DU	
No. of color memories		6	254	255 (2x15)	
Repeatability		$\Delta E \leq 0.5$	$\Delta E \leq 0.3$	$\Delta E \leq 0.8$	
Detection distance		2 - 100 mm	2 - 200 mm	2 - 200 mm	
Light spot Ø		0.6 - 20 mm	0.6 - 30 mm	0.6 - 30 mm	
Fiber optics + lens		•	•	•	
TEACH-IN		•	•	•	
Teach-in via keys		6	254	8 (2x4)	
Software		•	•	•	
Software teach		6 (256)	254 (>320)	255	
RS232 interface		•	•	•	
USB interface			•	•	
Ethernet interface		•	•		
Application properties	Mat surfaces	•	•	•	
	Shiny surfaces	¹⁾	¹⁾	¹⁾	
	Reflecting surfaces				
	Textured surfaces				
	High temperatures up to 400°C	•	•	•	
	Fluorescent surfaces				
	Large working distance				
LED test		•	•	•	
Page		8 - 9	10 - 11	12 - 13	

¹⁾ only to a limited extent with focus lens KL-D-XX

colorSENSOR with fixed lens		OT-3-MA	OT-3-GL	OT-3-HR	OT-3-LD
No. of color memories		31	31	31	31
Repeatability		$\Delta E \leq 0.9$	$\Delta E \leq 0.9$	$\Delta E \leq 0.9$	$\Delta E \leq 0.9$
Detection distance		10 - 400 mm	10 - 300 mm	10 - 300 mm	200 - 800 mm
Light spot Ø		4 - 50 mm	4 - 50 mm	4 - 50 mm	20 - 80 mm
Fiber optics + lens					
TEACH-IN		•	•	•	•
Teach-in via keys (colors)		31	31	31	31
Software		•	•	•	•
Software teach (colors)		31	31	31	31
RS232 interface		•	•	•	•
USB interface					
Application properties	Mat surfaces	•	•	•	•
	Shiny surfaces		•	•	
	Reflecting surfaces			•	
	Textured surfaces		•	•	
	High temperatures up to 400 °C				
	Fluorescent surfaces				
	Large working distance				•
LED test		•	•	•	•
Page		24 - 25	26 - 27	28 - 29	30 - 31



- 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
- Sturdy 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 for 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 fiber optics, 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.

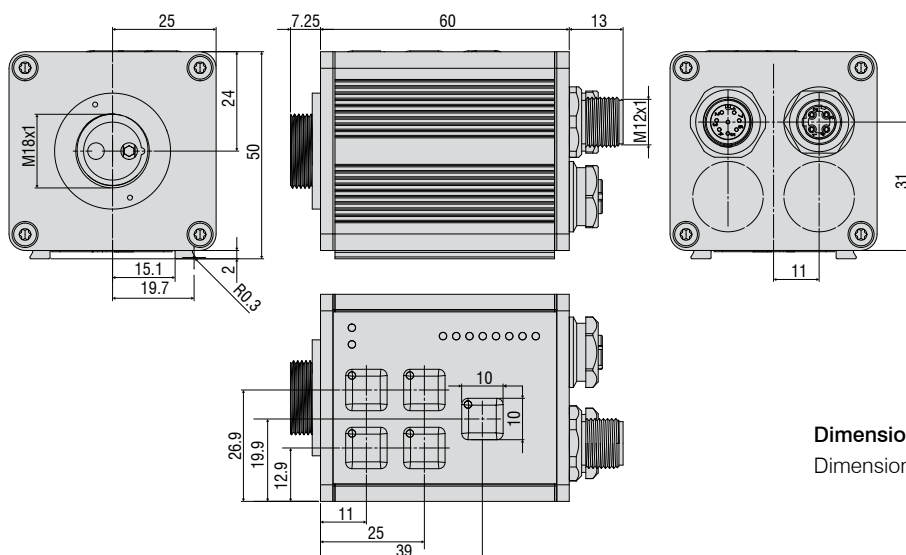
If the sensor recognizes one of the taught colors, the switching state changes via three digital outputs. Binary output switching provides cable breakage protection and enables output of up to 6 color groups.

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	depending on the fiber optics used as well as front lens attachment 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 ¹⁾
Repeatability ¹⁾	$\Delta E \leq 0.5$
Color distance	$\Delta E \leq 1.0$
Color spaces	XYZ, xyY, L*a*b*, L*u*v*, u'vL*
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
Measuring 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
Outputs	OUT 0 - OUT 2, digital (0 V/+U _b), 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. 10 ms, adjustable > 30 μ s
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-A2.0-2.5-1200-67° Reflex; Model: FAD-T-A2.0-2.5-1200-67° Transmitted light



Dimensions:

Dimensions in mm, not to scale



- *More than 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
- Sturdy aluminum housing
- Measurement frequency up to 20 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 fiber optics, 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 more than 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.

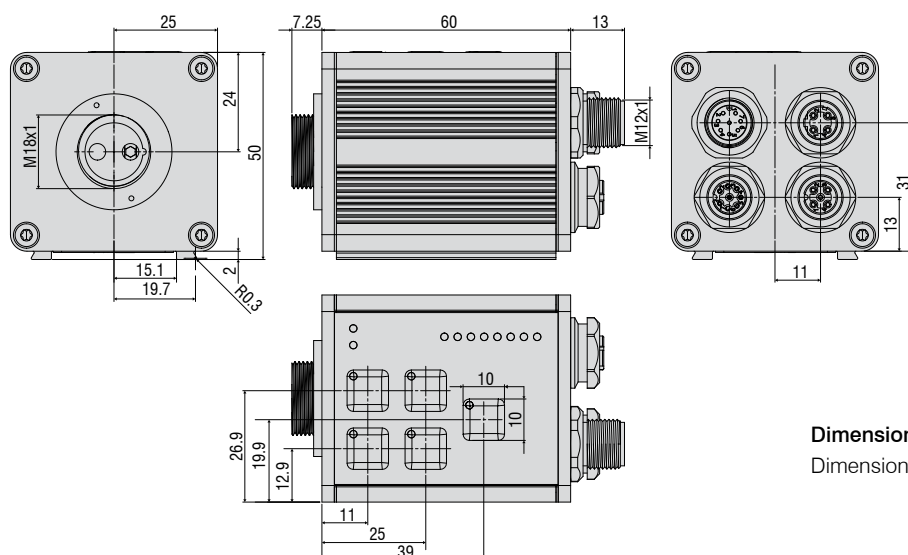
If the sensor recognizes one of the taught colors, the switching state changes via 8 digital outputs. Binary output switching provides cable breakage protection and enables output of up to 254 color groups.

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'vL*
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
Measuring frequency	standard 1 kHz; max. 20 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. 20 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
Outputs	OUT 0 - OUT 7, digital (0 V/+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 μ s
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-A2.0-2.5-1200-67° Reflex; Model: FAD-T-A2.0-2.5-1200-67° Transmitted light



Dimensions:

Dimensions in mm, not to scale



- Dual channel color sensor
- 255 colors can be saved
- Teach-In (8 colors)
- PC programming via RS232/USB
- Fiber optics with focus lenses
- Distinguishes colors like the human eye

Features:

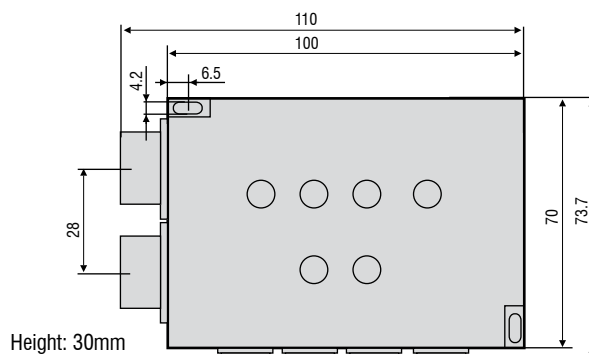
- Color memory: 8 colors (teach-in), 255 colors (software)
- 2x white light LEDs
- RS232 and USB 2.0 interfaces
- Color spaces: XYZ, xyY, $L_{99}a_{99}b_{99}$, $L^*a^*b^*$, $L^*u^*v^*$, $u^*v^*L^*$
- Switchable for LED recognition
- Several TEACH options (via PC or external)
- Modes: difference/reference/2 channels
- Adaptable fiber optics (FASOP) and focus lenses
- Logical operation, deviation mode
- Switching frequency up to 15 kHz
- Perceptive color processing
- Six teach keys on the housing
- Four-stage signal amplification
- colorCONTROL LT software

Application examples:

- Quality assurance
- Color values can be read and statistically evaluated
- Detection of color rings on metal and plastic sleeves
- Color mark recognition in printing industry
- Color and gray-scale detection
- Control of color gradient
- Control of color transitions
- Control of color deviation
- Packaging control
- Color recognition on vehicle body parts, bumpers, doors, etc.
- LED recognition of color and intensity

Dimensions:

Dimensions in mm, not to scale



Model	LT-2-DU
Article number	10234064
Object distance	depending on the fiber optics used as well as front lens attachment 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 - 30 mm ²⁾
Repeatability ¹⁾	$\Delta E \leq 0.8$
Color distance	$\Delta E \leq 1.6$
Color spaces	XYZ, xyY, $L_{99}a_{99}b_{99}$, $L^*a^*b^*$, $L^*u^*v^*$, $u^*v^*L^*$
Averaging	over a maximum of 57,600 values
Size of color memory	max. 255 colors in non-volatile EEPROM with parameter sets
Switching frequency	max. 15 kHz (depending on number of colors learned and setting for averaging)
Temperature drift X, Y	0.2% / K
Light source	2x white light LEDs; AC operation (adjustable or OFF for self-luminous objects, switchable via software) ³⁾
Type of illumination	via fiber optics
Effect from illumination	flexible application
Ambient light	up to 5000 lux
Alternating light operation	AC: typ. up to 15 kHz (depending on 4 amplification stages)
Power supply	+18 ... 28 VDC
Power consumption	typ. 500 mA
Max. switching current	100 mA
TEACH key/inputs	6 keys, Tol, Lo/Hi and IN0/4 - IN3/8 for externally teaching color reference and tolerance stage
Outputs	OUT 0 - OUT 7, digital (0 V/+Ub), 100 mA max. switching current
Switching state display	visualization with 6 yellow LEDs
Interface	RS232, USB 2.0
Type of connector	PLC: 8-pin flange socket (Binder series 712) PC: 4-pin flange socket (Binder series 712)
Connection cable	Power/PLC: 2x art.no. 11234091 / PC: art.no. 11234093 (RS232); 11234094 (USB)
Receiver	2x 3-color filter detector (XYZ TRUE COLOR Detector, color filter curve according to CIE1931)
Software	colorCONTROL LT
Pulse extension	adjustable from 0 ms to 100 ms
Signal amplification	4 stages (1, 5, 25, 100)
Housing material	Aluminum, anodized black
Operating temperature	-10 ... +55 °C
Storage temperature	-10 ... +85 °C
Protection class	IP54
Fiber optics	from page 34

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⁾ Model: FAR-T-A2.0-2.5-1200-67° Reflex; Model: FAD-T-A2.0-2.5-1200-67° Transmitted light (p. 36 ff.)

³⁾ suitable for LED testing

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

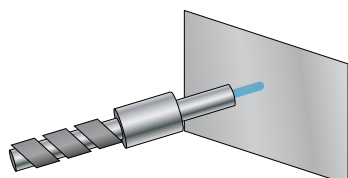
- Temperature resistance from -270 °C to +2000 °C
- Flexible and highly flexible with flux
- Cut and polished surfaces
- Wavelength from 180 nm (UV) to 3500 nm (IR)
- Customer-specific modification even for 1 single piece only

Heads for versatile applications

Functions of the fiber optics

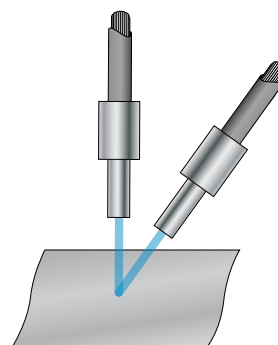


Application instructions on selecting the appropriate function.



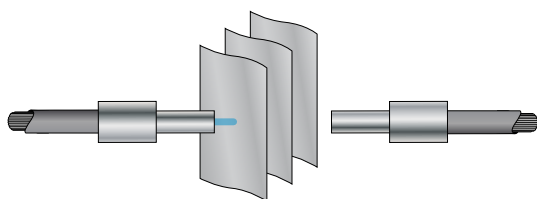
Reflex mode

- 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



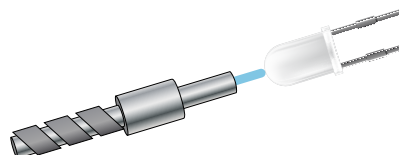
Reflex mode V arrangement

- 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



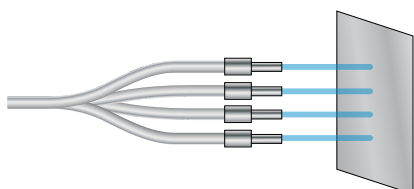
Transmitted light mode

- 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

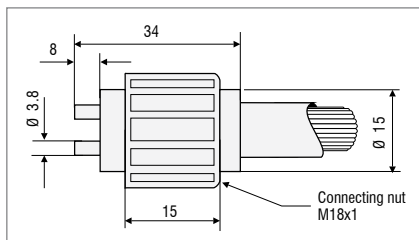
Transmission and receiving fibers are, statistically mixed, guided in two or more separated fiber optics. Therefore, several positions can be detected using only one sensor.



Available on request

Special types for multiple transmitted light mode

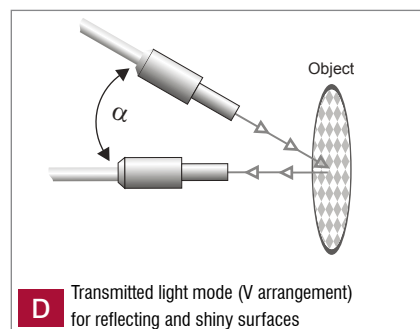
The light path of the axially opposing probe head ferrules is interrupted or damped by one or more objects.



Adapter, FA System FASOP

1 Function of the fiber optics

Please define the accessibility of the spot to be inspected and the size of the measurement object for the appropriate function of the fiber optics and the diameter of the glass fiber bundle.



* 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 $\varnothing F$ (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.

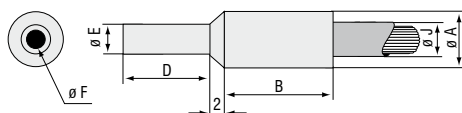
Detection ranges of the probe heads

Fiber bundle $\varnothing F$ mm	Working distance mm	Light spot for 67° fiber approx. $\varnothing$ mm	Light spot for 22° fiber approx. $\varnothing$ 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



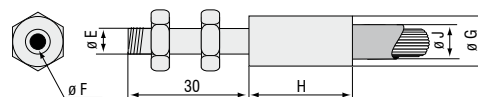
$\varnothing F$	Model	$\varnothing A$	B	D	$\varnothing E$	P	$\varnothing J$ M	T
1.5	A 1.0	4.6	8	11	2.5	4	4	–
1.5	A 1.1	6.6	8	11	2.5	–	5	4.4
2.5	A 2.0	6.6	10	12	4.5	6	6	5.8
3	A 3.0	8.5	11	15	6	7	7	7.5

B Type B ferrule (only suitable for PVC sheathing)



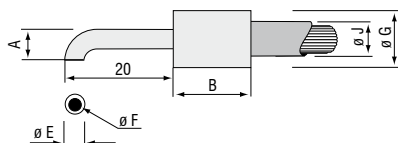
Ø F	Model	Ø A	D	Ø E	Ø J P	Ferrule
0.6	B 1.1	2	30	1	2	Stainless steel
0.6	B 1.2	2	10	1	2	Stainless steel
1	B 2.0	3	10	2	3	Alu
2.5	B 3.0	5	12	4	5	Alu
3	B 4.0	8	12	6	8	Alu

C Type C ferrule, stainless steel



Ø F	Model	E	Ø G	H	P	Ø J M	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

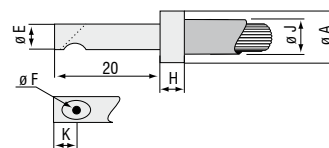
D Type D ferrule, stainless steel With angular probe heads, a reduction in range can be expected compared to axially emerging versions.



Ø F	Model	Ø A	B	Ø E	Ø G	r	P	Ø J M	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

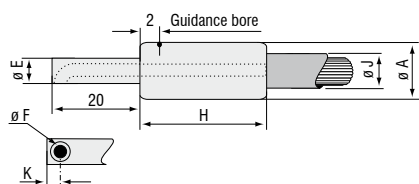
* D1.0 only suitable for PVC sheathing

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



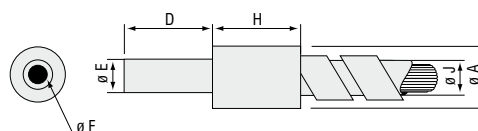
Ø F	Model	Ø A	Ø E	H	K	P	Ø J M	T
1.5	E 1.0	4	3	1.5	4	4	—	—
2.5	E 2.0	5	4	1.5	4	5	5	—
2.5	E 2.1	7	4	10	4	—	—	5.8
3	E 3.0	8	6	1.5	5	7	7	—

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	P	Ø J M	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

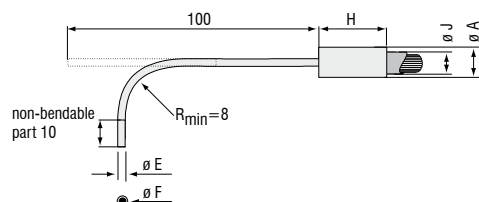


Ø F	Model	Ø A	D	Ø E	H	Ø J M	T	Ferrule
0.6	M 1.1	6	30	1	10	5	4.4	Stainless steel
0.6	M 1.2	6	10	1	10	5	4.4	Stainless steel
1	M 2.0	6	10	2	10	5	4.4	Alu
2.5	M 3.0	7	12	4	12	6	5.8	Alu
3.5	M 4.0	9	12	6	12	7	7.5	Alu

Larger fiber cross-sections are possible

O Type O ferrule, bendable to a certain extent

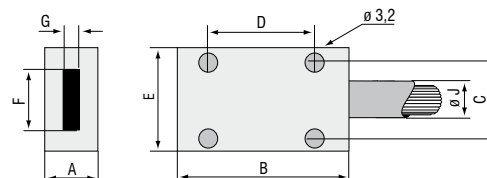
With angular probe heads, a reduction in range can be expected compared to axially emerging versions.



Ø F	Model	Ø A	Ø E	H	P	Ø J M	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



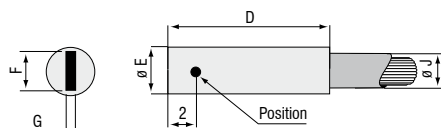
Model	A	B	C	D	E	F	G	Ø J
Q1	12	25	9	15	15	5	0.5	depends on fiber cross-section
Q2	12	30	14	20	20	10	0.3	
Q3	12	35	24	25	30	18	0.3	
Q4	12	55	34	40	40	28	0.2	
Q5	12	55	44	40	50	38	0.15	
Q6	12	55	54	40	60	48	0.15	
Q7	16	75	64	60	70	58	*	
Q8	16	75	74	60	80	68	*	
Q9	20	90	84	75	90	78	*	
Q10	20	90	94	75	100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

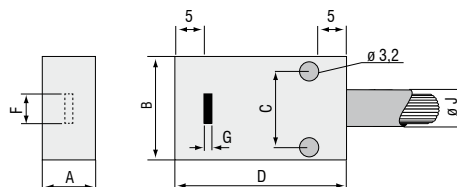


Model	D	Ø E	F	G max.	P	Ø J M	T
R 1.0*	25	4	3	0.5	3	—	—
R 1.1	30	7	3	0.5	6	6	5.8
R 2.0	25	7	6	1	6	6	5.8**
R 2.1	30	10	6	1	—	7	7.5

* R1.0 and R2.0 only suitable for PVC sheathing

** at 6 x 1 mm², can be made to a length of 1200

P Type P ferrule, aluminum



Model	A	B	C	D	F	G	P	Ø J M	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



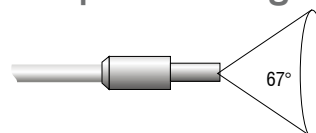
Standard lengths are: 600*, 1200*, 1800 and 2400 mm.

*Bearing types

Length tolerance typ.: ± 4 %

Cable lengths of up to 30 m can be supplied on request.

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)	

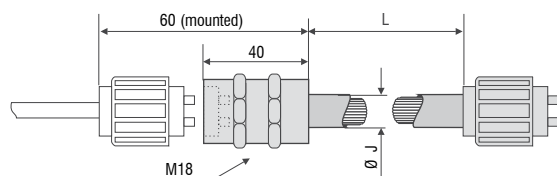
¹⁾ Fiber transmission with standard fiber 390 - 1390 nm

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



- *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
- Increasing the range with C-mount objective
> 300 mm distance
- 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. 11 mm x 14 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. 11 mm x 14 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. 11 mm x 14 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)



- Color sensor for large distances and mat surfaces
- 31 colors can be saved
- Focused illumination for rapidly changing object distances
- Color and gray scale evaluation
- PC programming via RS232

Features:

- White light LED ring, focused, covered with clear glass
- Object distance, typically 10 mm - 400 mm
- Focused white light operation enables large dynamic range
- Color memory: 31 colors per Teach-in and software
- RS232 interface (optional USB adapter)
- Switchable brightness readjustment
- Max. switching frequency: 30 kHz
- Different evaluation algorithms can be activated, e.g. „BEST HIT“ mode
- Switching state display via 5 yellow LEDs
- Switchable averaging
- Color control of self-luminous objects

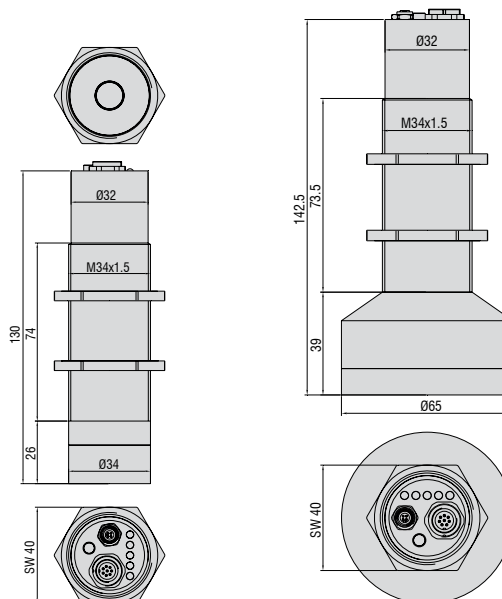
Application examples:

- Color recognition of mat surfaces at a distance of up to 400 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.)
- Illumination recognition as per color and intensity

colorSENSOR OT color sensors are fixed lens sensors with True-Color detection. The sensor automatically illuminates the surface with white light and records the reflected color values. Aside from the optics, the models are almost identical. The illumination can be disabled by software. OT sensors are then suitable for the color detection of self-luminous sources.

Dimensions:

Dimensions in mm, not to scale



OT-3-MA-30-8/OT-3-MA-30-16
OT-3-MA-50-12.5/OT-3-MA-50-25

OT-3-MA-80-36

Model	OT-3-MA-30-8	OT-3-MA-30-16	OT-3-MA-50-12.5	OT-3-MA-50-25	OT-3-MA-80-36
Article number	10234067	10234068	10234069	10234070	10234071
Object distance	typ. 10 mm - 100 mm ideal distance 30 mm		typ. 20 mm - 120 mm ideal distance 50 mm		typ. 40 mm - 150 mm ideal distance 80 mm
Light spot	Ø 5 - 16 mm	Ø 10 - 31 mm	Ø 4 - 24 mm	Ø 8 - 48 mm	Ø 30 - 48 mm
Light spot diameter	Ø 8 mm with 30 mm	Ø 16 mm with 30 mm	Ø 12.5 mm with 50 mm	Ø 25 mm with 50 mm	Ø 36 mm with 80 mm
Repeatability ¹⁾	$\Delta E \leq 0.9$				
Color distance	$\Delta E \leq 1.8$				
Color spaces	X/Y INT; s/i M (Lab)				
Averaging	over a maximum of 32,768 values				
Size of color memory	max. 31 colors in non-volatile EEPROM with parameter sets				
Switching frequency	max. 30 kHz (depending on number of colors learned and setting for averaging)				
Temperature drift X, Y	< 0.01% / K				
Light source	8x white light LEDs, AC/DC operation ²⁾ (adjustable or OFF for self-luminous objects, switchable via software)				12x white light LEDs, AC/DC operation ²⁾ (adjustable or OFF for self-luminous objects, switchable via software)
Type of illumination	focused				
Effect from illumination	Large dynamic range for mat/dark surfaces				
Ambient light	up to 5000 Lux (AC mode)				
Alternating light operation	AC: typ. 10 kHz to 40 kHz (depending on amplification level AMP1 to AMP8) DC: switchable by PC software				
Power supply	+24 VDC ($\pm 10\%$), reverse polarity protection, overload-proof				
Power consumption	typ. 320 mA				
Max. switching current	100 mA, short circuit proof				
TEACH key/inputs	1 key and IN0 for external teaching of the color references				
Outputs	OUT 0 - OUT 4, digital (0 V/+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	power/PLC: 8-pole flange socket; (Binder series 712) PC: 4-pole flange socket (Binder series 712)				
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 0 ms to 100 ms				
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-TA2.0-2,5-1200-67" at 1000 Hz and brightness adjustment with a white standard (R = 95%)

²⁾ suitable for illumination testing



- Color sensor of inhomogeneous surfaces and gloss suppression
- 31 colors can be saved
- Diffuse illumination reduces gloss effect
- Color and gray scale evaluation
- PC programming via RS232

Features:

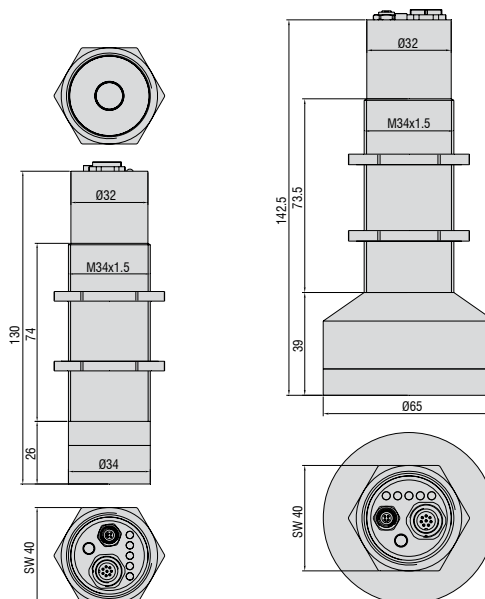
- White light LED ring with diffuser
- Object distance, typically 10 mm - 300 mm
- Gloss effect suppression through diffuse illumination
- Color memory: 31 colors per Teach-in and software
- RS232 interface (optional USB adapter)
- Insensitive to external light up to 5000 Lux
- Switchable brightness readjustment
- Max. switching frequency: 30 kHz
- Different evaluation algorithms can be activated, e.g. „BEST HIT“ mode
- Switching state display via 5 yellow LEDs
- Switchable averaging
- Color control of self-luminous objects

Application examples:

- Color recognition of structured and/or shiny surfaces
- Detection of color rings
- Color mark recognition in printing industry
- Packaging control
- Color sorting tasks
- Color control of self-luminous object (LEDs, displays, etc.)

Dimensions:

Dimensions in mm, not to scale



OT-3-GL-30-8/OT-3a-GL-30-16
OT-3-GL-50-12.5/OT-3-GL-50-25

OT-3-GL-80-36

Model	OT-3-GL-30-8	OT-3-GL-30-16	OT-3-GL-50-12.5	OT-3-GL-50-25	OT-3-GL-80-36
Article number	10234073	10234074	10234075	10234076	10234077
Object distance	typ. 10 mm - 60 mm ideal distance 30 mm		typ. 20 mm - 80 mm ideal distance 50 mm		typ. 40 mm - 100 mm ideal distance 80 mm
Light spot	Ø 4 - 14 mm	Ø 8 - 28 mm	Ø 5 - 20 mm	Ø 10 - 40 mm	Ø 30 - 40 mm
Light spot diameter	Ø 8 mm with 30 mm	Ø 16 mm with 30 mm	Ø 12.5 mm with 50 mm	Ø 25 mm with 50 mm	Ø 36 mm with 80 mm
Repeatability ¹⁾	$\Delta E \leq 0.9$				
Color distance	$\Delta E \leq 1.8$				
Color spaces	X/Y INT; s/i M (Lab)				
Averaging	over a maximum of 32,768 values				
Size of color memory	max. 31 colors in non-volatile EEPROM with parameter sets				
Switching frequency	max. 30 kHz (depending on number of colors learned and setting for averaging)				
Temperature drift X, Y	<0.01 % / K				
Light source	8x white light LEDs, AC/DC operation (adjustable or OFF for self-luminous objects, switchable via software)				12x white light LEDs, AC/DC operation (adjustable or OFF for self-luminous objects, switchable via software)
Type of illumination	diffuse				
Effect from illumination	gloss effect suppression				
Ambient light	up to 5000 Lux (AC mode)				
Alternating light operation	AC: typ. 10 kHz to 40 kHz (depending on amplification level AMP1 to AMP8) DC: switchable by PC software				
Power supply	+24 VDC ($\pm 10\%$), reverse polarity protection, overload-proof				
Power consumption	typ. 320 mA				
Max. switching current	100 mA, short circuit proof				
TEACH key/inputs	1 key and IN0 for external teaching of the color references				
Outputs	OUT 0 - OUT 4, digital (0 V/+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	power/PLC: 8-pole flange socket; (Binder series 712) PC: 4-pole flange socket (Binder series 712)				
Connection cable	to power/PLC: art. no. 11234091 to PC: 11234095 (RS232); art.no. 11234096 (USB)				
Receiver	3-color filter detector (XYZ TRUE COLOR Detector, color filter curve according to CIE1931)				
Software	colorCONTROL S				
Pulse extension	adjustable from 0 ms to 100 ms				
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-TA2.0-2,5-1200-67° at 1000 Hz and brightness adjustment with a white standard ($R = 95\%$)



- Color sensor for reflecting and structured surfaces
- 31 colors can be saved
- Polarized illumination for highly reflecting surfaces
- Color and gray scale evaluation
- PC programming via RS232

Features:

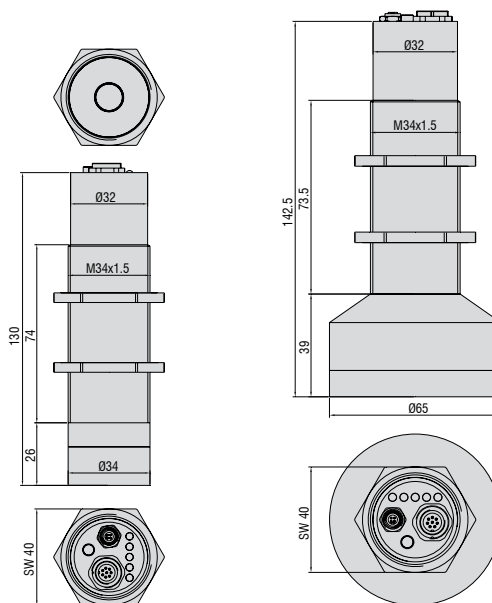
- White light LED ring with polarization filter, covered with clear glass
- Object distance, typically 10 mm - 300 mm
- Polarization filter (strongly reduces the gloss effect)
- Color memory: 31 colors via Teach-in and software
- RS232 interface (optional USB adapter)
- Insensitive to external light up to 5000 Lux
- Switchable brightness readjustment
- Max. switching frequency: 30 kHz
- Different evaluation algorithms can be activated, e.g. „BEST HIT“ mode
- Switching state display via 5 yellow LEDs
- Switchable averaging function
- Color control of self-luminous objects

Application examples:

- Color recognition on highly reflective and/or strongly structured surfaces
- Detection of color rings
- Color mark recognition in printing industry
- Packaging control
- Color sorting tasks
- Color control of self-luminous object (LEDs, displays, etc.)

Dimensions:

Dimensions in mm, not to scale



OT-3-HR-30-8/OT-3-HR-30-16
OT-3-HR-50-12.5/OT-3-HR-50-25

OT-3-HR-80-36

Model	OT-3-HR-30-8	OT-3-HR-30-16	OT-3-HR-50-12.5	OT-3-HR-50-25	OT-3-HR-80-36
Article number	10234079	10234080	10234081	10234082	10234083
Object distance	typ. 10 mm - 40 mm ideal distance 30 mm		typ. 20 mm - 80 mm ideal distance 50 mm		typ. 40 mm - 100 mm ideal distance 80 mm
Light spot	Ø 4 - 10 mm	Ø 8 - 20 mm	Ø 5 - 20 mm	Ø 10 - 40 mm	Ø 30 - 40 mm
Light spot diameter	Ø 8 mm with 30 mm	Ø 16 mm with 30 mm	Ø 12.5 mm with 50 mm	Ø 25 mm with 50 mm	Ø 36 mm with 80 mm
Repeatability ¹⁾	$\Delta E \leq 0.9$				
Color distance	$\Delta E \leq 1.8$				
Color spaces	X/Y INT; s/i M (Lab)				
Averaging	over a maximum of 32,768 values				
Size of color memory	max. 31 colors in non-volatile EEPROM with parameter sets				
Switching frequency	max. 30kHz (depending on number of colors learned and setting for averaging)				
Temperature drift X, Y	< 0.01 % / K				
Light source	8x white light LEDs	8x white light LEDs	8x white light LEDs	8x white light LEDs	12x white light LEDs
	AC/DC modes (adjustable or OFF for self-luminous objects, switchable via software)				
Type of illumination	polarization filter, focused				
Effect from illumination	strongly reduced gloss effect, suitable for highly reflecting surfaces				
Ambient light	up to 5000 Lux (AC mode)				
Alternating light operation	AC: typ. 10 kHz to 40 kHz (depending on amplification level AMP1 to AMP8) DC: switchable by PC software				
Power supply	+24 VDC ($\pm 10\%$), reverse polarity protection, overload-proof				
Power consumption	typ. 320 mA				
Max. switching current	100 mA, short circuit proof				
TEACH key/inputs	1 key and IN0 for external teaching of the color references				
Outputs	OUT 0 - OUT 4, 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	power/PLC: 8-pole flange socket; (Binder series 712) PC: 4-pole flange socket (Binder series 712)				
Connection cable	to power/PLC: art. no. 11234091 to 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 0 ms to 100 ms				
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 ($R = 95\%$)



- Color sensor for large distances
- 31 colors can be saved
- Coaxial lens for large working distances up to 900 mm
- 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 via Teach-in and software
- RS232 interface (optional USB adapter)
- Super bright white light LED
- Color, contrast and gray-scale detection
- Insensitive to external light up to 5000 Lux
- 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

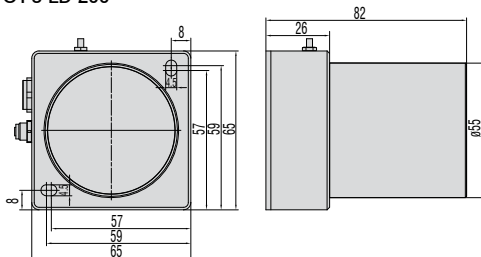
Application examples:

- 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

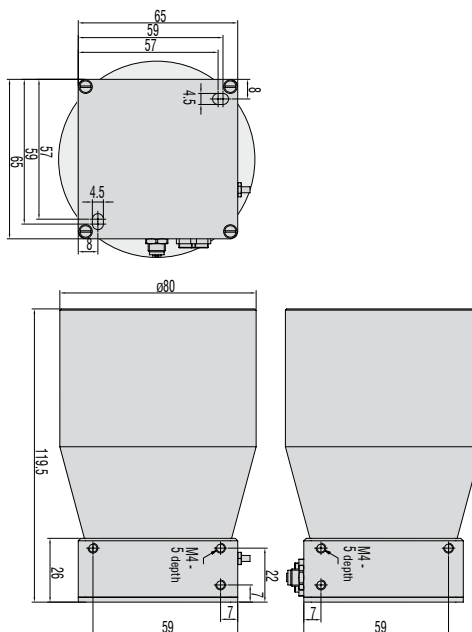
Dimensions:

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 32,768 values				
Size of color memory	max. 31 colors in non-volatile EEPROM with parameter sets				
Switching frequency	max. 35kHz (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	OUT 0 - OUT 4, digital (0 V/+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 0 ms to 100 ms				
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-TA2.0-2,5-1200-67° at 1000 Hz and brightness adjustment with a white standard ($R = 95\%$)

²⁾ suitable for illumination testing



- 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, USB and Ethernet
- External trigger
- Exchangeable adapter for fiber optics
- Suitable for POF (2 m) and optical glass fiber optics up to 5 m
- Up to 20 testing points using different assembly kits

Applications:

- Testing self-luminous objects
- LED tests (binning)
- Indication tests
- Display tests
- Display tests with 7 segments
- Parallel and simultaneous inspection of up to 100 colors ≤ 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.

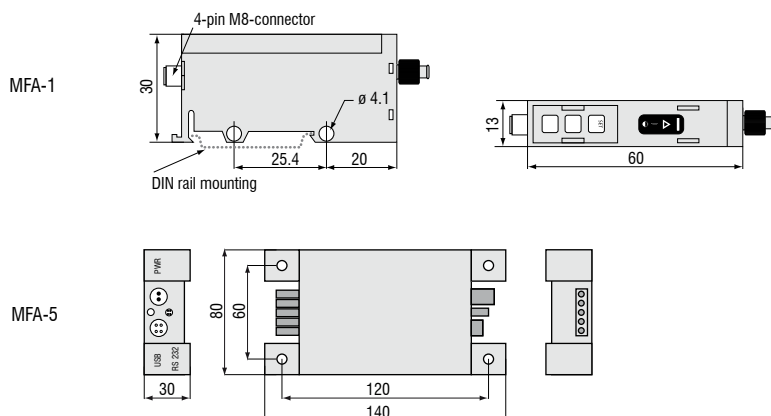
The inspection of inaccessible specimens and/or specimens situated far apart from one another can easily be achieved using the MFA series, as optical fibers transmit the information to the evaluation unit.

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.

Dimensions:

Dimensions in mm, not to scale



Model	MFA-1	MFA-5	MFA-5-M¹	MFA-5-P
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 VDC ± 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 %	± 4 nm		
Resolution	-	9 - 81 pixels / detection point		
Data memory	EEPROM	-	-	-
Object distance	typ. 1 - 5 mm			
Optical fiber (length)	incl. POF 1 m; max. POF 2 m / glass 5 m	incl. POF 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

colorSENSOR Accessory		
Art. No.	Description	suitable for:
11234717	CAB-M12-8P-co-fm-straight; 2m-PUR; open ends	colorSENSOR CFO (SYS; power and PLC)
11234718	CAB-M12-8P-co-fm-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; 2 m-PUR; open ends	colorSENSOR LT and OT series (power und PLC)
11234099	CAB-M9-8P-co-straight; 5 m-PUR; open ends	colorSENSOR LT and OT series (power und PLC)
11234093	CAB-M9-4P-co-straight; 2 m-PVC; RS232	colorSENSOR LT-2-DU (RS232)
11234101	CAB-M9-4P-co-straight; 5m-PVC; RS232	colorSENSOR LT-2-DU (RS232)
11234094	CAB-M9-4P-co-straight; 2m-PVC; USB	colorSENSOR LT-2-DU (USB)
11234102	CAB-M9-4P-co-straight; 5m-PVC; USB	colorSENSOR LT-2-DU (USB)
11234095	CAB-M5-4P-co-straight; 2m-PUR; RS232	colorSENSOR OT-3 Serie (RS232)
11234103	CAB-M5-4P-co-straight; 5m-PUR; RS232	colorSENSOR OT-3 series (RS232)
11234096	CAB-M5-4P-co-straight; 2m-PVC; USB	incl. RS232/USB converter suitable for: colorSENSOR OT-3 series (USB)
11234104	CAB-M5-4P-co-straight; 5m-PVC; USB	incl. RS232/USB converter suitable for: colorSENSOR OT-3 series (USB)
11234368	CAB-M5-4P-co-straight; 2m-PVC; RJ45-fm-Eth	incl. RS232/Ethernet converter suitable for: colorSENSOR OT-3 series (Ethernet)
11234694	White standard 30 mm zenith	colorSENSOR and colorCONTROL
11234695	White standard 30 mm zenith calibrated	colorSENSOR and colorCONTROL
11233482	White reference module	colorSENSOR LT-2-DU
2420065	PS2030 power supply 24 V / 24 W / 1 A; 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-2.2mm 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-1mm
10813842	POF-1mm fiber optics	colorCONTROL MFA in connection with the reducing adapter 2.2/1mm POF
11253906	End sleeve 1 mm	POF-1 mm
10824431	End sleeve 1 mm x 50 mm	POF-1 mm
11234305	CAB-M8-4P-co-fm-straight; 2m-PUR; open ends	colorCONTROL MFA-1 (power and PLC)
11234306	CAB-M8-4P-co-fm-straight; 5m-PUR; open ends	colorCONTROL MFA-1 (power and PLC)
11294205	CAB-M9-2P-co-fm-straight; 2m-PUR; open ends	colorCONTROL MFA-5 (power)
11294206	CAB-M9-2P-co-fm-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)

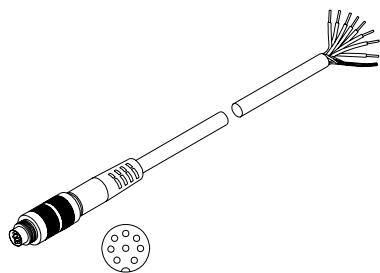
Pin assignment

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)



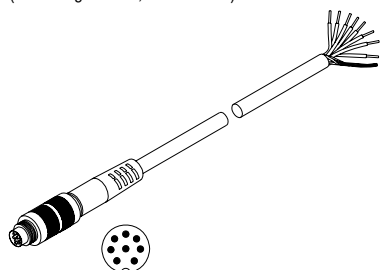
Pin	Color	CFO100/200
1	white	IN0
2	brown	+UB
3	green	TX
4	yellow	RX
5	gray	OUT0
6	pink	OUT1
7	blue	GND
8	red	OUT2

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)



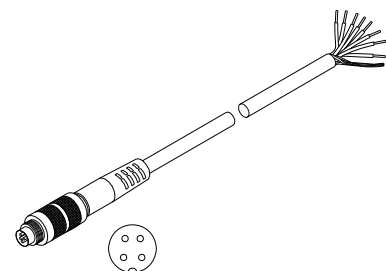
Pin	Color	LT-2-DU SB1	LT-2-DU SB2	OT-3-XX
1	white	OUT 0 / OUT A 0	OUT1	GND (0V)
2	brown	OUT 1 / OUT A 1	OUT2	+24 VDC ($\pm 10\%$)
3	green	IN1	OUT3	IN0
4	yellow	IN0	OUT4	OUT0
5	gray	CLK (OUT K)	OUT5	OUT1
6	pink	OUT 2 / OUT A 2	OUT6	OUT2
7	blue	GND (0V)	OUT7	OUT3
8	red	+24 VDC ($\pm 10\%$)	OUT0	OUT4

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)



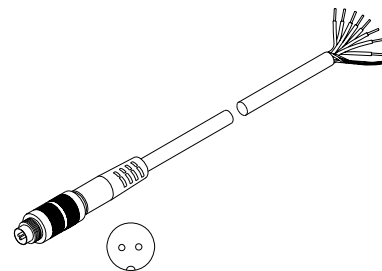
Pin	Color	MFA-1
1	brown	+ 24 VDC
2	white	External Teach
3	blue	GND
4	black	NPN/PNP

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

High performance sensors made by Micro-Epsilon



Sensors and systems for displacement and position



Sensors and measurement devices for non-contact temperature measurement



2D/3D profile sensors (laser scanner)



Optical micrometers, fiber optic sensors and fiber optics



Color recognition sensors, LED analyzers and color inline spectrometer



Measurement and inspection systems

