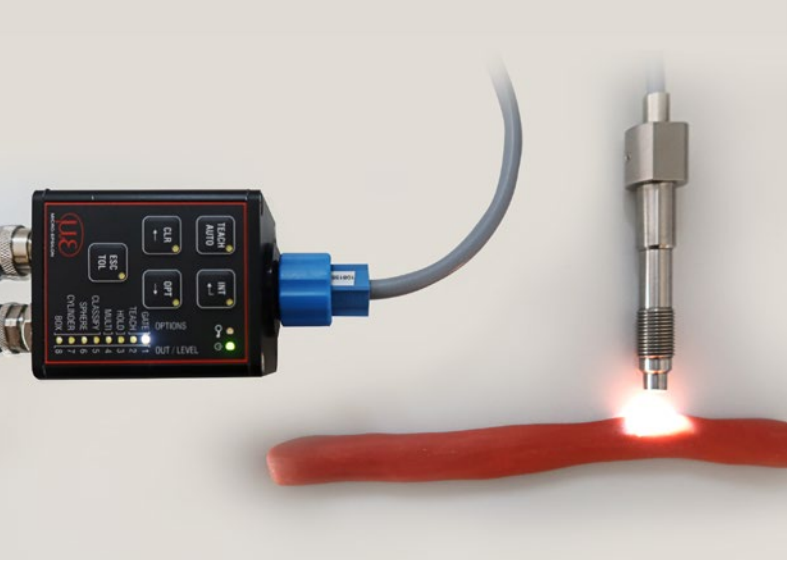
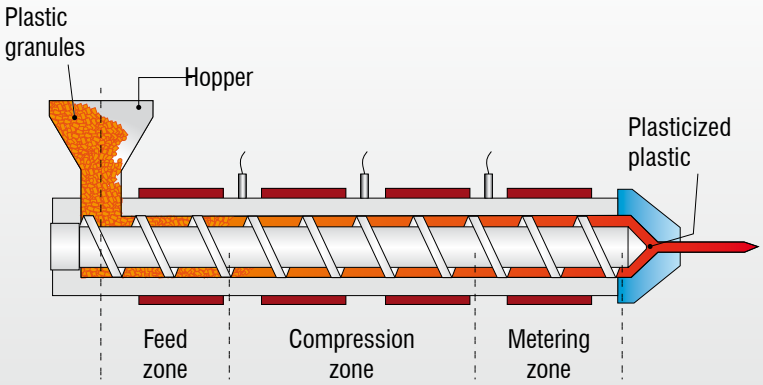
Color sensor
colorSENSOR

MICRO-EPSILON

Sensor system for precise color measurement under pressure in an extruder





During the production of solid or viscous masses such as gelatin, syrup and plastics, the mass is continuously compressed in the extruder and pressed out as a strand (extrudate).

During extrusion, it is important that the material does not get too hot, as otherwise this can result in unwanted discoloration (burning). Therefore, the color is measured directly at various points in the extruder. This can be done in transmission for transparent masses such as gelatin or in reflection for opaque masses such as plastic.

The solution offered here uses a CFS4-T150-P200 reflex sensor or a CFS3-T150-P200 transmission sensor, which are directly integrated in the extruder. The CFS4-S-E-T250 reflex sensor is also available in the M12 design. Here, the color of the mass is measured directly at the inner wall of the extruder at up to 200 bar of pressure and at up to 250 °C. The measurement results are processed further for process control purposes.

The smart and precise color sensors of the colorSENSOR series by Micro-Epsilon are characterized by their high color accuracy and repeatability. They are intended for 100% inline monitoring, as they precisely detect even the smallest color differences and allow for immediate intervention during operation. Up to 320 colors in 254 color groups can be taught in. Operation is intuitive via the web-based interface. The attractive sensor system for precise color measurement in the extruder (article number 10235604, 10235605 and 10235606) consists of the CFO200 controller and a CFS4-T150-P200, CFS3-T150-P200 or CFS4-S-E-T250 sensor. This combination impresses both by the high accuracy and the attractive price-performance ratio.

Requirements for the measurement system
- Inline color measurement
- Pressure resistance < 200 bar
- Repeatability ΔE < 0.3
- Temperature resistance < 250°C

Ambient conditions
- The mass is continuously compressed (< 200 bar)
- Hot material in the form of extrudate (< 250°C)

System design
- Controller: colorSENSOR CFO200
- Reflex sensor: CFS4-T150-P200 (20UNF)
- Transmission sensor: CFS3-T150-P200 (20UNF)
- Reflex sensor: CFS4-S-E-T250 (M12)

Advantages
- Sensors directly in the extruder with ½"-20UNF or M12 fit
- Pressure-resistant < 200 bar
- Temperature-resistant < 250 °C
- High repeatability ΔE < 0.3
- Multi-teach function and formation of color groups
- Modern, user-friendly web interface
- High color accuracy
- Simple and fast integration of the system in existing plants

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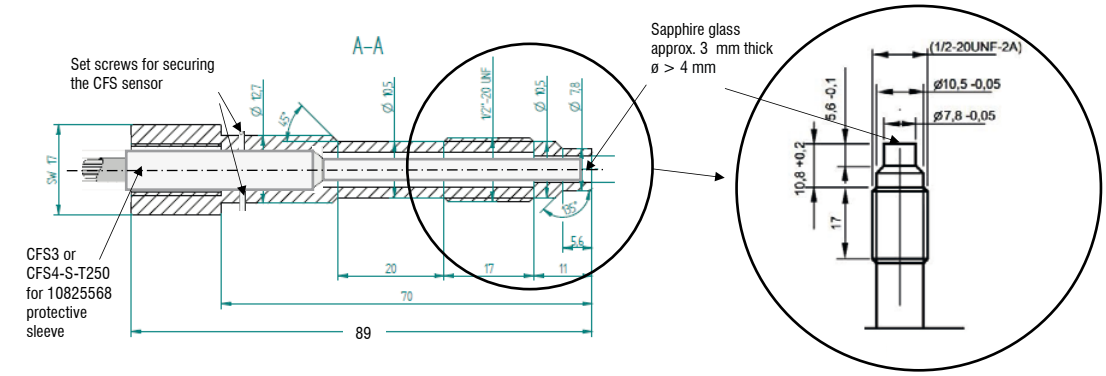
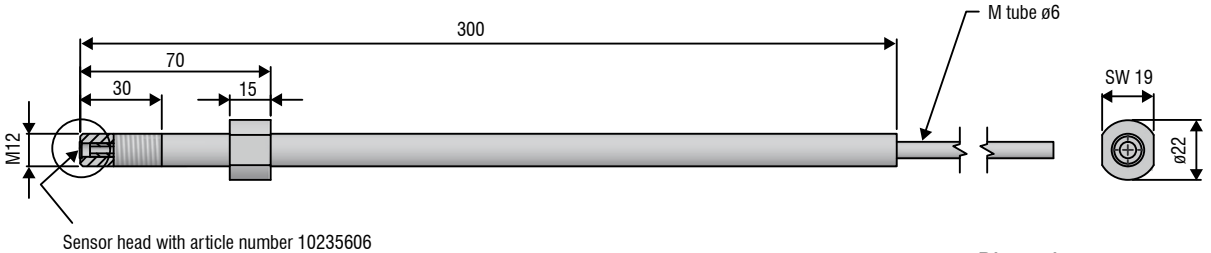
Model		CFS4-T150-P200	CFS3-T150-P200	CFS4-S-E-T250
Sensor type		Reflection	Transmission	Reflection
Working distance [1]		0 mm (internally 5 mm)	0 mm (internally 5 mm)	0 mm (internally 5 mm)
Measurement spot diameter [1]		10 mm	2.5 mm	10 mm
Light spot diameter [1]		12 mm	12 mm	12 mm
Measurement geometry		0°:0°	0°:180°	0°:0°
Min. target size (flat)		Ø 10 mm	Ø 2.5 mm	Ø 10 mm
Minimum curvature radius of target (curved)		100 mm	25 mm	100 mm
Sensitivity	Distance [1] [2]	< 10.4 ΔE / mm	< 0.3 ΔE / mm	< 10.4 ΔE / mm
	Tilt angle [1] [2]	< 0.3 ΔE / °	< 0.3 ΔE / °	< 0.3 ΔE / °
	Ambient light [1] [2]	< 0.3 ΔE / 1,000 lx	< 0.3 ΔE / 1,000 lx	< 0.3 ΔE / 1,000 lx
Permissible ambient light [1] [2]		< 40,000 lx	< 40,000 lx	< 40,000 lx
Maximum tilt angle [1] [2]		±45°	±30°	±45°
Pressure resistance of sensor head		< 200 bar	< 200 bar	< 0.5 bar
Connection		Axial integrated fiber optic cable with metal silicone (T) Sheath, standard length 1.2 m; Other lengths 0.3 ... 2.4 m Optionally available	Axial integrated fiber optic cable with metal silicone (T) Sheath, standard length 1.2 m; Other lengths 0.3 ... 2.4 m Optionally available	Axial integrated fiber optic cable with metal with special bonding (E) Sheath, standard length 1.2 m; Other lengths 0.3 ... 2.4 m Optionally available
Mounting		FA (M18x1)	FA (M18x1)	FA (M18x1)
Temperature range	Storage / Operation	Sensor: -40 ... +150 °C; Cable: -60 ... +180 °C	Sensor: -40 ... +150 °C; Cable: -60 ... +180 °C	Sensor: -40 ... +250 °C; Cable: -60 ... +180 °C
Humidity		20 ... 80 % r.H. (non-condensing)	20 ... 80 % r.H. (non-condensing)	20 ... 80 % r.H. (non-condensing)
Protection class (DIN EN 60529)		IP64	IP64	IP40
Material		Stainless steel, glass fiber bundle with metal-silicone sheath (T)	Stainless steel, glass fiber bundle with metal-silicone sheath (T)	Stainless steel, glass fiber bundle with metal with special bonding (E)
Weight		110 g	200 g	90 g

The specified data apply to a white, diffuse reflecting surface (zenith white reference)
[1] In conjunction with colorSENSOR CFO200 and a repeatability of ΔE ≤ 0.3
[2] Valid for optimal working distance



Sensor head with article numbers 10235604 and 10235605



Sensor head with article number 10235606

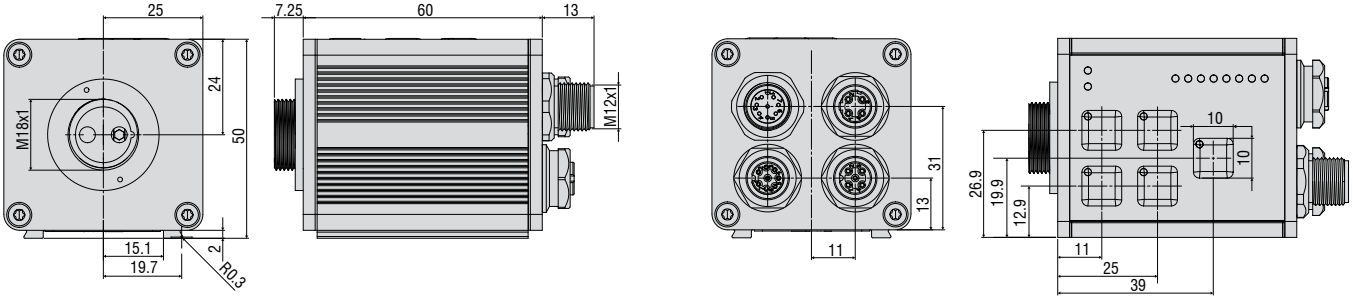
Dimensions:
Dimensions in mm, not to scale

Model		CFO200
No. of measurment channels		1
Repeatability [1]		ΔE ≤ 0.3
Color distance		ΔE ≤ 0.6
Spectral range		400 … 680 nm
Color spaces		XYZ, xyY, L*a*b*, L*u*v*, u'v'L*
Illuminants		D65
Standard observer		2°
Tolerance model		Classification; sphere (ΔE); cylinder (ΔL, Δab); box (ΔL, Δa, Δb)
Color memory		Max. 320 colors in non-volatile EEPROM with parameter sets
Measuring rate		Standard 1 kHz; max. 30 kHz (depending on number of colors learned and setting for averaging)
Temperature stability		< 0.1 % FSO / K
Light source		White light LED (425 ... 750 nm); AC operation (luminous flux at 1 kHz 220 lm) (adjustable or OFF for self-luminous switchable via software)
Permissible ambient light		Max. 40,000 lx (depending on CFS sensor)
Synchronization		Synchronization is possible
Supply voltage		18 ... 28 VDC
Max. current consumption		500 mA
Signal input		4 (IN0 - IN3): IN0 via keys; IN0 - IN3 configurable via web interface (trigger, teach, delete, lock, calibrate)
Digital interface		RS232 (standard 9600 Baud)[2], Ethernet, USB
Switching output		OUT0-OUT7 push-pull / NPN / PNP (color identification, binary coding, 254 color groups)
Connection	Optical	Screw-in optical fiber via FA socket M18x1, length 1.3 m, min. bending radius 18 mm
	Electrical	8-pin male flange connector M12A (Power/PLC); 8-pin female flange connector M12A (Signal); 4-pin female flange connector M12D (Ethernet DHCP-compatible); 5-pin female flange connector M12A (USB)
Installation		DIN rail installation/screw connection via adapter
Temperature range	Storage	-10 ... +85 °C
	Operation	-10 ... +55 °C
Humidity		20 … 80 % r.H. (non-condensing)
Shock (DIN EN 60068-2-27)		15 g / 6 ms in 3 axes, two directions and 1000 shocks each
Vibration (DIN EN 60068-2-6)		2 g / 10 … 500 Hz in 3 axes, 10 cycles each
Protection class (DIN EN 60529)		IP65 (connected)
Material		Aluminum, anodized black
Weight		Approx. 200 g
Control and indicator elements		Operation via keyboard and web interface, visualization with 13 white LEDs
Special features		Multicolor teach function, automatic adaptation of brightness, measurement signal amplification and averaging depending on measuring frequency, adjustable hold time of > 30 µs

FSO = Full Scale Output

[1] Maximum color distance ΔE of 1000 successive measurements from the color value of a red and a dark gray (R = 5%) reference tile, measured with the CFS4-A20 sensor at 1000 Hz and brightness adjustment to white standard (R = 95%).

[2] Adjustable up to max. 115200 Baud,



Dimensions:
Dimensions in mm, not to scale