

Sensor system for precise turbidity measurement



Liquids are ubiquitous in industrial manufacturing processes, for example in sewage treatment plants, drinking water treatment, the chemical & pharmaceutical industry or in food production. The color or turbidity of the liquids allows conclusions to be drawn about both process and product quality. A change in the liquid's color also means a change in quality and measured value. Color measuring systems from Micro-Epsilon reliably detect the smallest color differences in the process and are therefore used for reliable color and turbidity measurement of liquids.

During the textile dyeing process, the sensors continuously detect the water color, which allows conclusions to be drawn about the color concentration present. During dyeing, the color concentration is 100%. In the subsequent wash cycle, the concentration must be 25% or optimally 0%, which corresponds to clear water.

The colorSENSOR CFO100 controller from Micro-Epsilon is used together with the CFS3-A30 transmission sensor for this application. The determined color value is then output directly to the process control. When measurements are taken during the process, the water is pumped via a secondary arm through a glass tube, which is illuminated from behind with the transmission fibers of the CFS3 sensor. The controller analyzes and classifies the color opacity. The measurement can be carried out either from the outside on the pipe or directly in the water.

The smart, accurate colorSENSORS from Micro-Epsilon series impress with their high color accuracy and repeatability. They are used, inter alia, for inline color measurement of liquids. They reliably detect minor color changes, which means that the sensors contribute to maintaining the highest quality standards. In addition, they significantly simplify testing processes, since laborious and cost-intensive sampling with laboratory analysis is no longer necessary. Up to 320 colors in 254 color groups can be taught.

Operation is intuitive via the web interface. The attractive sensor system for precise material differentiation (item number 10235586) consists of the CFO100 controller and the CFS3-A20 sensor. Its high level of accuracy as well as its attractive price-performance ratio are impressive.

Requirements for the measurement system

- Measuring rate 1 kHz
- Repeatability $\Delta E \leq 0.6$
- Resistance to a variety of chemical substances

Ambient conditions

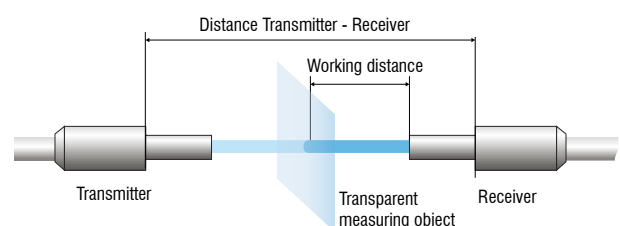
- Constant ambient light
- Liquid temperature up to 120 °C

System design

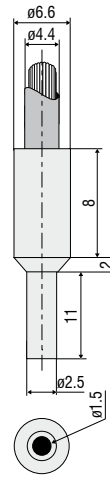
- Controller: colorSENSOR CFO100
- Transmission sensor: CFS3-A20

Advantages

- CFS3 sensors are resistant to many oils and chemicals
- Multi-teach function and formation of color groups
- Modern, user-friendly web interface
- High color precision and repeatability
- Currently brightest illumination in this class
- The sensor system detects the turbidity, concentration and permeability of materials, liquids, glasses, petrol, sewage, wastewater and exhaust gas



Model	CFS3-A20	
Sensor type	Transmission sensor	
Working distance ¹⁾	10 mm	
Measurement spot diameter ¹⁾	2.5 mm	
Light spot diameter ¹⁾	20 mm	
Measurement geometry ²⁾	0°:180°	
Min. target size (flat)	Ø 2.5 mm	
Minimum curvature radius of target (curved)	25 mm	
Sensitivity	Distance ^{1) 3)}	< 0.3 ΔE / mm
	Tilt angle ^{1) 3)}	< 0.3 ΔE / °
	Ambient light ^{1) 3)}	< 0.3 ΔE / 1,000 lx
Permissible ambient light ^{1) 3)}	< 40,000 lx	
Max. tilt angle ^{1) 3)}	±30°	
Connection	Integrated fiber optic cable axial with metal-silicone sheath (T), length 1.2 m	
Mounting	FA (M18x1)	
Temperature range	Storage / Operation	Sensor head: -10 ... +80 °C; Cable: -60 ... +180 °C
Air humidity	20 ... 80 % r.H. (non-condensing)	
Protection class (DIN EN 60529)	IP64	
Material	Stainless steel, fiberglass bundle with metal-silicone sheath (T)	
Weight	160 g	



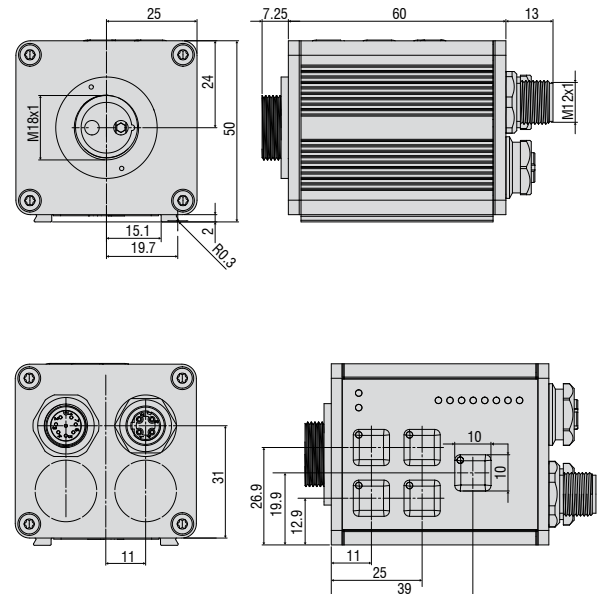
Data valid for white, diffusely reflecting surfaces (white reference Zenith)

¹⁾ In combination with colorSENSOR CFO200 and a repeatability of ΔE ≤ 0.3

²⁾ Can also be used for indirect gloss measurement in an angular arrangement of 60°: 60° (total reflection).

³⁾ Valid for optimal working distance

Model	CFO100	
No. of measurement channels	1	
Repeatability ¹⁾	ΔE ≤ 0.5	
Color difference	ΔE ≤ 1.0	
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	Classify; sphere (ΔE); cylinder (ΔL, Δab); box (ΔL, Δa, Δb)	
Color memory	max. 256 colors in non-volatile EEPROM with parameter sets	
Measuring rate	max. 10 kHz; standard 1 kHz (depending on the number of colors to learn and setting the averaging)	
Temperature stability	< 0.1 % FSO / K	
Light source	White light LED (425 ... 750 nm); AC operation (luminous flux at 1 kHz 130 lm); (adjustable or OFF for self-luminous switchable via software)	
Permissible ambient light	max. 5,000 lx	
Synchronization	Synchronization is possible	
Supply voltage	18 ... 28 VDC	
Maximum power consumption	500 mA	
Signal input	1 (IN0) configurable via keyboard or web page (trigger, teach, delete, lock, match)	
Digital interface	RS232 (standard 9600 kBaud) ²⁾ , Ethernet	
Switching output	OUT0-OUT2 Push-Pull / NPN / PNP (color recognition, binary coding 6 color groups)	
Connector	Optical	screw-on optical fiber via FA socket M18x1, length 1.3 m, min. bending radius 18 mm
	Electrical	8-pin flange connector M12A (power/PLC); 4-pin flange socket M12D (PC/Ethernet DHCP capable) length 2 m
Assembly	DIN rail assembly/screw connection via adapter	
Temperature range	Storage	-10 ... +85°C
	Operation	-10 ... +55°C
Air humidity	20 ... 80 % r.H. (non-condensing)	
Shock (DIN EN 60068-2-27)	15 g / 6 ms in 3 axes in two directions, 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, black anodized	
Weight	approx. 200 g	
Control and indicator elements	Operation via keyboard and web interface, visualization through 13 white LEDs	
Special features	Multi-color teach function, automatic adjustment of illumination brightness, measurement signal amplification and averaging depending on the measurement frequency, adjustable hold time of > 30 μs	



Dimensions:

Dimensions in mm, not to scale

FSO = Full Scale Output

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

²⁾ Adjustable up to max. 115200 kBaud,