

# Colour, contrast and luminescence sensors

## A broad spectrum

### FT 25-C RGB colour sensor from Page 190

- Smallest RGB colour sensor with high switching frequency of  $\leq 10$  kHz
- Precise detection of "non-colours", e.g. black, white and grey
- Small, precise light spot for the detection of smallest marks

### FT 50 C – white-light colour sensor from Page 194

- Colour detection with simplest teach-in
- Patented optical technology ensures reliable detection with fluctuating scanning distances
- Parameterisation and online colour information via RS485

### FT 25-W/-RGB contrast sensor from Page 204

- Miniature contrast sensor – 15-times smaller than standard housing
- Detection of minimum contrast differences through multi-colour RGB evaluation or white-light illumination
- Automatic selection of ideal transmission colour after teach-in
- High positioning accuracy thanks to minimum response time ( $\leq 20 \mu\text{s}$ ) and very precise light spot

### FT 50 C-UV – luminescence sensor from Page 214

- High flexibility through large scanning range
- Small, precise light spot for maximum positioning accuracy
- Robust reflection-resistant operation



## 5 operation principles for colour detection

The attachment of colour marks that are then evaluated with a colour or contrast sensor is a proven method for identifying objects in industrial production. Even objects with differing shapes and surface properties can be very reliably detected in this way. SensoPart offers sensors with five different functional principles for colour and contrast detection.

### VISOR® Color

With the VISOR® Color you can exploit the colour feature economically and thus open up numerous new application potentials. It is now just as possible to automate inspections previously carried out visually as it is to add the evaluation of the colour feature to an existing process – because the VISOR® Color is not just a colour sensor, but also offers a wide range of additional functions for object detection.

### FT 25/50 C

SensoPart offers the FT 25/50 C colour sensors for the "classic" colour detection of objects and printed marks. The FT 25-RGB is well suited for the detection of one colour in fast processes.

The FT 50 C can not only differentiate between individual colours, but also user-defined colour ranges. Thanks to its high level of colour selectivity, this sensor is suitable for almost all industrial colour detection tasks.

### FT 25-W/-RGB

The F 25 series also includes contrast sensors which, with their small and precise light spot, can differentiate between the slightest of contrast differences on objects or printed marks at high process speeds. The FT 25-RGB, with its multi-colour RGB evaluation, can even automatically select the ideal transmission colour (red, green or blue) for the contrast that is present.

### FT 50 C-UV

Finally, the FT 50 C-UV luminescence sensor is a special product: this innovative sensor detects features that are invisible to the human eye by irradiating the target object with ultraviolet light. This sensor has a highly varied range of applications because luminophores are not only attached to labels, but can also be mixed with different materials (e.g. paint, chalk, glue and lubricants).

**VISOR® Color**  
from Page 80

**V10C-CO-S2-W12**

- Standard version for colour detection with up to 8 inspection tasks and up to 32 evaluations
- >> Page 88

**V20C-CO-A2-W12**

- Advanced version for colour detection and object detection with up to 255 inspection tasks and up to 255 evaluations
- >> Page 82



SENSOPART IN COLOURS

- Five different sensor principles for a wide range of uses
- Precise detection of the finest colour or grey value differences and non-colours
- Detection of self-illuminating colours and luminophores
- Numerous outputs and interfaces for simple integration in machine control systems
- Comfortable operation by means of teach-in or configuration software
- Maximum positioning accuracy, even at high process speeds
- Automatic transmission LED colour selection; communication via light spot – simple, comprehensible, clearly defined

# Colour sensors

## System description

### Functional description

Colour sensors operate according to the energetic reflection principle, whereby the partial spectra of red, green and blue are evaluated separately. Either the three colours are emitted sequentially and the quantity of light reflected from the target object is individually registered (FT 25-C), or the sensor emits white light that is first split into the RGB partial spectra in the receiver (FT 50 C). The RGB intensity values thus determined are compared with previously taught-in reference values. The switching output is activated if the colour values are within the defined tolerance range.

A special feature of the FT 25-C colour sensor is teach-in with a “communicating” light spot: the quality of the colour detection is signalled to users by the blinking of the light spots in the various colours.

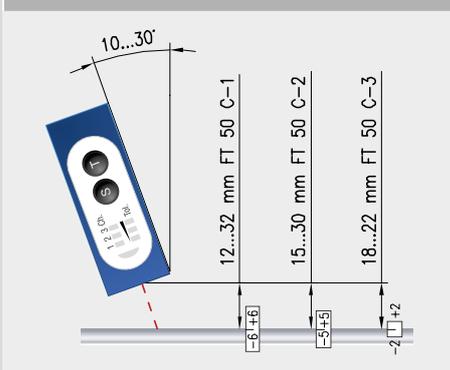
The FT 50 C colour sensor operates according to the passive three-range process with white-light LED and an optical “funnel” that we developed. This patented sensor concept allows very fine colour selection – so that even minimal colour differences can be detected – and an above-average depth of field that ensures the reliable function of the colour sensor, even with fluctuating scanning distances.

### High process speed



The FT 25-C miniature colour sensor reliably switches with 10 kHz with the taught-in colour (including black and white) and is particularly suitable for use in rapid processes, e.g. in labeling machines.

### Depth of field



The depth of field of the FT 50 C also varies depending on the light spot geometry:

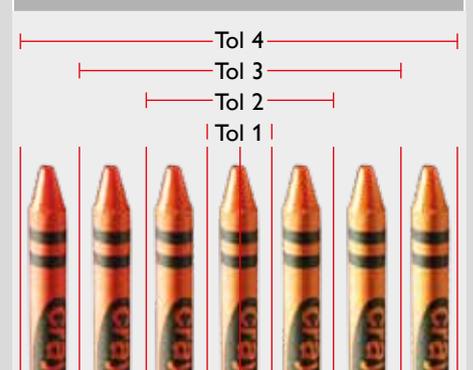
- +/- 6 mm (with default setting)
- +/- 5 mm (with default setting)
- +/- 2 mm (with default setting)

### Scan function



In the case of heterogeneously coloured surfaces, the Scan function of the FT 50 C allows the scanning-in and storage of colour gradients. The colours within the scanned colour range are then detected.

### Tolerance ranges



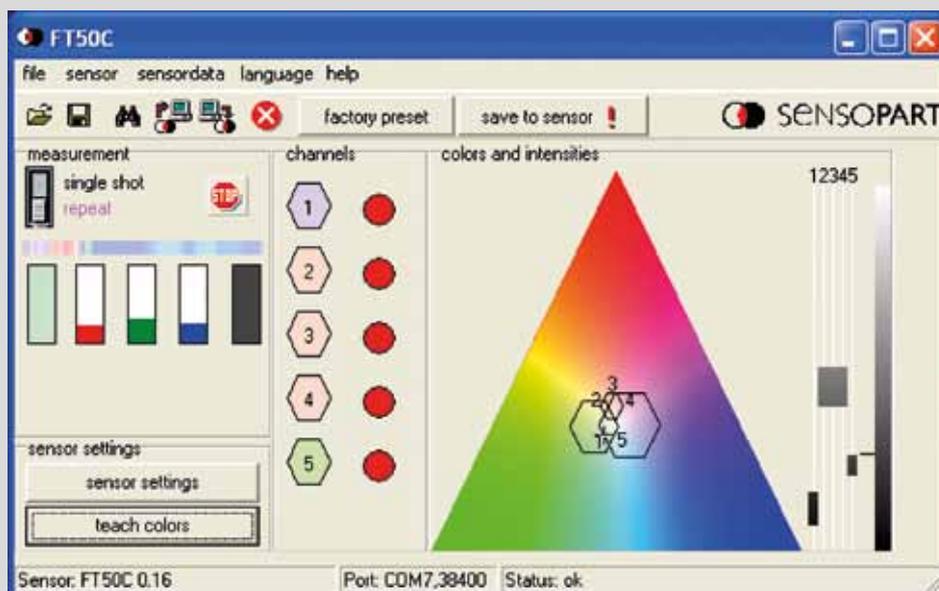
The detection window can be adapted by adjusting colour selectivity.

### Versatile colour settings

The FT 50 C colour sensor offers very comprehensive opportunities for teaching-in and administrating colours. Additional reference colours can be taught-in, or the colour range expanded, in up to four steps. In practice, this function proves helpful when, for example, labels with fluctuating print quality require reliable detection. Larger colour ranges, as well as heterogeneously coloured surfaces or colour gradients, can be detected using the “ColourScan” function (see Figs. 1 and 2 below). In this case, high colour selectivity can be achieved with the “Scanplus” function so that the sensor reliably detects incorrect or missing colours.

As many colours as desired can be taught-in via the interface and stored in the machine controller – and called up again in the form of colour vectors (data string with a target value incl. tolerance).

7



### PC-based software (FT 50 C)

The serial interface and PC software also allow the entire bandwidth of the sensor’s functions to be controlled from the PC. Thus settings can be made interactively and the sensors easily adapted to the particular application. Colour patterns can also be stored after teach-in and, when necessary, reloaded. No renewed teach-in is necessary.

The current version of the software can be obtained at [www.sensopart.com](http://www.sensopart.com)



### ColourScan (FT 50 C)

Heterogeneously coloured surfaces can be taught-in (scanned in) with the help of the integrated Scan or Scanplus functions. If a larger colour range is scanned-in and assigned to a single channel, the sensor switches with all colours that lie within this colour spectrum (Fig. 1). An improved selectivity is achieved with the Scanplus function, with which this range can be split into several parts (Fig. 2).

# Contrast sensors

## System description

### Functional description

Contrast sensors operate on the energetic reflection principle and detect grey value differences on matt, glossy or transparent objects and surfaces.

### White-light contrast sensors

The FT 25-W contrast sensor uses white light and has a very small and precise rectangular light spot ( $1 \times 4 \text{ mm}^2$ ). This also allows the detection of very small printed marks and coloured objects with weak contrast differences. The sensor can be parameterised during running operation and, during the teach-in process, automatically adapts the switching threshold to the object colour and background.

### RGB contrast sensors

The FT 25-RGB contrast sensor has three different transmission LEDs (red, green and blue). During teach-in, the sensor evaluates the taught-in contrast and then automatically selects the ideal transmission colour (red, green or blue) for the contrast present. As a result, even extremely low contrast differences can be reliably detected.

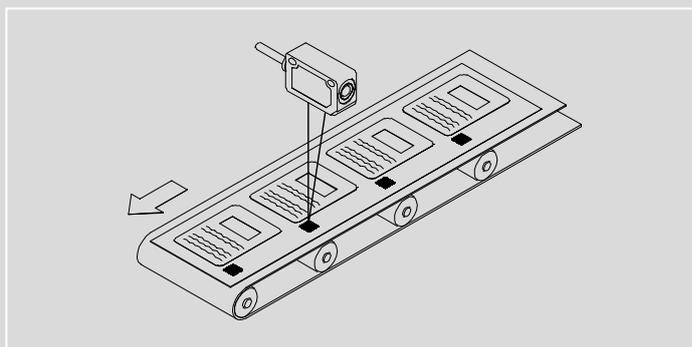
### Switching frequency

As a result of the high switching frequency (25 kHz) of the FT 25-W and FT 25-RGB contrast sensors, the front edges of printed marks are very precisely detected, achieving maximum position accuracy. This also ensures reliable sensor switching behaviour even at very high process speeds.

### Laser contrast sensors

These sensors operate with red laser light (Laser Class 1) and also have a very small light spot ( $\varnothing 0.7 \text{ mm}$  in focus). This permits even very small printed marks of differing colours to be read at longer distances. During the teach-in process, the sensor automatically adapts the switching threshold to the mark colour and background.

### Application example



#### Detection of printed marks

The contrast difference between the printed marks and the unprinted paper is evaluated here.

### Functional description

The detection process is based on the luminescence of certain materials, called luminophores. The sensor transmits invisible UV light at a wavelength of 375 nm. This excites the luminophores contained in the object so that they emit light in the visible range of the electromagnetic spectrum. The sensor energetically evaluates these precisely taught-in, material-specific frequencies and compares them with the taught-in value.

Luminophores can be attached to labels or mixed with a variety of materials (e.g. paints, chalk, glue and lubricants) for detection purposes. Thus, for example, paper contains optical brighteners that are excited by the UV light and reflect light (mostly blue) to the sensor.

### Applications

Examples of applications include the detection of labels on glass bottles, invisible printed marks for object alignment, and the presence of oils to which luminescent materials have been added. Fluorescent chalks, paints and dyes; text markers; glues; sealants; lubricants; and optical brighteners in paper, textiles and plastics are examples of luminescent materials.

#### Universal

- One variant for all types of luminescence (red, blue, etc.)
- Competitors require several variants for this, because they need supplementary filters!

#### RGB-3 range reception system

- Reliable detection even with low amounts of luminophores in the object
- Extremely reliable detection thanks to high signal reserves
- Immune to reflections (e.g. on glass or glossy metals)
- Differentiation between different luminophores

#### Very good depth of field

- Detection at varying object distances, even with fluttering objects such as paper
- No fine adjustment necessary, e.g. with batch changes

#### Small, precise light spot

- Accurate detection of the smallest of invisible printed marks

#### Easy teach-in

(on device or comfortably via external connection)

- Single channel: ready-to-run

# FT 25-C

RGB colour sensor in miniature housing with high switching frequency



 made in Germany



## **Reliable colour detection:**

*The main task of the FT 25-C RGB colour sensor is the detection of a defined colour. It is also suitable for very rapid applications thanks to its high switching frequency. Mounting by means of a dovetail and the MBD F25ST mounting rod, available as an accessory, allows easy and precise fine alignment.*

## TYPICAL FT 25-C

- Smallest cubic colour sensor on the market (34 x 20 x 12 mm<sup>3</sup>)
- High switching frequency of 10 kHz for rapid applications
- Detection of a taught-in colour
- Detection of "non-colours", e.g. black, white and grey
- Bright light spot with sharp contour for easy alignment and precise front-edge detection
- Static or external teach-in
- "Communicating" light spot for simplest setup
- Hermetically sealed housings (IP 69K & IP 67)

The FT 25-C RGB colour sensor is not only the smallest cubic colour sensor currently available on the market, but is also one of the quickest: with a switching frequency of up to 10 kHz it is as fast as a contrast sensor and thus also suitable for the most rapid printed mark applications. The FT 25-C can identify any colour in the visible spectrum including all the “non-colours” and also very reliably detects the smallest of colour differences. It keeps even the narrowest print marks and smallest markings in view thanks to its bright light spot with a sharp elongated contour (1 × 5 mm<sup>2</sup>).

#### Fits into every space

Thanks to its miniature design, SensoPart's smallest colour sensor is also easily accommodated in very restricted installation spaces, whereby the patented dovetail mounting allows user-friendly fine

alignment. The operating concept is also clever: the FT 25-C is rapidly and easily configured via teach-in or control line. The quality of the colour detection is signalled via a “communicating” light spot: the blinking of the red, blue or green transmission LED provides you with a clear statement on the stability of your process.

As a result of its space-saving design and rapidity, the FT 25-C is suitable for use in numerous sectors and applications, for example, packaging and labeling machines as well as bottling lines.

FT 25-C – Product Overview				
	Type of light	Scanning distance	Special features	Page
FT 25-C	Red LED, green LED, blue LED	12 ± 3 mm	The world's smallest RGB colour sensor with a switching frequency of ≤ 10 kHz	192

# FT 25-C

RGB colour sensor



## PRODUCT HIGHLIGHTS

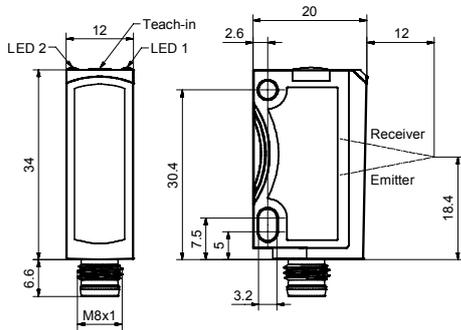
- Smallest RGB colour sensor with high switching frequency  $\leq 10$  kHz
- Precise detection of the slightest of contrast differences
- Very robust operation despite fluttering and glossy objects
- Feedback via „responding light spot“ about quality of taught-in colour value

Optical data		Functions	
Scanning distance	12 mm	Indicator LED, green	Operating voltage indicator
Depth of field	$\pm 3$ mm	Indicator LED, yellow	Switching output indicator
Type of light	Red LED, 633 nm Green LED, 525 nm Blue LED, 460 nm	Sensitivity adjustment	Via Teach-in button and control input
Light spot size	$1 \times 5$ mm <sup>2</sup>	Adjustment possibilities	N.O./N.C. via Teach-in button and control input
		Default settings	Button lock via control input
			N.O.
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	10 ... 30V DC <sup>1</sup>	Dimensions	34 x 20 x 12 mm <sup>3</sup>
No-load current, I <sub>0</sub>	$\leq 30$ mA	Enclosure rating	IP 67 / IP 69K <sup>3</sup>
Output current, I <sub>e</sub>	$\leq 100$ mA	Material, housing	ABS
Protective circuits	Reverse-polarity protection, U <sub>B</sub> / short-circuit protection (Q)	Material, front screen	PMMA
Protection class	2	Type of connection	See Selection Table
Power On Delay	< 300 ms	Ambient temperature: operation	-20 ... +55 °C <sup>4</sup>
Switching output, Q	Push-Pull	Ambient temperature: storage	-20 ... +80 °C
Output function	N.O. / N.C.	Weight (metal plug device)	10 g
Switching frequency, f (ti/tp 1:1) <sup>2</sup>	See Selection Table	Vibration and impact resistance	EN 60947-5-2
Response time	See Selection Table		

<sup>1</sup> Max. 10 % ripple, within U<sub>B</sub>, ~ 50 Hz / 100 Hz    <sup>2</sup>  $f = 1 / (T \times Nyq \times 2)$     <sup>3</sup> With connected IP 67 / IP 69K plug    <sup>4</sup> UL: -20 ... +50 °C

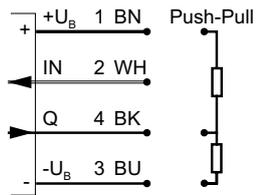
Switching frequency, f (ti/tp 1:1) <sup>2</sup>	Response time	Scanning distance	Type of connection	Part number	Article number
$\leq 10000$ Hz	$\leq 50$ $\mu$ s	$12 \pm 3$ mm	Metal plug, M8x1, 4-pin	FT 25-C1-GS-M4M	607-21020
$\leq 2500$ Hz	$\leq 200$ $\mu$ s	$12 \pm 3$ mm	Metal plug, M8x1, 4-pin	FT 25-C2-GS-M4M	607-21021

Plug connection



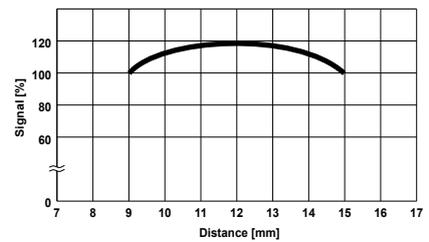
153-00995

Connection, 4-pin



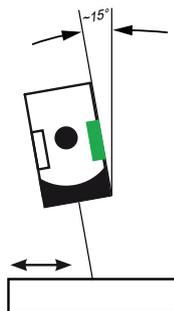
154-00320

Signal process



155-01648

Installation



155-01726

Accessories

Connection cables

From Page A-32

Brackets

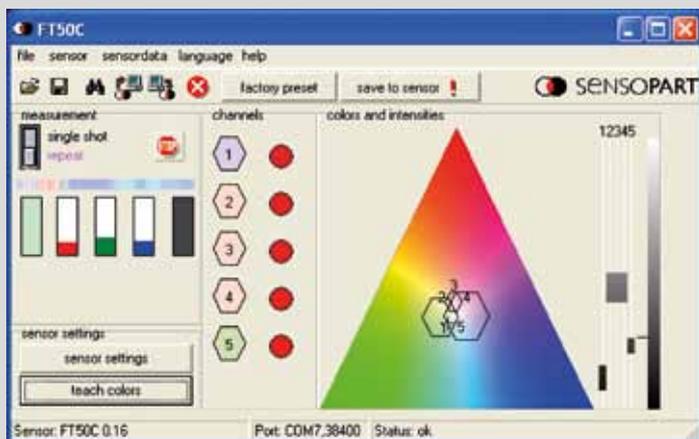
From Page A-4

# FT 50 C white-light colour sensor

Reliability despite varying object distances



 made in Germany



## PC-based software

The entire range of sensor functions can also be controlled from a PC, thanks to the serial interface and PC software.

## TYPICAL FT 50 C

- High depth of field for reliable detection despite vibrations
- Up to 5 colours or colour ranges internally, or unlimited colours via RS485 serial interface
- Three different light spot geometries available
- High colour selectivity for reliable detection despite scanning distance fluctuations
- Simple teach-in or scan-in of colours
- Up to 3 result outputs
- IO Link on request

The FT 50 C white-light colour sensor is one of the most important innovations that SensoPart has placed on the sensor market in recent years. The scanner, awarded a prestigious innovation prize, offers a considerably expanded range of functions and particularly user-friendly operation compared to conventional colour sensors.

The compact sensor can administrate up to 5 reference colours or colour ranges internally. These can either be taught-in or, particularly easily, scanned-in. Separate tolerance values for colour and intensity can be defined for each taught-in reference colour. In practice, this function proves helpful when, for example, labels with fluctuating print quality must be reliably detected. The tolerances are automatically determined when the colours are scanned in. As a result of its special patented optical system – the optical “funnel” – the FT 50 C also achieves an above-average depth of field. It can thus easily detect even inexactly trans-

ported, moving or vibrating target objects, e.g. workpieces on a conveyor belt. Rapidly moving objects are also reliably detected thanks to the high switching frequency of up to 500 Hz.

The range of interfaces on the FT 50 C is also particularly varied: depending on the variant, it has up to three switching outputs, a serial RS485 interface or an IO-Link interface. The serial interface variant is not internally restricted to a maximum of five colours: as many reference colours as desired can be taught-in and transferred to the machine controller, where they can be stored – in the form of colour vectors (target values and tolerances) – for later retrieval. This range of functions, together with the high detection reliability and very user-friendly operation, is unique in this class of sensors!

FT 50 C – Product Overview				
	Type of light	Scanning distance	Special features	Page
FT 50 C	LED, white	... 32 mm	1 switching output	196
FT 50 C	LED, white	... 32 mm	3 switching outputs	198
FT 50 C	LED, white	... 32 mm	Serial interface	200
IO Box for FT 50 C				202

# FT 50 C

Colour sensor with a switching output



## PRODUCT HIGHLIGHTS

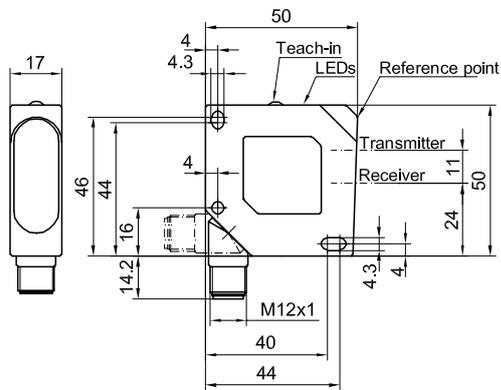
- Colours are reliably detected despite fluctuating scanning distances thanks to patented optical technology
- Very good depth of field
- Very simple setup (via button and control line)
- Even the smallest of colour differences are reliably detected due to pulsed white light
- Varying light spot sizes depending on task

Optical data		Functions	
Scanning distance	See Selection Table	Indicator LED, green	Operating voltage indicator
Scanning distance tolerance	See Selection Table	Indicator LED, yellow	Switching output indicator
Type of light	LED, white	Colour setting	Via teach-in button and control line
Light spot size	See Selection Table	Default setting	N.O.
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	12 ... 28 V DC <sup>1</sup>	Dimensions	50 x 50 x 17 mm <sup>3</sup>
No-load current, I <sub>0</sub>	≤ 40 mA	Enclosure rating	IP 67 <sup>2</sup>
Output current, I <sub>e</sub>	≤ 100 mA	Material, housing	ABS, impact-resistant
Voltage drop, U <sub>D</sub>	≤ 2.4 V	Material, front screen	PMMA
Max. capacitive load	< 100 nF	Type of connection	Plug, M12, 5-pin, rotatable
Protective circuits	Reverse-polarity protection, U <sub>B</sub> / short-circuit protection (Q)	Ambient temperature: operation	-10 ... +55 °C
Protection Class	2	Ambient temperature: storage	-20 ... +80 °C
Power On Delay	≤ 300 ms	Weight (plug device)	40 g
Input IN ET (external teach-in)	> 12 V ... 28V: button locked < 3V or open: normal operation Min. response time: 100 ms	Vibration and impact resistance	EN 60947-5-2
Input lock (button lock)	> 12 V ... 28V: button locked < 3V or open: button free		
Switching output, Q	PNP		
Output function	N.O.		
Switching frequency, f (ti/tp 1:1)	≤ 500 Hz		

<sup>1</sup> Max. 10 % ripple, within U<sub>B</sub>    <sup>2</sup> With connected IP 67 plug    <sup>3</sup> At scanning distance of 22 mm

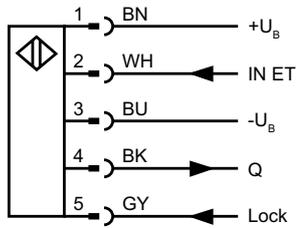
Scanning distance/Scanning distance tolerance/Light spot size	Switching output	Type of connection	Part number	Article number
12 ... 32 mm / ± 6 mm / Ø 4 mm <sup>3</sup>	PNP	Plug, M12, 5-pin	FT 50 C-1-PSL5	575-11016
15 ... 30 mm / ± 5 mm / 2 x 2 mm <sup>3</sup>	PNP	Plug, M12, 5-pin	FT 50 C-2-PSL5	575-11017
18 ... 22 mm / ± 2 mm / 5 x 1 mm <sup>3</sup>	PNP	Plug, M12, 5-pin	FT 50 C-3-PSL5	575-11018

Plug connection



153-00826

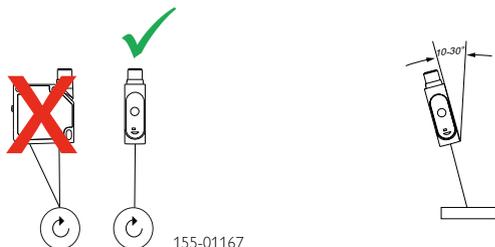
Connection, 5-pin



154-00262

7

Installation



155-01167

155-01228

Accessories

Connection cables

From Page A-32

Brackets

From Page A-4

# FT 50 C

Colour sensor with 3 switching outputs



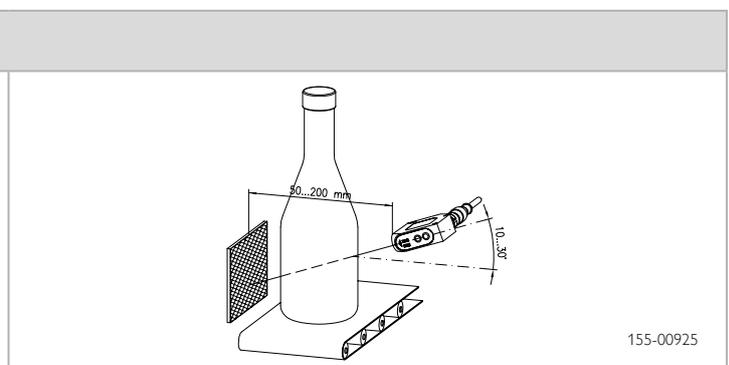
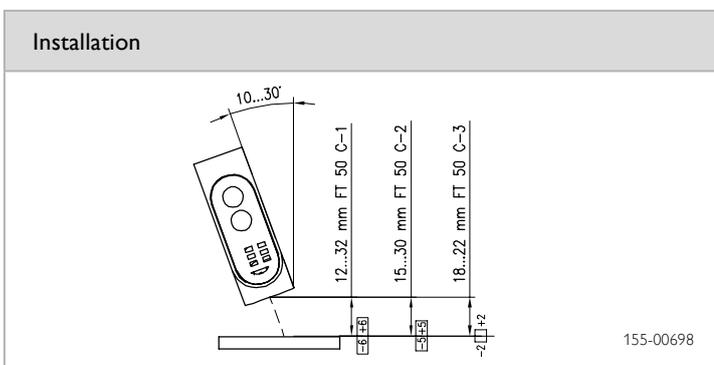
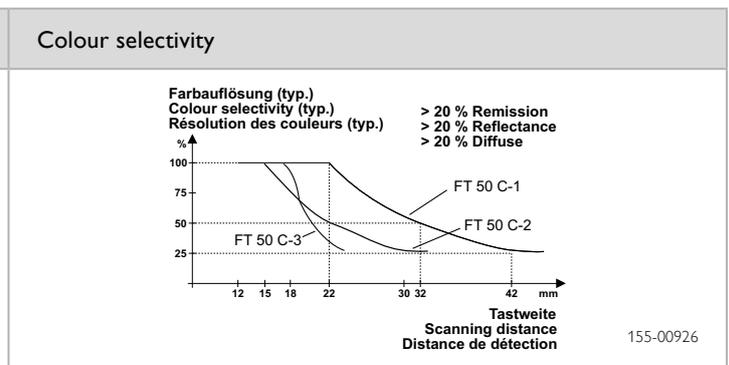
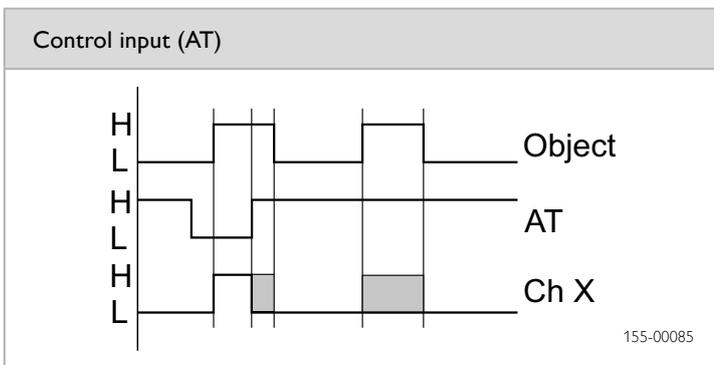
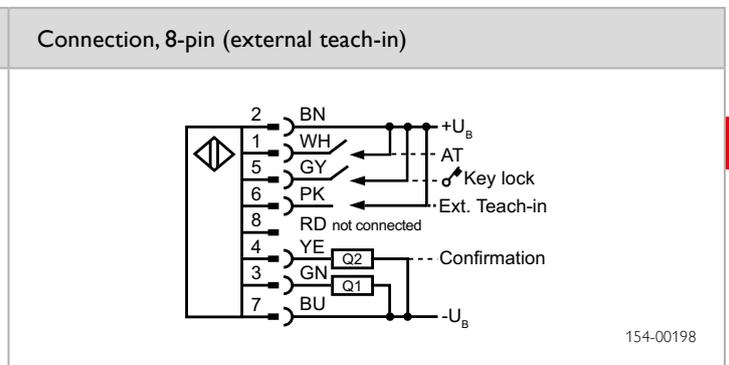
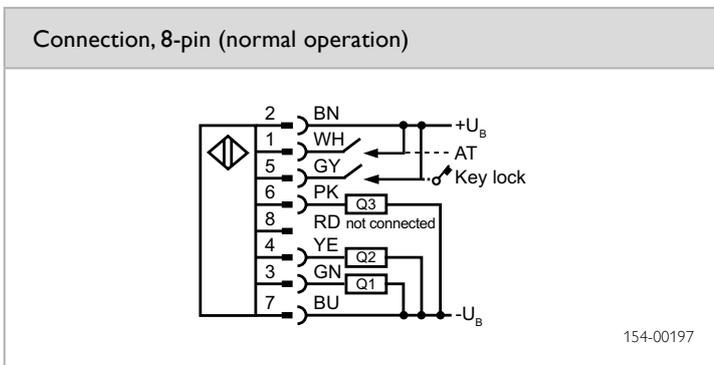
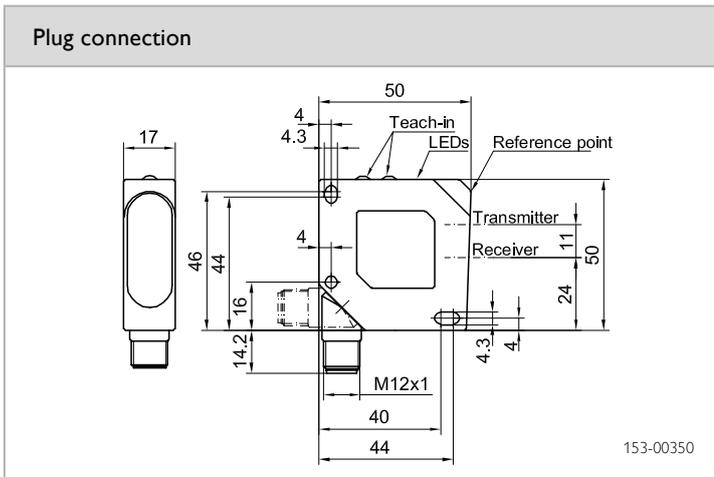
## PRODUCT HIGHLIGHTS

- Colours are reliably detected despite fluctuating scanning distances thanks to patented optical technology
- 3 colours distinguishable via 3 switching outputs
- Even the smallest of colour differences are reliably detected
- Easy teach-in of colours via Teach-in button or control line

Optical data		Functions	
Scanning distance	See Selection Table	Indicator LED, green	Operating voltage indicator
Scanning distance tolerance	See Selection Table	Indicator LED, yellow	3 x switching output indicators
Type of light	LED, white	Indicator LED, red	3 x tolerance level indicators
Light spot size	See Selection Table	Colour and tolerance settings	Via teach-in button and control line
		Adjustment possibilities	Colours taught-in via Teach-in button and control line
			Pulse stretching via Teach-in button
			Button lock via control input
		Default setting	Normal operation, Tol. 3 for X01, typ. = Tol. 5
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	12 ... 28V DC <sup>2</sup>	Dimensions	50 x 50 x 17 mm <sup>3</sup>
No-load current, I <sub>0</sub>	≤ 40 mA	Enclosure rating	IP 67 <sup>3</sup>
Output current, I <sub>e</sub>	≤ 100 mA	Material, housing	ABS, impact-resistant
Voltage drop, U <sub>d</sub>	≤ 2.4V	Material, front screen	PMMA
Protective circuits	Reverse-polarity protection, U <sub>B</sub> / short-circuit protection (Q)	Type of connection	See Selection Table
Protection Class	2	Ambient temperature: operation	-10 ... +55 °C
Power On Delay	≤ 300 ms	Ambient temperature: storage	-20 ... +80 °C
Switching output, Q	3 x PNP	Weight (plug device)	40 g
Output function	N.O.	Vibration and impact resistance	EN 60947-5-2
Switching frequency, f (ti/tp 1:1)	500 Hz		
Response time	10 ms		
Control input, AT	> 12V ... 28V = triggered < 3V / open = free-running Response time: 10 ms		
Control input, KeyLock	> 12V ... 28V = button locked < 3V / open = normal operation Pulse stretching / release delay: 50 ms		
Control input, Ext. Teach-in (normal operation Q3)	> 12V ... 28V = Teach-in < 3V / open = normal operation Min. response time: 2 ms		

<sup>1</sup> At scanning distance of 22 mm    <sup>2</sup> Max. 10 % ripple, within U<sub>B</sub>    <sup>3</sup> With connected IP 67 plug

Scanning distance/Scanning distance tolerance/Light spot size	Switching output	Type of connection	Part number	Article number
12 ... 32 mm / ± 6 mm / Ø 4 mm <sup>1</sup>	3 x PNP	Plug, M12, 8-pin	FT 50 C-1-PSL8	575-11000
15 ... 30 mm / ± 5 mm / 2 x 2 mm <sup>1</sup>	3 x PNP	Plug, M12, 8-pin	FT 50 C-2-PSL8	575-11003
18 ... 22 mm / ± 2 mm / 5 x 1 mm <sup>1</sup>	3 x PNP	Plug, M12, 8-pin	FT 50 C-3-PSL8	575-11004



### Accessories

Connection cables	From Page A-32
Brackets	From Page A-4

# FT 50 C

## Colour sensor with serial switching interface



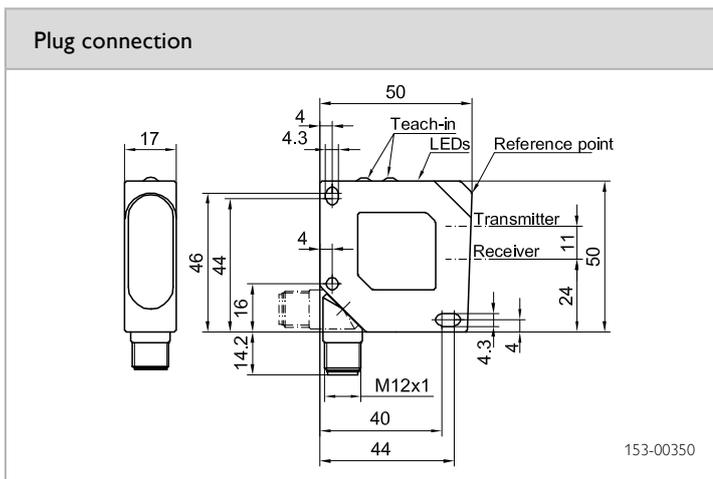
### PRODUCT HIGHLIGHTS

- Colours are reliably detected despite fluctuating scanning distances thanks to patented optical technology
- Transfer of colour channel or colour value, as well as reading, modification and storage of sensor parameters, via RS485 interface
- Even the smallest of colour differences are reliably detected
- ColourScan function for detection of colour ranges
- Reliable detection of even the smallest of coloured objects

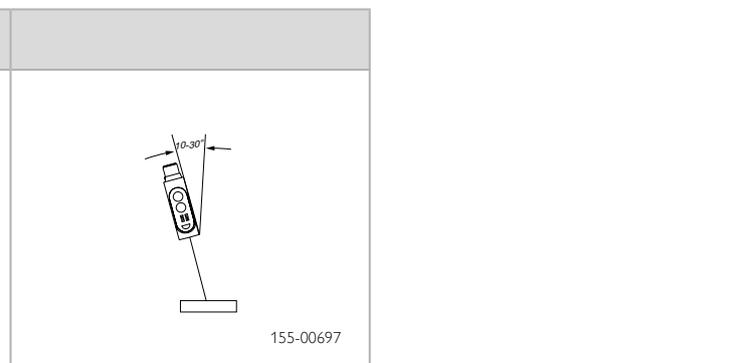
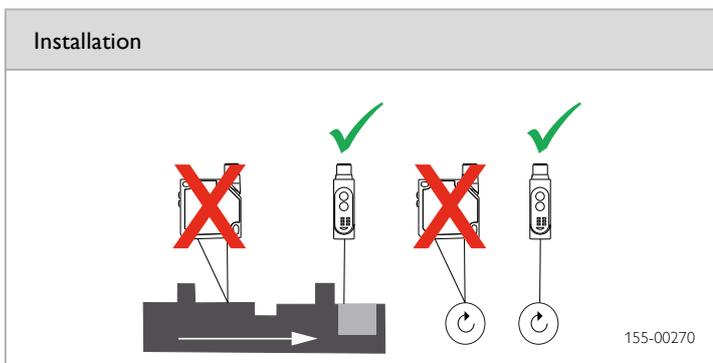
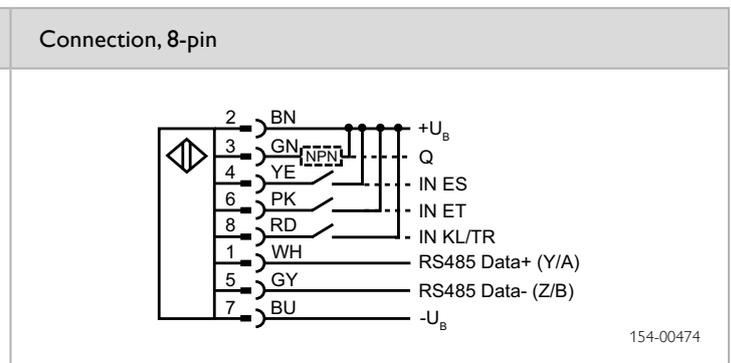
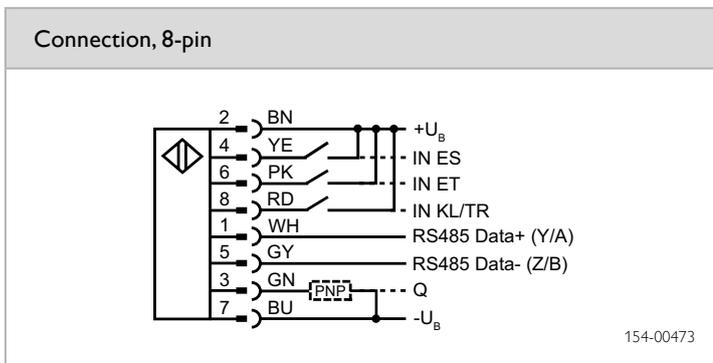
Optical data		Functions	
Scanning distance	See Selection Table	Indicator LED, green	Operating voltage indicator
Scanning distance tolerance	See Selection Table	3 x indicator LEDs, yellow	Switching output indicators
Type of light	LED, white	3 x indicator LEDs, red	Tolerance level indicators
Light spot size	See Selection Table	Colour & tolerance setting	Via teach-in button and control line
		Default setting	White, 90 %, taught-in, sensor address = 1 (RS485)
		Supplementary functions	ColourScan, triggering, teach-in, button lock
Electrical data		Mechanical data	
Operating voltage, +U <sub>b</sub>	12 ... 28 V DC <sup>1</sup>	Dimensions	50 x 50 x 17 mm <sup>3</sup>
No-load current, I <sub>0</sub>	≤ 40 mA	Enclosure rating	IP 67 <sup>3</sup>
Output current, I <sub>e</sub>	≤ 100 mA	Material, housing	ABS, impact-resistant
Voltage drop, U <sub>D</sub>	≤ 2.4 V	Material, front screen	PMMA
Max. capacitive load	< 100 nF	Type of connection	Plug, M12x1, 8-pin, rotatable
Protective circuits	Reverse-polarity protection, U <sub>b</sub> / short-circuit protection (Q) (not RS485)	Ambient temperature: operation	-10 ... +55 °C
Protection Class	2	Ambient temperature: storage	-20 ... +80 °C
Power On Delay	< 300 ms	Weight (plug device)	40 g
Switching output, Q	See Selection Table	Vibration and impact resistance	EN 60947-5-2
Output function	N.O. / N.C.		
Switching frequency, f (ti/tp 1:1)	Max. 500 Hz		
Time stage for Q	50 ms release delay, adjustable		
Control input, KL / TR	Button lock input (KL) or triggering (TR), adjustable		
Control input, IN ET	PNP / NPN, input for external teach-in		
Min. response time	2 ms		
Control input, IN ES	PNP / NPN, input for external scanning		
Serial interface	RS485 (half-duplex)		

<sup>1</sup> At scanning distance of 22 mm    <sup>2</sup> Max. 10 % ripple, within U<sub>b</sub>    <sup>3</sup> With connected IP 67 plug

Scanning distance/Scanning distance tolerance/Light spot size	Switching output	Type of connection	Part number	Article number
12 ... 32 mm / ± 6 mm / Ø 4 mm <sup>1</sup>	PNP	Plug, M12, 8-pin	FT 50 C-1-PS1-L8	575-11007
12 ... 32 mm / ± 6 mm / Ø 4 mm <sup>1</sup>	NPN	Plug, M12, 8-pin	FT 50 C-1-NS1-L8	575-11010
15 ... 30 mm / ± 5 mm / 2 x 2 mm <sup>1</sup>	PNP	Plug, M12, 8-pin	FT 50 C-2-PS1-L8	575-11008
15 ... 30 mm / ± 5 mm / 2 x 2 mm <sup>1</sup>	NPN	Plug, M12, 8-pin	FT 50 C-2-NS1-L8	575-11011
18 ... 22 mm / ± 2 mm / 5 x 1 mm <sup>1</sup>	PNP	Plug, M12, 8-pin	FT 50 C-3-PS1-L8	575-11009
18 ... 22 mm / ± 2 mm / 5 x 1 mm <sup>1</sup>	NPN	Plug, M12, 8-pin	FT 50 C-3-NS1-L8	575-11012



7



### Accessories

Connection cables	From Page A-32
Brackets	From Page A-4
Progsensor software	<a href="http://www.sensopart.com">www.sensopart.com</a>

# IO Box

Expansion box for FT 50 C



## PRODUCT HIGHLIGHTS

- Input/output expansion for FT50C...-S1L8 colour sensors
- Up to 32 colours can be stored
- 32 PNP output channels
- Definition of colour sequences and colour groups
- ColourScan function
- Display for simple visualisation and operator guidance
- Time function selectable
- DIN rail mounting

Functions	
Off-delay	5 ms to 2000 ms in increments
On-delay	5 ms to 2000 ms in increments
Wipe function (shot)	5 ms to 2000 ms in increments
Output function	Conversion between N.C. and N.O. for each individual switching output

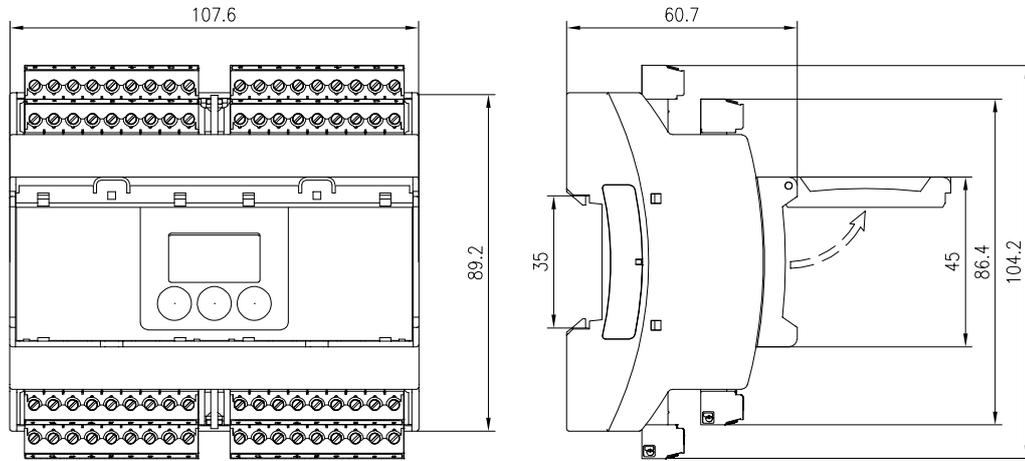
  

Electrical data		Mechanical data	
Operating voltage, +U <sub>b</sub>	24V DC ± 10 %	Dimensions	107.6 × 104.2 × 60.7 mm <sup>3</sup> (lid closed)
No-load current, I <sub>0</sub>	≤ 250 mA	Enclosure rating	IP 20
Switching output, Q	32 × PNP	Material, housing	Plastic
Switching frequency, f (ti/tp 1:1)	166 Hz in combination with colour sensor FT 50 C ... S1L8	Connection system	Screw clamp contacts
On-delay t <sub>On</sub> switching output	≤ 2 ms	Ambient temperature: operation	0 ... +50 °C
Off-delay t <sub>Off</sub> switching output	≤ 2 ms	Ambient temperature: storage	0 ... +50 °C
Maximal permissible cable length	Power supply 3 m, otherwise 30 m	Vibration and impact resistance	EN 60947-5-2
Serial interface	RS485 Z/B / RS485 Y/A		

Part number	Article number
T-CS1T-12T34PRD	533-01007

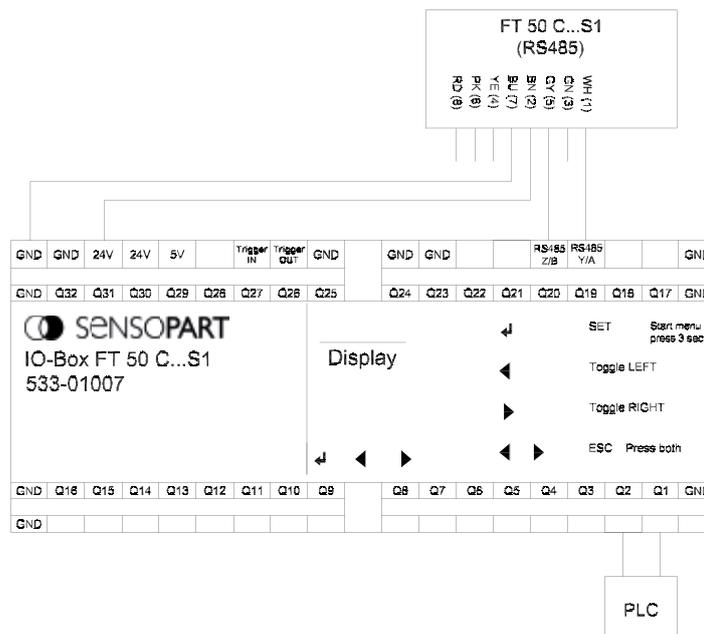
Accessories (not included in scope of delivery of colour terminal)	
Part number	Article number
FT 50 C-1-PS1-L8	575-11007
FT 50 C-2-PS1-L8	575-11008
FT 50 C-3-PS1-L8	575-11009
FT 50 C-1-NS1-L8	575-11010
FT 50 C-2-NS1-L8	575-11011
FT 50 C-3-NS1-L8	575-11012

Dimensional drawing, IO Box



153-00795

Connection IO Box



155-01763

Accessories

Connection cables  
Brackets

From Page A-32  
From Page A-4

# FT 25 – Contrast sensor

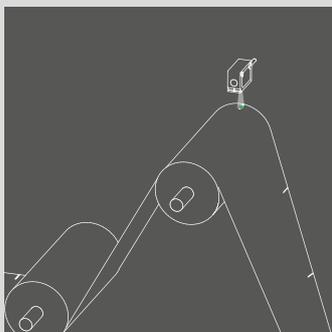
Miniature housing, maximum performance



 made in Germany



*Rod mounting MBD F 25ST allows user-friendly and precise sensor alignment (see accessories).*

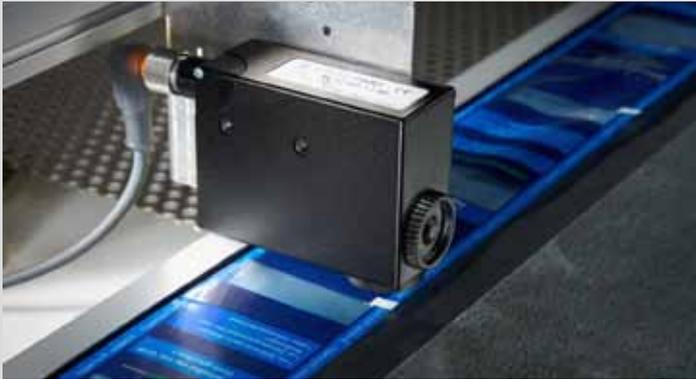


## Areas of application:

- Printing machines
- Labelling machines
- Horizontal packaging machines
- Vertical packaging machines
- Bottling plants

## TYPICAL FT 25-W/-RGB

- Precise detection of any printed marks
- High positioning accuracy thanks to minimum response time
- High switching frequency of 25 kHz with compact miniature housing
- Small, precise light spot with sharp contour for easy sensor alignment and detection of even the smallest of printed marks
- Feedback via light spot (simple, comprehensible, clearly defined)
- Dynamic, static or external teach-in
- High depth of field
- White-light LED or RGB diode options available



**Out with the old, in with the new:** The contrast sensors from the F 25 series are assembly and connection compatible with the conventional standard housing (image on the left). The fastening bores are aligned in the same distance from each other. The integrated cable with a M12-connector fits to the corresponding mating connector.

Contrast sensors are mainly used for printed mark detection in very rapid processes in the print and packaging industries. SensoPart offers high quality products – with white-light LED (FT 25-W, FT 20WT series), red-light laser (FT 25-RL) or RGB diode (FT 25-RGB) options.

While the white-light and RGB scanners can detect even the smallest of contrast differences, the red-light laser offers the advantage of a particularly small light spot ( $\varnothing$  0.7 mm in focus) in combination with a long scanning distance.

The sensors can be configured during running operation via teach-in, whereby the switching threshold is automatically adapted to object and mark colours and the background. After teach-in, the quality of the taught-in contrast is communicated via the light spot. Users thus receive unambiguous feedback on how reliable their process is.

FT 25 / FT 20 – Product Overview				
	Type of light	Scanning distance	Special features	Page
FT 25-W	White LED	12 ± 2,5 mm	Minimal response time	206
FT 25-RGB	Red LED, green LED, blue LED	12 ± 3 mm	Automatic selection of ideal transmission colour; minimal response time	208
FT 25-RL	Laser 	250 mm	Long scanning distance	210
FT 20 WT	White LED	17 ± 2 mm		212

# FT 25-WV

## White-light contrast sensor



### PRODUCT HIGHLIGHTS

- Precise detection of the slightest contrast differences
- Very robust operation despite fluttering and glossy objects
- Simple alignment through very precise and easily visible light spot
- Housings that are many times smaller than standard housings – and offer better performance
- Very high positioning accuracy with 10 μs scanning

Optical data		Functions	
Scanning distance	12 mm	Indicator LED, green	Operating voltage indicator
Depth of field	± 2.5 mm	Indicator LED, yellow	Switching output indicator
Type of light	White LED, 400 ... 780 nm	Sensitivity adjustment	Via teach-in button and control line
Light spot size	1 x 4 mm <sup>2</sup>	Teach-in modes	Mode 1: with running process Mode 2: with standing process
		Adjustment possibilities	LO / DO DO via Teach-in button and control line Button lock via control input
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	10 ... 30V DC <sup>1</sup>	Dimensions	34 x 20 x 12 mm <sup>3</sup>
No-load current, I <sub>0</sub>	≤ 25 mA	Enclosure rating	IP 69K & IP 67 <sup>3</sup>
Output current, I <sub>e</sub>	≤ 100 mA	Material, housing	ABS
Protective circuits	Reverse-polarity protection, U <sub>B</sub> / short-circuit protection (Q)	Material, front screen	PMMA
Protection Class	2	Type of connection	See Selection Table
Power On Delay	< 300 ms	Ambient temperature: operation	-20 ... +55 °C
Switching output, Q	PNP / NPN, push-pull	Ambient temperature: storage	-20 ... +80 °C
Output function	LO / DO	Weight (plug device)	10 g
Switching frequency, f (ti/tp 1:1) <sup>2</sup>	See Selection Table	Weight (integrated cable)	20 g
Response time	See Selection Table	Vibration and impact resistance	EN 60947-5-2
Jitter (electrical)	See Selection Table		

<sup>1</sup> Max. 10 % ripple, within U<sub>B</sub>, ~ 50 Hz / 100 Hz    <sup>2</sup> f = 1 / (T x Nyq x 2)    <sup>3</sup> With connected IP 67 / IP 69K plug

Switching frequency, f (ti/tp 1:1) <sup>2</sup>	Response time	Jitter (electrical)	Type of connection	Part number	Article number
≤ 25000 Hz	≤ 20 μs	10 μs	Metal plug, M8x1, 4-pin	FT 25-W1-GS-M4M	607-21013
≤ 25000 Hz	≤ 20 μs	10 μs	Integrated cable: 150 mm with plug M12x1, 4-pin	FT 25-W1-GS-KL4	607-21012
≤ 10000 Hz	≤ 50 μs	25 μs	Plug, M8x1, 4-pin	FT 25-W2-GS-M4	607-21014
≤ 10000 Hz	≤ 50 μs	25 μs	Integrated cable: 150 mm with plug M12x1, 4-pin	FT 25-W2-GS-KL4	607-21015

Plug connection	Integrated cable
<p style="text-align: right;">153-00995</p>	<p style="text-align: right;">153-00996</p>

Connection, 4-pin	Signal process
<p style="text-align: right;">154-00320</p>	<p style="text-align: right;">155-01647</p>

Accessories	
Connection cables	From Page A-32
Brackets	From Page A-4

# FT 25-RGB

Multi-colour contrast sensor



## PRODUCT HIGHLIGHTS

- Precise detection of the slightest of contrast differences through multi-colour RGB evaluation
- Very robust operation despite fluttering and glossy objects
- Simple alignment thanks to very precise and easily visible light spot
- Communication via 3-colour light spot (simple, comprehensible, clearly defined)
- Very accurate positioning due to rapid scanning rate of 10  $\mu$ s

Optical data		Functions	
Scanning distance	12 mm	Indicator LED, green	Operating voltage indicator
Depth of field	$\pm$ 3 mm	Indicator LED, yellow	Switching output indicator
Type of light	Red LED Green LED Blue LED	Sensitivity adjustment	Via teach-in button and control line
Light spot size	1 x 4 mm <sup>2</sup>	Teach-in modes	Mode 1: with running process Mode 2: with standing process
		Adjustment possibilities	LO / DO via Teach-in button and control line Button lock via control input
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	10 ... 30V DC <sup>1</sup>	Dimensions	34 x 20 x 12 mm <sup>3</sup>
No-load current, I <sub>0</sub>	$\leq$ 25 mA	Enclosure rating	IP 69K & IP 67 <sup>3</sup>
Output current, I <sub>e</sub>	$\leq$ 100 mA	Material, housing	ABS
Protective circuits	Reverse-polarity protection, U <sub>B</sub> / short-circuit protection (Q)	Material, front screen	PMMA
Protection Class	2	Type of connection	See Selection Table
Power On Delay	< 300 ms	Ambient temperature: operation	-20 ... +55 °C <sup>4</sup>
Switching output, Q	PNP / NPN, push-pull	Ambient temperature: storage	-20 ... +80 °C
Output function	LO / DO	Weight (plug device)	10 g
Switching frequency, f (ti/tp 1:1) <sup>2</sup>	See Selection Table	Weight (integrated cable)	20 g
Response time	See Selection Table	Vibration and impact resistance	EN 60947-5-2
Jitter (electrical)	See Selection Table		

<sup>1</sup> Max. 10 % ripple, within U<sub>B</sub>, ~ 50 Hz / 100 Hz    <sup>2</sup> f = 1 / (T x Nyq x 2)    <sup>3</sup> With connected IP 67 / IP 69K plug    <sup>4</sup> UL: -20 ... +50 °C

Switching frequency, f (ti/tp 1:1) <sup>2</sup>	Response time	Jitter (electrical)	Type of connection	Part number	Article number
$\leq$ 25000 Hz	$\leq$ 20 $\mu$ s	< 10 $\mu$ s	Metal plug, M8x1, 4-pin	FT 25-RGB1-GS-M4M	607-21011
$\leq$ 25000 Hz	$\leq$ 20 $\mu$ s	< 10 $\mu$ s	Integrated cable: 150 mm with plug M12x1, 4-pin	FT 25-RGB1-GS-KL4	607-21010
$\leq$ 10000 Hz	$\leq$ 50 $\mu$ s	< 25 $\mu$ s	Plug, M8x1, 4-pin	FT 25-RGB2-GS-M4	607-21017
$\leq$ 10000 Hz	$\leq$ 50 $\mu$ s	< 25 $\mu$ s	Integrated cable: 150 mm with plug M12x1, 4-pin	FT 25-RGB2-GS-KL4	607-21018

Plug connection	Integrated cable
<p style="text-align: right;">153-00995</p>	<p style="text-align: right;">153-00996</p>

Connection, 4-pin	Signal process
<p style="text-align: right;">154-00320</p>	<p style="text-align: right;">155-01648</p>

Accessories	
Connection cables	From Page A-32
Brackets	From Page A-4

# FT 25-RL

## Laser contrast sensor



### PRODUCT HIGHLIGHTS

- Differentiation even with low grey value differences at long scanning distances
- Sensor setup via teach-in and control input
- Resilient laser printing
- Very small, easily visible laser light spot
- Large range of variants

Optical data		Functions	
Scanning distance	1 ... 250 mm <sup>1</sup>	Indicator LED, green	Operating voltage indicator
Adjustment range	25 ... 250 mm <sup>1</sup>	Indicator LED, yellow	Switching output indicator
Type of light	Laser, red, 650 nm	Sensitivity adjustment	Via teach-in button and control line
Light spot size	See diagram	Teach-in modes	Mode 1: with running process
Laser Class (DIN EN 60825-1:2008-5)	1	Adjustment possibilities	Mode 2: with standing process
Hysteresis	≤ 10% <sup>2</sup>	Default setting	LO / DO via Teach-in button and control line
			Button lock via control input
			Max. scanning distance and N.O.
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	10 ... 30V DC <sup>3</sup>	Dimensions	34 × 20 × 12 mm <sup>3</sup>
No-load current, I <sub>0</sub>	≤ 30 mA	Enclosure rating	IP 69K & IP 67 <sup>4</sup>
Output current, I <sub>e</sub>	≤ 100 mA	Material, housing	ABS
Protective circuits	Reverse-polarity protection, U <sub>B</sub> / short-circuit protection (Q)	Material, front screen	PMMA
Protection Class	2	Type of connection	See Selection Table
Power On Delay	< 300 ms	Ambient temperature: operation	-20 ... +60 °C
Switching output, Q	PNP / NPN (See Selection Table)	Ambient temperature: storage	-20 ... +80 °C
Output function	LO / DO	Weight (plug device)	10 g
Switching frequency, f (ti/tp 1:1)	≤ 1500 Hz	Weight (cable device)	40 g
Response time	333 μs	Weight (integrated cable)	20 g
Control input, IN	+U <sub>B</sub> = teach-in -U <sub>B</sub> = button locked open = normal operation	Vibration and impact resistance	EN 60947-5-2

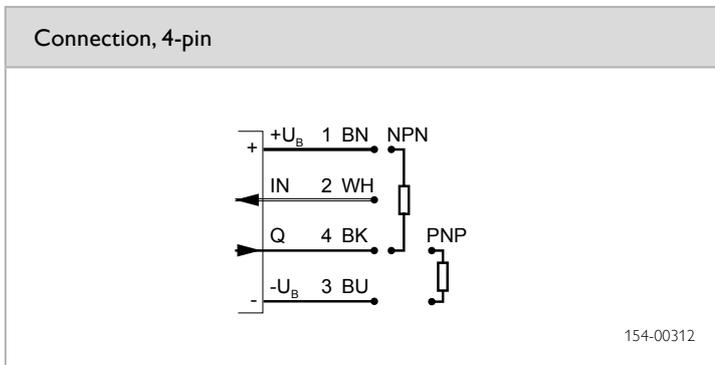
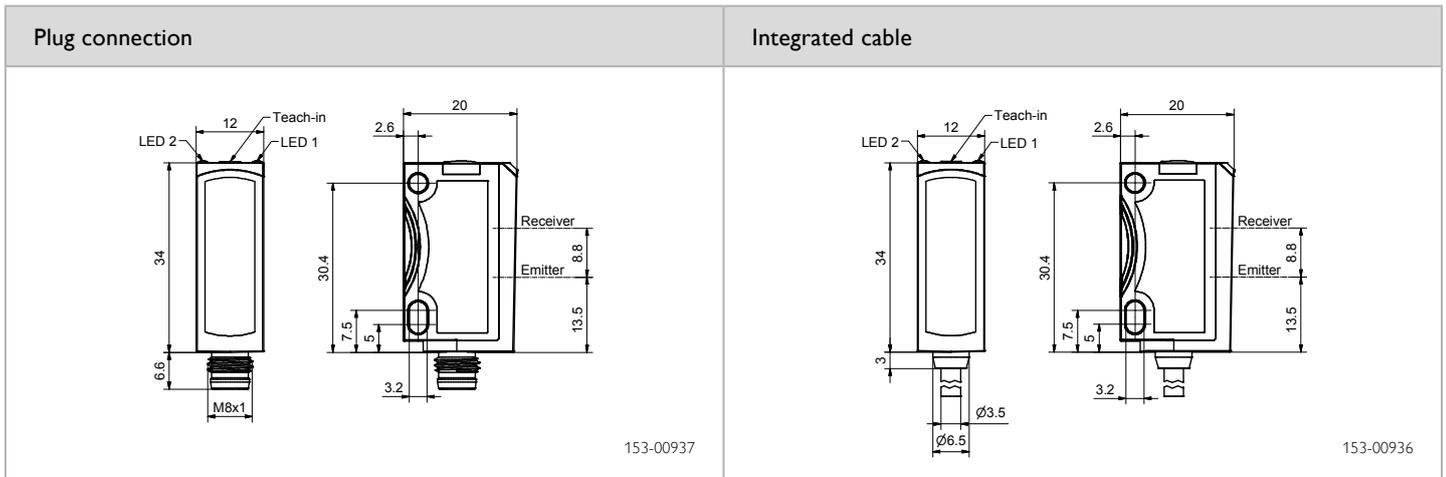
<sup>1</sup> Reference material: white, 90 % reflectivity

<sup>2</sup> Up to scanning distance of 150 mm

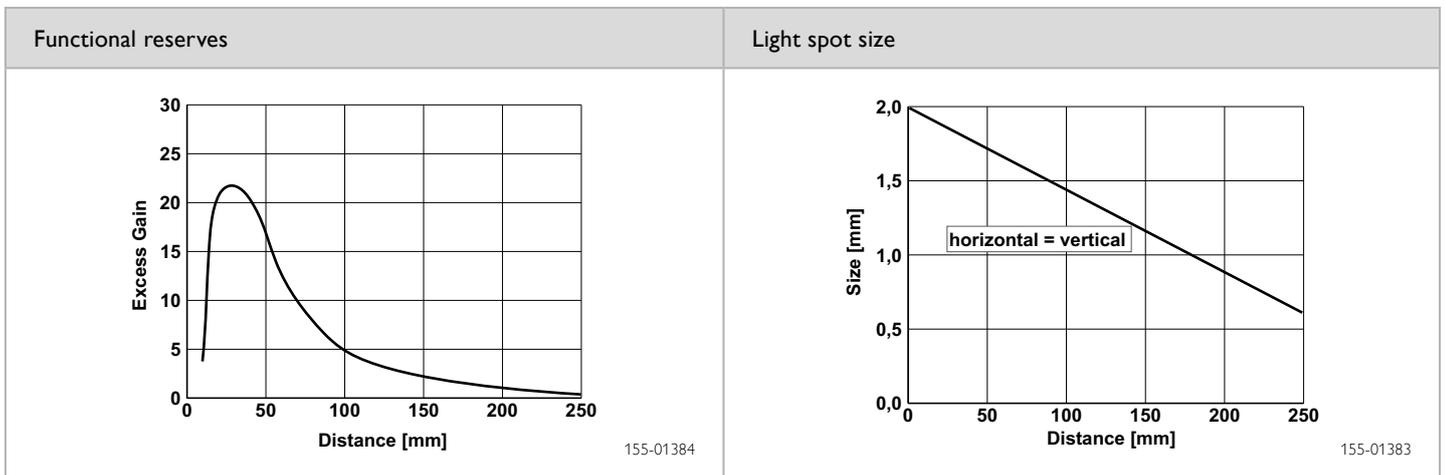
<sup>3</sup> Max. 10 % ripple, within U<sub>B</sub>, ~ 50 Hz / 100 Hz

<sup>4</sup> With connected IP 67 / IP 69K plug

Scanning distance	Switching output	Type of connection	Part number	Article number
1 ... 250 mm	PNP	Metal plug, M8x1, 4-pin	FT 25-RL-PS-M4M	609-21013
1 ... 250 mm	NPN	Metal plug, M8x1, 4-pin	FT 25-RL-NS-M4M	609-21014
1 ... 250 mm	PNP	Cable, 2 m, 4-wire	FT 25-RL-PS-K4	609-21010
1 ... 250 mm	NPN	Cable, 2 m, 4-wire	FT 25-RL-NS-K4	609-21008
1 ... 250 mm	PNP	Integrated cable: 150 mm with plug M12, 4-pin	FT 25-RL-PS-KL4	609-21012
1 ... 250 mm	NPN	Integrated cable: 150 mm with plug M12, 4-pin	FT 25-RL-NS-KL4	609-21009



7



Reference material	Detection range
White (90 %)	1 ... 250 mm
Grey (18 %)	6 ... 100 mm
Black (6 %)	20 ... 60 mm

Accessories	
Connection cables	From Page A-32
Brackets	From Page A-4

# FT 20 WT

## White-light contrast sensor



### PRODUCT HIGHLIGHTS

- Small rectangular light spot – ideal for detecting even the smallest of marks
- 30 contrast levels (resolution)
- Depth of field:  $\pm 2$  mm
- Switching frequency: 5 kHz
- N.O. / N.C. selectable
- Dynamic / static / external teach-in possible

Optical data		Functions	
Scanning distance	17 mm	Indicator LED, green	Operating voltage indicator
Depth of field	$\pm 2$ mm	Indicator LED, yellow	Switching output indicator
Type of light	LED, white, 400 ... 600 nm	Sensitivity adjustment	Via teach-in button and control line
Light spot size	$< 1.5 \times 4$ mm	Teach-in modes	Mode 1: with running process
Resolution	30 contrast levels	Adjustment possibilities	Mode 2: with standing process
		Default setting	Light-switching /dark-switching via Teach-in button and control input
			Button lock via control input
			Max. sensitivity and dark-switching
Electrical data		Mechanical data	
Operating voltage, $+U_B$	10 ... 30V DC	Dimensions	$32 \times 20 \times 12$ mm <sup>3</sup>
No-load current, $I_0$	$\leq 25$ mA	Enclosure rating	IP 67 <sup>1</sup>
Output current, $I_e$	$\leq 100$ mA	Material, housing	ABS
Protective circuits	Reverse-polarity protection, $U_B$ / short-circuit protection (Q)	Material, front screen	PMMA
Protection Class	2	Type of connection	See Selection Table
Power On Delay	$< 300$ ms	Ambient temperature: operation	$-20 \dots +60$ °C
Switching output, Q	PNP / NPN (see Selection Table)	Ambient temperature: storage	$-20 \dots +80$ °C
Output function	Light-switching / dark-switching	Weight (plug device)	10 g
Switching frequency, f (ti/tp 1:1)	$\leq 5000$ Hz	Weight (cable device)	40 g
Response time	100 $\mu$ s	Vibration and impact resistance	EN 60947-5-2
Control input, IN	$+U_B$ = teach-in $-U_B$ = button locked open = normal operation		

<sup>1</sup>With connected IP 67 plug

Scanning distance	Switching output	Type of connection	Part number	Article number
17 $\pm$ 2 mm	PNP	Metal plug, M8x1, 4-pin	FT 20 WT-PSM4	551-61000
17 $\pm$ 2 mm	NPN	Metal plug, M8x1, 4-pin	FT 20 WT-NSM4	551-61001
17 $\pm$ 2 mm	PNP	Cable, 2 m, 4-wire	FT 20 WT-PSK4	551-61002
17 $\pm$ 2 mm	NPN	Cable, 2 m, 4-wire	FT 20 WT-NSK4	551-61003



# FT 50 C-UV – luminescence sensor

An eye for the invisible



 made in Germany



*Simple sensor adjustment via Teach-in button or external control line.*

*The FT 50 C-UV is very robust and dazzle-proof due to its reliable optical concept.*

## TYPICAL FT 50 C-UV

- Very reliable detection regardless of object surface
- Teach-in for setup of differing objects by means of button or external control line
- Reliable detection even with minimum amounts of luminophores
- Wide scanning range provides reliable detection with varying object distances
- Small precise light spot for maximum positioning & small part accuracy
- Robust and dazzle-proof operation, e.g. on glass and highly reflective metals
- Rotatable plug (270°)
- UL certification

Low contrast or colour differences between printed marks and objects, or uneven object surfaces (e.g. rough, mottled or printed surfaces), frequently prove problematic for conventional colour and contrast sensors. The evaluation of luminescent features offers a simple and reliable alternative in these cases, or when marks are intended to be invisible on a product. Thus printed labels or the package inserts for medicines can be checked, chalk marks on wooden surfaces can be detected, and bottles can be positioned in the filling plant with the help of invisible printed marks. Other applications include checking the presence of oils with added luminescent materials, or monitoring glue application on paper.

With its three-range reception system, the FT 50 C-UV can evaluate luminescences over the entire spectral range of visible light – users can easily choose the desired RGB partial spectrum via teach-in. This differentiates the SensoPart solution from most of the UV sensors available on the market, which require appropriate filters to achieve this. The FT 50 C-UV can also distinguish between differing luminophores on the basis of the frequency of the emitted light.

The powerful sensor detects even minimal amounts of luminophores, and thus operates very reliably. Highly reflective surfaces or varying object distances, e.g. with fluttering objects such as paper or when there is a batch change, have no effect at all on proper function. An absolutely reliable automation solution made by SensoPart!

7

FT 50 C-UV – Product Overview			
	Type of light	Scanning distance	Page
FT 50 C-UV	UV diode	5 ... 50 mm	216

# FT 50 C-UV

Luminescence sensor



## PRODUCT HIGHLIGHTS

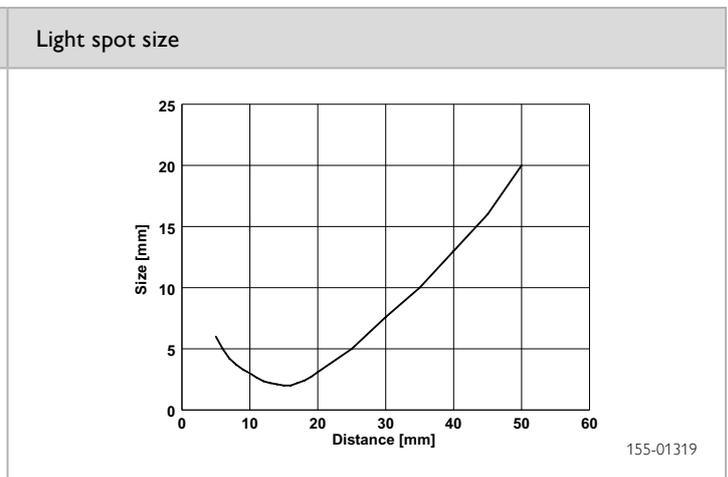
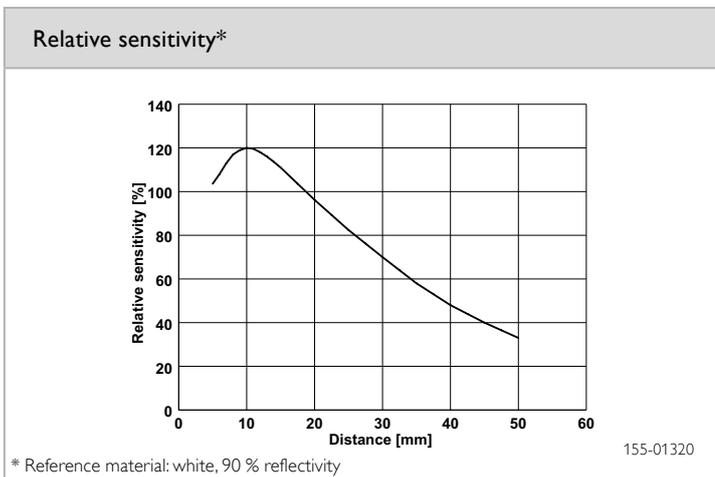
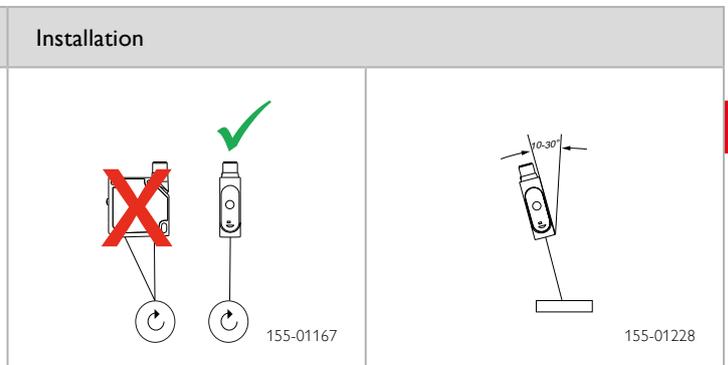
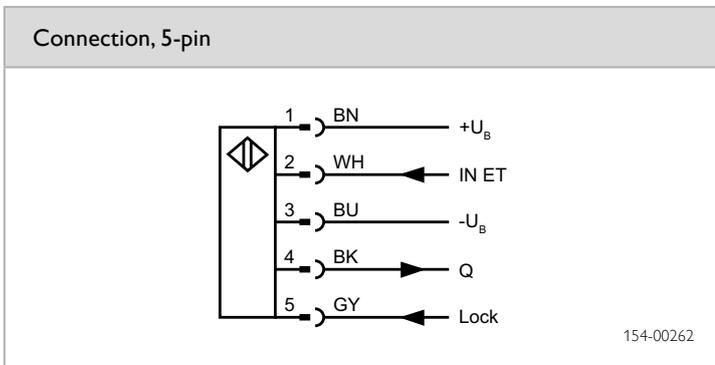
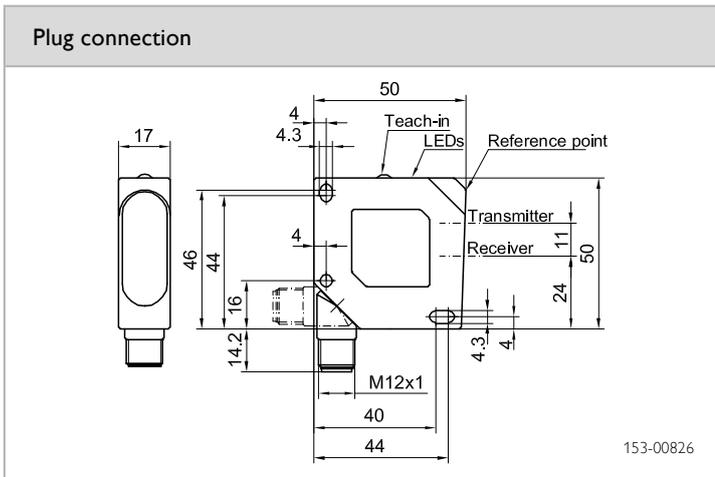
- Detection of luminescent materials, e.g. in paper, oil and glues
- Precise, small light spot for maximum positioning accuracy
- Flexibility through large scanning range
- Robust, dazzle-proof operation
- Plug rotatable for simple integration in the machine

Optical data		Functions	
Scanning distance	5 ... 50 mm	Indicator LED, green	Operating voltage indicator
Optimum scanning distance	18 mm	Indicator LED, yellow	Switching output indicator
Type of light	UV diode, 375 nm <sup>1</sup>	Sensitivity adjustment	Via teach-in button and control line
Light spot size	See diagram	Teach-in	During standing process
		Adjustment possibilities	Button lock via control input
		Default setting	Max. sensitivity and N.O.
Electrical data		Mechanical data	
Operating voltage, +U <sub>B</sub>	12 ... 28V DC <sup>2</sup>	Dimensions	50 x 50 x 17 mm <sup>3</sup>
No-load current, I <sub>0</sub>	≤ 40 mA	Enclosure rating	IP 67 <sup>4</sup>
Output current, I <sub>e</sub>	≤ 100 mA	Material, housing	ABS
Voltage drop, U <sub>D</sub>	≤ 2.4V	Material, front screen	Glass
Max. capacitive load	< 100 nF	Type of connection	(See Selection Table)
Protective circuits	Reverse-polarity protection, U <sub>B</sub> / short-circuit protection (Q)	Ambient temperature: operation	-10 ... +55 °C
Protection Class	2	Ambient temperature: storage	-20 ... +80 °C
Power On Delay	< 300 ms	Weight (plug device)	40 g
Switching output, Q	PNP	Vibration and impact resistance	EN 60947-5-2
Output function	N.O.		
Switching frequency, f (ti/tp 1:1)	≤ 500 Hz		
Response time	1 ms		
Control input, ET <sup>3</sup>	12V ... 28V = teach-in < 3V / open = normal operation		
Control input, Lock	12V ... 28V = button locked < 3V / open = normal operation (button free)		

<sup>1</sup> Risk-free at observation distances of > 60 mm acc. to DIN EN 62471:2008. Do not look into beam at observation distances of < 60 mm.

<sup>2</sup> Max. 10 % ripple, within U<sub>B</sub>, ~ 50 Hz / 100 Hz    <sup>3</sup> Min. response time 100 ms    <sup>4</sup>With connected IP 67 / IP 69K plug

Scanning distance	Switching output	Type of connection	Part number	Article number
5 ... 50 mm	PNP	Plug, M12x1, 5-pin	FT 50 C-UV-1-PSL5	575-11020



### Accessories

Connection cables	From Page 670
Brackets	From Page 642