

# SI-COLO Series

## ▶ SI-COLO2-LWL-HAMP-COL4

- Big measuring range: typ. 25 mm ... 40 mm (with optical fiber and attachment optics KL-14 or KL-17)
- Large assortment of optical fibers available (reflected or transmitted light operation)
- Insensitive to outside light due to modulated white-light LED
- RS232 - interface (USB adapter available)
- Detection of extremely dark objects
- 'Averaging' can be activated (from 1 up to over 32000 values)
- Up to 4 colors can be stored\*
- Dynamic range indication when only 1 color is taught respectively when COL-TEACH-BOX-2 is used
- External teaching by means of COL-TEACH-BOX-2



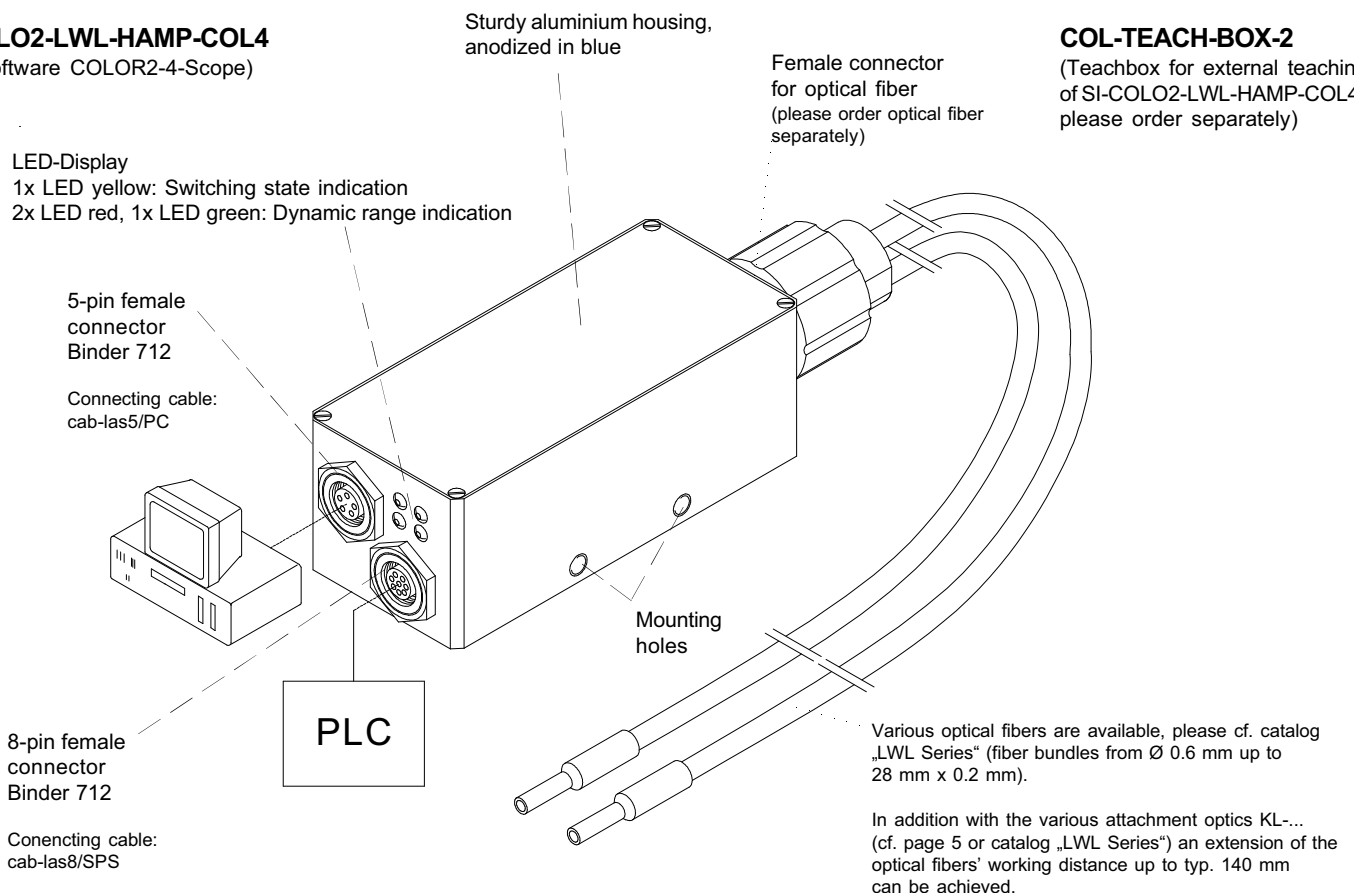
## Design

### Product name:

**SI-COLO2-LWL-HAMP-COL4**  
(incl. software COLOR2-4-Scope)

### Accessories:

**COL-TEACH-BOX-2**  
(Teachbox for external teaching of SI-COLO2-LWL-HAMP-COL4, please order separately)



### Parameterization under Windows® with software COLOR2-4-Scope:

The color sensor SI-COLO2-LWL-HAMP-COL4 can be parameterized via serial interface (RS232) under Windows® (please cf. pages 6-8). One color\* can be taught and stored in the sensor. If the sensor detects one of the taught colors, a change of switching state is performed through 4 encoded digital outputs (visual display by means of 4 LEDs at the housing: The yellow LED indicates the switching state, the two red LEDs indicate that the dynamic range was left to the top or to the bottom, whereas the green LED indicates that the sensor is in the dynamic range).

\* Optionally up to 4 colors can be taught, however then the dynamic range indication is not possible.



**Technical Data**

<b>Model</b>	<b>SI-COLO2-LWL-HAMP-COL4</b>
Light source	Super bright white-light LED, modulated 100 kHz
Light spot dimensions	Depends on the optical fiber used respectively attachment optics (please cf. catalog LWL Series)
Reproducibility	In the x,y color range 1 digit each with 8 bit A/D conversion
Target distance	<p>Reflected light operation:</p> <ul style="list-style-type: none"> <li>- with reflected light optical fiber: typ. 2 mm ... 25 mm (depends on the optical fiber used)</li> </ul> <p>Transmitted light operation:</p> <ul style="list-style-type: none"> <li>- with transmitted light optical fiber: typ. 10 mm ... 200 mm (depends on the optical fiber used)</li> <li>- in addition with focus lense KL-1: typ. 10 mm ... 400 mm</li> <li>- in addition with prism optics KL-90: typ. 10 mm ... 400 mm</li> <li>- in addition with attachment optics KL-14: typ. 50 mm ... 140 mm</li> <li>- in addition with attachment optics KL-17: typ. 25 mm ... 85 mm</li> </ul>
Receiver	3-color filter detector
Alternating light operation	100 kHz
Ambient light	up to 5000 Lux
Type of protection	IP64
Current consumption	typ. 180 mA
Interface	RS232, parameterizable under Windows®
Connector type	Connection to PLC: 8-pin female connector (Binder Series 712) Connection to PC: 5-pin female connector (Binder Series 712)
EMC test acc. to	IEC - 801...
Housing	Aluminum, anodized in blue Connector for optical fiber made of glass fiber reinforced plastic
Operating temperature range	-20°C ... +55°C
Storage temperature range	-20°C ... +85°C
Pulse lengthening	Adjustable under Windows® 0 ms ... 100 ms
Max. switching current	100 mA, short-circuit-proof
Switching frequency	Max. 5 kHz
Outputs	When up to 4 colors are taught: OUT 0 to OUT 3 When only 1 color is taught or when using EXT-TEACH-BOX-2: OUT1 ... OUT3 for dynamic range indication)
Averaging	Over 32768 values max.
Voltage supply	+12VDC ... +30VDC, protected against polarity reversal, overload-protected
Switching state display	Visualization by means of 1 yellow LED for switching output, 2 red LEDs and 1 green LED for dynamic range indication
Optical fibers	Various optical fibers are available (please cf. catalog LWL Series)

Technical Data

DYN-Mode

COLOR VALUE CHANGE [temperature], typ.

SI-COLO2-LWL-HAMP-COL4

$\Delta x/\Delta T = 0.3/^\circ\text{C}$   
 $\Delta y/\Delta T = 0.2/^\circ\text{C}$

Color: RAL 3020 (traffic red)

DYN-Mode

INTENSITY CHANGE [temperature], typ.

SI-COLO2-LWL-HAMP-COL4

$\Delta \text{INT}/\Delta T = 0.1/^\circ\text{C}$

Color: RAL 3020 (traffic red)

STAT-Mode

COLOR VALUE CHANGE [temperature], typ.

SI-COLO2-LWL-HAMP-COL4

$\Delta x/\Delta T = 0.3/^\circ\text{C}$   
 $\Delta y/\Delta T = 0.2/^\circ\text{C}$

Color: RAL 3020 (traffic red)

STAT-Mode

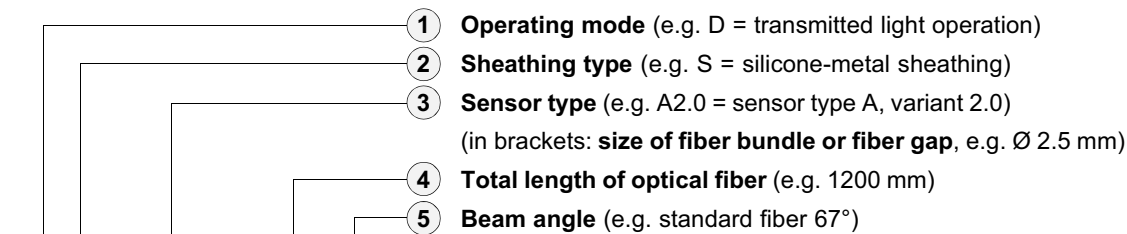
INTENSITY CHANGE [temperature], typ.

SI-COLO2-LWL-HAMP-COL4

$\Delta \text{INT}/\Delta T = 0.7/^\circ\text{C}$

Color: RAL 3020 (traffic red)

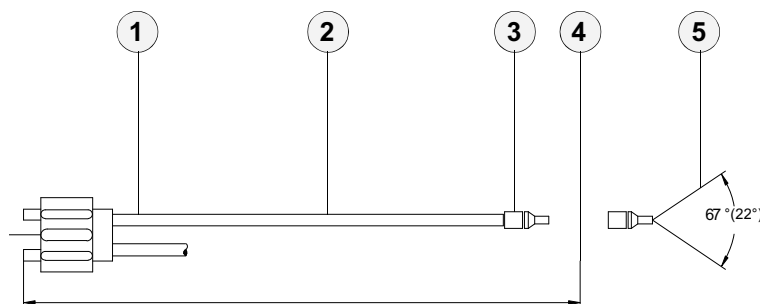
Optical Fibers



**D-S-A2.0-(2.5)-1200-67°**

Order code for optical fiber

(Please cf. catalog „LWL Series“ for detailed information on the various optical fibers available)



Dimensions of adaptor

Attachment optics (e.g. focus lenses)

Overview: Optical fibers with reflected light operation

Overview: Optical fibers with transmitted light operation

Important information on mounting of optical fibers

cf. catalog LWL Series

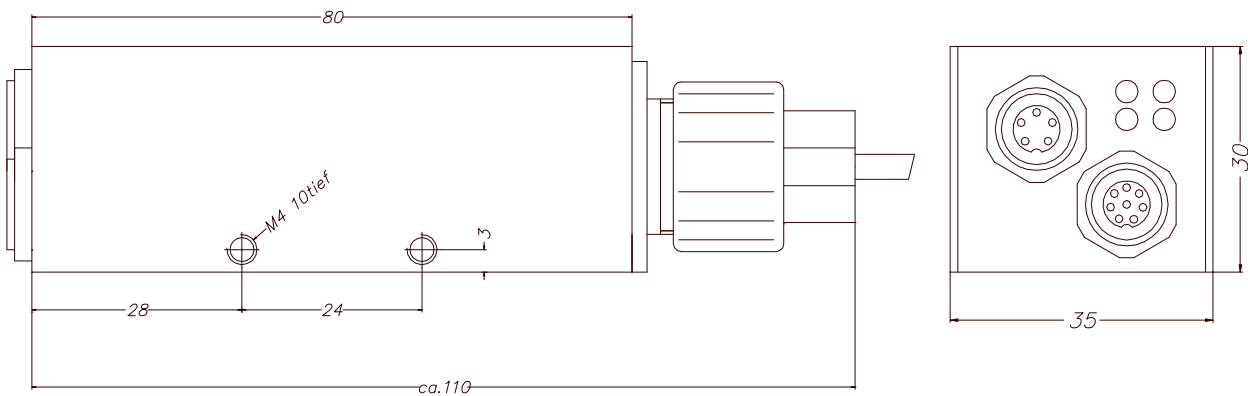
cf. catalog LWL Series

cf. catalog LWL Series

cf. catalog LWL Series

cf. catalog LWL Series

**Dimensions**



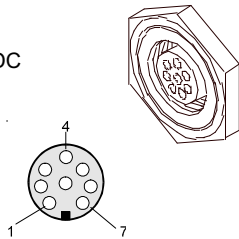
All dimensions in mm

**Connector Assignment**

**Connection SI-COLO2-LWL-HAMP-COL4 to PLC:**

**8-pin female connector Binder 712**

Pin:	Color:	Assignment:
1	wht	GND (0V)
2	brn	+12 ... +30 VDC
3	grn	IN0
4	yel	OUT0
5	gry	OUT1
6	pnk	OUT2
7	blu	OUT3
8	red	n.c.

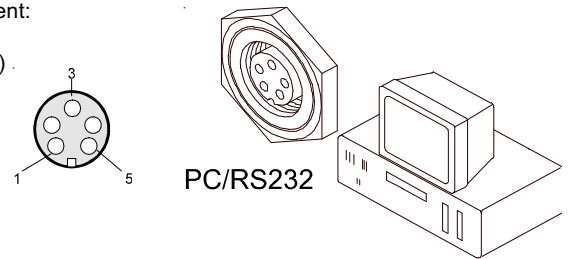


\* When only 1 color is teached or when using the COL-TEACH-BOX-2 the outputs OUT1 ... OUT3 are used for dynamic range indication

**Connection SI-COLO2-LWL-HAMP-COL4 to PC:**

**5-pin female connector Binder 712**

Pin:	Assignment:
1	GND (0V)
2	TX0
3	RX0
4	n.c.
5	n.c.

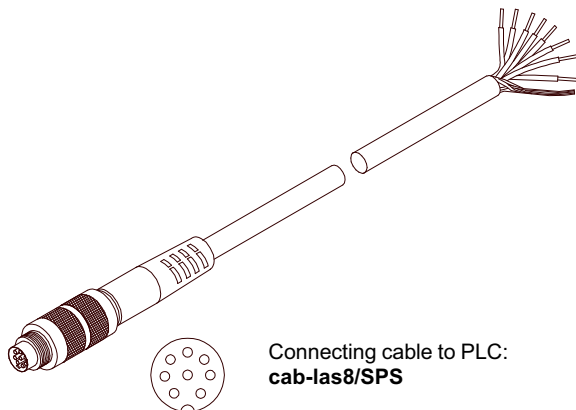


PC/RS232

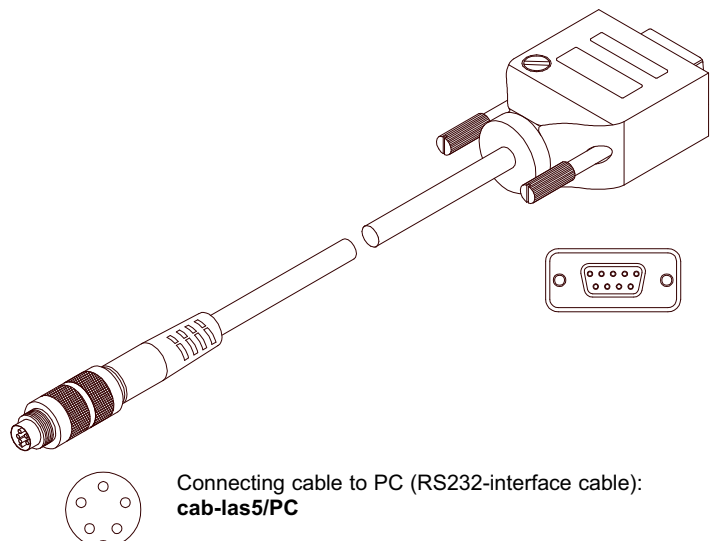
**Connecting Cables**

**Connecting cables for SI-COLO2-LWL-HAMP-COL4:**

**cab-las8/SPS** Length: 2m Outer jacket: PUR  
**cab-las5/PC** Length: 2m Outer jacket: PUR



Connecting cable to PLC:  
**cab-las8/SPS**



Connecting cable to PC (RS232-interface cable):  
**cab-las5/PC**



## Accessories

### Teachbox COL-TEACH-BOX-2

The COL-TEACH-BOX-2 is used for indication of dynamic range and switching state. Moreover, with the teach key button the current color value as well as intensity value can be taught.

#### Characteristics:

- Dynamic range indication by means of 2 red and one green LED
- Switching state indication by means of a yellow LED
- Sturdy aluminum housing
- Cable length 3m



### Attachment optics for optical fibers (cf. catalog LWL Series):

- |           |   |
|-----------|---|
| KL-1      | for use with transmitted light optical fibers (for a transmitted light application two KL-1 are necessary)  |
| KL-2      | for use with transmitted light optical fibers (for a transmitted light application two KL-2 are necessary)  |
| KL-3      | for use with reflected light optical fibers (working range typ. 10 mm ... 20 mm)  |
| KL-14     | for use with transmitted light optical fibers (working range typ. 60 mm ... 120 mm)   |
| KL-17     | for use with transmitted light optical fibers (working range typ. 30 mm ... 80 mm)  |
| KL-20     | for use with transmitted light optical fibers (working range typ. 20 mm ... 40 mm)  |
| KL-40     | for use with transmitted light optical fibers (working range typ. 10 mm ... 20 mm)  |
| KL-90     | for use with transmitted light optical fibers (working range typ. 20 mm ... 80 mm), (for a transmitted light application two KL-90 are necessary) |
| KL-M18    | for use with reflected light optical fibers (working range typ. 20 mm ... 65 mm)  |
| KL-M34    | for use with reflected light optical fibers (working range typ. 100 mm ... 250 mm)  |
| KL-M34/42 | for use with reflected light optical fibers (working range typ. 130 mm ... 170 mm)  |



KL-1



KL-2



KL-3



KL-14



KL-17



KL-20



KL-40



KL-90



KL-M18



KL-M34



KL-M34/42

**Measuring Principle**

**Measuring principle:**

Through glass fiber bundle a modulated white-light LED projects a white-light spot onto a surface to be checked. Through the glass fiber bundle part of the light that is reflected from the target is then directed onto a color-sensitive detector element. The received light is separated according to the 3-color-range process (red, green, blue).

**Parameterization**

**Parameterization under Windows® with software COLOR2-4-Scope:**

The SI-COLO2-LWL-HAMP-COL4 color sensor is parameterized under Windows® with the COLOR2-4-Scope software. The RS232 interface is used for setting parameters such as:

- Averaging over a maximum of 32768 values
- Number of colors to be checked
- Light power of the white-light LED
- Automatic light power control ON/OFF
- Pulse lengthening up to 100ms max.
- External or continuous trigger
- Minimum intensity required for color evaluation

**Visualization:**

Under Windows® representation of the color value on a PC in numeric form and in a color chart, and representation of RGB values in a time chart. In addition the current RGB values are displayed as a bar chart.

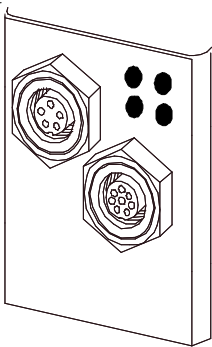
The following evaluation algorithms can also be selected:

- Target lies within the color tolerance circle of a taught color and within an intensity window (FIRST HIT)
- Determination of the taught color that is most similar to the target (minimum distance between target color and reference color in the color chart) (MINIMAL DIST)
- Checking of the target's color series with a taught color sequence (SENSOR SERIES)
- EXTERN TEACH: With this function field the color sensor can be taught by means of a LOW-signal at pin 3 (for instance via push button, or PLC). During this procedure the object to be taught has to be in the visibility range of the color sensor. The LEDs indicate a successful teaching procedure.

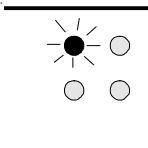
**LED-Display:**

**When 1 color is to be taught:**

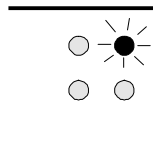
The switching state is visualized by means of 4 LEDs at the housing of the SI-COLO2-LWL-HAMP-COL4 color sensor.



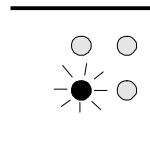
**LED yellow**  
Switching state  
yellow = color detected



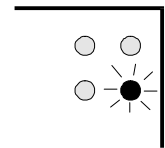
**LED red (+)**  
Dynamic range left  
towards bottom



**LED green**  
Within dynamic range



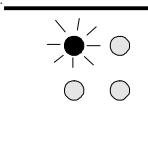
**LED red (-)**  
Dynamic range left  
towards top



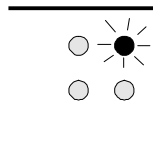
**When up to 4 colors are to be taught (optional):**

The color code is visualized by means of 4 LEDs at the housing of the SI-COLO2-LWL-HAMP-COL4 color sensor.

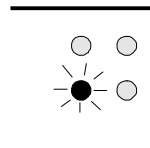
**LED yellow**  
Color 0



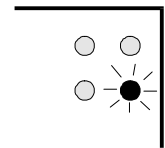
**LED red**  
Color 1



**LED green**  
Color 2



**LED red**  
Color 3



In the DIRECT mode the maximum numbers of colors to be taught is 4 (color no. 0,1,2,3). These 4 colors can be directly output at the 4 digital outputs. The respective detected color is displayed by means of the 4 LEDs at the color sensor housing.

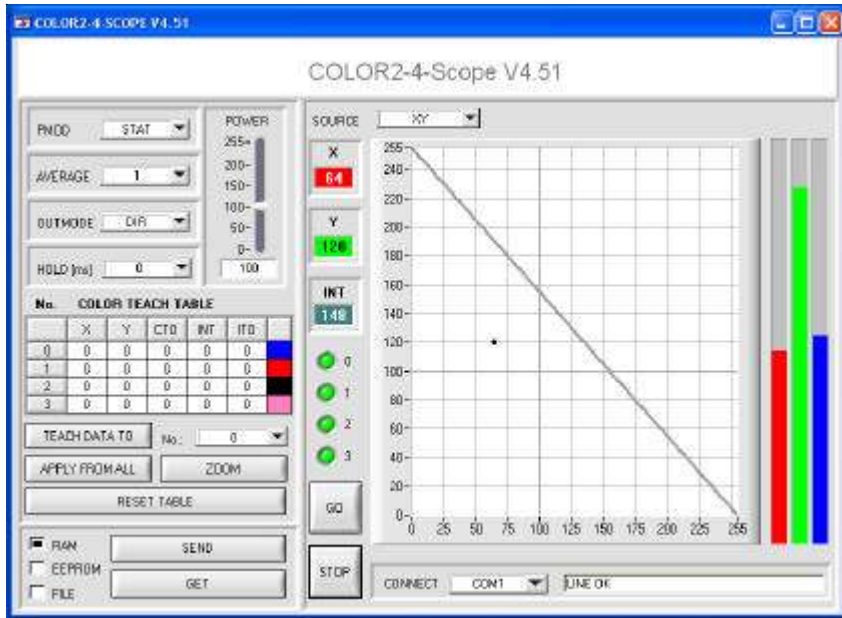


Parameterization

**Parameterization under Windows® with software COLOR2-4-Scope:**

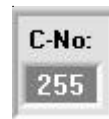
The Windows® user interface facilitates the teach-in process at the SI-COLO2-LWL-HAMP-COL4 color sensor and supports the operator in the task of adjustment and commissioning of the color sensor.

**X,Y-chart:**



The color value is displayed graphically by way of the X,Y-color triangle and also in the numerical output fields. The current raw data (red, green, blue) from the color detector are visualized in a bar chart.

If a color is detected during measuring operation, the currently detected color is displayed in a numeric output field:

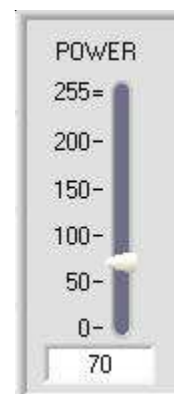


**Parameter setting:**

Among others the following parameters can be set:



**PMOD:**  
In this function field the operating mode of automatic light power control at the transmitter unit (white-light LED) can be set.  
STAT: The LED transmission power is constantly kept at the value set with the POWER slider.  
DYN: The LED transmission power is dynamically controlled in accordance with the amount of radiation that is diffusely reflected from the object.



**POWER:**  
With this slider the intensity of the white-light transmitter LED at the SI-COLO2-LWL-HAMP-COL4 color sensor can be adjusted.



**AVERAGE:**  
Averaging (over 32768 scanning values max.). Here the number of scanning values over which the raw signal measured at the receiver is averaged can be set.



**HOLD:**  
In this edit box a pulse lengthening (100 ms max.) at the digital outputs of the SI-COLO2-LWL-HAMP-COL4 color sensor can be set.

Parameterization

No.	COLOR TEACH TABLE				
	X	Y	CTO	INT	ITO
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0

TEACH DATA TO No.: 0

APPLY FROM ALL ZOOM

RESET TABLE

**COLOR TEACH TABLE („Farb-Lern-Tabelle“):**

Input of parameters X, Y, CTO, INT, and ITO in the corresponding input fields, or automatically by clicking the **TEACH DATA TO** button.



- X: X-value of the teach-in color, normalized red color content
- Y: Y-value of the teach-in color, normalized green color content
- CTO: Tolerance circle around the teach color that is defined as (X,Y) point
- INT: Teach-in value for the total intensity
- ITO: Intensity tolerance around the INT teach-in value

Each of the color ranges defined in the color teach table is represented as a tolerance circle around the teach-in color (X,Y) after a click on the **APPLY FROM ALL** button.

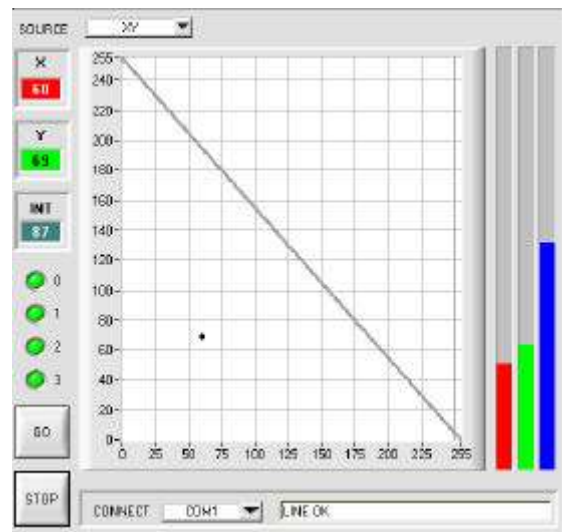
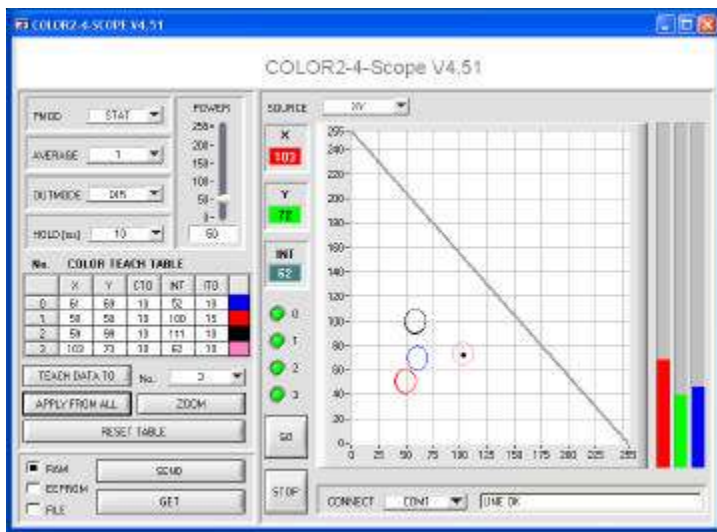


The tolerance circle around the teach-in color (X,Y) is specified by entering „CTO“.

**"COLOR TRIANGLE":**

In the color triangle the currently detected color is represented by an X,Y value pair, with the X-value representing the normalized red content, and the Y-value representing the normalized green content of the teach-in color.

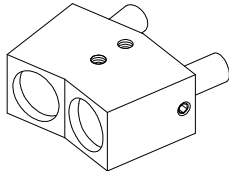
The blue content on the color triangle is proportional to the distance of the X,Y value pair from the hypotenuse.





Diagrams

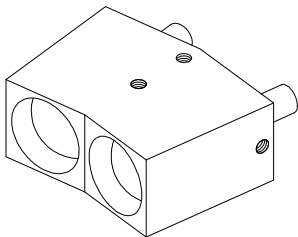
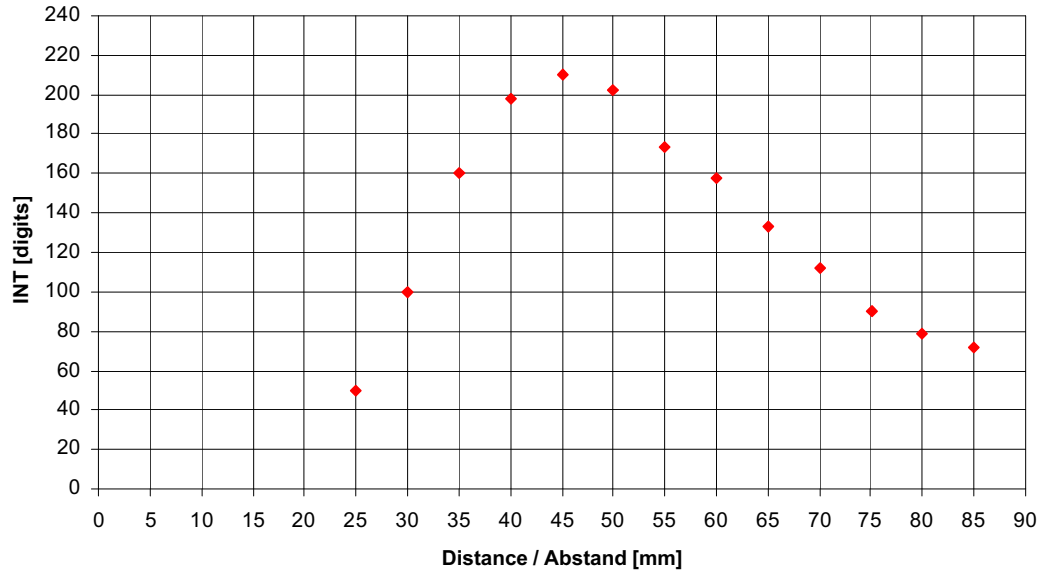
**Diagrams:** INTENSITY  
dependent on distance  
STAT-Mode



INTENSITY [distance], typ.

SI-COLO2-LWL-HAMP-COL4 with  
optical fiber D-S-A2.0-(2.5)-1200-67°  
and optics-frontend KL-17

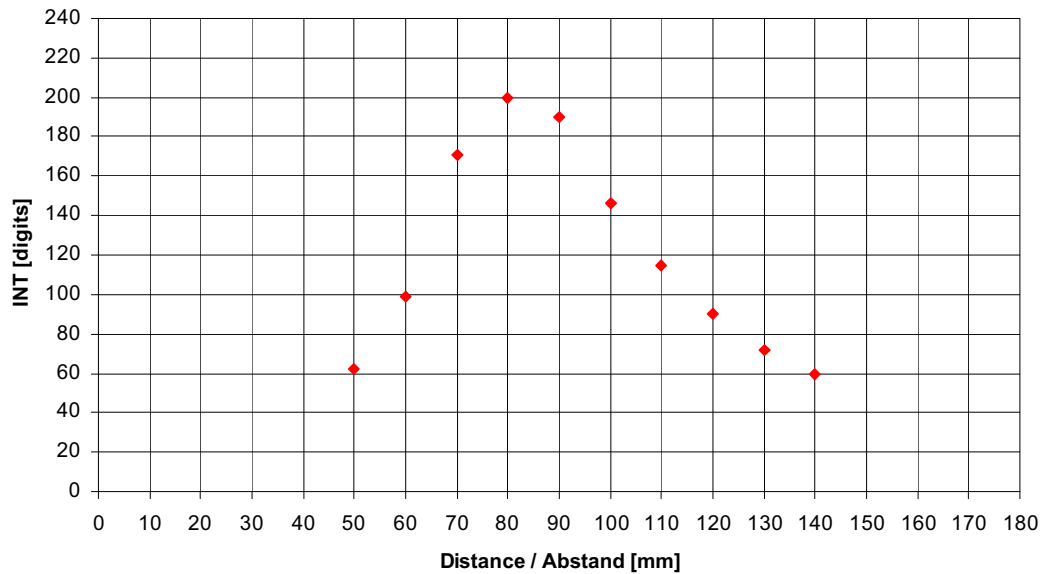
Color: Black mat  
POWER = 175



INTENSITY [distance], typ.

SI-COLO2-LWL-HAMP-COL4 with  
optical fiber D-S-A2.0-(2.5)-1200-67°  
and optics-frontend KL-14

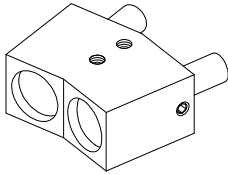
Color: Black mat  
POWER = 182





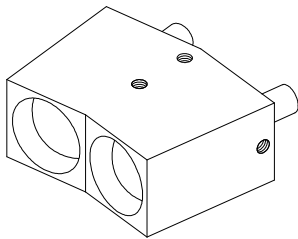
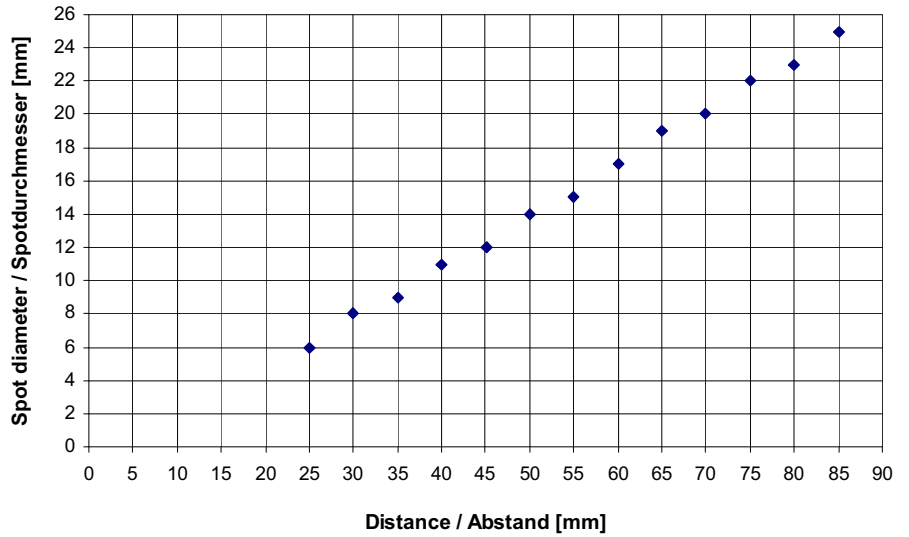
Diagrams

**Diagrams:** SPOT DIAMETER  
dependent on distance



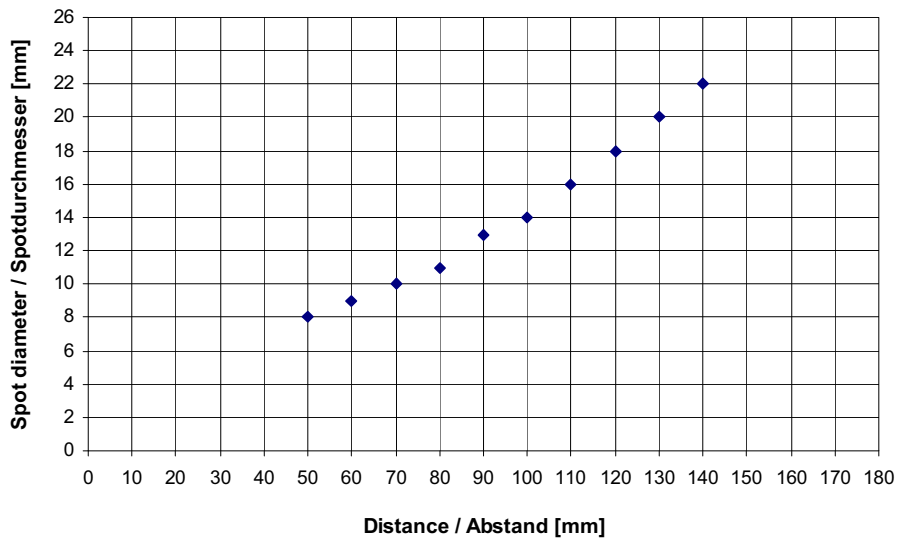
SPOT DIAMETER [distance], typ.

SI-COLO2-LWL-HAMP-COL4 with  
optical fiber D-S-A2.0-(2.5)-1200-67°  
and optics-frontend KL-17



SPOT DIAMETER [distance], typ.

SI-COLO2-LWL-HAMP-COL4 with  
optical fiber D-S-A2.0-(2.5)-1200-67°  
and optics-frontend KL-14



**Application Example****Detection of painted components in the ex-area with the SI-COLO2-LWL-HAMP-COL4 and mounted optical unit KL-14**

In a spraying system, components must be checked with respect to color and grey content; a distinction has to be made between 3 states: Raw part (no paint applied yet), primed parts (1st layer of paint applied), and completely painted parts (2nd layer of paint applied).

The task is made more difficult by the fact that the parts have to be checked in the ex-area and therefore with the help of an optical fiber front-end, with a minimum distance from front-end to object of approx. 100 mm.

An external teach-box, which is connected to the color sensor by way of a 3 m cable, is used to facilitate the teach process; during the teach process the teach-box can therefore be positioned in the ex-area. A special software indicates whether the sensor is in its dynamic range (red/green/red LEDs).





**Notes**