# SI-COLO **Series**

► **SI-COLO3-200**

- Measuring range typ. 100 mm ... 350 mm
- Transmitter and receiver optics integrated (confocal)
- Up to 15 colors can be stored
- White-light LED, 100 kHz modulated
- Color and gray scale detection
- Insensitive to outside light
- Brightness correction can be activated
- Several TEACH functions (via PC, PLC, or push button)
- RS232 interface (USB and Ethernet adapter available)
- Various evaluation algorithms can be activated
- Switching state display by means of 4 yellow LEDs
- 'Averaging' can be activated (from 1 up to over 32000 values)
- Material adaptation can be activated ("Adaptive Control")
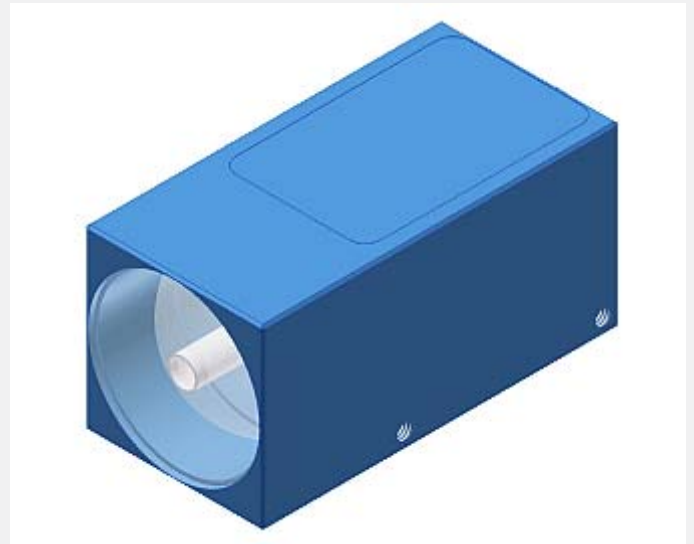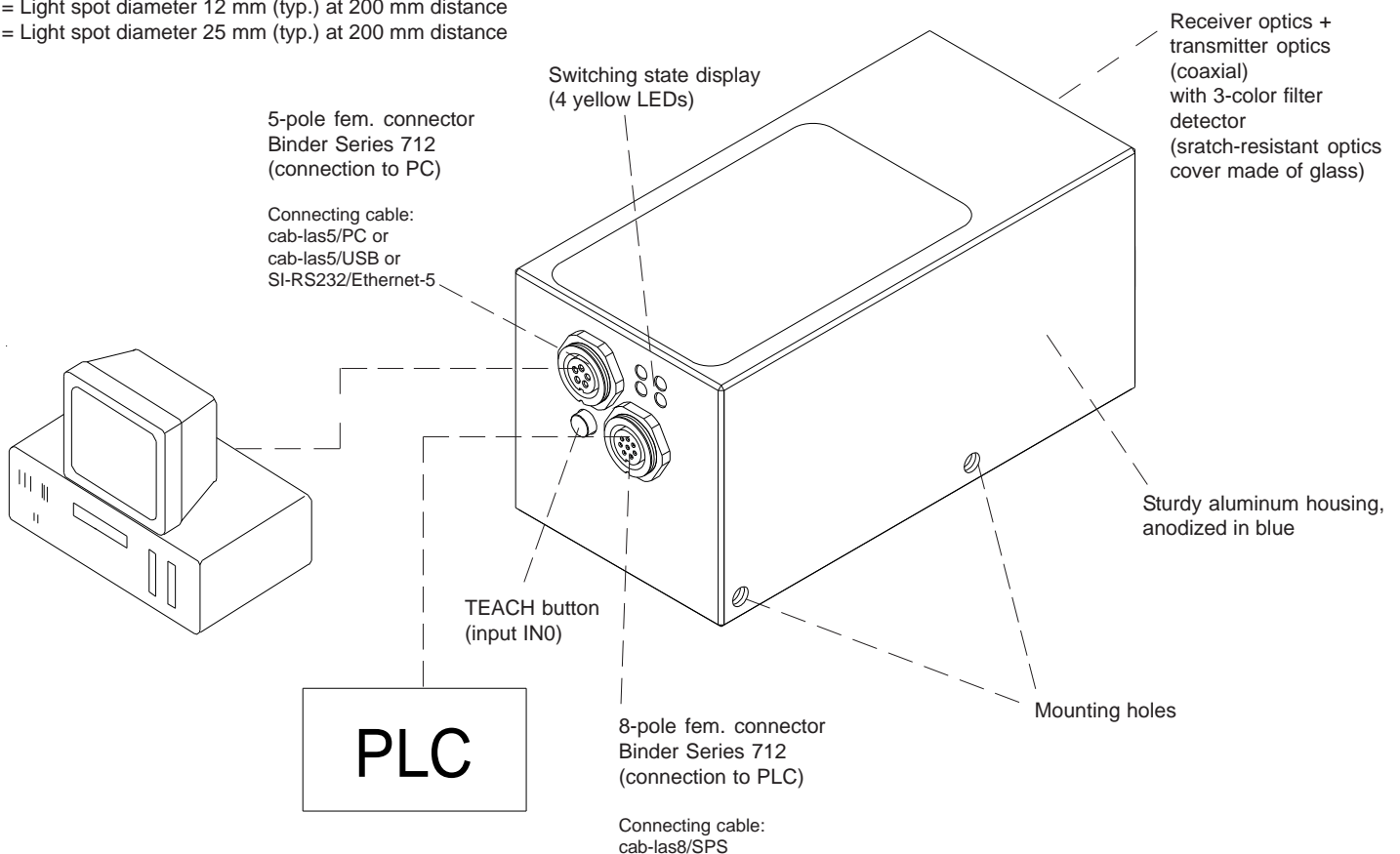
Design

Product name:

SI-COLO3-200-d1
SI-COLO3-200-d2
(incl. Windows® PC software SI-COLO3-Scope)

d1 = Light spot diameter 12 mm (typ.) at 200 mm distance
d2 = Light spot diameter 25 mm (typ.) at 200 mm distance

Switching state display
(4 yellow LEDs)

Receiver optics +
transmitter optics
(coaxial)
with 3-color filter
detector
(sratch-resistant optics
cover made of glass)

5-pole fem. connector
Binder Series 712
(connection to PC)

Connecting cable:
cab-las5/PC or
cab-las5/USB or
SI-RS232/Ethernet-5

Sturdy aluminum housing,
anodized in blue

TEACH button
(input IN0)

PLC

8-pole fem. connector
Binder Series 712
(connection to PLC)

Connecting cable:
cab-las8/SPS

Mounting holes

Technical Data

Model	SI-COLO3-200-...
Light source	White-light LED, modulated 100 kHz
Target distance	Type -d1: typ. 100 mm ... 350 mm Type -d2: typ. 100 mm ... 400 mm
Light spot size	Type -d1: typ. Ø 12 mm at a distance of 200 mm Type -d2: typ. Ø 25 mm at a distance of 200 mm
Reproducibility	In the X,Y color range 1 digit each at 12 bit A/D conversion
Receiver	3-color filter detector
Pulsating light operation	100 kHz
Ambient light	Up to 5000 Lux
Type of protection	IP64
Current consumption	<180 mA
Interface	RS232, parameterizable under Windows®
Connector type	Connection to PLC: 8-pole female connector (Binder Series 712) Connection to PC: 5-pole female connector (Binder Series 712)
Connecting cables	to PLC: cab-las8/SPS or cab-las8/SPS-w to PC/RS232 interface: cab-las5/PC or cab-las5/PC-w to PC/USB interface: cab-las5/USB or cab-las5/USB-w, to PC/Ethernet interface: SI-RS232/Ethernet-5
EMC test acc. to	DIN EN 60947-5-2 $C\,E$
Housing material	Aluminum, anodized in blue
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. 1.6 kHz with 15 teach-in colors, max. 11.5 kHz with 1 teach-in color, max. 95 kHz with contrast detection
Input digital (1x)	IN0 (Pin 3), digital (0V/+24V) or teach button at the housing
Outputs digital (4x)	OUT0 ... OUT3 (Pin 4 ... 7): digital (0V/+24V), npn-/pnp-able (bright-/dark-switching, can be switched)
Averaging	Over 32768 values max.
Voltage supply	+24VDC (± 10%), protected against polarity reversal, overload-protected
Switching state display	Visualization by means of 4 yellow LEDs
Color memory capacity	non-volatile EEPROM with parameter sets for 15 colors max.
TEACH button	for external teaching of color references via input IN0
Temperature drift X,Y	$\Delta X/\Delta T$; $\Delta Y/\Delta T$ typ. 0,3 digits/°C (< 0,01% / °C)

Dimensions
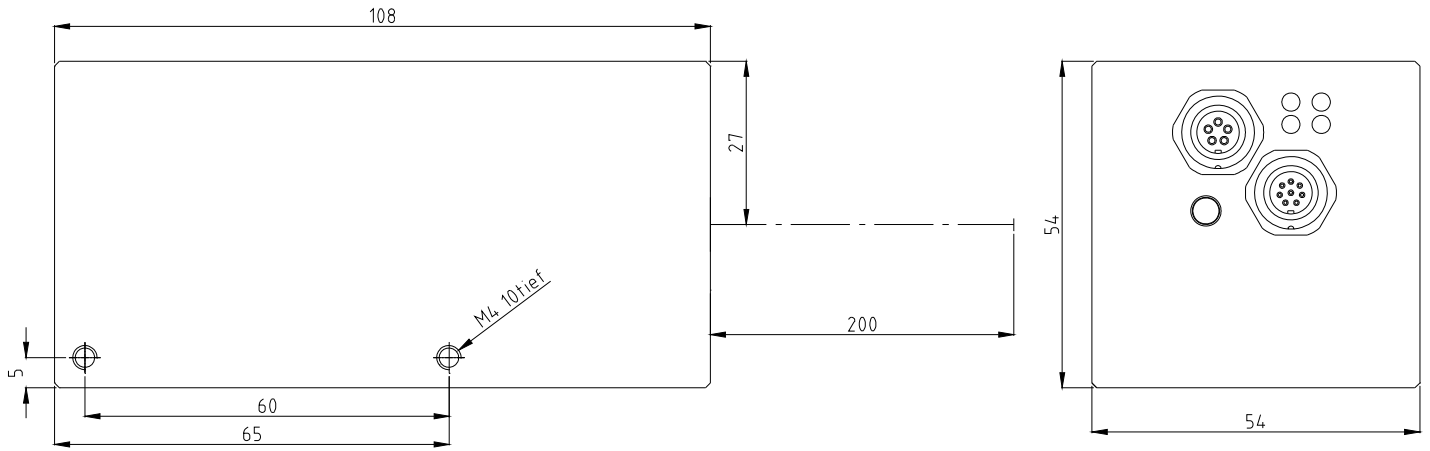
All dimensions in mm

Connector Assignment

Connection to PLC:
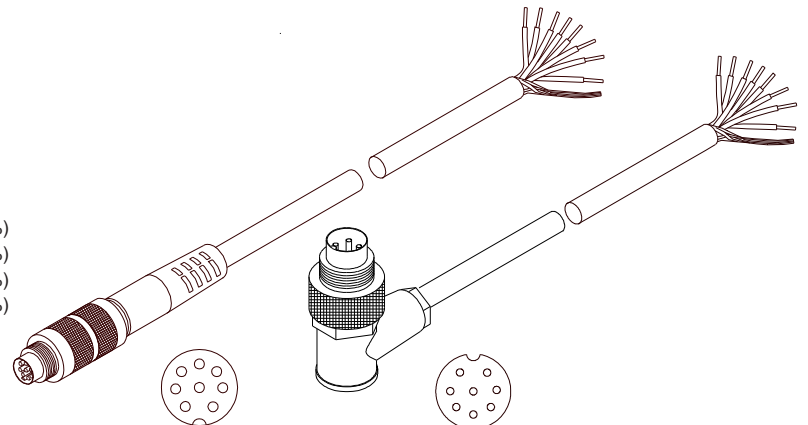**8-pole fem. connector Binder Series 712**

Pin: Color: Assignment:

1 white GND (0V)
2 brown +24VDC (±10%)
3 green IN0
4 yellow OUT0 (Digital 0: typ. 0…1V, Digital 1: typ. +Ub - 10%)
5 grey OUT1 (Digital 0: typ. 0…1V, Digital 1: typ. +Ub - 10%)
6 pink OUT2 (Digital 0: typ. 0…1V, Digital 1: typ. +Ub - 10%)
7 blue OUT3 (Digital 0: typ. 0…1V, Digital 1: typ. +Ub - 10%)
8 red not connected

Connecting cable:
cab-las8/SPS-(length)
cab-las8/SPS-w-(length) (angle type, 90°)
(standard length 2m)

cab-las8/SPS-...
(max. length 25m,
outer jacket: PUR)

cab-las8/SPS-w-...
(max. length 25m,
outer jacket: PUR)

Connection to PC:
5-pole fem. connector Binder Series 712

Pin: Assignment:
1 GND (0V)
2 TxD
3 RxD
4 +24V (+Ub, OUT)
5 not connected

Connection via RS232 interface at the PC:
Connecting cable:
cab-las5/PC-(length)
cab-las5/PC-w-(length) (angle type 90°)
(standard length 2m)

alternative:
Connection via USB interface at the PC:
Connecting cable (incl. driver software):
cab-las5/USB-(length)
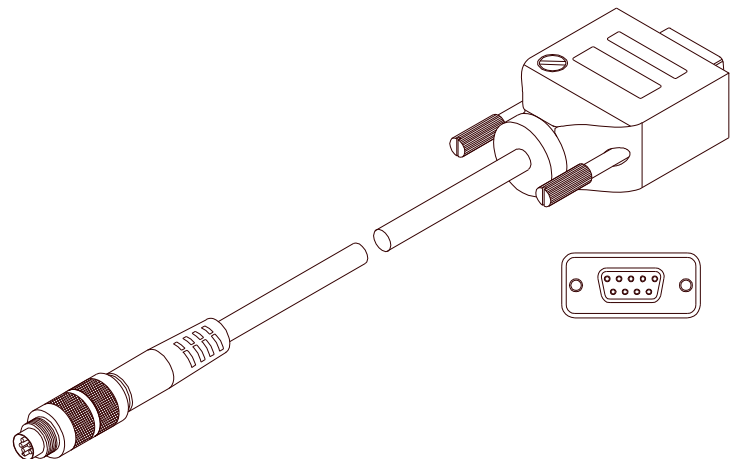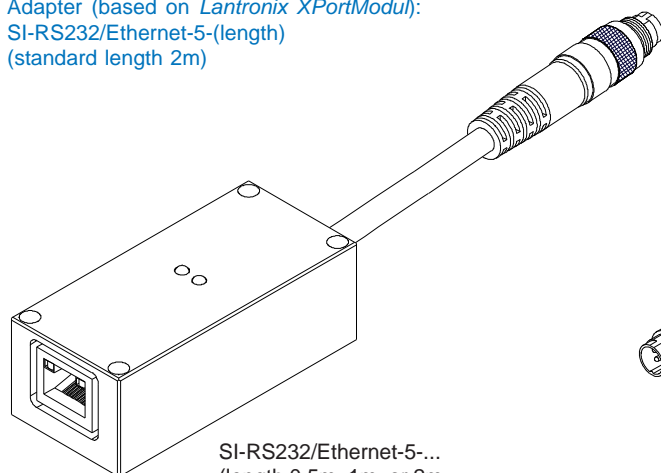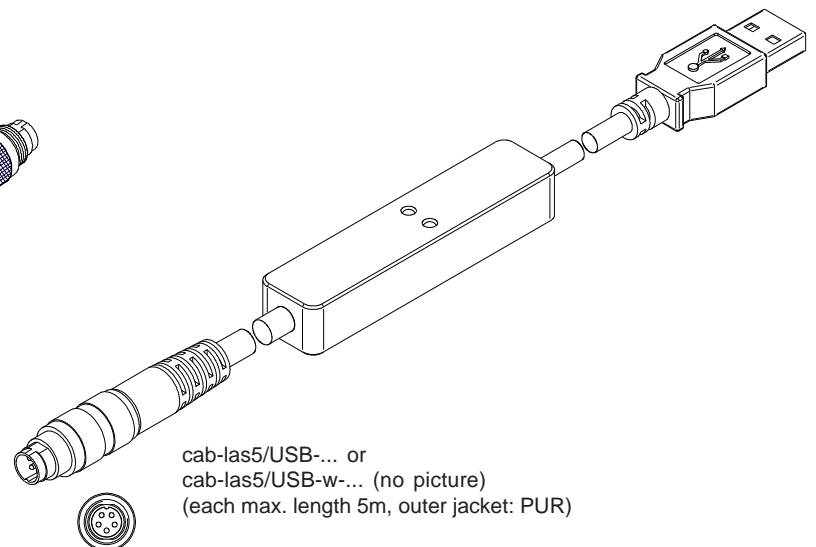cab-las5/USB-w-(length) (angle type 90°)
(standard length 2m)

cab-las5/PC-...
(max. length 10m, outer jacket: PUR) or
cab-las5/PC-w-... (no picture)
(max. length 5m, outer jacket: PUR)

alternative:
Connection to local network via Ethernet bus:
Adapter (based on *Lantronix XPortModul*):
SI-RS232/Ethernet-5-(length)
(standard length 2m)

cab-las5/USB-... or
cab-las5/USB-w-... (no picture)
(each max. length 5m, outer jacket: PUR)

SI-RS232/Ethernet-5-...
(length 0.5m, 1m, or 2m,
outer jacket: PUR)

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Measuring Principle

Measuring principle of the SI-COLO3 color sensor:

The SI-COLO3 color sensor detects the radiation that is diffusely reflected by the target. The SI-COLO3 color sensor uses a white-light LED with adjustable power as a light source. A triple receiver for the RED, GREEN, and BLUE content of the light reflected from the target is used as a receiver. With the stepless adjustment of the integrated light source and the selectable gain of the receiver signal the sensor can be set to almost any surface.

The SI-COLO3 color sensor can be "taught" up to 15 colors. Tolerances can be set for every taught color. In X/Y INT or s/i M mode the tolerances represent a color cylinder in space. In X/Y/INT or s/i/M mode the tolerance represents a color sphere in space. Color evaluation according to s/i M and s/i/M uses the Lab calculation method. All the modes can be used in combination with various operating modes, among others "FIRST HIT" and "BEST HIT". The raw data are represented with 12 bit resolution. Color detection either operates continuously or is started by means of an external SPC trigger signal.

The respective detected color either is output as binary code at the 4 digital outputs, or it can be sent directly to the outputs, if only up to 4 colors are to be detected. Simultaneously the detected color code is visualised at the SI-COLO3 housing by means of 4 LEDs. With the TEACH button at the sensor housing the sensor can be taught up to 15 colors. For this purpose the corresponding evaluation mode must be set with the software. The TEACH button is connected in parallel to the input IN0 (green wire of cable cab-las8/SPS).

Through the RS232 interface parameters and measured values can be exchanged between the PC and the SI-COLO3 color sensor. All the parameters for color detection can be stored in the non-volatile EEPROM of the SI-COLO3 color sensor. When parameterization is finished the color sensor continues to operate with the current parameters in "stand alone" mode without a PC.

The sensors of the SI-COLO3 V6.4 series can be calibrated (white light balancing). Balancing can be performed to any white surface. A ColorCheckerTM table with 24 color fields according to CIE standard is available as an alternative, and white light balancing or calibration can then be performed to one of the white fields.

Parameterization

Windows® user interface:

The Windows® user interface facilitates the teach-in process at the color sensor and supports the operator in the task of adjustment and commissioning of the color sensor.
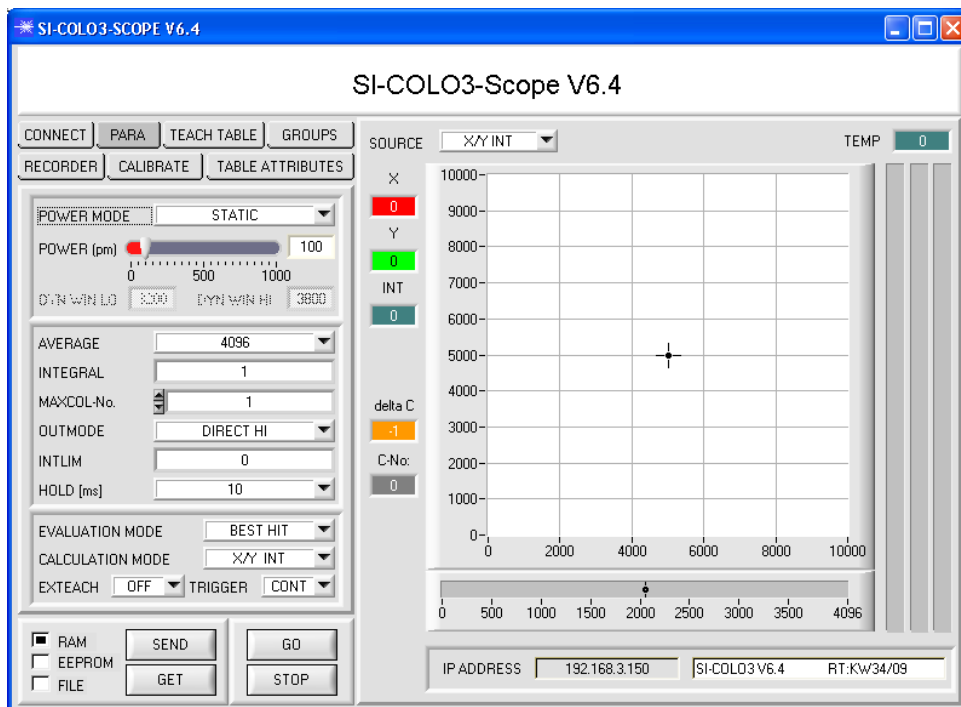
The RS232 interface (PARA tab) is used for setting parameters such as:

- POWER MODE:
  Light power of the white light LED
- AVERAGE:
  Averaging over max. 32768 values
- INTEGRAL:
  This function field is used to set the number of scan values (measurement values) over which the raw signal measured at the receiver is summed up. This integral function allows the reliable detection even of extremely weak signals.
- TRIGGER:
  Trigger continuous, external, or self trigger
- MAXCOL-No.:
  Number of colors to be checked
- GROUPS:
  Colors can be assigned to certain groups
- OUTMODE:
  Control of the digital outputs
- INTLIM:
  Setting of a minimum intensity limit for color evaluation
- HOLD:
  Pulse lengthening up to max. 100 ms

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.

Parameterization

Offset calibration:

To avoid an increase of the electronic offset when using the integral function (INTEGRAL parameter), this offset can be eliminated by way of offset calibration or zero-point calibration. The corresponding tab is password-protected to prevent inadvertent incorrect settings.

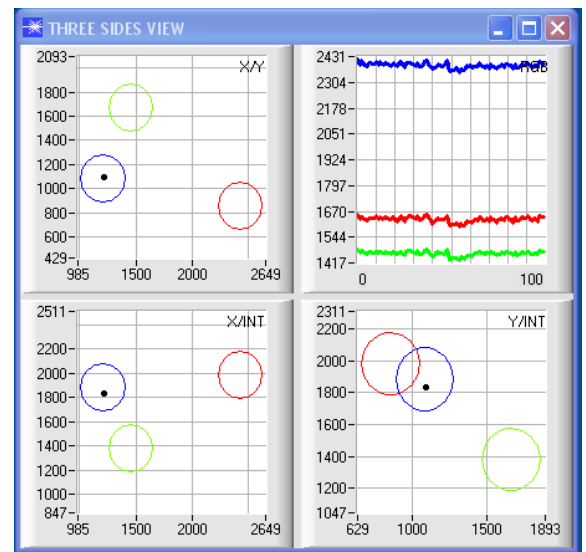

Graphic display elements:

SOURCE:
A click on the arrow button opens a selection field for the selection of a display mode in the graphic display window.
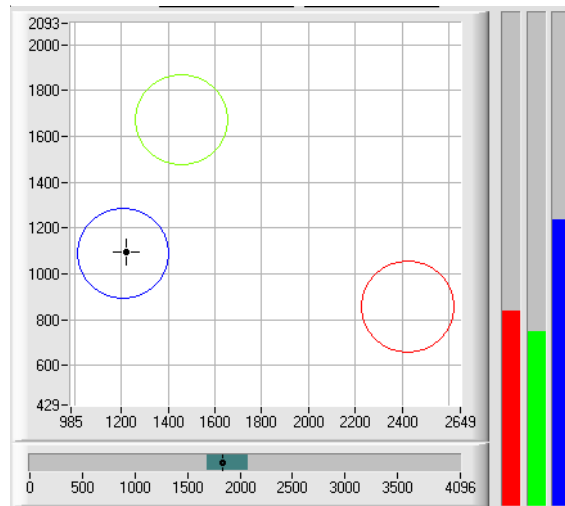
X/Y INT bzw. s/i M:
X/Y or s/i pairs are displayed in a zoomed graph.
The intensity INT or M with the tolerance window set under No.: is shown directly below.
Two-side view of the color cylinder in space.

X/Y/INT bzw. s/i/M:
A panel opens that shows the taught color spheres and the current color position. For improved representation a three-side view with the graphs X/Y (s/i), X/INT (s/M) and Y/INT (i/M) was chosen.
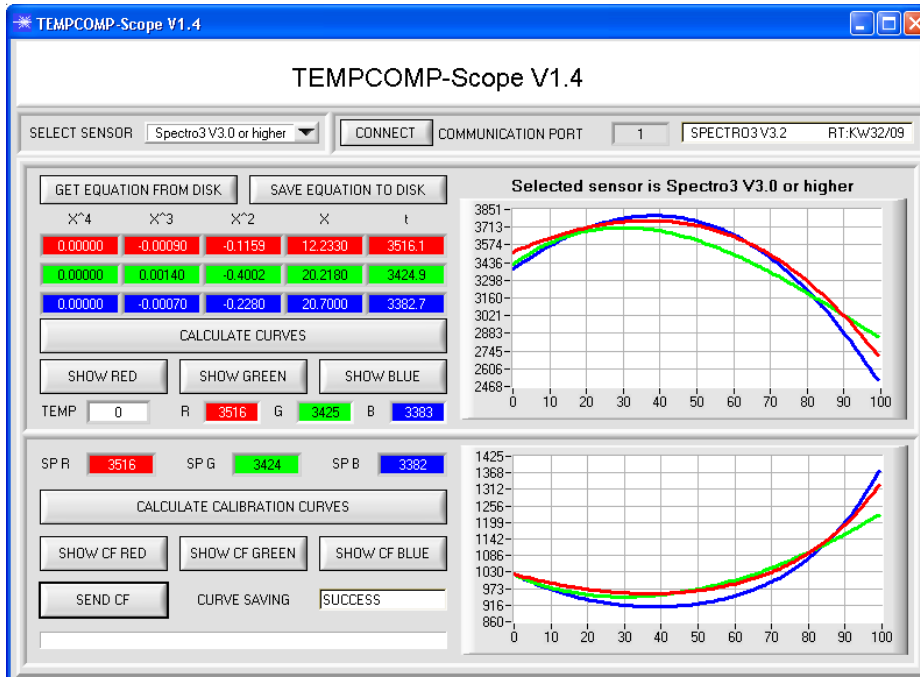
TEMP:
This display shows the temperature prevailing in the sensor housing.
The display DOES NOT show degrees Centigrade or Fahrenheit.

delta C:
This display (delta color) shows the deviation from a color hit, delta C corresponds with ΔE that is calculated in a color measurement.

Temp. Compensation

Operation of the TEMPCOMP-Scope software:

If a firmware update should go wrong and the temperature characteristics that are stored in the EEPROM should be lost, these characteristics must be created anew. For this purpose you will need a file with the corresponding data. This file can be obtained from your supplier.

To perform temperature compensation please start the corresponding TEMPCOMP-Scope software that is included on the supplied CD. Please make sure that you have a functioning sensor connection. It may be necessary to select the connection with CONNECT. Set the correct sensor under SELECT SENSOR, if this is not done automatically.

Firmware Update

Firmware Update by means of the software Program Loader:
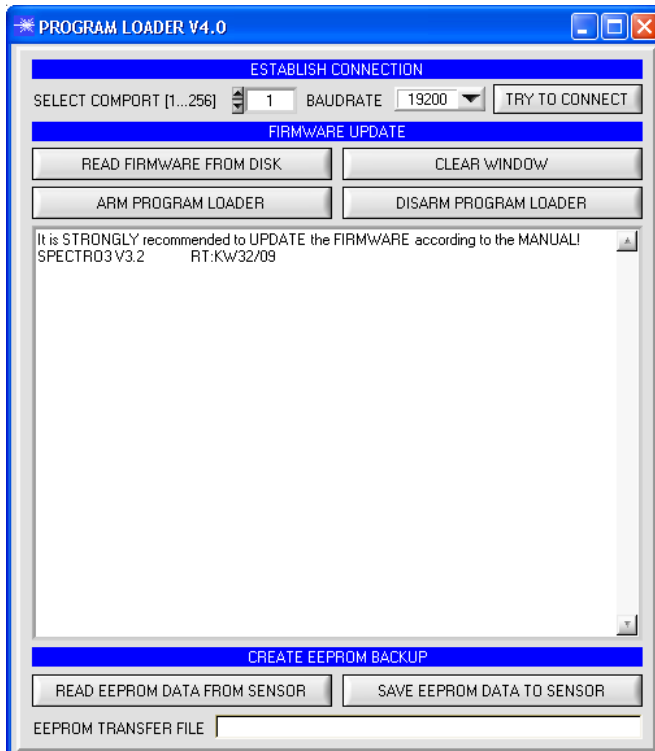
The software „Program Loader" allows the user to perform an automatic firmware update. The update will be carried out through the RS232 interface.

An initialisation file (xxx.ini) and a firmware file (xxx.elf.S) are required for performing a firmware update. These files can be obtained from your supplier. In some cases an additional firmware file for the program memory (xxx.elf.p.S) is also needed, and this file will be automatically provided together with the other two files.

A plausibility check is performed after the initialisation file has been loaded with the Program Loader. If the initialisation file was changed or damaged, it will not be possible to perform a firmware update.

When the plausibility check is successfully completed, the instructions contained in the initialisation file will be carried out step by step.

The complete memory contents of the micro-controller in the sensor will be deleted in a firmware update. This means that both the program in the program memory and the data in the data memory will be lost.

The new firmware automatically writes the correct data to the program memory again.

However, the parameter settings, temperature curves, linearization curves, etc. that are stored in the data memory (EEPROM) will be deleted.

With the Program Loader V4.0 software the data will be saved in the EEPROM, and can be written back again after successful firmware update. For this purpose the software creates an EEPROM backup file.

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LED Display

LED display:

The color code is visualised by way of 4 yellow LEDs at the housing of the SI-COLO2 color sensor. At the same time in the binary modus (OUT BINARY) the color code indicated on the LED display is output as 4-bit binary information at the digital outputs OUT0 to OUT3 of the 8-pin SI-COLO3/PLC socket.

The SI-COLO3 color sensor is able to process a maximum of 15 colors (color code 0 ... 14) in accordance with the corresponding rows in the COLOR TEACH TABLE. An "error" respectively a "not detected color" is displayed by the lighting of all LED (OUT0 .. OUT3 digital outputs are set to HIGH-level).

ERROR or
NO COLOR DETECTED
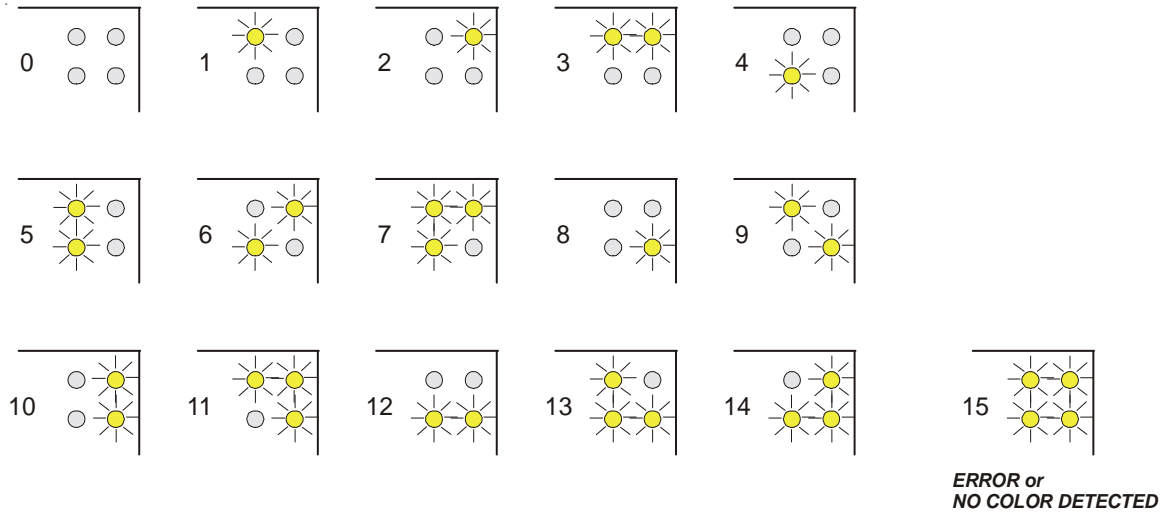
In the DIRECT mode (OUT DIRECT HI or OUT DIRECT LO) the maximum numbers of colors to be teached is 4 (color no. 0, 1, 2, 3).
If DIRECT HI is activated, the specially digital output is set to HI. If the current color does not correspond with any of the teach-in colors, color C-No = 0 is set, i.e. all digital outputs are set to LOW (no LED is lighting).
If DIRECT LO is activated, the specially digital output is set to LO, while the other 3 are set to HI. If the current color does not correspond with any of the teach-in colors, color C-No = 255 is set, i.e. all digital outputs are set to HIGH (all LED are lighting).
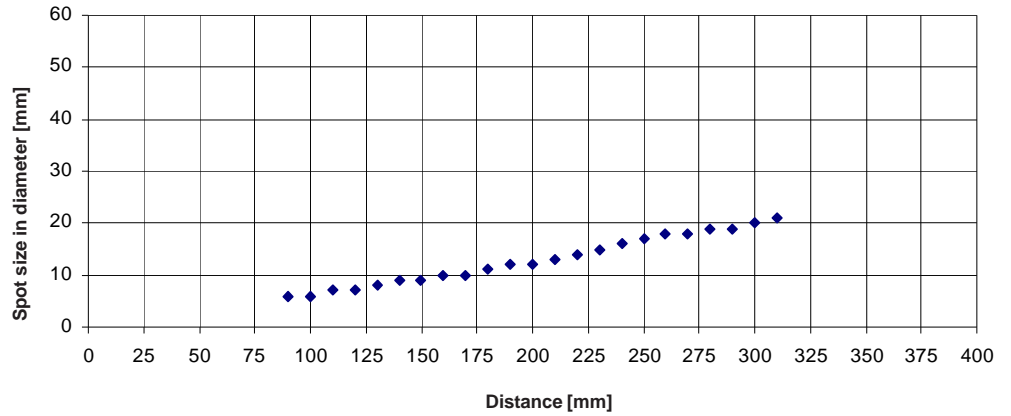
DIRECT HI

DIRECT LO

NO COLOR DETECTED

NO COLOR DETECTED
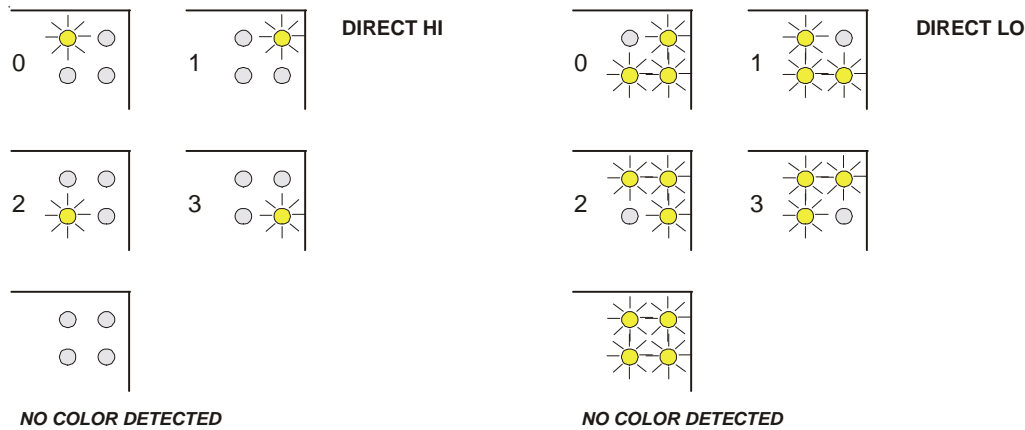
Diagrams

Diagrams: **SPOT SIZE (DIAMETER)**

Spot size in diameter at reference distance 200 mm:

SI-COLO3-200-d1: Ø 12 mm (typ.)
SI-COLO3-200-d2: Ø 25 mm (typ.)

SI-COLO3-200-d1

SPOT DIAMETER [distance], typ.

SI-COLO3-200-d2

SPOT DIAMETER [distance], typ.