

# SPECTRO Series

## ► SPECTRO-3-500-COF-...-CL-MSM-DIG

- Measuring range typ. 100 mm ... 1000 mm
- Integrated transmitter and receiver optics (confocal)
- $L^*a^*b^*$ ,  $L^*C^*h^*$ ,  $L^*u^*v^*$ ,  $L^*u^*v'$  and  $xyY$  evaluation (CIE standard)
- Up to 31 colors (max. 48 in group mode) can be stored
- RS232 interface (USB or Ethernet adapter is available)
- Super-bright white-light LED (AC-/DC-operation or OFF for luminous objects can be switched)
- Color measurement (contrast detection, and gray scale detection)
- Insensitive to outside light (in AC-operation)
- Scan frequency max. 35 kHz (in DC- or OFF-operation)
- Switching frequency typ. 40 kHz
- Several TEACH functions (via PC, PLC, or push button)
- Various evaluation algorithms can be activated
- "BEST HIT" mode ("human color assessment")
- Switching state display by means of 5 yellow LEDs
- Parameterizable via Windows® software, scope function
- Temperature compensated
- Averaging can be activated (from 1 up to over 32000 values)
- Color control of luminous objects (LEDs, halogen lamps, displays, ...)
- 3-color filter detector (true color detector: "human color perception")



### Design

#### Product name:

**SPECTRO-3-500-COF-d12.0-CL-MSM-DIG**

**SPECTRO-3-500-COF-d25.0-CL-MSM-DIG**

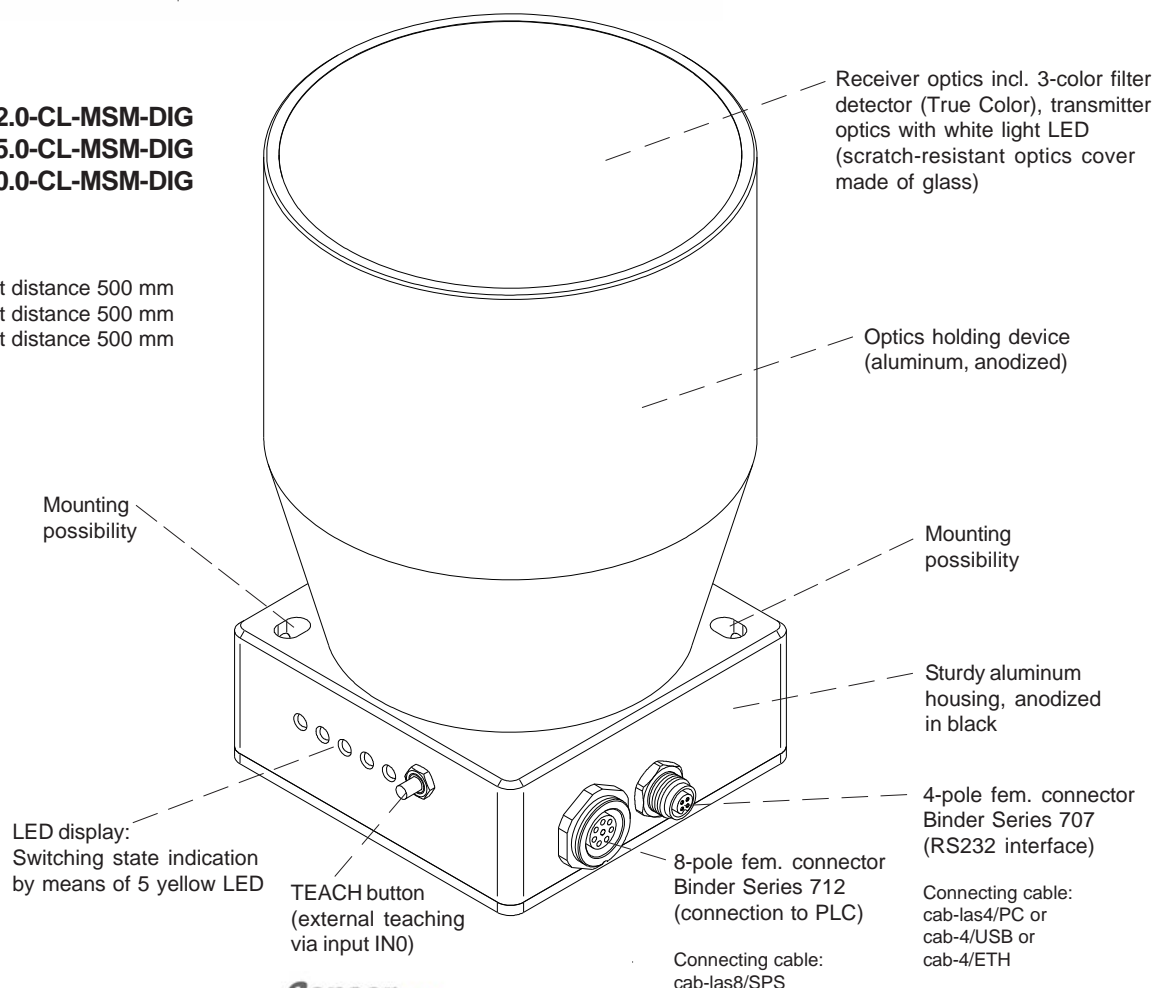
**SPECTRO-3-500-COF-d50.0-CL-MSM-DIG**

(incl. Windows® PC software  
SPECTRO3-MSM-DIG-Scope)

d12.0: spot size typ.  $\varnothing$  12 mm at distance 500 mm

d25.0: spot size typ.  $\varnothing$  25 mm at distance 500 mm

d50.0: spot size typ.  $\varnothing$  58 mm at distance 500 mm



**Sensor**

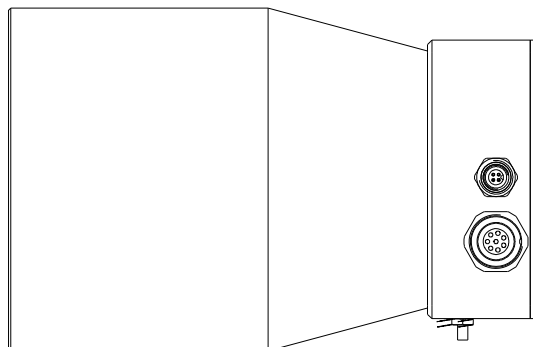
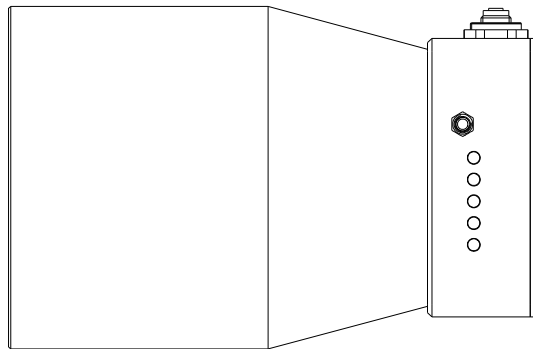
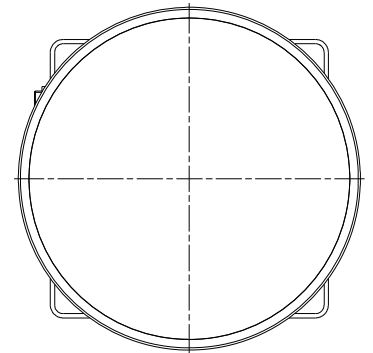
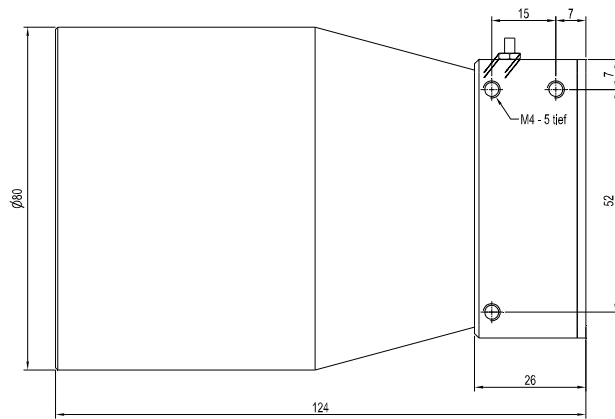
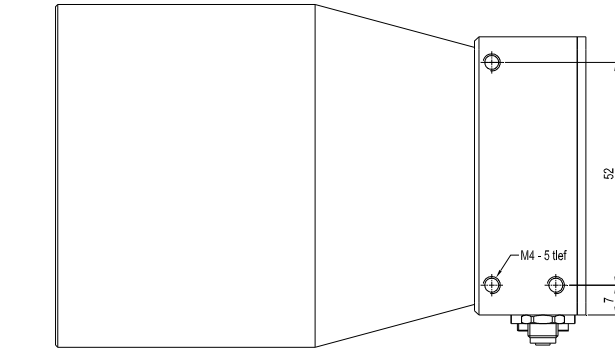
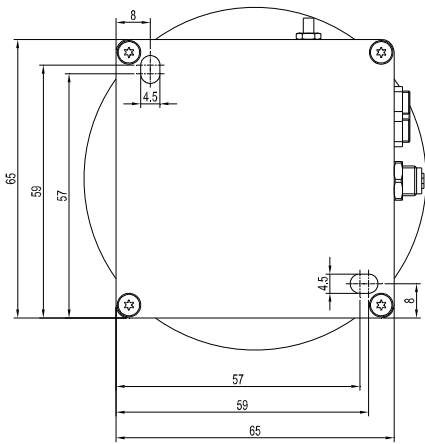
**Instruments**



**Technical Data**

Model	SPECTRO-3-500-COF-d12.0-CL-MSM-DIG	SPECTRO-3-500-COF-d25.0-CL-MSM-DIG	SPECTRO-3-500-COF-d50.0-CL-MSM-DIG
Voltage supply	+24VDC ( $\pm 10\%$ ), reverse polarity protected, overcurrent protected		
Current consumption	< 160 mA		
Max. switching current	100 mA, short circuit proof		
Switching state indication	5 yellow LED visualize the physical state of the outputs OUT0 ... OUT4		
Input digital (1x)	IN0 (Pin 3), digital (0V/+24V) or teach button at the housing		
Outputs digital (5x)	OUT0 ... OUT4 (Pin 4 ... 8): digital (0V/+24V), npn/pnp-able (bright/dark-switching, can be switched)		
Interface	RS232		
Pulse lengthening	0 ... 100 ms, adjustable via PC software		
Averaging	max. 32768 values, adjustable via PC software		
Scan frequency	LED operation, can be switched via PC software: AC operation: max. 20 kHz (depends on parameterization) DC and OFF operation: max. 35 kHz (depends on parameterization)		
Switching frequency	typ. 40 kHz		
Transmitter (light source)	super-bright white-light LED		
Transmitter control	can be switched via PC software: AC operation (LED MODE-AC), DC operation (LED MODE-DC), OFF operation (LED MODE-OFF)		
Measuring range	typ. 160 mm ... 1000 mm	typ. 100 mm ... 1000 mm	typ. 100 mm ... 1000 mm
Receiver	3-color filter detector (TRUE COLOR detector, "human color perception"), color filter curves acc. to CIE 1931		
Receiver gain setting	8 steps (AMP1 ... AMP8), adjustable via PC software		
Ambient light	max. 5000 Lux		
Size of light spot	typ. $\varnothing$ 6.5 mm at distance 200 mm typ. $\varnothing$ 8 mm at distance 300 mm typ. $\varnothing$ 11.5 mm at distance 500 mm typ. $\varnothing$ 16.5 mm at distance 700 mm typ. $\varnothing$ 21.5 mm at distance 900 mm	typ. $\varnothing$ 6 mm at distance 100 mm typ. $\varnothing$ 12 mm at distance 300 mm typ. $\varnothing$ 25 mm at distance 500 mm typ. $\varnothing$ 36 mm at distance 700 mm typ. $\varnothing$ 46 mm at distance 900 mm	typ. $\varnothing$ 8 mm at distance 100 mm typ. $\varnothing$ 33 mm at distance 300 mm typ. $\varnothing$ 58 mm at distance 500 mm typ. $\varnothing$ 85 mm at distance 700 mm typ. $\varnothing$ 105 mm at distance 900 mm
Reproducibility	in the X, Y color range each 1 digit at 12-bit A/D conversion		
Temperature drift X,Y	$\Delta X/\Delta T$ ; $\Delta Y/\Delta T$ typ. 0,2 digits/ $^{\circ}\text{C}$ (< 0,01% / $^{\circ}\text{C}$ )		
Measurement accuracy	$\Delta E = 0.7$		
Resolution	$\Delta E \geq 0.01$ in case of color space L*u*v': $\Delta u'v' = 0.001$		
Color spaces	L*a*b*, L*C*h*, L*u*v*, L*u'v', and xyY (CIE standard)		
Color memory capacity	non-volatile EEPROM with parameter sets for max. 31 colors (max. 48 in group mode)		
Housing dimensions	LxWxH approx. 65 mm x 65 mm x 124 mm (incl. optics holding device $\varnothing$ 80 mm, without flange connectors)		
Housing material	aluminum, anodized in black (optics holding device: aluminum, anodized)		
Enclosure rating	IP67 (optics), IP64 (electronics)		
Connecting cables	to PLC: cab-las8/SPS or cab-las8/SPS-w to PC/RS232 interface: cab-las4/PC or cab-las4/PC-w to PC/USB interface: cab-4/USB or cab-4/USB-w to PC/Ethernet interface: cab-4/ETH		
Type of connector	connection to PLC: 8-pole fem. connector (Binder 712), connection to PC: 4-pole fem. connector (Binder 707)		
Operating temp. range	-20 $^{\circ}\text{C}$ ... +55 $^{\circ}\text{C}$		
Storage temp. range	-20 $^{\circ}\text{C}$ ... +85 $^{\circ}\text{C}$		
EMC test acc. to	DIN EN 60947-5-2		

Dimensions



All dimensions in mm



## Connector Assignment

### Connection to PLC:

#### 8-pole fem. connector Binder Series 712

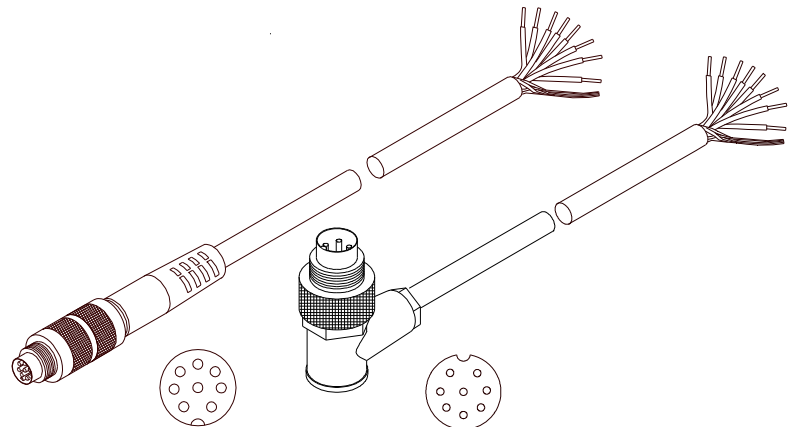
Pin:	Color:	Assignment:
1	white	GND (0V)
2	brown	+24VDC ( $\pm 10\%$ )
3	green	IN0
4	yellow	OUT0 (Digital 0: typ. 0...1V, Digital 1: typ. +Ub - 10%)
5	grey	OUT1 (Digital 0: typ. 0...1V, Digital 1: typ. +Ub - 10%)
6	pink	OUT2 (Digital 0: typ. 0...1V, Digital 1: typ. +Ub - 10%)
7	blue	OUT3 (Digital 0: typ. 0...1V, Digital 1: typ. +Ub - 10%)
8	red	OUT4 (Digital 0: typ. 0...1V, Digital 1: typ. +Ub - 10%)

#### 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:

#### 4-pole fem. connector Binder Series 707

Pin:	Assignment:
1	+24VDC (+Ub, OUT)
2	GND (0V)
3	RxD
4	TxD

#### Connection via RS232 interface at the PC:

##### Connecting cable:

[cab-las4/PC-\(length\)](#)

[cab-las4/PC-w-\(length\)](#) (angle type 90°)

(standard length 2m)

#### alternative:

#### Connection via USB interface at the PC:

Connecting cable (incl. driver software):

[cab-4/USB-\(length\)](#)

[cab-4/USB-w-\(length\)](#) (angle type 90°)

(standard length 2m)

#### alternative:

#### Connection to local network via Ethernet bus:

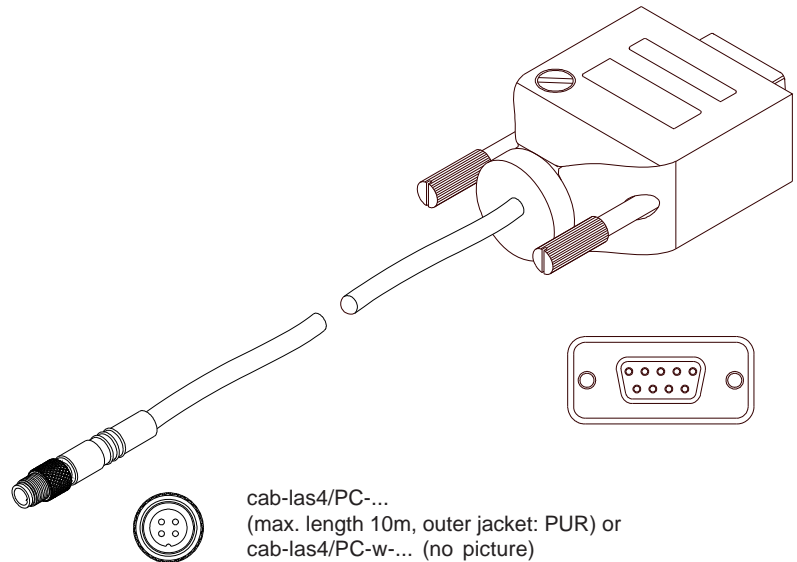
Adapter (incl. software „SensorFinder“):

[cab-4/ETH-500](#)

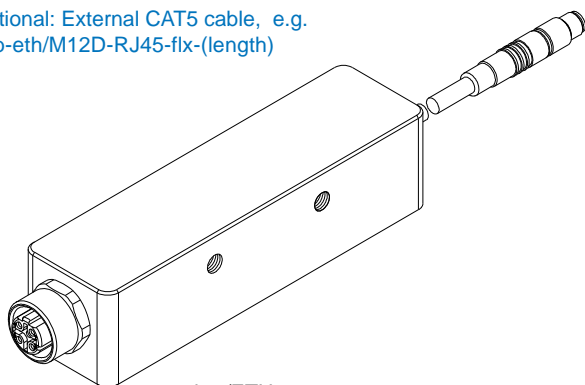
(standard length 0.5m)

Optional: External CAT5 cable, e.g.

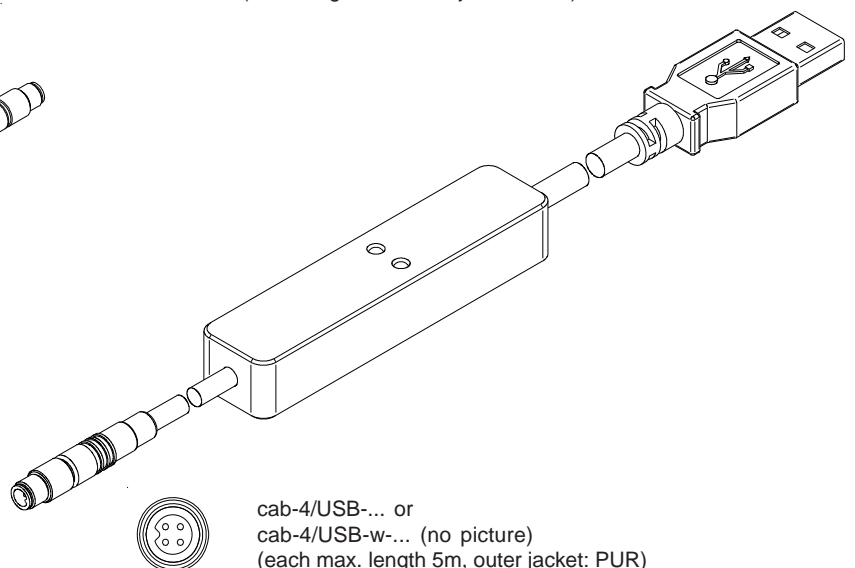
[cab-eth/M12D-RJ45-flx-\(length\)](#)



[cab-las4/PC-...](#)  
(max. length 10m, outer jacket: PUR) or  
[cab-las4/PC-w-...](#) (no picture)  
(max. length 5m, outer jacket: PUR)



[cab-4/ETH-500](#)  
(length 0.5m, outer jacket: PUR)  
4-pole M12 fem. conn. (D-coded)  
for connection of an external  
CAT5 cable, e.g.  
[cab-eth/M12D-RJ45-flx-\(length\)](#)



[cab-4/USB-...](#) or  
[cab-4/USB-w-...](#) (no picture)  
(each max. length 5m, outer jacket: PUR)



## Measuring Principle

### Measuring principle of the color sensors of SPECTRO-3-MSM-DIG series:

The SPECTRO-3-MSM-DIG provides highly flexible signal acquisition. For example, the sensor can be operated in alternating-light mode (AC mode), which makes the sensor insensitive to extraneous light. It also can be set to constant-light mode (DC mode), which makes the sensor extremely fast. With the stepless adjustment of the integrated light source as well as the selectable gain of the receiver signal and an INTEGRAL function the sensor can be set to almost any surface or any "self-luminous object".

When the integrated light source of the SPECTRO-3-MSM-DIG color sensor is activated, the sensor detects the radiation that is diffusely reflected from the object. As a light source the SPECTRO-3-MSM-DIG color sensor uses LEDs (in case of color sensor type -VISUV additionally UV LEDs) with adjustable transmitter power. An integrated 3-fold receiver for the red, green, and blue content of the light that is reflected from the object, or the light that is emitted by a "self-luminous object", is used as a receiver.

The color sensors of the SPECTRO-3-MSM-DIG series can be taught up to 31 colors that are provided directly at the outputs, and up to 48 colors that are output by means of grouping. For each of these taught colors it is possible to set tolerances. Evaluation of the taught colors is performed either with the "FIRST HIT" or with the "BEST HIT" mode. With "FIRST HIT" the first hit in the teach table is output, and with "BEST HIT" the best hit in the teach table is output. Raw data are represented with 12 bit resolution.

Color detection either operates continuously or is started through an external PLC trigger signal. The respective detected color either is provided as a binary code at the 5 digital outputs or can be sent directly to the outputs, if only up to 5 colors are to be detected. At the same time the detected color code is visualised by means of 5 LEDs at the housing of the SPECTRO-3-MSM-DIG. **[Please note: Visualisation by means of LEDs not available with SPECTRO-3-JR-MSM-DIG and SPECTRO-3-MSM-DIG-VIS or -VISUV types.]**

With a TEACH button at the sensor housing the color sensor can be taught up to 31 colors (max. 48 colors in group mode). 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 at cable cab-las8/SPS). **[Please note: TEACH button not available with SPECTRO-3-JR-MSM-DIG and SPECTRO-3-MSM-DIG-VIS or -VISUV types.]**

Parameters and measurement values can be exchanged between a PC and the SPECTRO-3-MSM-DIG color sensor through the serial RS232 interface. All the parameters for color detection also can be saved to the non-volatile EEPROM of the SPECTRO-3-MSM-DIG color sensor through this serial RS232 interface. When parameterisation is finished, the color sensor continues to operate with the current parameters in STAND-ALONE mode without a PC.

Possible firmware updates can be easily performed through the RS232 interface, even with the sensor system in installed condition (a firmware update is performed via the software „FirmwareLoader“).



## Visualization

### Visualization of the color code:

**[not available with SPECTRO-3-JR-MSM-DIG and SPECTRO-3-MSM-DIG-VIS or -VISUV types.]**

The color code is visualised by way of 5 yellow LEDs at the housing of the SPECTRO-3-MSM-DIG color sensor. At the same time in the binary mode (OUT BINARY) the color code indicated on the LED display is output as 5-bit binary information at the digital outputs OUT0 to OUT4 of the 8-pole SPECTRO-3/PLC socket.

The SPECTRO-3-MSM-DIG color sensor is able to process a maximum of 31 colors (color code 0 ... 30) 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 ... OUT4 digital outputs are set to HIGH-level).

In the DIRECT mode (OUT DIRECT HI or OUT DIRECT LO) the maximum numbers of colors to be taught is 5 (color no. 0, 1, 2, 3, 4). If DIRECT HI is activated, the specially digital output is set to HI, while the other 4 are set to LO. If the current color does not correspond with any of the teach-in colors, 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 4 are set to HI. If the current color does not correspond with any of the teach-in colors, all digital outputs are set to HIGH (all LED are lighting).

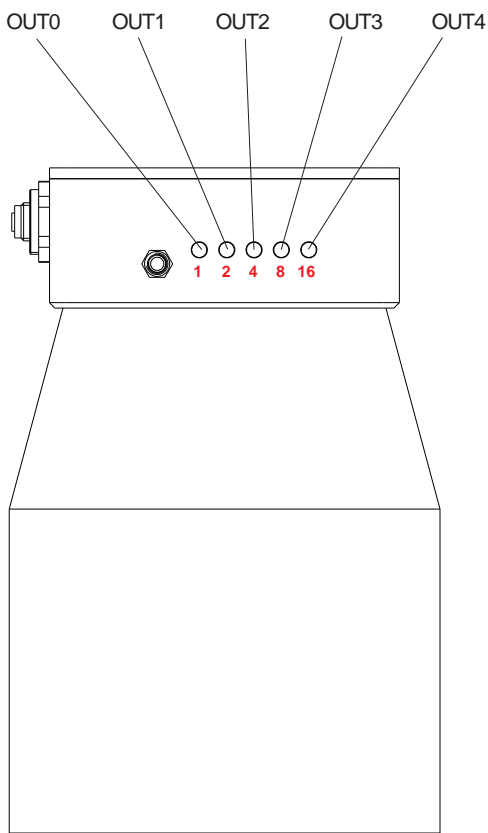


LED Display

**LED display:**

The color code is visualized by means of 5 yellow LEDs at the housing of the color sensor. At the same time the color code indicated at the LED display is output as 5-bit binary information at the digital outputs OUT0 ... OUT4 of the 8-pole PLC connector.

In the DIRECT mode the maximum number of color codes to be taught is 5. These 5 color codes can be directly output at the 5 digital outputs. The respective detected color code is displayed by means of the 5 yellow LEDs at the color sensor housing.



○ ○ ○ ○ ○	● ○ ○ ○ ○	○ ● ○ ○ ○
0	1	2
● ● ○ ○ ○	○ ○ ● ○ ○	● ○ ● ○ ○
3	4	5
○ ● ● ○ ○	● ● ● ○ ○	○ ○ ○ ● ○
6	7	8
● ○ ○ ● ○	○ ● ○ ● ○	● ● ○ ● ○
9	10	11
○ ○ ● ● ○	● ○ ● ● ○	○ ● ● ● ○
12	13	14
● ● ● ● ○	○ ○ ○ ○ ●	● ○ ○ ○ ●
15	16	17
○ ● ○ ○ ●	● ● ○ ○ ●	○ ○ ● ○ ●
18	19	20
● ○ ● ○ ●	○ ● ● ○ ●	● ● ● ○ ●
21	22	23
○ ○ ○ ● ●	● ○ ○ ● ●	○ ● ○ ● ●
24	25	26
● ● ○ ● ●	○ ○ ● ● ●	● ○ ● ● ●
27	28	29
○ ● ● ● ●	● ● ● ● ●	
30	Error or „not detected“	

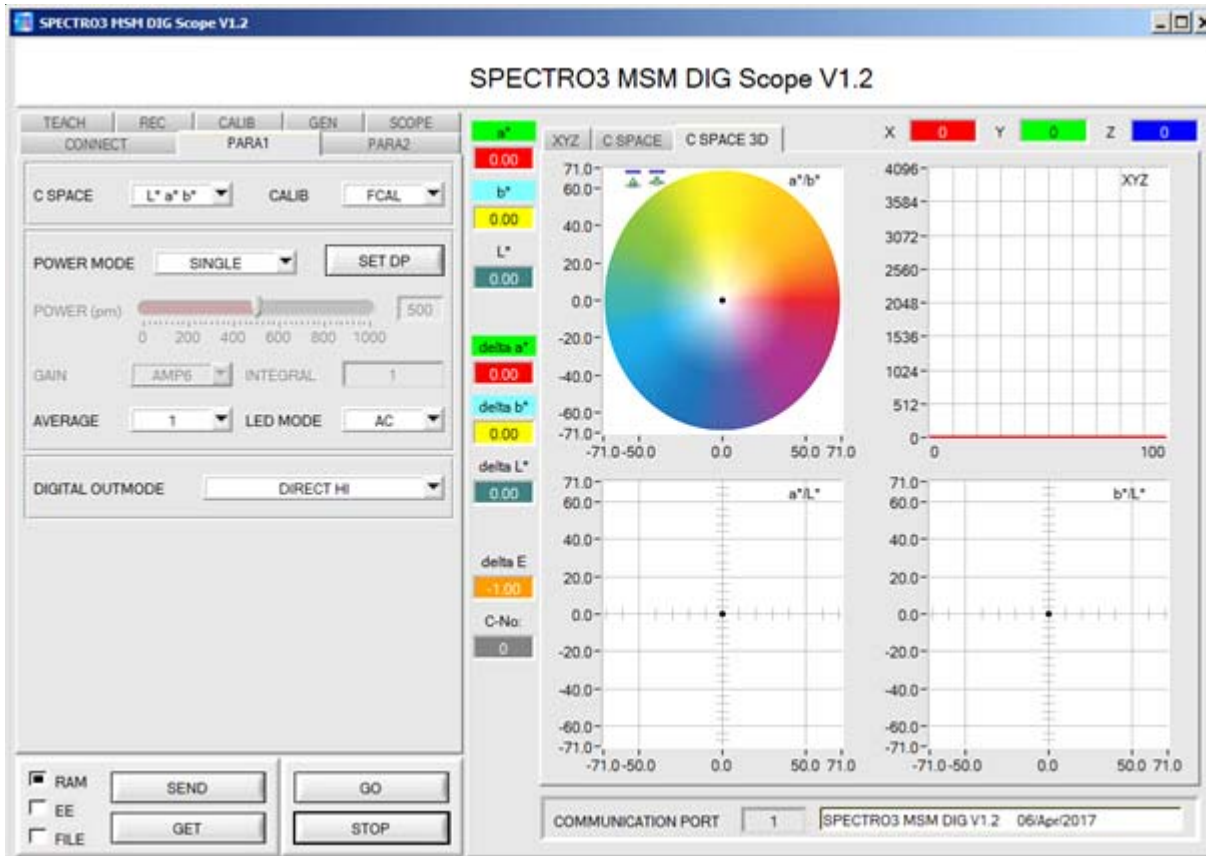


## Parameterization

**Windows® user interface:**

(The current software version is available for download on our website.)

The color sensor is parameterized under Windows® with the SPECTRO3-MSM-DIG-Scope software. 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.



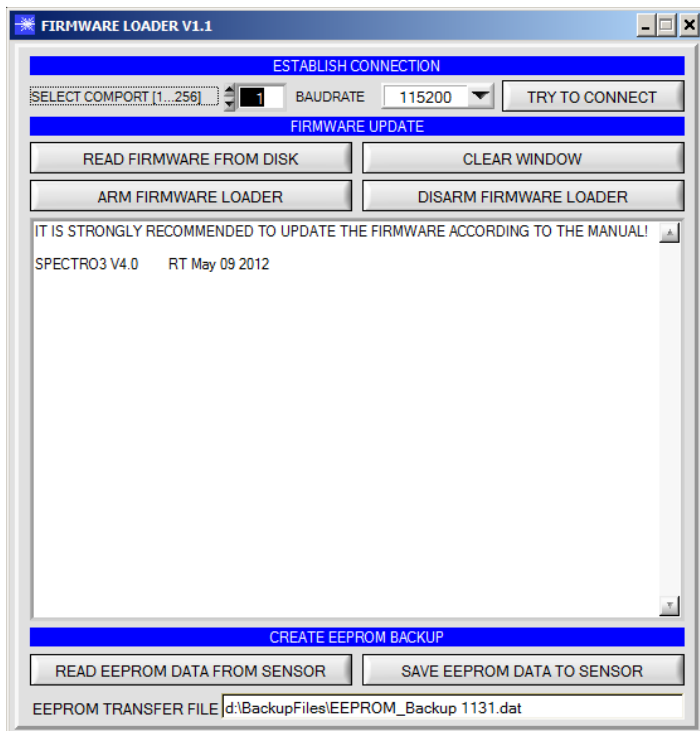
The RS232 interface (tab PARA1 or PARA2) is used for setting parameters such as:

- POWER MODE: Light power of the LED
  - SET DP: Set Double Parameter
  - LED MODE: Triggering of the internal light source (AC, DC)
  - GAIN: Used for setting the gain of the receiver (AMP1 ... AMP8)
  - AVERAGE: Number of scanning values (measurement values, 1 ... 32768) over which the raw signal measured at the receiver is averaged. A higher AVERAGE default value reduces noise of the raw signals at the receiver unit and there will be a decrease of the maximal available switching frequency of the sensor.
  - INTEGRAL: 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
  - C SPACE: Selection of a color space ( $L^*a^*b^*$ ,  $L^*C^*h^*$ ,  $L^*u^*v^*$ ,  $L^*u^*v^*$ , or  $xyY$ ) for the calculation of the color stimulus specification
  - DIGITAL OUTMODE: Triggering of the five digital outputs (OUT0 ... OUT4)
  - EVALUATION MODE: Evaluation mode (FIRST HIT or BEST HIT)
  - TRIGGER: Continuous or external or self trigger (CONT, EXT1, EXT2, TRANS)
  - EXTEACH: In all the evaluation modes teaching of a color can be performed externally through IN0 or by means of the button at the sensor housing [Please note: TEACH button not available with SPECTRO-3-JR-MSM-DIG and SPECTRO-3-MSM-DIG-VIS or -VISUV types.]
  - INTLIM: Minimum intensity required for color evaluation
  - MAXCOL-No.: Number of colors to be checked
- Tab TEACH  
Opens a window where you can teach colors to the TEACH TABLE
- Tab CALIB  
Selection of calibration mode (FCAL = factory calibration or UCAL = user calibration).
- Tab SCOPE  
Visualises an oscilloscope
- Tab GEN  
Displays the current temperature value TEMP in the sensor housing
- Tab REC  
Data recorder



## Firmware Update

### Firmware update by means of the software „FirmwareLoader“:



The software „Firmware 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.



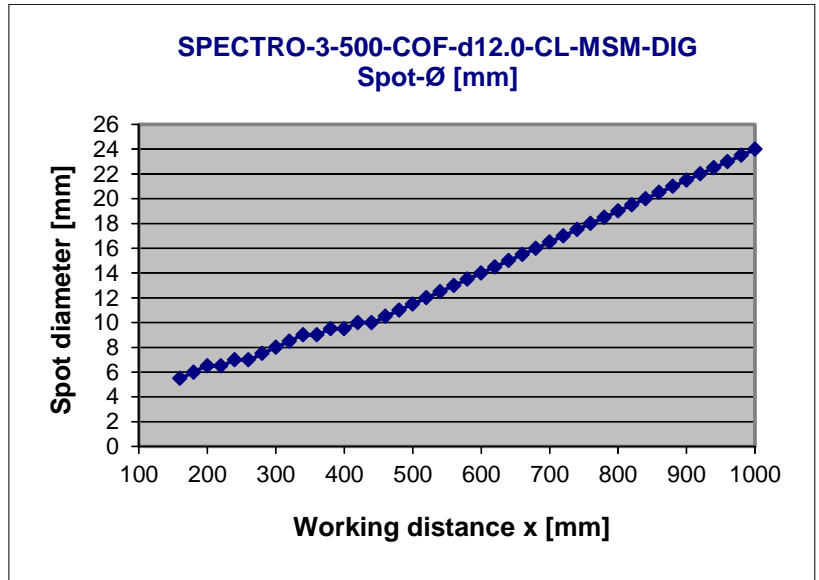


Diagrams

**Diagrams:** SPOT DIAMETER and RELATIVE INTENSITY  
SPECTRO-3-500-COF-d12.0-CL-MSM-DIG

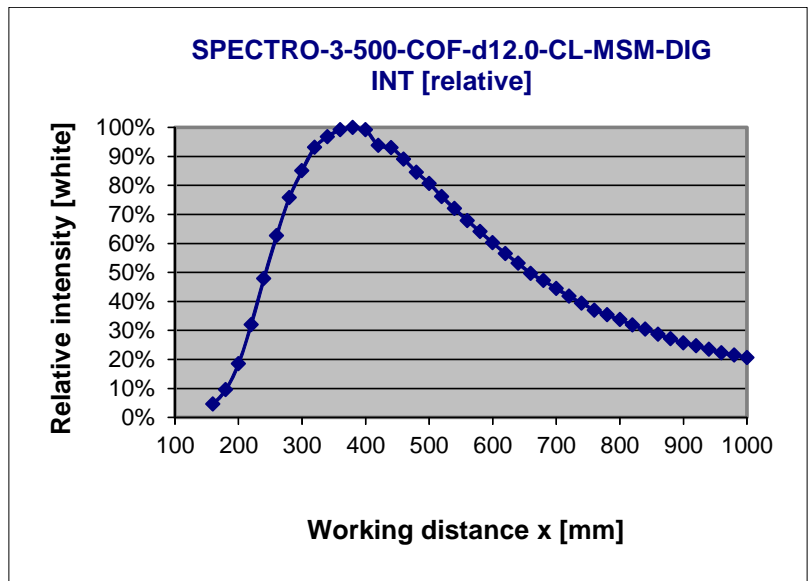
**Spot diameter**

SPECTRO-3-500-COF-d12.0-CL-MSM-DIG:  
12 mm (typ.) at a working distance of 500 mm



**Relative intensity**

SPECTRO-3-500-COF-d12.0-CL-MSM-DIG:  
100% at a working distance of 380 mm  
(INTENSITY 3437)

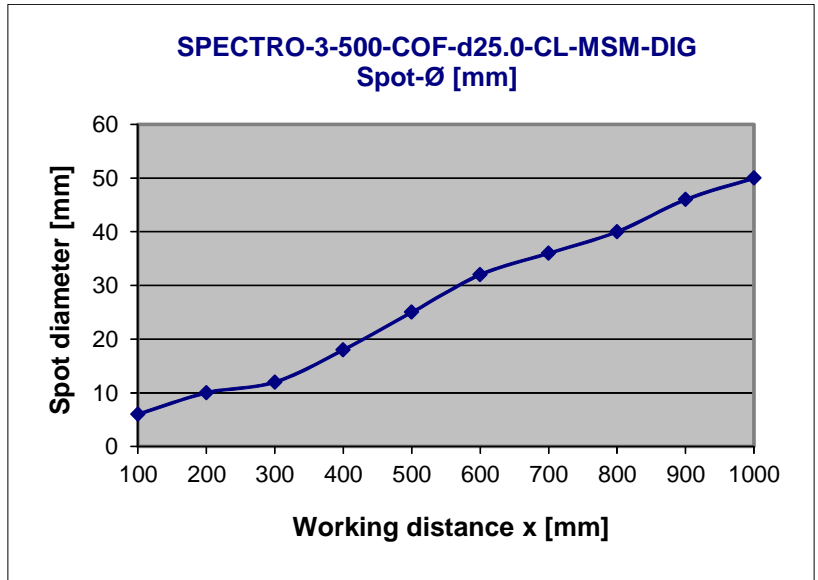




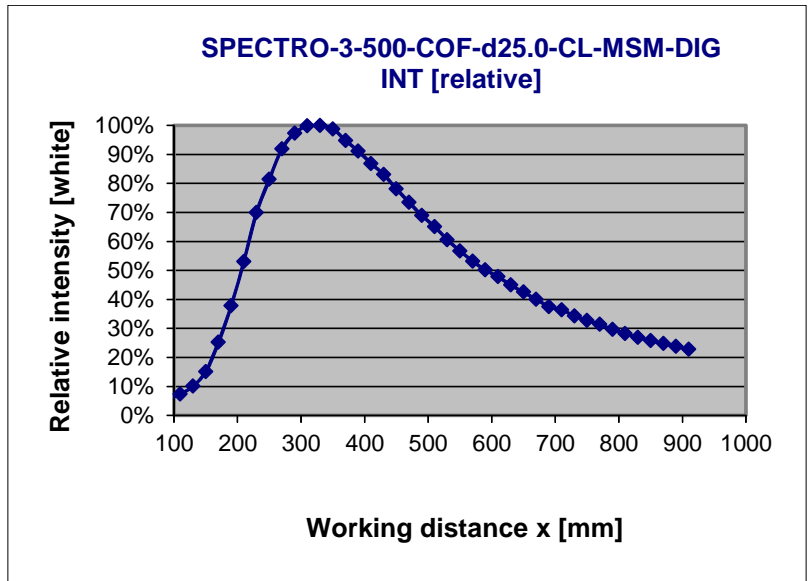
Diagrams

**Diagrams:** SPOT DIAMETER and RELATIVE INTENSITY  
SPECTRO-3-500-COF-d25.0-CL-MSM-DIG

**Spot diameter**  
SPECTRO-3-500-COF-d25.0-CL-MSM-DIG:  
25 mm (typ.) at a working distance of 500 mm



**Relative intensity**  
SPECTRO-3-500-COF-d25.0-CL-MSM-DIG:  
100% at a working distance of 330 mm  
(INTENSITY 3650)



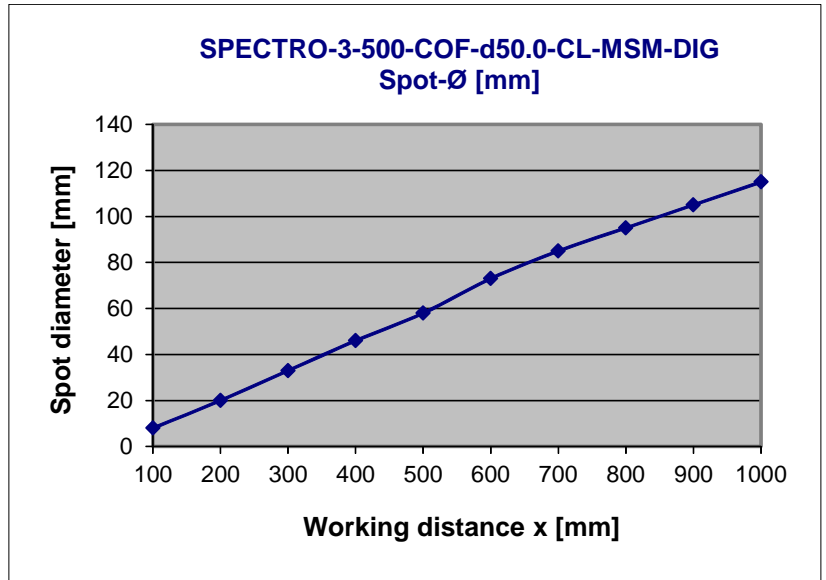


Diagrams

**Diagrams:** SPOT DIAMETER and RELATIVE INTENSITY  
SPECTRO-3-500-COF-d50.0-CL-MSM-DIG

**Spot diameter**

SPECTRO-3-500-COF-d50.0-CL-MSM-DIG:  
58 mm (typ.) at a working distance of 500 mm



**Relative intensity 100%**

SPECTRO-3-500-COF-d50.0-CL-MSM-DIG:  
100% at a working distance of 230 mm  
(INTENSITY 3670)

