

# SPECTRO Series

## ► SPECTRO-3-FCL-SLE

- Measuring range typ. 5 mm ... 120 mm
- Integrated transmitter and receiver optics
  - Big dynamic range due to focused white-light operation
  - Up to 31 colors can be taught (max. 64 colors in GROUP mode)
  - RS232 interface (USB or Ethernet adapter is available)
  - Super-bright white-light LED, focused (AC-/DC-operation or OFF for luminous objects can be switched)
  - Color detection, contrast detection, and gray scale detection
  - Insensitive to outside light (in AC-operation)
  - Brightness correction can be activated (STATIC/DYNAMIC)
  - Scan frequency max. 35 kHz (in DC- or OFF-operation)
  - Switching frequency typ. 35 kHz
  - 5 digital outputs to output the detected colors (provided either as a binary code or directly, if only up to 5 colors are to be detected)
  - Several TEACH functions (via PC or PLC)
  - Various evaluation algorithms can be activated
  - "BEST HIT" mode ("human color assessment")
  - 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")

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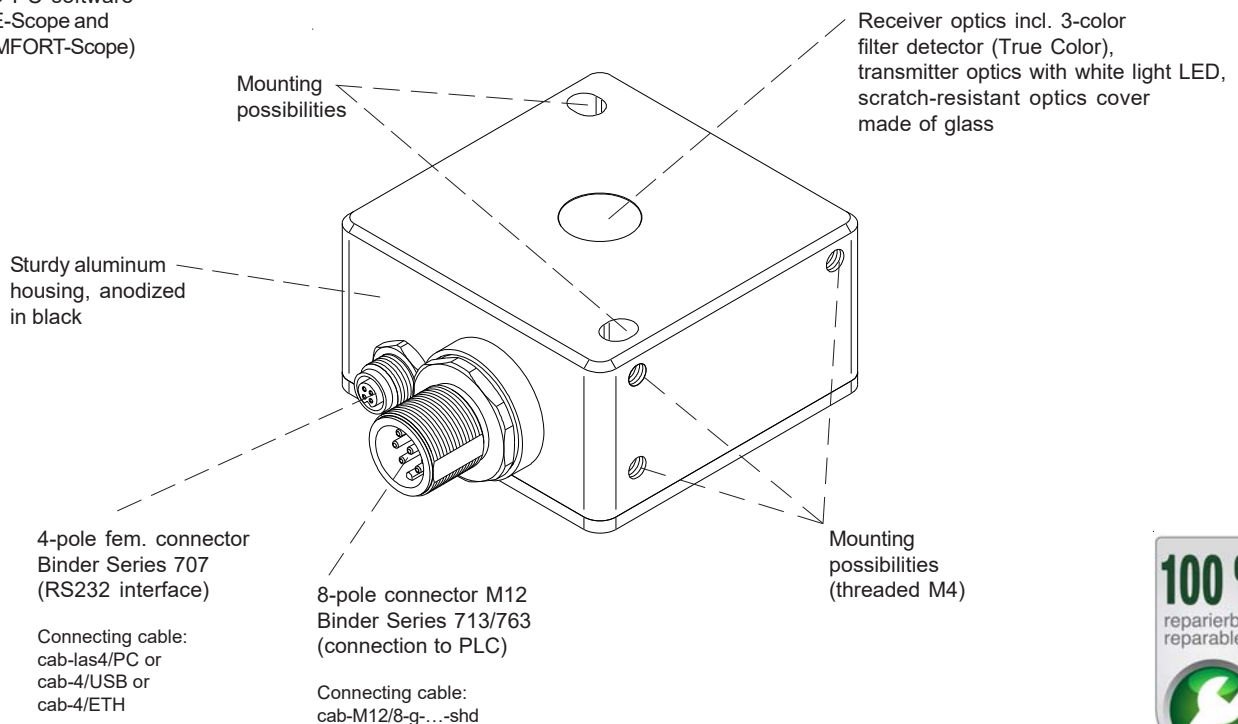


## Design

### Product name:

#### SPECTRO-3-FCL-SLE

(incl. Windows® PC software  
SPECTRO3-SLE-Scope and  
SPECTRO3-COMFORT-Scope)

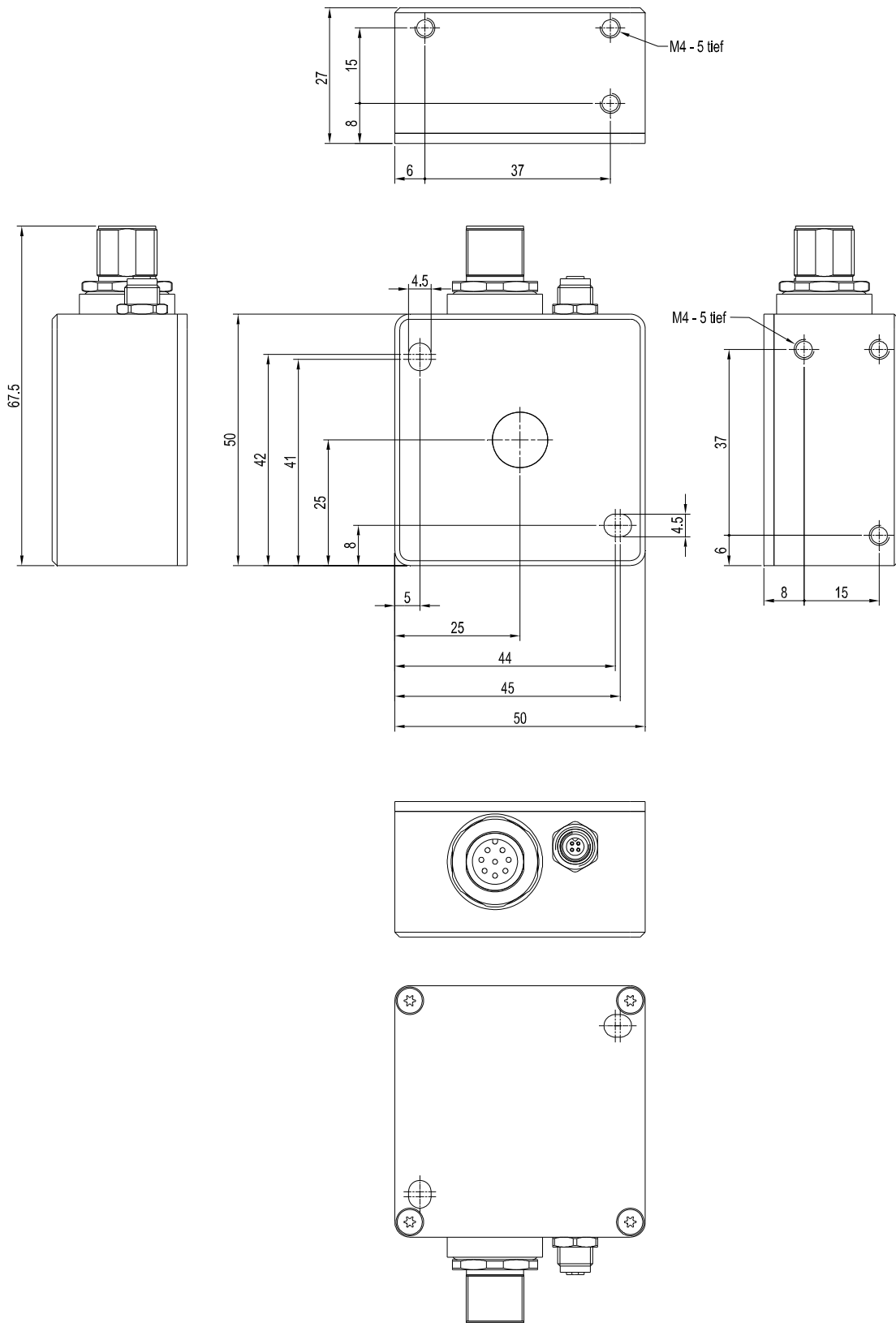




**Technical Data**

Model	SPECTRO-3-FCL-SLE	
Voltage supply	+24VDC ( $\pm 10\%$ ), reverse polarity protected, overcurrent protected	
Current consumption	< 160 mA	
Max. switching current	100 mA, short circuit proof	
Input digital (1x)	IN0 (Pin 3), digital (0V/+24V)	
Outputs digital (5x)	OUT0 ... OUT1 (Pin 4 ... Pin 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. 35 kHz	
Transmitter (light source)	super-bright white-light LED, focused	
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. 5 mm ... 120 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	
Detection range (half intensity width)	typ. 3 mm at a distance of 5 mm typ. 6 mm at a distance of 15 mm typ. 10 mm at a distance of 30 mm	typ. 16 mm at a distance of 60 mm typ. 23 mm at a distance of 80 mm typ. 29 mm at a distance of 120 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/ $^{\circ}\text{C}$ ( $< 0,01\% / ^{\circ}\text{C}$ )	
Color difference	$\Delta E \geq 0,5$	
Color space	X Y INT siM (Lab)	
Color memory capacity	non-volatile EEPROM with parameter sets for max. 31 colors (max. 64 colors in GROUP mode)	
Housing dimensions	LxWxH approx. 50 mm x 50 mm x 27 mm (without flange connectors)	
Housing material	aluminum, anodized in black	
Enclosure rating	IP64	
Connecting cables	to PLC: cab-M12/8-g-...-shd 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 M12-connector (Binder 713/763), connection to PC: 4-pole fem. connector (Binder 707)	
Operating temp. range	-20 $^{\circ}\text{C}$ ... +55 $^{\circ}\text{C}$	
Storage temperature range	-20 $^{\circ}\text{C}$ ... +85 $^{\circ}\text{C}$	
EMC test acc. to	DIN EN 60947-5-2	

Dimensions



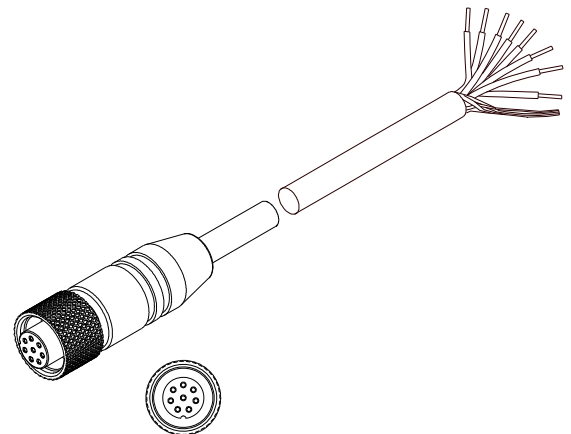
All dimensions in mm



**Connector Assignment**
**Connection to PLC:****8-pole M12 connector Binder Series 713/763**

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-M12/8-g-(length)-shd (shielded)  
 (standard length 2m)



cab-M12/8-g-...-shd  
 (max. length 5m, 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)

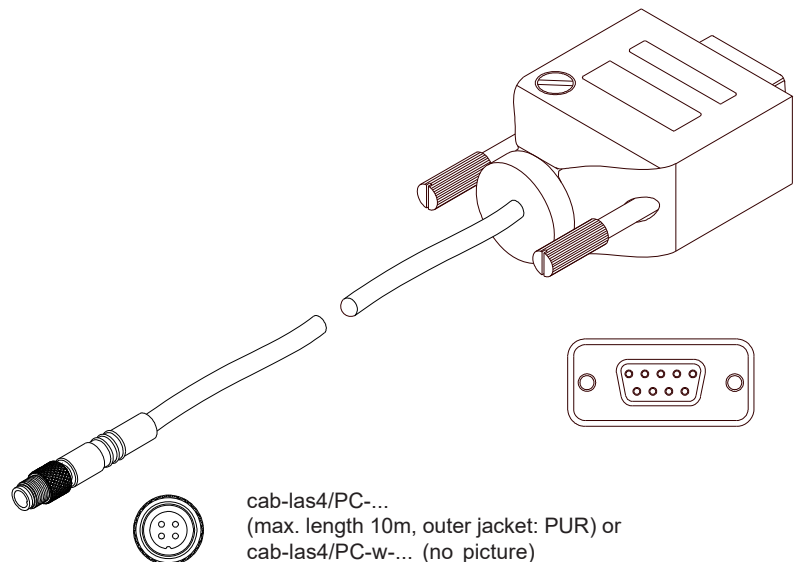
**alternative:****Connection via USB interface at the PC:**

Connecting cable (incl. driver software):  
 cab-4/USB-(length)  
 cab-4/USB-w-(length) (angle type 90°)  
 (standard length 2m)

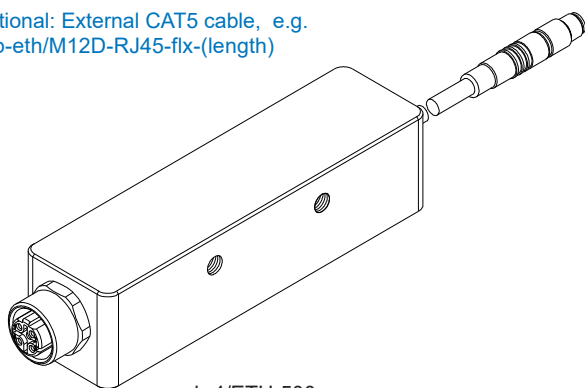
**alternative:****Connection to local network via Ethernet bus:**

Adapter (incl. software „SensorFinder“):  
 cab-4/ETH-500  
 (standard length 0.5m)

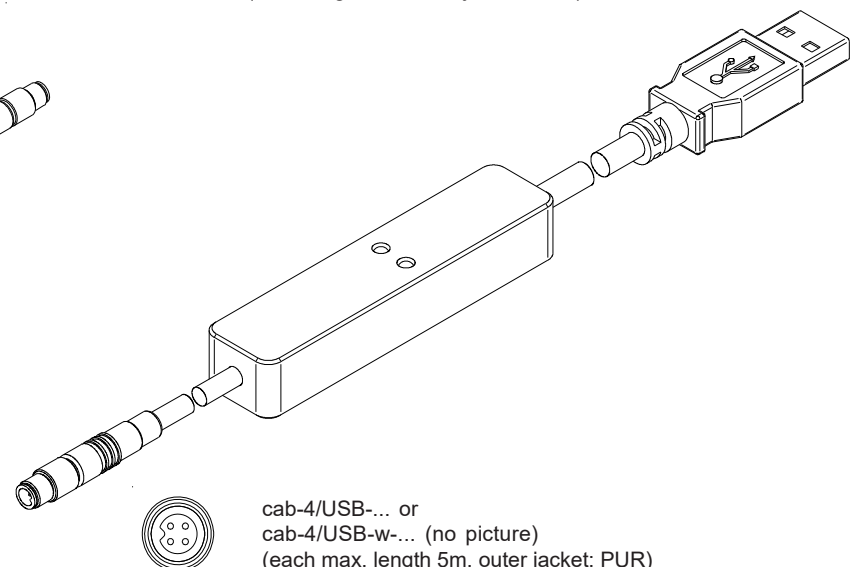
Optional: External CAT5 cable, e.g.  
 cab-eth/M12D-RJ45-flx-(length)



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-SLE series:**

The SPECTRO-3-...-SLE color sensor 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. An OFF function turns off the integrated light source at the sensor and changes to DC operation. The sensor then can detect so-called "self-luminous objects". 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-...-SLE color sensor is activated, the sensor detects the radiation that is diffusely reflected from the object. As a light source the SPECTRO-3-...-SLE color sensor uses a white-light LED 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.

As a light source the SPECTRO-3-UV-SLE or SPECTRO-3-FIO-UV-SLE color sensor uses a UV-LED (375 nm) with adjustable transmitter power to excite the luminescent marking. An integrated 3-fold receiver for the red, green, and blue content of the visible light that is emitted by the luminescent marking is used as a receiver. A special feature here is that the gain of the receiver can be set in 8 steps. This makes it possible to optimally adjust the sensor to almost any luminescent colorant that can be excited in the long-wave UV range.

The SPECTRO-3-...-SLE color sensor can be "taught" up to 31 colors, which are output directly via the outputs, and up to 64 colors which are output via color groups. For each of these taught colors it is possible to set tolerances. In "X Y INT - 2D" or "s i M - 2D" mode these tolerances form a color cylinder in space. In "X Y INT - 3D" or "s i M - 3D" mode the tolerances form a color sphere in space. Color evaluation according to "s i M - 2D" is based on the lab calculation method. All modes can be used in combination with several operating modes such as "FIRST HIT" and "BEST HIT". Raw data are represented with 12 bit resolution.

As a special feature the sensor can be taught two completely independent parameter sets. Input IN0 can be used to tell the sensor which parameter set it should work with.

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. Through input IN0 the color sensor can be taught up to 31 colors (64 colors in group mode). For this purpose the corresponding evaluation mode must be set with the software.

Parameters and measurement values can be exchanged between a PC and the SPECTRO-3-...-SLE 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-...-SLE 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.

The sensors of the SPECTRO-3-...-SLE series can be calibrated (white-light balancing). Balancing can be performed to any white surface. A ColorChecker™ table with 24 color fields is available as an alternative. White-light balancing or calibration can be performed to one of the white, grey, or black fields.

The UV color sensors SPECTRO-3-UV-SLE and SPECTRO-3-FIO-UV-SLE also can be calibrated. Analogous to white-light balancing with color sensors, balancing of the SPECTRO-3-UV-SLE or SPECTRO-3-FIO-UV-SLE could be performed to any luminescent color marking.

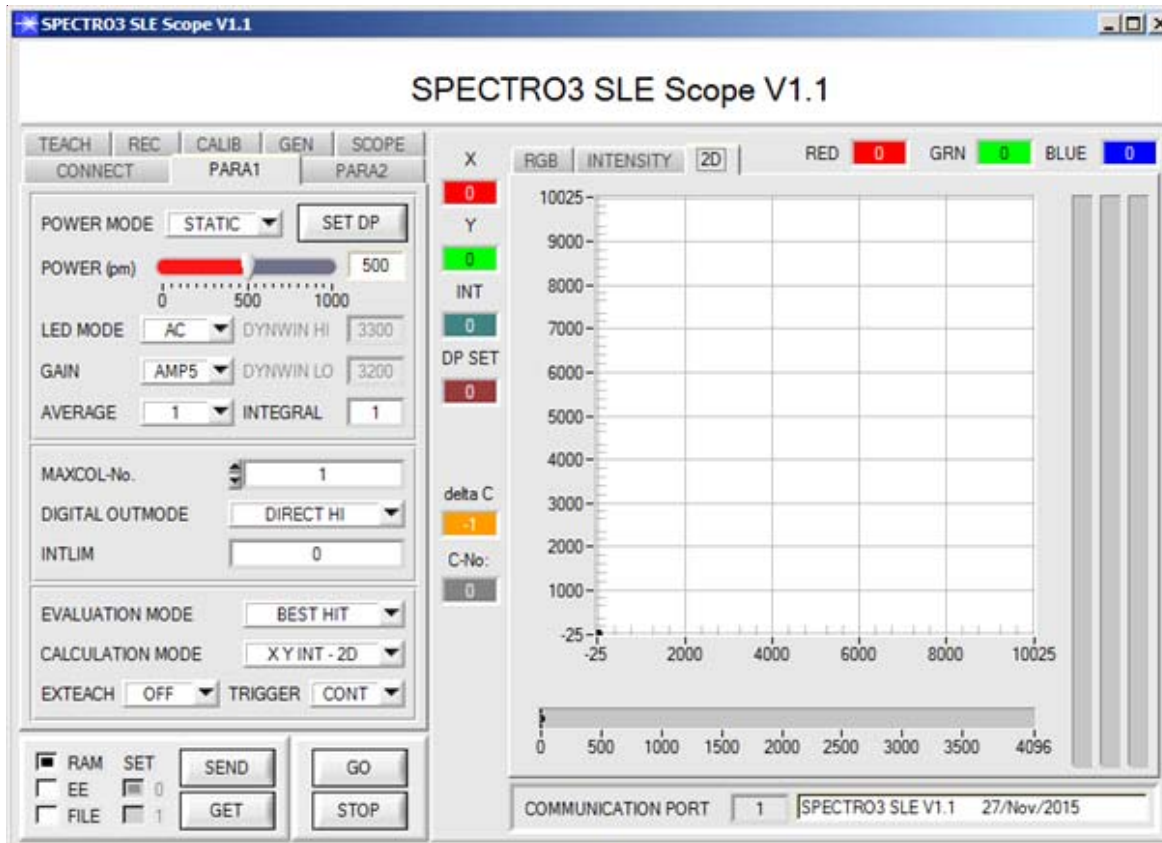


## Parameterization

### Windows® user interface:

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

The color sensor is parameterized under Windows® with the SPECTRO3-SLE-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.

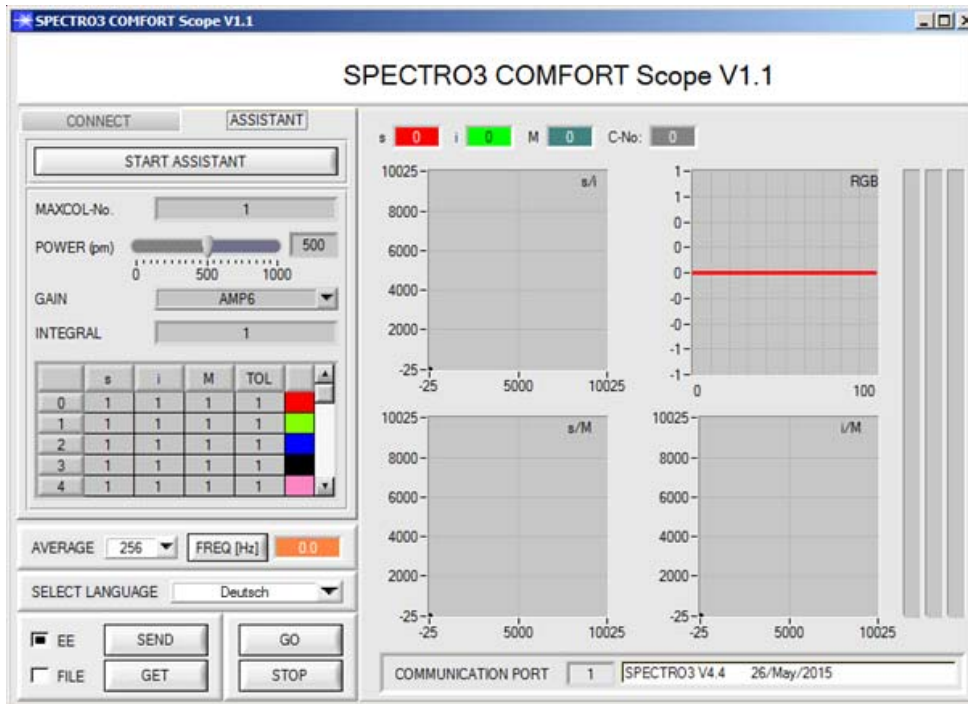


Under Windows® representation of the color value on a PC in numeric form and in a color chart, and representation of RGB values in a time chart. In addition the current RGB values are displayed as a bar chart.

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

- POWER MODE: Light power of the LED
- SET DP: Setting of two parameter sets (Set Double Parameter)
- LED MODE: Triggering of the internal light source
- GAIN: Used for setting the gain of the receiver
- AVERAGE: Averaging over a maximum of 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
- MAXCOL-No.: Number of colors to be checked
- DIGITAL OUTMODE: Triggering of the digital outputs
- INTLIM: Minimum intensity required for color evaluation
- EVALUATION MODE: Various evaluation modes to choose from (FIRST HIT, BEST HIT, MIN DIST, COL5, THD RGB)
- CALCULATION MODE: There are 2 methods of teaching a color, which are selectable via CALCULATION MODE. The CALCULATION MODE „X Y INT - 3D“ (or „s i M - 3D“) uses a color sphere in space with radius TOL. Contrary to this, the CALCULATION MODE „X Y INT - 2D“ (or „s i M - 2D“) uses a color cylinder in space with radius CTO or siTO and with height ITO or M. The teach process is the same for both methods. Color evaluation according to „s i M - 2D“ uses the Lab calculation method
- EXTEACH: In all the evaluation modes teaching of a color can be performed externally through IN0
- TRIGGER: Continuous or external or self trigger


 Parametrization

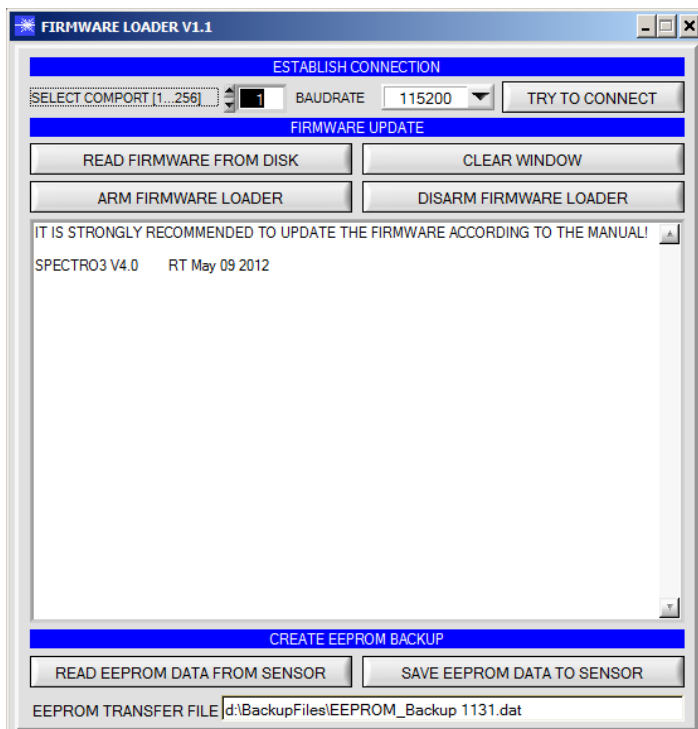
**Windows® user interface SPECTRO3-COMFORT-Scope as an alternative to SPECTRO3-SLE-Scope:**


Color sensors of the following types can be quickly parameterised with the SPECTRO3-COMFORT-SCOPE software:

SPECTRO-3 (im M34 housing)  
 SPECTRO-3-CL  
 SPECTRO-3-JR  
 SPECTRO-3-SL  
 SPECTRO-3-SLE

The software features menu guidance that prompts the user to enter all the relevant parameters.


 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.

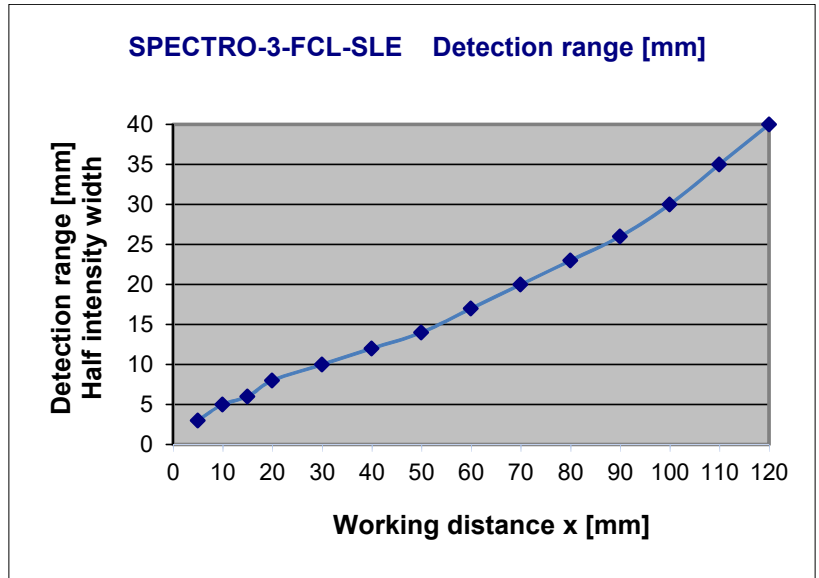
An initialisation file (xxx.ini) and a firmware file (xxx.elf.S) are required for performing a firmware update. These files can be obtained from your supplier. In some cases an additional firmware file for the program memory (xxx.elf.p.S) is also needed, and this file will be automatically provided together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



Diagrams

**Diagramme:** DETECTION RANGE (HALF INTENSITY WIDTH) and RELATIVE INTENSITY  
SPECTRO-3-FCL-SLE

**Detection range (half intensity width)**  
SPECTRO-3-FCL-SLE:  
17 mm (typ.) at a working distance of 60 mm



**Relative intensity:**  
SPECTRO-3-FCL-SLE:  
100% at a working distance of 10 mm  
(INTENSITY 3785)

