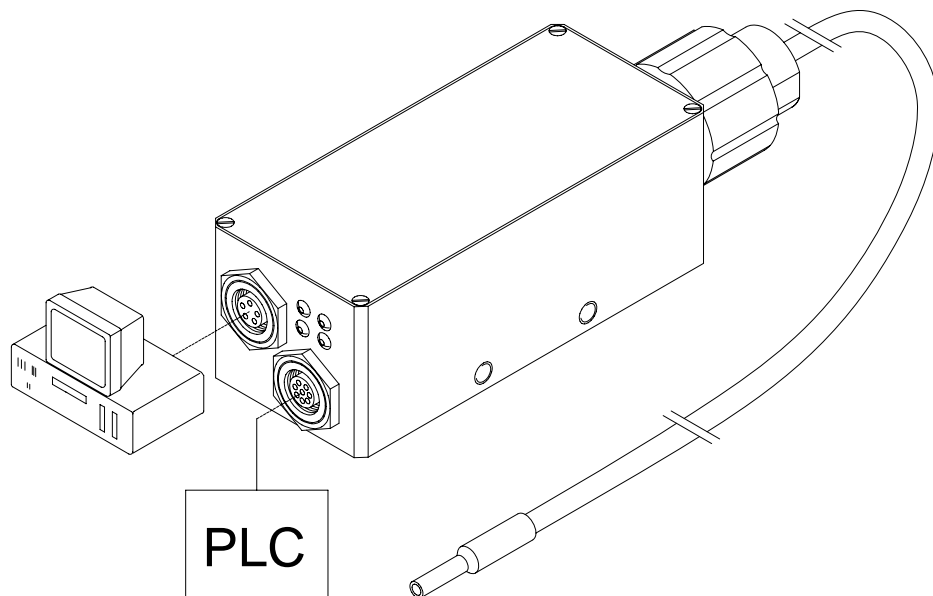


Manual

Software COLOR2-Scope V4.51

(PC-Software for Microsoft® Windows® 7, Vista, XP)

for Color Sensors of Series SI-COLO2



This manual describes the installation of the PC software for the SI-COLO2 color sensor. As a support for commissioning of the color sensor this manual explains the functional elements of the Windows® user interface.

The SI-COLO2 color sensor detects the radiation that is diffusely reflected by the target. The SI-COLO2 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.

The SI-COLO2 color sensor can be "taught" up to 15 colors; 5 different color-detection modes and 3 contrast-detection modes for the respective primary color are available for selection. 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-COLO2 housing by means of 4 LEDs.

Through the RS232 interface parameters and measured values can be exchanged between the PC and the SI-COLO2 color sensor. All the parameters for color detection can be stored in the non-volatile EEPROM of the SI-COLO2 color sensor. When parameterization is finished the color sensor continues to operate with the current parameters in "stand alone" mode without a PC.

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1 Installation of the COLOR2-Scope Software

Hardware requirements for successful installation of the COLOR2-Scope software:

- IBM PC AT or compatible
- VGA graphics
- Microsoft® Windows® XP, Me, 2000
- Serial RS232 interface at the PC
- Microsoft-compatible mouse
- Cable for the RS232 interface
- CD-ROM drive
- 20 MByte of free hard disk space

The COLOR2-Scope software can only be installed under Windows. Windows must therefore be started first, if it is not yet running.

Please install the COLOR2-Scope software as described below:

1. The software can be installed directly from the installation CD-ROM. To install the software, start the SETUP program in the INSTALL folder of the CD-ROM.
2. The installation program displays a dialog and suggests to install the COLOR2-Scope software in the C:\COL2V451 directory on the hard disk. You may accept this suggestion with **OK** or **[ENTER]**, or you may change the path as desired. Installation is then performed automatically.
3. During the installation process a new program group for the COLOR2-SCOPE software is created in the Windows Program Manager. In the COLOR2-SCOPE program group an icon for starting the software is created automatically. When installation is successfully completed the installation program displays "Setup OK".
4. After successful installation the software can be started with a left mouse button double-click on the COLOR2-SCOPE icon.

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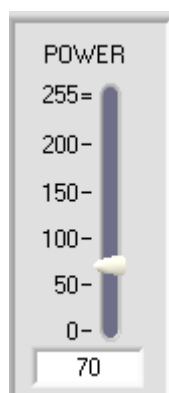
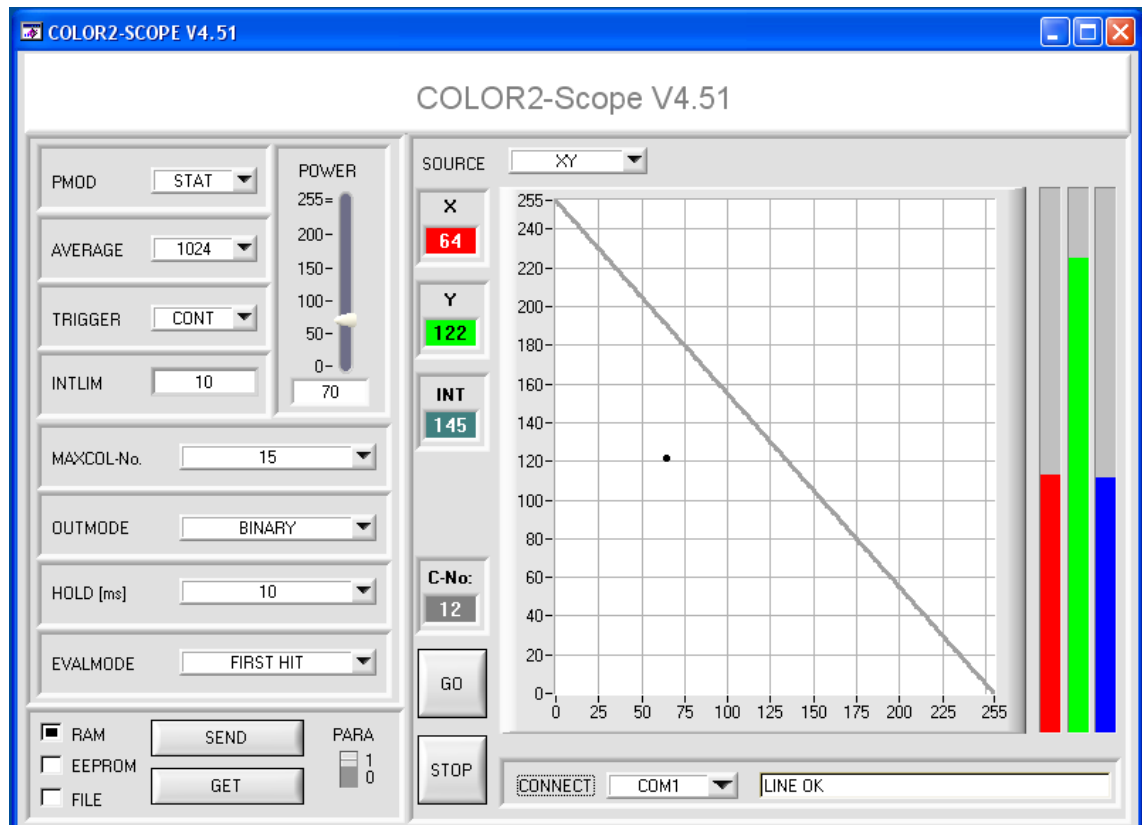
2 Operation of the COLOR2-Scope Software

2.1 Functions of the individual COLOR2-Scope control elements

Please read this chapter first before you start to adjust and parameterise the SI-COLO color sensor.

Pressing the right mouse button on an individual element will call up a short help text.

When the COLOR2-Scope software is started, the following window appears on the Windows interface:



In this function field the intensity of the transmitter LED can be adjusted by using the slider or by entering a value in the edit box.

A value of 255 means full intensity at the transmitter LED, a value of 0 stands for the lowest transmitter intensity adjustment!

The POWER slider is only effective in the PMOD STAT.

ATTENTION!

A change of the transmitter power only becomes effective at the SI-COLO2 color sensor after actuation of the SEND button in the MEM function field!

PMOD STAT ▼

PMOD:

In this function field the operating mode of automatic power correction at the transmitter unit (transmitter LED) can be set.

STAT:

The LED transmitter power is constantly kept at the value set with the POWER slider.

DYN:

The LED transmitter power is dynamically controlled in accordance with the amount of radiation that is diffusely reflected from the object. By using the intensities measured at the triple receiver the automatic control circuit attempts to adjust the transmitter power in such a way that the dynamic range is not exceeded.

ATTENTION!

The setting of the POWER slider has no effect in this operating mode.

AVERAGE 1024 ▼

AVERAGE:

This function field is used for adjusting the number of scanning values (measurement values) 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.

TRIGGER EXT ▼

TRIGGER:

This function field serves for setting the trigger mode at the SI-COLO2 color sensor.

EXT:

Color detection is started through the external trigger input (IN0 pin3 green of the PLC connection cable cab-las8/SPS). A trigger event is recognized as long as +24V is present at the IN0 input (HIGH-active).

CONT:

Continuous color detection (no trigger event required).

INTLIM 19

INTLIM:

This edit box is used for setting an intensity limit. Color evaluation is stopped, if the current intensity INT arriving at the receiver unit falls below this limit, and ERROR STATE is output.

ATTENTION!

ERROR STATE if: $INT < INTLIM$

MAXCOL-No. 15 ▼

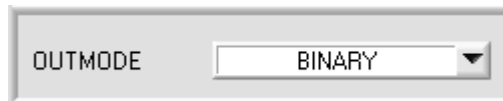
MAXCOL-No.:

This function field serves for setting the number of colors to be checked.

In the BINARY modus the maximum number of colors to be checked is 15. In the DIRECT HI or DIRECT LO modus the maximum number of colors to be checked is 4 (colors no. 0,1,2,3). The numerical value set here determines the currently possible scanning rate of the color sensor. The less the colors to be checked, the faster the operation of the SI-COLO2 color sensor. With 15 taught-in colors a switching frequency of ≥ 2 kHz can be maintained. The numerical value set here refers to the number of rows (starting with row 0) in the color table.
(→ COLOR TEACH TABLE).

PLEASE NOTE:

Active lines in the COLOR TEACH TABLE are shown in green, inactive lines are shown in red.



OUTMODE:

This group of buttons offers the method of how to control the 4 digital outputs.

BINARY:

If in this row-by-row comparison the current color values correspond with the teach-in parameters entered in the color table, this color in the color table is displayed as a color number (C-No.) and is sent to the digital outputs (OUT0 ... OUT3) as a bit pattern.

The maximum number of colors to be taught is 15.

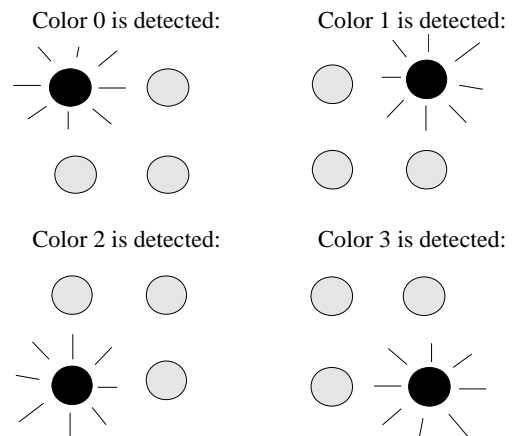
DIRECT:

In this mode the maximum number of colors to be taught is 4 !

If in this row-by-row comparison the current color values correspond with the teach-in parameters entered in the color table, this color in the color table is displayed as a color number (C-No.) and is sent direct to the digital outputs (OUT0 ... OUT3).

If DIRECT HI is activated, the specially digital output is set to HI (see example below).

If the current color does not correspond with any of the teach-in colors, color code 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 code C-No = 255 is set, i.e. all digital outputs are set to HIGH (all LEDs are lighting).

HOLD [ms]

The SI-COLO2 color sensor operates with minimum scanning times in the magnitude of 100µs. This is why most of the PLCs that are connected to the digital outputs OUT0 - OUT3 have difficulties with the safe detection of the resulting short switching state changes. For the digital outputs of the SI-COLO2 color sensor pulse lengthening of up to 100 ms can be set by selecting the corresponding HOLD value.

ATTENTION!

With high transport speed and low HOLD value, AVERAGE should be set to values below 64 (experience figures).

EVALMODE

- ✓ FIRST HIT
- MINIMAL DIST
- COLOR SERIES
- CONTRAST R
- CONTRAST G
- CONTRAST B
- EXTERN TEACH
- ADAPTIVE CONT

EVALMODE:

This function field serves for setting the evaluation mode at the SI-COLO2 color sensor (see also the function OUT).

→ See also function group **OUTMODE**.

FIRST HIT:

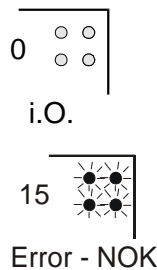
The currently measured color values are compared with the default values in the COLOR-TABLE, starting with teach-color 0. If in the line-by-line comparison the current color values correspond with the teach-parameters entered in the color table, this first "hit" in the color table is displayed as a color number (C-No.) and is output at the digital outputs (OUT0 ... OUT3) according to the settings of the OUTMODE parameter (see OUTMODE).

If the current color does not correspond with any of the teach-colors, the color code C-No. = 255 will be set ("error status").

MINIMAL DIST:

The individual teach-in colors defined in the color table are present as points in the color triangle, defined by their (X,Y) value pairs. When this evaluation mode is set at the SI-COLO2 color sensor, the evaluation algorithm, starting from the currently measured color value (X,Y), calculates the distance to the individual teach-in colors in the color triangle. The current color value (X,Y) is assigned to the teach-in color that is closest in the color triangle. The color detected this way is output at the digital outputs (OUT0 ... OUT3) according to the settings of the OUTMODE parameter (see OUTMODE).

C-No. will only be set to 255, if the current intensity falls below the value set under INTLIM (see INTLIM).



COLOR SERIES:

If this option is activated at the SI-COLO2 color sensor, a color series can be detected at the targets. The color series is defined in the color table.

Please note that the color series must be entered in the color table starting with row 0. The number of colors in the color series can be preset with the MAXCOL-No. function field.

Detection of the color series must be started and stopped through the external trigger input IN0 (pin3 SI-COLO2/PLC).

Color series detection is active, as long as the external trigger input IN0 is connected to HIGH (+24V).

In case of correct detection of the color series (OK) color code C-No. = 0 is set, i.e. all the digital outputs are on LOW level.

In case of incorrect color series (NOK) color code C-No. = 255 is set, i.e. all the digital outputs are on HIGH level.

CONTRAST R:

CONTRAST G:

CONTRAST B:

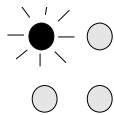
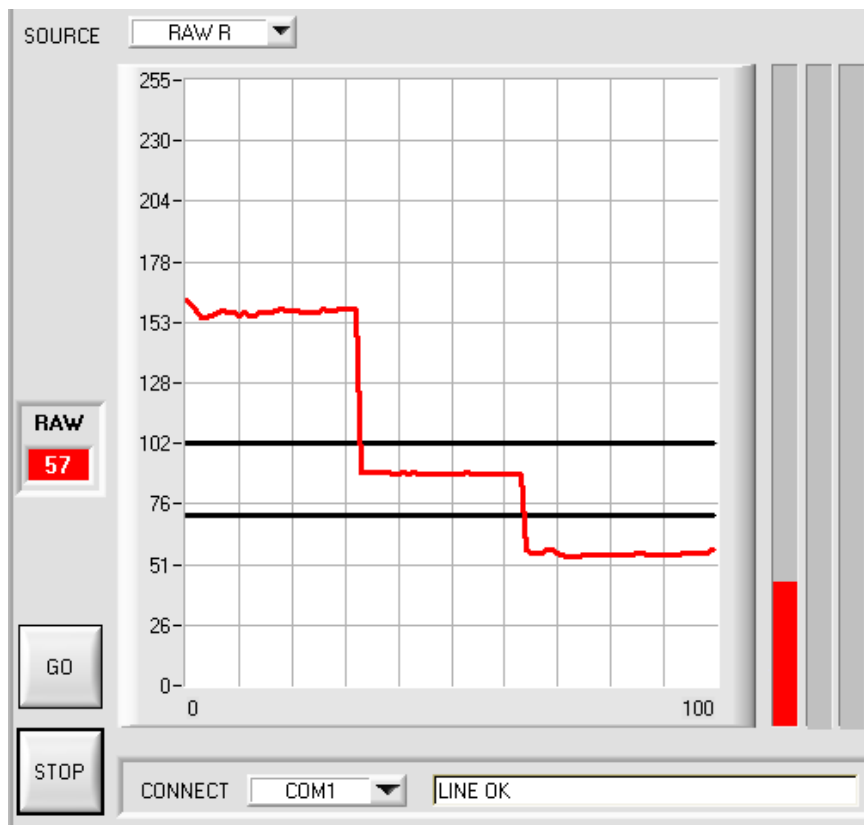
If one of these three function fields is selected, contrast evaluation is activated at the SI-COLO2 color sensor after a click on the SEND button.

In contrast evaluation mode only one selected primary color (RED, GREEN, or BLUE) is evaluated for its intensity INT. Since only one primary color is evaluated, a maximum switching frequency of approx. 28 kHz can be maintained.

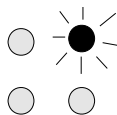
The switching frequency depends on the adjusted value for AVERAGE and is listed in appendix 3.

No.	COLOR TEACH TABLE				
	UL	LL			
0	124	94	1	1	1
1	1	1	1	1	1
2	1	1	1	1	1
3	1	1	1	1	1

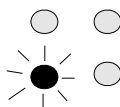
The upper limit (in graph = 122) and the lower limit (in graph = 92) constitute an intensity window of the contrast transition to be detected. The two limits (UL, LL) must be entered in line 0 of the COLOR TEACH TABLE, or they must be automatically taught with TEACH DATA TO. In case of automatic teaching, a certain upper and lower limit are suggested. These limits can of course be changed by entering different values in the corresponding fields (UL, LL).



If the current intensity of the selected primary color lies below the tolerance band set with LL (Lower Limit), digital output OUT0 is set to HIGH level (+24 VDC).



If the current intensity of the selected primary color lies within the tolerance window set with UL and LL, digital output OUT1 is set to HIGH level (+24 VDC).



If the current intensity of the selected primary color lies above the tolerance band set with UL (Upper Limit), digital output OUT2 is set to HIGH level (+24 VDC).

EVALMODE „EXTERN TEACH“:

This evaluation mode allows the user to teach 15 colors externally through the IN0 input, which offers the advantage of not having to start the parameterization software for this purpose. Teaching is performed through the external IN0 input. When the input is activated, the currently present colour is stored in the non-volatile EEPROM memory.

Please note that when this evaluation mode is selected, the tolerance for the intensity and the colour itself must once be stored in the EEPROM at the beginning.

The MAXCOL-No. also must be set first, and must be stored in the EEPROM.

TEACH PROCEDURE:

Click on the EVALMODE window to scroll the pull-down menu. Choose the function “EXTERN TEACH”.

Select how many colors you wish to teach externally.

Click on the field “0” of the PARA switcher to change into the COLOR TEACH TABLE.

EVALMODE EXTERN TEACH ▼

MAXCOL-No. 15 ▼

PARA

1

0

No.
COLOR TEACH TABLE

	X	Y	CTO	INT	ITO	
0	1	1	10	1	10	
1	1	1	10	1	10	
2	1	1	10	1	10	
3	1	1	10	1	10	
4	1	1	1	1	1	
5	1	1	1	1	1	
6	1	1	1	1	1	
7	1	1	1	1	1	
8	1	1	1	1	1	
9	1	1	1	1	1	
10	1	1	1	1	1	
11	1	1	1	1	1	
12	1	1	1	1	1	
13	1	1	1	1	1	
14	1	1	1	1	1	

SEND

Now enter the corresponding tolerances for the colors you wish to teach.

(CTO = COLOR tolerance ITO = INTENSITY tolerance)

In this example, MAXCOL-No. = 4 was selected, i.e. the sensor should detect the color information that is stored in the first 4 lines of the COLOR TEACH TABLE by means of external teaching through IN0. Since the sensor cannot calculate the tolerances for color (CTO) and intensity (ITO) itself, these values must be entered once (in this case 10 at all places) and must be stored in the EEPROM (see MEM) together with the MAXCOL-No. and with EVALMODE = EXTERN TEACH.

Now select the setting EEPROM in the MEM function field, and then click on SEND

From now on, the PC is no longer necessary, as long as you only wish to teach colors up to the MAXCOL-NO. and do not want to change the tolerances.

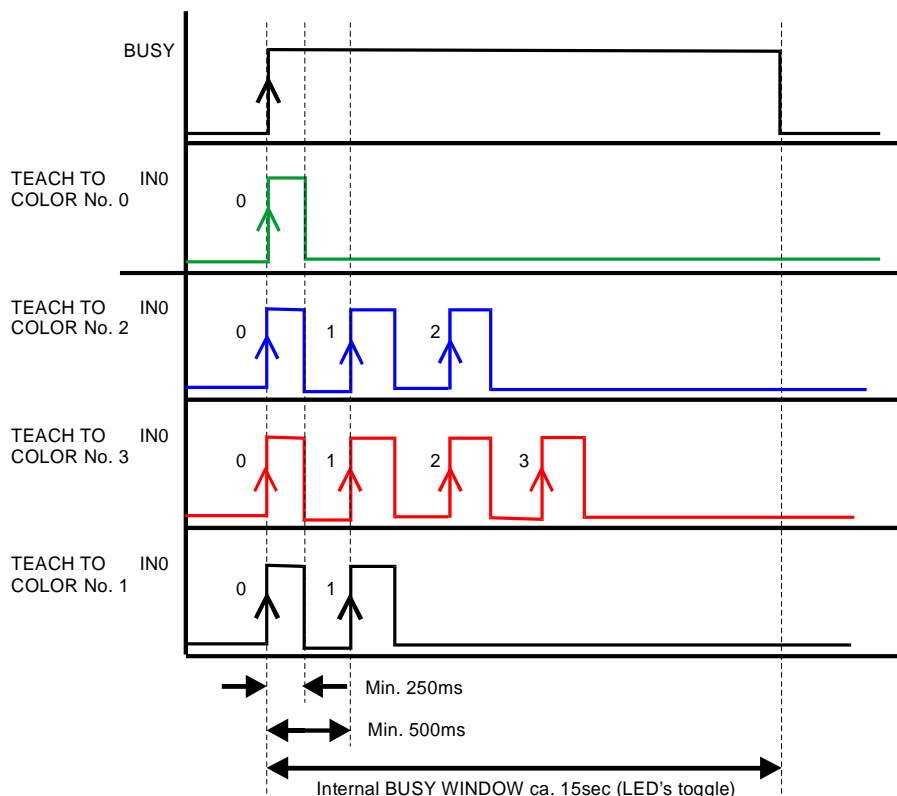
INFO: Of course the taught colours can be viewed at any time with the PC.

Before the external teach-process can be started, the color to be taught must be presented to the sensor.
The external teach-process is started with a positive edge at IN0 (green wire). When such a positive edge is applied, the output LEDs (OUT0 ... OUT3) start to blink. From now on, the user has approx. 15 seconds time to inform the sensor about the position at which the color information (X,Y,INT) should be placed in the COLOR TEACH table.
The first positive edge (start edge 0) selects position 0 in the COLOR TEACH table.
Every additional positive edge selects one position higher (see table below).

Example:

If you wish to save the current color to position 3 in the COLOR TEACH table, the following steps have to be performed:

1. Start of the external TEACH process with a positive edge (0) at IN0 → Position 0 is selected, the LEDs start to blink.
2. An additional positive edge (1) selects position 1 in the COLOR TEACH table. This position 1 is indicated by the LEDs. The LED with binary value 1 remains on HIGH level all the time, while the other 3 LEDs continue to blink.
3. An additional positive edge (2) selects position 2 in the COLOR TEACH table. This position 2 is indicated by the LEDs. The LED with binary value 2 remains on HIGH level all the time, while the other 3 LEDs continue to blink.
4. An additional positive edge (3) selects position 3 in the COLOR TEACH table. This position 3 is indicated by the LEDs. The LEDs with binary value 3 remain on HIGH level all the time, while the other 2 LEDs continue to blink.
5. The desired position is now selected.
6. When the BUSY window is over (the LEDs stop to blink), the sensor starts the evaluation.
7. To teach another color → go to pos. 1





EVALMODE „ADAPTIVE CONTROL“:

With the help of this evaluation mode the learned color value (the color value is learned and stored in the RAM when the sensor is switched on and the first external trigger signal is received) is automatically adapted to the object, if the color value of the object lies within the specified color or intensity tolerances.

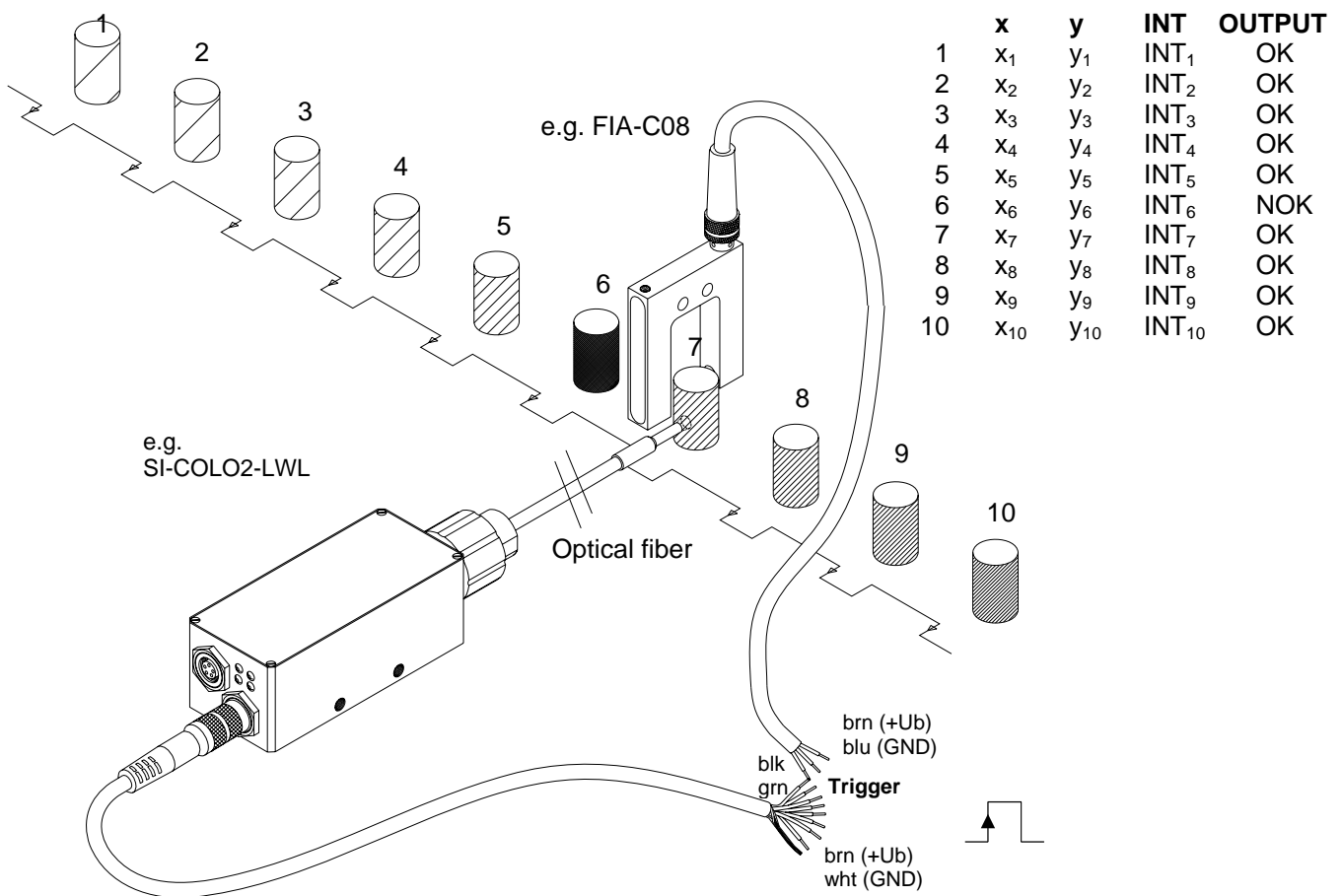
The current color value is determined from 8 successive objects that lie within the tolerance range.

This mode is especially used for applications where the objects to be checked are subject to slight color or intensity fluctuations (e.g. when recycling granulate is used).

The “adaptive control” mode requires a trigger input signal; the input is high-active, i.e. at the rising edge of the input signal the current color value (X,Y) and the intensity value INT are compared to the calculated mean value of the last eight stored values.

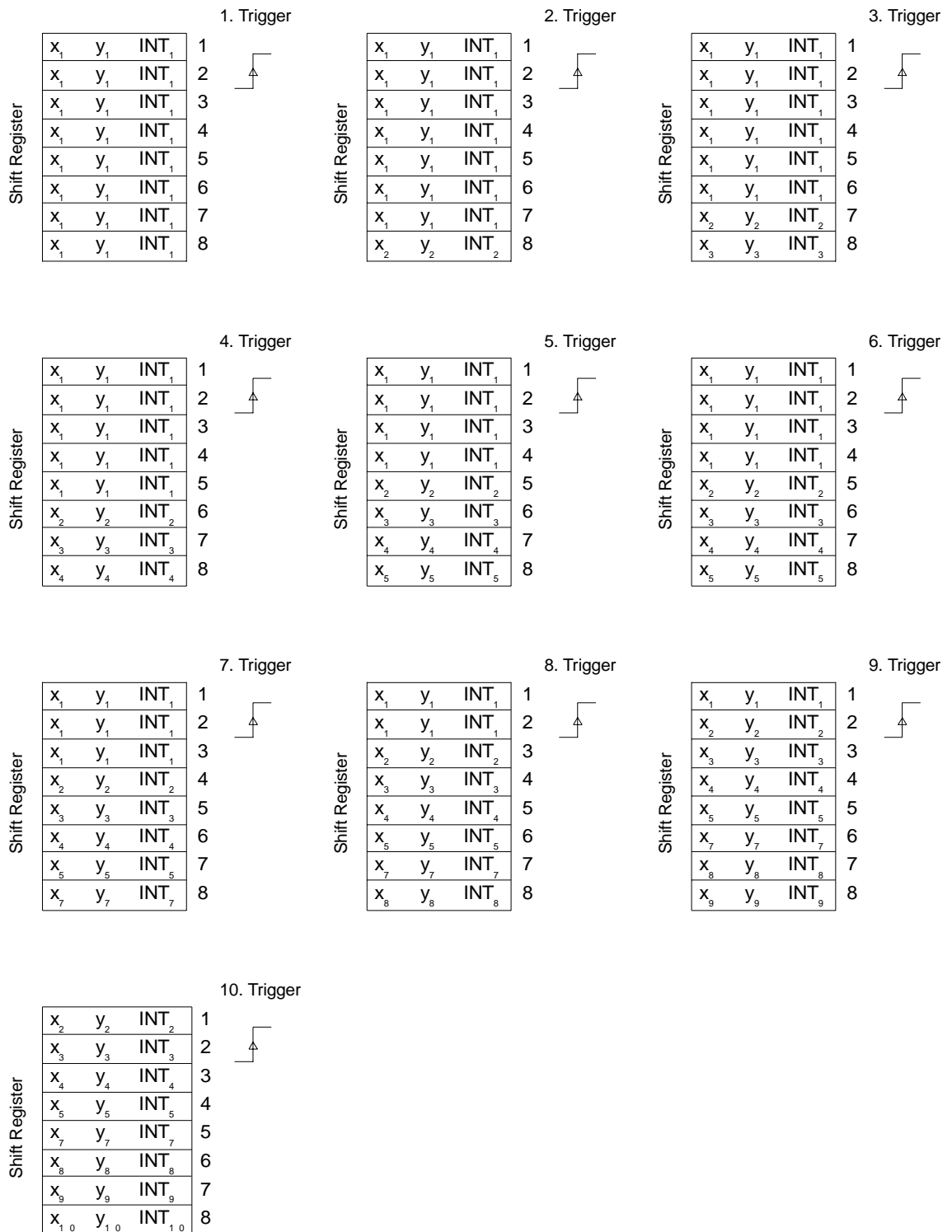
If the new color value and intensity value lie within the tolerances, an OK message is provided at the output, and an entry is made in the shift register.

If, however, the current color value and intensity value exceed the tolerances, a NOK message is provided at the output, and no entry is made in the shift register (8 values).



Entries in the shift register (at the example above):

Initialization:



No.	COLOR TEACH TABLE					
	X	Y	CTO	INT	ITO	
0	63	99	10	177	10	Blue
1	60	118	10	47	10	Red
2	101	69	10	50	10	Black
3	56	97	10	99	10	Pink
4	71	119	10	116	10	Green
5	56	60	10	40	10	Yellow
6	81	99	10	66	10	Olive
7	65	122	10	119	10	Purple
8	66	79	10	139	10	Cyan
9	88	62	10	65	10	Magenta
10	1	1	1	1	1	Dark Purple
11	1	1	1	1	1	Bright Pink
12	1	1	1	1	1	Bright Green
13	1	1	1	1	1	Teal
14	59	64	10	67	10	Brown

CTO and ITO (cf. page 15) are parameterised under Windows® and are stored in the EEPROM of the sensor.
 These values are not changed by the external trigger signal!

☐ RAM
 ☐ EEPROM
 ☐ FILE

☒ SEND
 ☐ GET

PARA

1

0

RAM, EEPROM, FILE:

This group of buttons controls parameter exchange between PC and SI-COLO2 color sensor through the serial RS232 interface.

PARA

1

0

PARA:

With this switch the display of the color table (COLOR TEACH TABLE) at the PC screen can be switched on and off.

1:

Display of function fields for entering and selecting general monitoring parameters.

0:

Display of the color table (COLOR TEACH TABLE) for entering the individual parameters for the teach-in colors.

No.	COLOR TEACH TABLE					
	X	Y	CTO	INT	ITO	
0	63	99	10	177	10	Blue
1	60	118	10	47	10	Red
2	101	69	10	50	10	Black
3	56	97	10	99	10	Pink
4	71	119	10	116	10	Green
5	56	60	10	40	10	Yellow
6	81	99	10	66	10	Olive
7	65	122	10	119	10	Purple
8	66	79	10	139	10	Cyan
9	88	62	10	65	10	Magenta
10	1	1	1	1	1	Dark Blue
11	1	1	1	1	1	Bright Pink
12	1	1	1	1	1	Light Green
13	1	1	1	1	1	Dark Grey
14	59	64	10	67	10	Brown

COLOR TEACH TABLE:

A click on switch position 0 of the PARA switch (MEM-function field) opens the color teach table shown here.

The color teach table shows the currently set parameters.

After a left mouse button click on the respective field the default values can be changed by entering numerical values with the PC keyboard.

The color teach table is organized in rows, i.e. the individual parameters for the teach-in colors are arranged side by side in the respective row.

The SI-COLO2 color sensor is able to check up to 15 teach-in colors. The number of the respective teach-in color is given in the left column of the table.

- X** X-value of the teach-in color (in the color triangle numerical value on the x-axis: RED color content)

$$X = \frac{R}{R + G + B} \times 255$$
- Y** Y-value of the teach-in color (in the color triangle numerical value on the y-axis: GREEN color content)

$$Y = \frac{G}{R + G + B} \times 255$$
- CTO** Color tolerance: "Tolerance circles" around the teach color in the color triangle that is defined as an (X,Y) point. The sensor internally calculates a "hysteresis ring". The numerical value of CTO determines the radius of the "tolerance circle" around the teach color. Within the "tolerance circle" defined by this method, the current color is recognised as the teach color.
- INT** Teach-in value for the intensity of the respective color.
Please note: For the detection of a teach-in color both criteria - color (X,Y) and intensity INT - must be fulfilled, i.e. the currently measured values for color and intensity must both lie within the respective preset tolerance limits CTO (color) and ITO (intensity).
- ITO** Default value for the permitted tolerance band around the intensity teach-in value (intensity tolerance).

No.: ☐ Inc

No.:

Selection of the current number of the teach-in color (0 ... 14) from the color table.

Inc:

When Inc is activated, and the TEACH DATA TO button is pressed, the No.: input field is automatically incremented (increased) by 1, i.e. the next line in the COLOR TEACH TABLE is selected.

TEACH DATA TO

TEACH DATA TO:

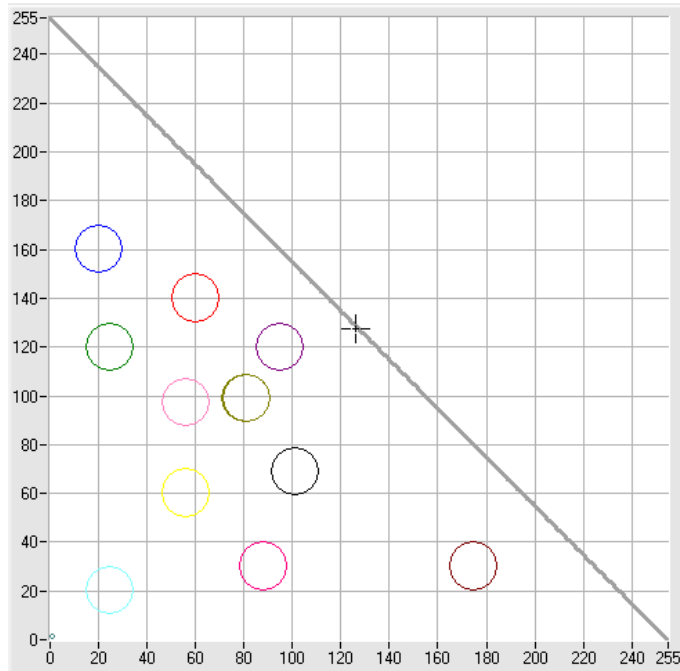
A click on this button starts an automatic teach-in process. The current measured values are defined as teach-in values. The teach-in values are assigned to the teach-in color selected in the No.: function field.

APPLY FROM ALL

APPLY FROM ALL:

If X/Y is selected under SOURCE, a click on this button displays all the teach-in colors entered in the COLOR TEACH TABLE in the color triangle with the corresponding "tolerance circle" (radius=CTO).

The picture on the left shows 11 color tolerance circles with the teach-in values (X,Y) and CTO (tolerance radius) preset in the color table.



AUTO ADJUST

AUTO ADJUST:

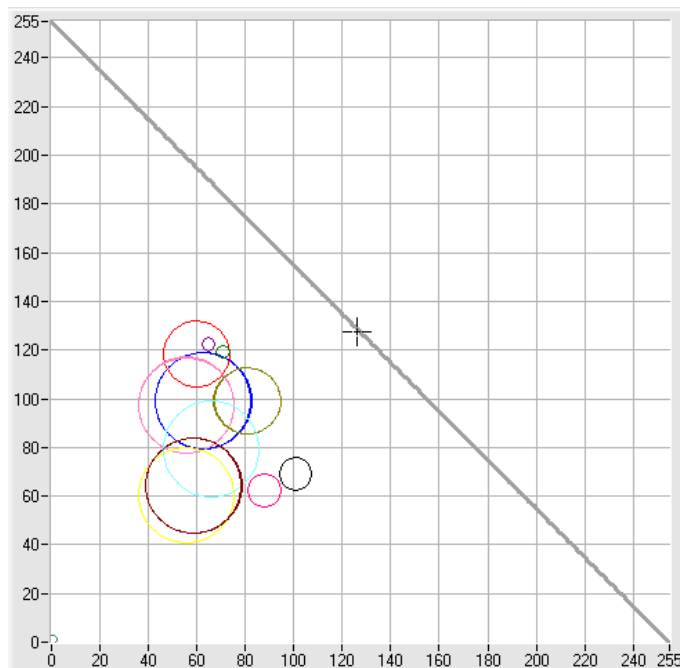
A click on this button initiates automatic adjustment of the circle tolerances (CTO).

A circle tolerance of max. 20 digits is allowed in calculation.

Circles may overlap if they are definitely separated by the intensity (please note: ITO must be set first!)

The number of circle tolerances to be calculated is determined by MAXCOL-No. (e.g. MAXCOL-No. = 5 → CTO adjustment up to and including line 4).

When the CTO values have been adjusted, a large graphic window appears, displaying the color circles. This graph features a zoom function (see ZOOM).





ZOOM:

A click on the ZOOM button opens a large graphic window. This graphic window features a zoom function. For zooming, the cursor that is visualised by a cross in the graphic window, is moved to the desired position in the graph with the mouse or the arrow keys.

The graph can be exited either by pressing the right mouse button, or by pressing the APPLY FROM ALL button.



RESET TABLE:

A click on this button resets the COLOR TEACH TABLE (RESET value = 1).



[F9]

SEND:

When the SEND button is clicked (or shortcut keybutton F9 is pressed), all the currently set parameters are transferred between PC and SI-COLO2 color sensor. The target of the respective parameter transfer is determined by the selected button (RAM, EEPROM, or FILE).



[F10]

GET:

The currently set values can be interrogated from the SI-COLO2 color sensor by clicking on the GET button (or with shortcut keybutton F10). The source of data exchange is determined by the selected button (RAM, EEPROM, or FILE).

RAM: The current parameters are written into the RAM memory of the SI-COLO2 color sensors, or they are read from the RAM, **i.e. these parameters are lost when the voltage at the SI-COLO2 color sensor is switched off.**

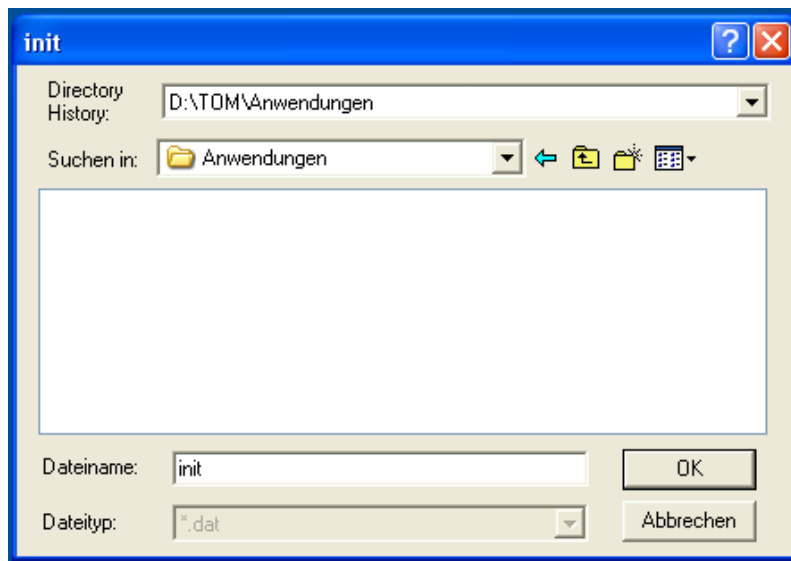
EEPROM: The current parameters are written into the non-volatile memory of the EEPROM in the SI-COLO2 color sensor, or they are read from the EEPROM, **i.e. the parameters in the internal EEPROM are stored when the voltage at the SI-COLO2 sensor is switched off.**

FILE: A click on this button opens an info field with the file name of the current parameter file.

PLEASE NOTE:

The current parameters are only stored in the current output file, or retrieved from the current output file, when the SEND or GET button is activated with a mouse click.

If another output file should be accessed, the file button must first be activated with the mouse pointer. Another dialog field then opens, in which an existing output file can be selected, or in which a file name for a new output file can be entered.



[F11]

GO:

A click on this button (or pressing shortcut keybutton F11) starts data transfer from the SI-COLO2 color sensor to the PC through the serial RS232 interface.

If *X/Y* is selected under *SOURCE*, the *X,Y* coordinates of the current color are displays in the graph.

If *RAW INT* is selected under *SOURCE*, the intensity of the current color and the intensity window of the color set under *No.:* (0 ... 14) are visualised in the graph.



[F12]

STOP:

A click on this button (or pressing shortcut keybutton F12) stops data transfer from the SI-COLO2 color sensor to the PC through the serial RS232 interface.

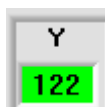


X:

This numerical value output field displays the red content of the color currently arriving at the receiver.

Formula for calculation:

$$X = \frac{R}{R + G + B} \times 255$$



Y:

This numerical value output field displays the green content of the color currently arriving at the receiver.

Formula for calculation:

$$Y = \frac{G}{R + G + B} \times 255$$



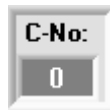
INT:

This numerical value output field displays the currently measured intensity (proportional to the average of the intensities at the triple receiver).

Formula for calculation:

$$INT = \frac{R + G + B}{4} + \frac{R + G + B}{16}$$

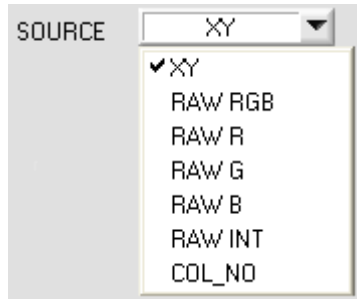
For reasons of a higher program execution speed, division by 4 respectively 16 is performed on the microcontroller level.



C-No.:

This numerical value output field displays the currently detected color number in accordance with the entry in the COLOR TABLE. The currently detected color number is sent to the digital outputs OUT0 - OUT3 as a corresponding bit pattern..

PLEASE NOTE: The above-mentioned 4 output fields are only updated when data transfer between PC and SI-COLO2 color sensor is active (POLL button pressed).



SOURCE:

A click on the arrow button opens a selection field for the selection of a display mode in the graphic display window.

- XY : Display of the color triangle and of the currently determined color.
- RAW RGB : The current raw signals of the 3-fold receiver (red, green, blue) are displayed.
- RAW R : The current raw signal for red is displayed
- RAW G : The current raw signal for green is displayed
- RAW B : The current raw signal for blue is displayed
- RAW INT : The currently determined total intensity is displayed.
- COL_NO : The currently detected color number is displayed.

The COLOR2-Scope software starts with the standard configuration COM1 and the respective communication status.



The software provides the following status messages:

- Init COM-PORT: The PC tries to establish a connection with the SI-COLO2 color sensor through the respective selected interface.
- LINE OK: The connection between PC and SI-COLO2 color sensor could be established successfully.
- TIMEOUT: A connection between SI-COLO2 color sensor and PC could not be established, or the connection is faulty.
In this case it should first be checked whether the SI-COLO2 color sensor is supplied with voltage, and whether the RS232 interface cable is correctly connected.
If the interface assignment at the PC is not known, a selection can be made from COM1, COM2, COM3, and COM4 by clicking on the [v] selection field in the CONNECT group.
- Invalid port number: The selected interface is not available at the PC.

ATTENTION!	The stable function of the RS232 interface (LINE OK status message after program start) is a basic prerequisite for measured value transfer from the PC to the SI-COLO2 color sensor.
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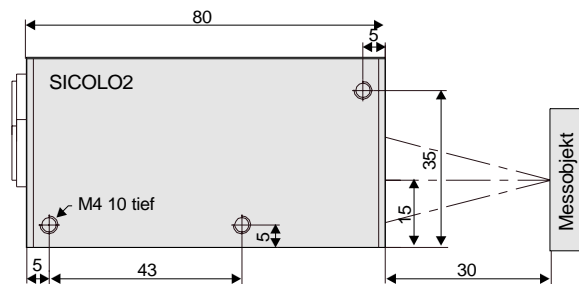


ATTENTION !

Due to the limited data transfer rate through the serial RS232 interface (9600 bit/s) only slow changes of the raw signals at the sensor front end can be observed in the graphic output window of the PC.

For maintaining maximum switching frequency at the SI-COLO2 color sensor data communication with the PC must be stopped (press the STOP button).

2.2 COLOR2-Scope as an aid for sensor adjustment



Prior to the use of the software aids (graphic display of sensor signals) the SI-COLO2 color sensor must be manually adjusted to the respective target or background as accurately as possible.

In the illustration opposite the reference distance of the SI-COLO2 color sensor to the target is 30 mm. The operating range (25mm ... 35mm) lies symmetrically around the reference distance!

ATTENTION! By using the SI-COLO2-LWL color sensor, there should be a working distance of approx. 2 mm ... 10 mm between the optical fiber head-end and the measuring object.

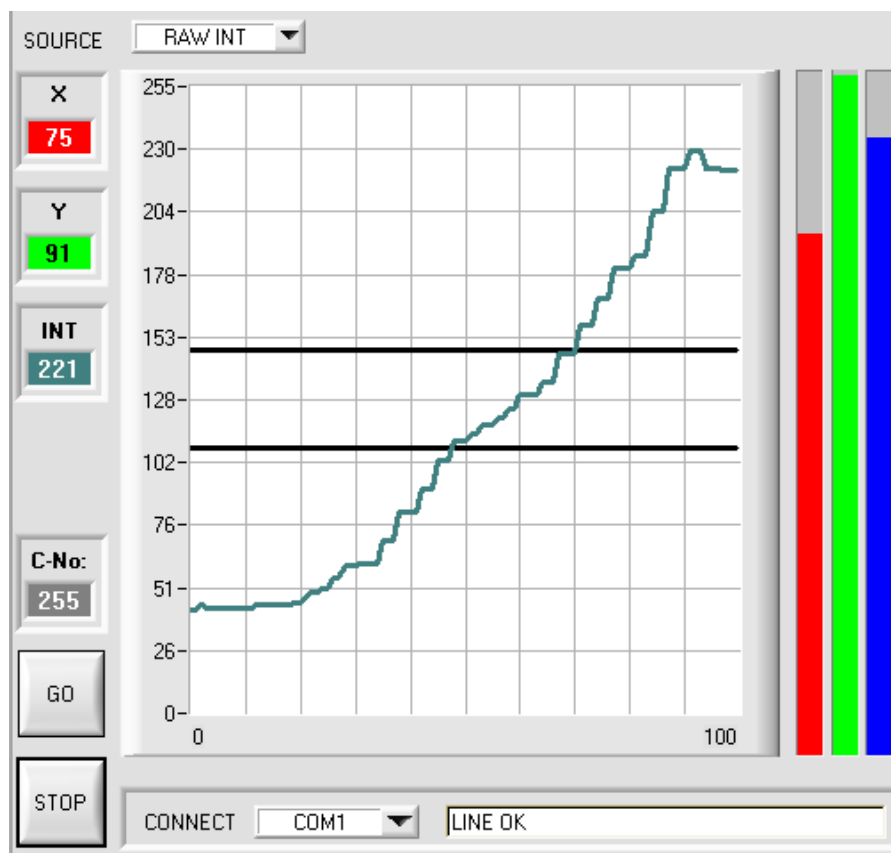
Fine adjustment of the SI-COLO2 color sensor is facilitated by the graphic display of the analog signals (raw signals from the triple receiver diode). First of all measurement data transfer from the SI-COLO2 color sensor to the PC must be activated by clicking on the GO button.



For this purpose the option RAW INT must be selected in the SOURCE selection field. With this setting the intensity measured at the receiver unit is shown in the graphic display window



Activation of measurement data transfer between PC and SI-COLO2 color sensor. The current measured values are shown in the graphic display window in "scroll mode" (in the display window the most recent values appear on the left side).



The measured intensity value from the receiver diode of the SI-COLO2 color sensor should now appear in "scroll mode" in the graphic display window (red). If one of the 3 measuring channels lies at the upper=255 or lower=0 limit (observe the bar display), it must first be ascertained that the intensity of the transmitter LED is correctly set.

For this purpose the laser mode is set to STAT (static) in the PMOD function field, and the POWER slider is then adjusted until the intensity value INT (red curve) ideally lies in the middle of the measuring range (0 .. 255 8-bit A/D converter).

If less intensity is diffusely reflected from the target, the color sensor can also be operated with less intensity. Color evaluation, however, is only possible, if the following is valid for the measured intensity INT:

$$\text{INT} > \text{INTLIM}$$



PLEASE NOTE:

The change of laser power only becomes active at the SI-COLO2 color sensor after a click on the SEND button !

2.3 COLOR2-Scope as an aid for teach-in

The SI-COLO2 color sensor is able to learn up to 15 different colors in the COLOR TEACH TABLE, either automatically or by manual parameter input.

Actual parameterization can be started when the target has been positioned at the reference distance and the intensity lies in the dynamic range ($INT > INTLIM$) (if necessary, readjust POWER).

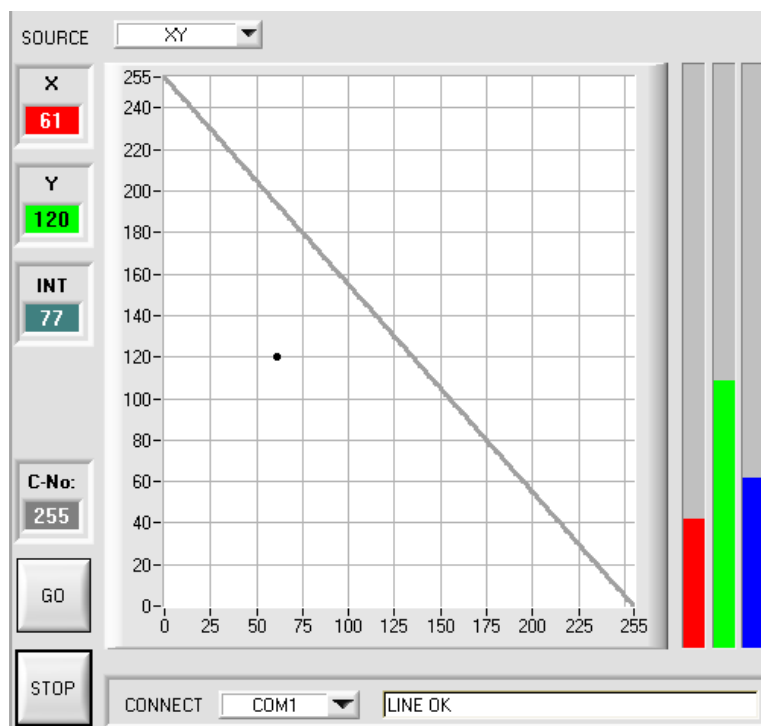


First the trigger mode should be set to CONT, which means that color detection is continuously active, also without external triggering.

With a click on the SEND button this setting is activated at the color sensor.



When this option is selected, the color triangle is shown in the graphic display window.



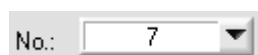
In the color triangle the currently measured color is represented by a (X,Y) value pair.

The RED content of the currently measured color corresponds with the X coordinate, the GREEN content corresponds with the Y coordinate in the color triangle. The BLUE content in the color triangle is proportional to the distance of the (X,Y) value pair from the hypotenuse.

In addition a circle is displayed around the currently detected color, the radius of which is proportional to the current scatter of the measured values.



After a click on the GO button measured values are transferred from the color sensor to the PC and displayed as (X,Y) value pairs in the color triangle.



Now the number of the current teach-in color (0 ... 14), in the row of which the current teach-in values should be entered, can be selected.

TEACH DATA TO

With a click on the TEACH DATA TO button the current measured values are entered as teach-in values in the previously selected row of the COLOR TEACH TABLE.

After automatic TEACH-IN the tolerance circle around the teach-in color should first be slightly corrected, i.e. increased, by entering CTO (e.g. to 10 .. 20, depending on the scatter of the measured value).

The position (push button APPLY FROM ALL pressed) of the taught tolerance circles around the respective teach-colour in the colour triangle determines the possible choice of the tolerance circles (radius=CTO). They should be chosen so, that they don't overlap each other.

No.	COLOR TEACH TABLE					
	X	Y	CTO	INT	ITO	
0	63	99	10	177	10	Blue
1	60	118	10	47	10	Red
2	101	69	10	50	10	Black
3	56	97	10	99	10	Pink

Tolerance ITO, which lies symmetrically around intensity INT, also should be increased first, because otherwise color detection might fail due to intensity evaluation.

For the detection of a teach-in color both criteria, color (X,Y) and intensity INT must be fulfilled !

Almost identical color value pairs (X,Y) often can be separated with the intensity criteria INT and ITO (tolerance).

INTLIM

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It must also be observed that in the INTLIM input field the lower limit for color evaluation may have to be corrected depending on the current intensity INT that is diffusely reflected to the color sensor.

Please note:

No color evaluation if: $INT < INTLIM$

MAXCOL-No.

15

The number of colors to be checked must be entered in the MAXCOL-No. input field.

When suitable parameters for the respective color detection have been established by observing the signal characteristics, the current parameters must be written to the non-volatile EEPROM memory of the SI-COLO2 color sensor by clicking on the SEND button.



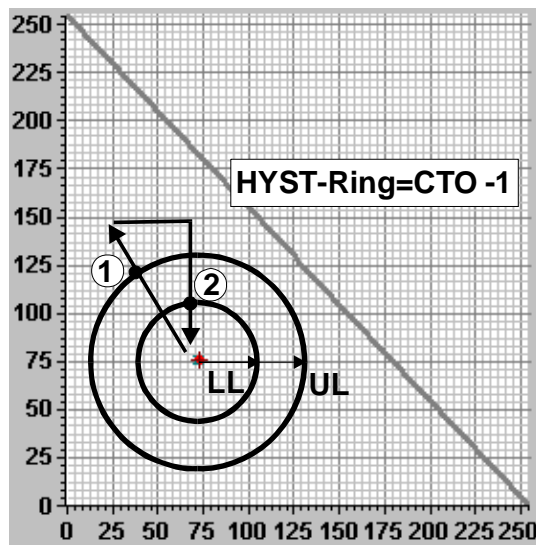
The selection button in the MEM field must be set to EEPROM !!

ATTENTION!!

When the parameters have been entered and the sensor has been adjusted with the help of the graphical representation provided by the COLOR2-Scope software, the PC is no longer required for the actual measuring task. The PC and the RS232 interface cable can then be disconnected from the SI-COLO2 color sensor.

The SI-COLO2 color sensor then performs the measuring task in STAND-ALONE operation.

2.4 Position of the hysteresis ring in the color tolerance circle



The tolerance circle (radius = CTO) lies symmetrically around the (X,Y) value pair of the respective teach-in color in the color triangle.

For avoiding unstable switching states at the digital outputs OUT0 - OUT3 the sensor defines internally a hysteresis ring around each teach-in color.

This internal hysteresis ring, which cannot be adjusted by the software user, is calculated by the following formula:
 $\text{HYST-RING} = \text{CTO} - 1$

A teach-in color is detected until the tolerance circle (radius=CTO) is exceeded at point (1). When this happens, the switching state at the digital outputs changes.

When the current measured values (X,Y value pair) enter the tolerance circle again, the teach-in color is only detected again when the value drops below the lower threshold US at point (2).

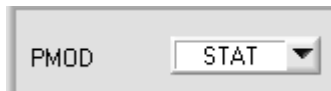
The hysteresis range is defined by the ring area between the outer tolerance circle (radius=CTO) and the inner circle (HYST-RING).

Please note:

The inner circle (radius=HYST-RING) for the lower hysteresis threshold is not shown in the graphic output field.

2.5 Contrast detection with the SI-COLO2 color sensors

In addition to the color evaluation modes the SI-COLO2 color sensor also features a contrast evaluation mode. Only one of the three primary colors (RED, GREEN, or BLUE) is used for this contrast evaluation. In this mode the color sensor operates with a switching frequency of up to 28 kHz.



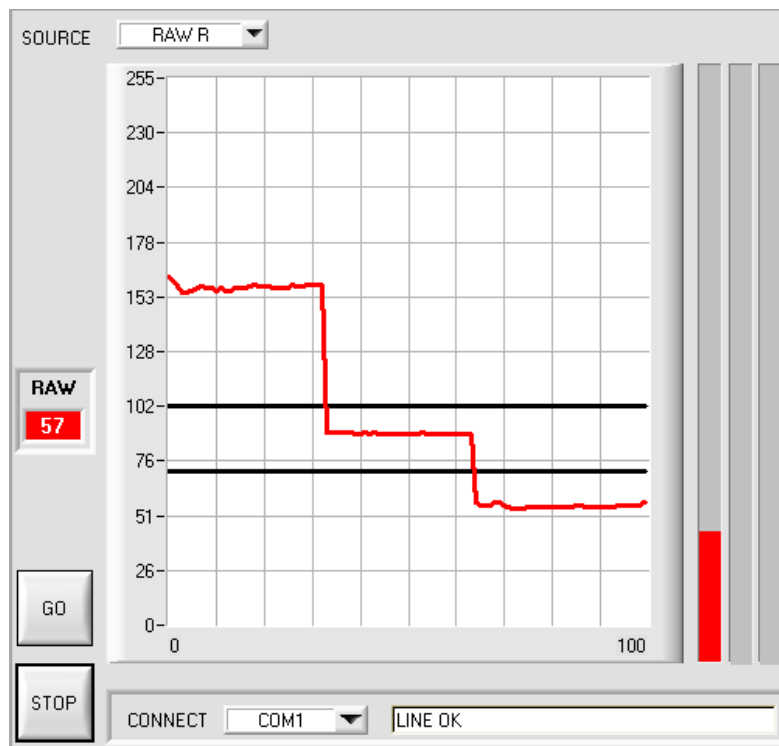
For contrast detection the LED mode should be set to static with PMOD=STAT, i.e. the LED transmission power constantly keeps the value set by the operator with the POWER slide switch. The LED transmission power should be set such that the light intensity diffusely reflected by the target approximately lies at the center of the dynamic range for the respective primary color.



For activating contrast evaluation (e.g. for primary color RED) the corresponding evaluation mode must be selected first. For this purpose the operator should select the primary color for contrast detection that offers the most distinct differences between background and the color to be detected.



Then the new evaluation mode must be activated in the SI-COLO2 control unit by clicking on the SEND button.



After a click on the GO button the raw data of the respective selected primary color (e.g. RED) can be observed in the graphic display window.

If, for example, a red print mark on a dark background should be detected, this print mark can first be slowly pulled through the color sensor's light spot. Due to the limited data transfer rate of the serial RS232 interface such movement should not be performed too fast.

It is important that there is a basic contrast difference between the respective background and the print mark to be detected.

The possible selection of tolerance limits (UL and LL) can be read off in the graphic display window (→ CONTRAST R/G/B).

No.	COLOR TEACH TABLE					
	UL	LL				
0	124	94	1	1	1	Blue
1	1	1	1	1	1	Red
2	1	1	1	1	1	Black
3	1	1	1	1	1	Pink

Next the setpoint value for the upper tolerance limit (UL=124) and the lower tolerance limit (LL=94) must be entered in the corresponding input fields. In contrast evaluation only row 0 of the COLOR TEACH TABLE is evaluated.

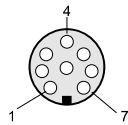
Any existing entries in the following rows can be kept!

Finally the new evaluation parameters must be activated in the SI-COLO2 control unit by clicking on the SEND button.

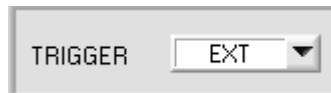
Evaluation:

The current intensity value is lower than LL (Lower Limit): OUT0 is on HIGH level (+24VDC)
 The current intensity value lies within the tolerance window (UL,LL): OUT1 is on HIGH level (+24VDC)
 The current intensity value is higher than UL (Upper Limit): OUT2 is on HIGH level (+24VDC)

2.6 External triggering of the SI-COLO2 color sensors



External triggering is performed through pin no. 3 (grn) at the 8-pin socket of the SI-COLO2/PLC connection.



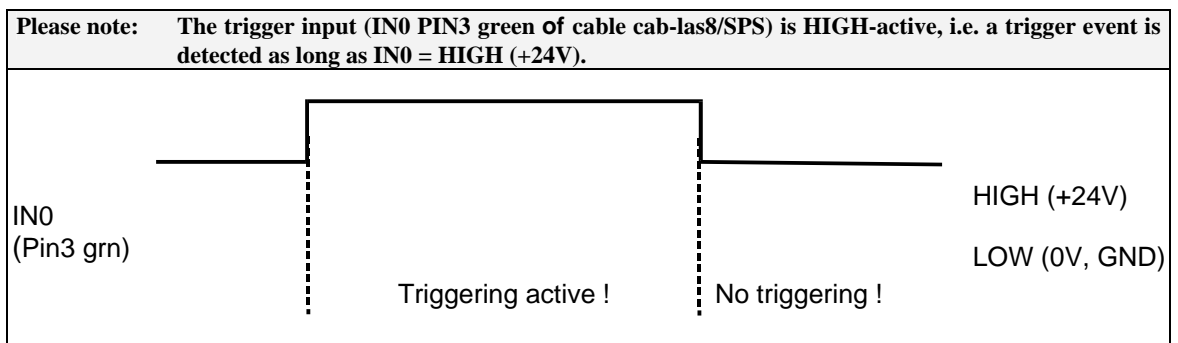
EXT:

First the external trigger mode must be set at the color sensor. For this purpose option EXT must be selected in the TRIGGER selection field.

PLEASE NOTE:

The new setting is only activated at the SI-COLO2 control unit after a click on the SEND button!

The TRIGGER = EXT mode is only available for the two evaluation cases FIRST HIT and MINIMAL DIST.



External triggering in the COLOR SERIES evaluation mode:

Detection of a color series can only be started and stopped by applying an external trigger.

The trigger input (IN0 PIN3 green of cable cab-las8/SPS) is HIGH-active, i.e. a trigger event is detected as long as IN0 = HIGH (+24V).

The IN0 input must stay on HIGH (+24V), until the complete (previously taught) color sequence has passed the sensor head.

The color series evaluation result is updated when trigger input IN0 changes to LOW level.

Color series OK: All digital outputs = LOW

Color series NOK: All digital outputs = HIGH

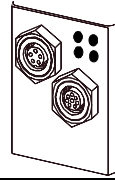
The number of colors in the color series must be set in the MAXCOL-No. input field.

Serial communication with the PC is not possible as long as external triggering is active (IN0=HIGH).

2.7 Function of the LED display of the SI-COLO2 color sensors

Please note:

LED display function is not available with SI-COLO2-...-ANA, SI-COLO2-LWL-ANA, and SI-COLO2-LWL-ACL-ANA!

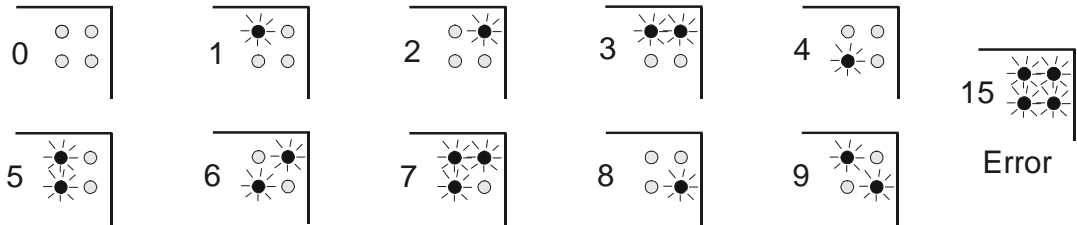


BINARY

The color code is visualised by way of 4 yellow LEDs at the housing of the SI-COLO2 color sensor.

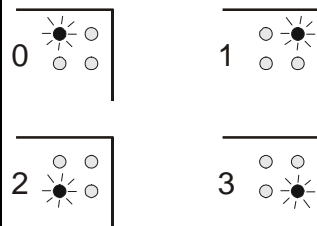
At the same time in the binary modus (OUT BINARY) the color code indicated on the LED display is output as 4-bit binary information at the digital outputs OUT0 to OUT3 of the 8-pin SI-COLO2/PLC socket.

The SI-COLO2 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).



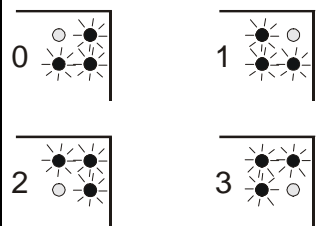
DIRECT

In the DIRECT mode (OUT DIRECT HI or OUT DIRECT LO) the maximum numbers of colors to be taught 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).



DIRECT HI

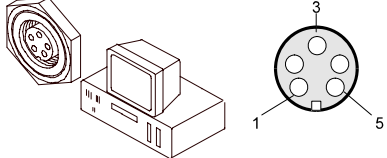
If DIRECT LO is activated, the specially digital output is set to LO, while the other 3 are set to HI. If the current color does not correspond with any of the teach-in colors, color C-No = 255 is set, i.e. all digital outputs are set to HIGH (all LED are lighting).



DIRECT LO

3 Connector assignment of the SI-COLO2 color sensors

Connection of SI-COLO2 to PC:

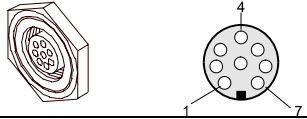
5-pin female connector (type Binder 712) SI-COLO2/PC-RS232			
Pin No.:		Assignment:	
1		0V (GND)	
2		TX0	
3		RX0	
4		n.c.	
5		n.c.	

Connection of SI-COLO2 to PLC for non-analog color sensor types:

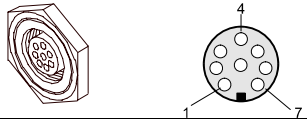
SI-COLO2-20
SI-COLO2-30
SI-COLO2-50

SI-COLO2-80
SI-COLO2-200
SI-COLO2-500

SI-COLO2-M18
SI-COLO2-LWL
SI-COLO2-LWL-ACL

8-pin female connector (type Binder 712) SI-COLO2/SPS			
Pin No.:	Color:	Assignment:	
1	wht	0V (GND)	
2	brn	+12VDC .. +30VDC	
3	grn	IN0	
4	yel	OUT0 (Digital 0: Type 0 ... 1V, Digital 1: Type +Ub – 10%)	
5	gry	OUT1 (Digital 0: Type 0 ... 1V, Digital 1: Type +Ub – 10%)	
6	pnk	OUT2 (Digital 0: Type 0 ... 1V, Digital 1: Type +Ub – 10%)	
7	blu	OUT3 (Digital 0: Type 0 ... 1V, Digital 1: Type +Ub – 10%)	
8	red	n.c.	

Connection of SI-COLO2 to PLC for analog color sensor types (SI-COLO2-ANA):

8-pin female connector (type Binder 712) SI-COLO2/SPS			
Pin-No.:	Color:	Assignment:	
1	wht	0V (GND)	
2	brn	+12VDC ... +30VDC	
3	grn	IN0	
4	yel	ANA RED 0VDC ... +10VDC	
5	gry	ANA GREEN 0VDC ... +10VDC	
6	pnk	ANA BLUE 0VDC ... +10VDC	
7	blu	n.c.	
8	red	n.c.	

4 RS232 communication protocol

RS232 communication protocol PC ↔ SI-COLO2 Color Sensor (COLOR2-Scope V4.51)	
<ul style="list-style-type: none"> - Standard RS232 serial interface without hardware-handshake - 3-wire: GND, TX0, RX0 - Speed: 9600 baud, 8 data-bits, no parity-bit, 1 stop-bit in binary mode <p>The control device (PC or PLC) has to send a data frame of 86 bytes to the SI-COLO2 hardware. All bytes must be transmitted in binary format. The meaning of the parameters is described in the software manual COLOR2-Scope.</p> <p><u>Method:</u> The SI-COLO2 hardware is permanently reading (polling) the incoming byte at the RS232 connection. If the incoming byte = 0x55 (synch-byte), then the 2.byte (order-byte) is read in, after this, 9 bytes (parameters) and then 15 teach vectors (15 x 5Bytes = 75Bytes) will be read. After reading in the completely data frame, the SI-COLO2 hardware executes the order which is coded at the 2. byte (order-byte).</p>	

Format of the data frame:		
Byte No.	Meaning:	Comment:
1	sync-byte = 0x55	hex-code 0x55, binary: 01010101, synchronisation byte
2	ORDER NUMBER	order byte
3	parameter POWER	LED intensity (0 ... 255) Attention inverse operation!
4	parameter PMOD	LED mode STAT, DYN (0, 1)
5	parameter TRIGGER	Trigger mode CONT or EXT (0 or 1)
6	parameter AVERAGE	Signal averaging 1,2,4,8,16,32,64,128,256,512,1024,2048,4096,8192,16384 or 32768 coded to (0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15)
7	parameter EVAL MODE	Evaluation mode FIRST HIT, MINIMAL DIST, COLOR SERIES, CONTRAST R, CONTRAST G, CONTRAST B, EXT TEACH, ADAPTIVE CONTROL coded to (0,1,2,3,4,5,6,7)
8	parameter HOLD[ms]	Hold time 0,1,2,3,5,10,50 or 100ms coded to (0,1,2,3,4,5,6,7)
9	parameter INTLIM	Lower Intensity limit (0 ... 255)
10	parameter MAXCOL-No.	Number of the colours (1,2,3,3,4,5,6,7,8,9,10,11,12,13,14,15)
11	parameter OUT	Function of the digital output (1=direct/HI, 2=binary, 3=direct/LO)
12 ... 86	15 teach vectors with each 5 bytes	Teach-vector 5-byte-format: X, Y, CTO, INT, ITO ; value range of each parameter is from 1 to 255

Value	ORDER NUMBER	(parameter byte no. 2)
0	nop	no operation
1	save parameter from PC into RAM	volatile: 86 bytes PC⇒SI-COLO2
2	save parameter from PC into RAM + EEPROM	nonvolatile: 86 bytes PC⇒SI-COLO2
3	Send parameter from RAM to PC	84 bytes binary SI-COLO2 ⇒ PC
4	Send parameter from EEPROM to RAM + to PC	84 bytes binary SI-COLO2 ⇒ PC
5*	Send data from RAM to PC (R,G,B,X,Y,INT,COL)	7 bytes binary SI-COLO2 ⇒ PC
6	nop	no operation
7	Send line ok = 0xAA to PC	1 byte binary SI-COLO2 ⇒ PC

*) With order no. 5 **no parameters and teach vectors** will be transmitted from the SI-COLO2 hardware to the PC or PLC:

Byte Frame transmitted by PC (PC ⇒ SI-COLO2): [0x55, 5]
Byte Frame response of SI-COLO2: (SI-COLO2 ⇒ PC): [R, G, B, X, Y, INT, COL]

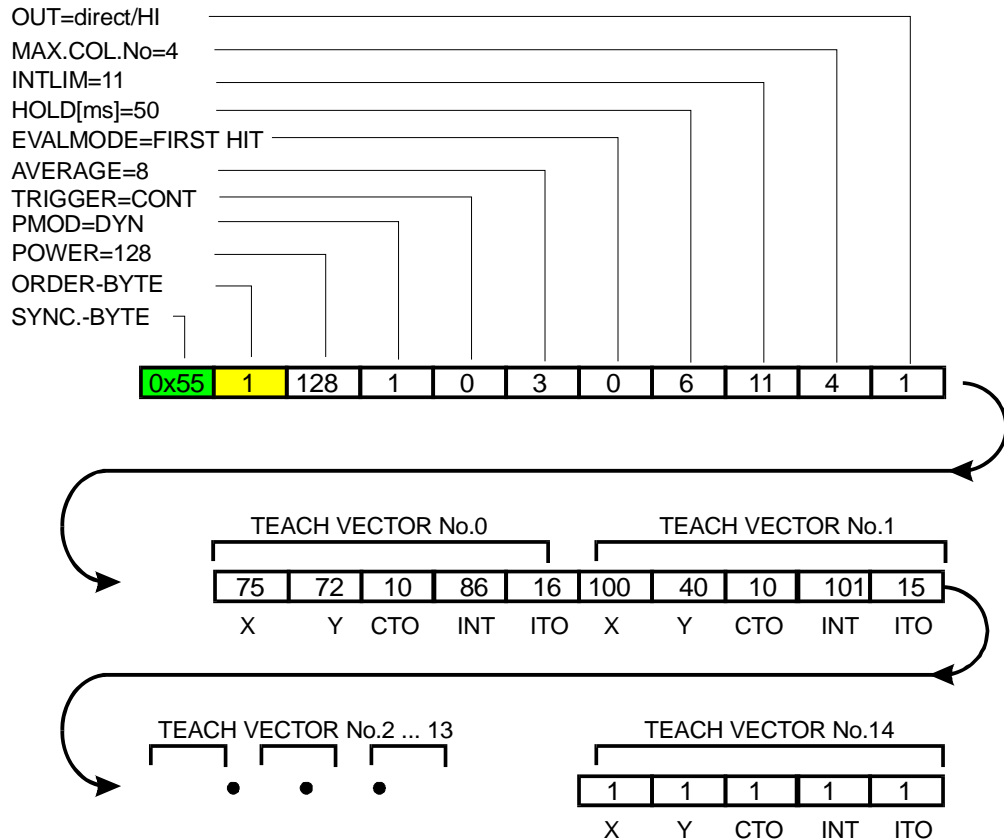
Example 1: DATA FRAME with ORDER NUMBER = 1:

ORDER NUMBER (second byte = 1): **WRITE parameters from PC into RAM of the SI-COLO2!**

The completely data frame = 86 bytes must be sent to the SI-COLO2 hardware in binary form:

(sync-byte / order-byte / 9 parameter bytes / 15 x 5 bytes teach-vectors).

Fill unused bytes of the TEACH VECTOR by value byte=1 in binary form.



Example 2: DATA FRAME with ORDER NUMBER = 5:

ORDER NUMBER (second byte = 5): READ SI-COLO2 RAM DATA

DATA FRAME PC → SI-COLO2 (2 BYTES)

ORDER-BYTE=5
 SYNC.-BYTE



DATA FRAME SI-COLO2 → PC (7 BYTES)

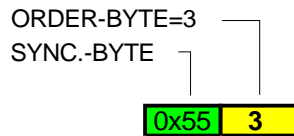
R	G	B	X	Y	INT	COL
75	76	121	70	71	122	0

Example 3: DATA FRAME with ORDER NUMBER = 3:

ORDER NUMBER (second byte = 3): **READ parameters out of SI-COLO2 RAM memory!**

The completely DATA FRAME which is responded by the SI-COLO2 hardware **is 84bytes** long:

DATA FRAME PC → SI-COLO2 (2 BYTES)



DATA FRAME SI-COLO2 → PC (69 BYTES)

