Manual
Software COLOR3-Scope V6.1

(PC software for Microsoft® Windows® Vista, XP, 2000, NT® 4.0, Me, 98, 95)

for color sensors of SI-COLO3 Series
with internal temperature compensation and white light balancing

This manual describes the installation of the PC software for the SI-COLO3 color sensor. As a support for commissioning of the color sensor this manual explains the functional elements of the Windows® user interface.

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.

The SI-COLO3 color sensor can be "taught" up to 15 colors. Different color detection operation modes are available for selection. Standardization of the colors is performed either in X/Y INT mode or in the so-called s/i M mode which follows the Lab calculation method. Both calculation modes can be used in combination with several operation modes, among others "FIRST HIT" and "BEST HIT". The visualization of the raw data is performed with 12-bit accuracy.

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.

Calibration of SI-COLO3 V6.1 color sensors with the COLOR3-CALIB-Scope V6.1 software:

The sensors of SI-COLO3 series can be calibrated by means of the separate COLOR3-CALIB-Scope software. Color balancing can be performed on any white target. As an alternative, a ColorChecker[TM] is available, which has 24 different color areas according to CIE standard. Calibration can be done on any of the white areas (→ separate manual for COLOR3-CALIB-Scope V6.1).

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Shortcuts:

SEND   F9
GET   F10
GO   F11
STOP   F12

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1   Installation of the COLOR3-Scope software

Hardware requirements for successful installation of the COLOR3-Scope software:

- IBM PC AT or compatible
- VGA graphics
- Microsoft® Windows® Vista, XP, Me, 2000, 98, NT® 4.0 or 95
- Serial RS232 interface at the PC
- Microsoft-compatible mouse
- Cable for the RS232 interface
- CD-ROM drive
- Approx. 5 MByte of free hard disk space

The COLOR3-Scope software can only be installed under Windows. Windows must therefore be started first, if it is not yet running.

Please install the 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 software in the C:\"FILENAME" 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 software is created in the Windows Program Manager. In the 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 icon.

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2 Operation of the COLOR3-Scope software

2.1 Functions of the individual COLOR3-Scope control elements

Please read this chapter first before you start to adjust and parameterise the SI-COLO3 color sensor.
Pressing the right mouse button on an individual element will call up a short help text.
The function of the OPEN RECORDER is explained in passage 2.5.

When the COLOR3-Scope software is started, the following window appears on the Windows interface:
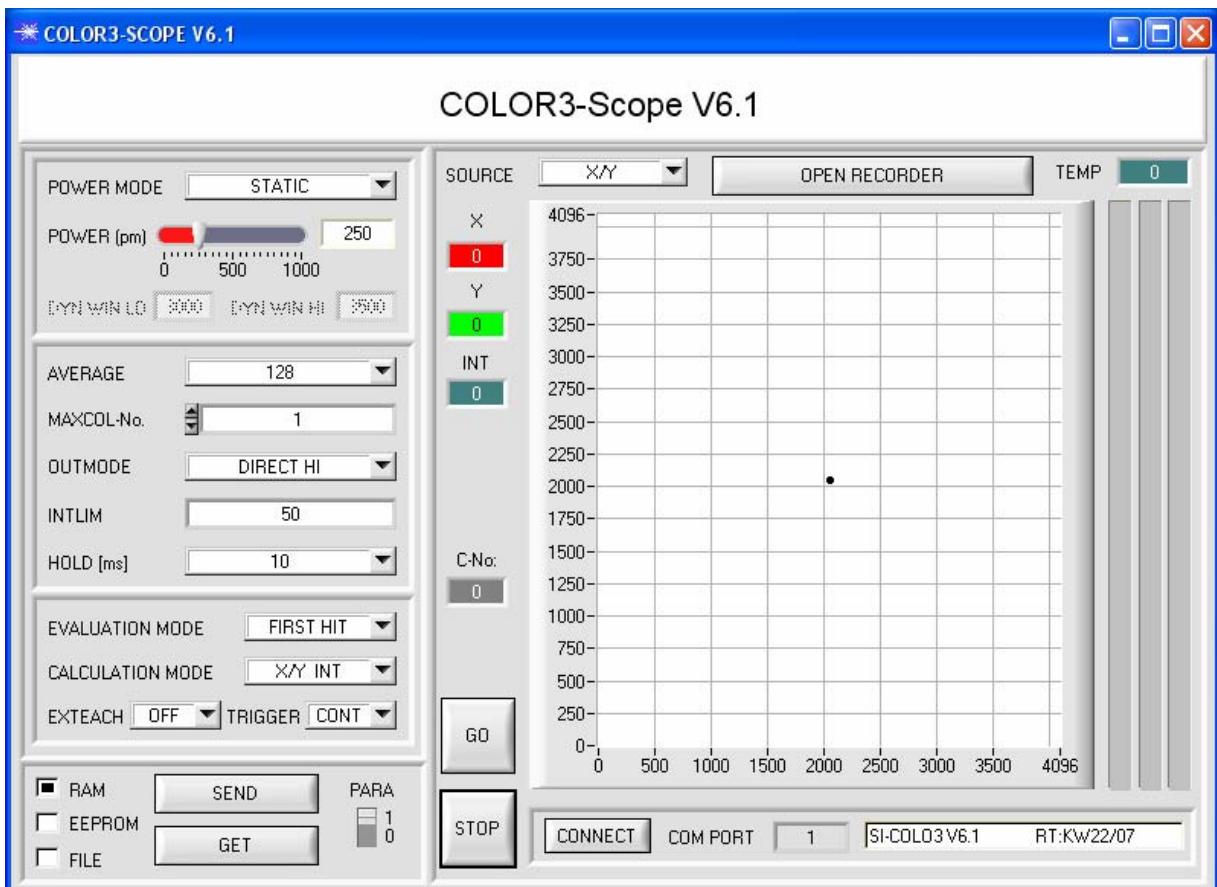
2.1.1 Explanation of general function groups and display elements

The COLOR3-Scope software starts with the standard configuration COM1 and the respective communication status.

> CONNECT   COM PORT   1   SI-COLO3 V6.1   RT:KW22/07
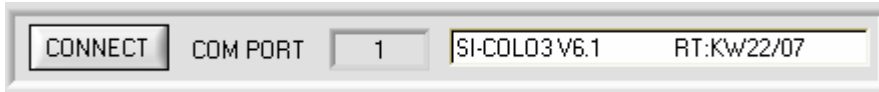
CONNECT:

CONNECT:
Pressing the CONNECT button opens a window for selecting and configuring the interface. The currently set connection type is displayed beside the CONNECT button.
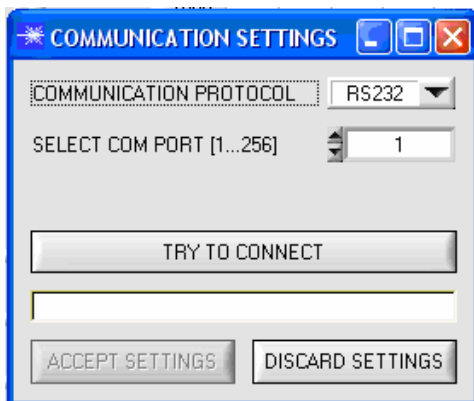
CONNECT:
The COMMUNICATION PROTOCOL function field is used for selecting either an RS232 or a TCP/IP protocol.

If RS232 is selected, a port from 1 to 256 can be selected with SELECT COM PORT, depending on which port the sensor is connected to.

If the sensor should communicate through a local area network, an RS232 to Ethernet adaptor will be needed. This adapter makes it possible to establish a connection to the sensor with the TCP/IP protocol.

The network adaptors that are available from us are based on the Lantronix XPort module. For parameterising these adapters (assigning of an IP address, setting of the Baud rate of 19200) please download the "DeviceInstaller" software that is provided free of charge by Lantronix at http://www.lantronix.com/. DeviceInstaller is based on Microsoft's ".NET" framework. Detailed operating instructions for the "DeviceInstaller" software also are available from Lantronix.

In order to establish a connection to the adaptor, its IP address must be entered in the IP ADRESS field. The DROP DOWN menu (down arrow) shows the last 10 IP addresses that were used. An address from this list can be directly selected by clicking on the respective item. The DROP DOWN list is saved and is thus always available when the software is closed.

The PORT NUMBER for the XPort-based network adaptors is 10001. This port number must not be changed.
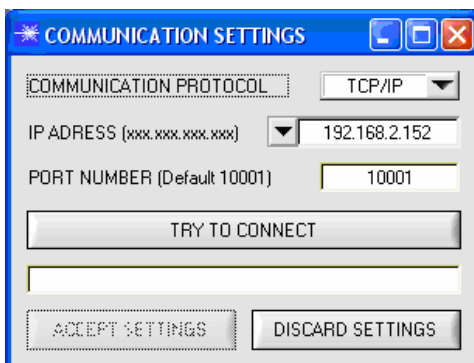
When you press the TRY TO CONNECT button, the software tries to establish a connection with the set parameters. The communication status is shown in the display field. If the sensor answers with its FIRMWARE ID, the set connection type can be accepted by pressing ACCEPT SETTINGS. You will then be returned to the main panel. If you get a CONNECTION FAILURE message, the software could not establish a connection to the sensor. In this case please check if the interface cable is correctly connected, if the sensor is supplied with power, and if the set parameters are correct.

Pressing DISCARD SETTINGS exits the COMMUNICATION SETTINGS panel with the parameters that were set before the panel was started.

| ⚠️ ATTENTION !	**The stable function of the interface is a basic prerequisite for measured value transfer from the PC to the SI-COLO3 color sensor.** **Due to the limited data transfer rate through the serial RS232 interface (19200 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 sensor data communication with the PC must be stopped (press the STOP button).**

ATTENTION!
A change of the transmitter power only becomes effective at the SI-COLO3 color sensor after actuation of the SEND button in the MEM function field!

EVALUATION MODE | FIRST HIT ▼

✔ FIRST HIT
BEST HIT
MIN DIST
COL4

EVALMODE:
This function field serves for setting the evaluation mode at the SI-COLO3 color sensor.
(→ See below.)

CALCULATION MODE | X/Y INT ▼
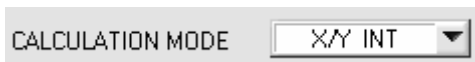
CALCULATION MODE:

X/Y INT:
X/Y pairs of the individual contents of red, green, and blue, and the intensity are used for evaluation.

s/i M:
"s.i." pairs of the individual contents of red, green, and blue, and M are calculated for evaluation. This calculation method follows the Lab calculation method.

X
s

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

$$X = \frac{R}{R + G + B} * 4095$$

s is calculated on the basis of the Lab color evaluation method.

Y
i

Y-value of the teach-in color (in the color triangle numerical value on the y-axis: GREEN color content)

$$Y = \frac{G}{R + G + B} * 4095$$

i is calculated on the basis of the Lab color evaluation method.

CTO
siTO

Color tolerance: "Tolerance circles" around the teach color in the color triangle that is defined as an (X,Y) or (s,i) point. The numerical value of CTO or siTO 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
M

Teach-in value for the intensity of the respective color.

$$INT = \frac{R + G + B}{3}$$

M is calculated on the basis of the Lab color evaluation method.

ITO
MTO

Default value for the permitted tolerance band around the intensity or M teach-in value (intensity tolerance).

POWER MODE: STATIC

POWER (pm) [_____] 0

0   500   1000

DYN WIN LO 3000   DYN WIN HI 3500
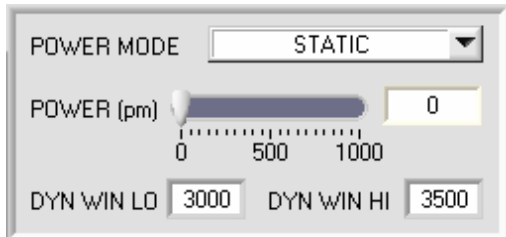
POWER MODE:
In this function field the operating mode of automatic power correction at the transmitter unit (transmitter LED) can be set.

STATIC:
The LED transmitter power is constantly kept at the value set with the POWER slider (recommended operation mode).

DYNAMIC:
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 receivers the automatic control circuit attempts to adjust the transmitter power in such a way that the dynamic range, which is determined by DYN WIN LO and DYN WIN HI, is not exceeded.

POWER [pm]:
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 1000 means full intensity at the transmitter LED, a value of 0 stands for the lowest transmitter intensity adjustment!

INFO:
The POWER slider is only effective in the POWER MODE STATIC.
DYN WIN LO and DYN WIN HI are only effective in POWER MODE DYNAMIC.

AVERAGE   4096
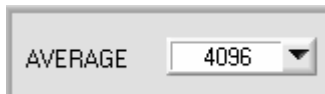
AVERAGE:
This function field is used for adjusting the number of scanning values (measurement values) over which the raw signal measured at the receiver is averaged. A higher AVERAGE default value reduces noise of the raw signals at the receiver unit and there will be a decrease of the maximal available switching frequency of the SI-COLO3 color sensor.
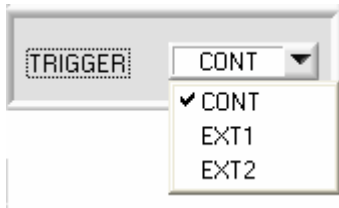
TRIGGER:
This function field serves for setting the trigger mode at the SI-COLO3 color sensor.

CONT:
Continuous color detection (no trigger event required).

EXT1:
Color detection is started through the external trigger input (IN0 pin3 green of cable cab-las8/SPS) or by means of a click on the TEACH button. A trigger event is recognized as long as +24V is present at the IN0 input (HIGH-active).
After the trigger input goes to LOW again, the state (color no.) that was last detected will be held at the outputs.

EXT2:
Same behaviour as in EXT1 mode, with the difference that an error state (color no. = 255) will be output after the trigger input goes to LOW again.

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.

OFF: The external TEACH feature is deactivated.
ON : See below

STAT1:
In static power mode, a color is taught to position 0 in the COLOR TEACH TABLE.
The POWER MODE is automatically set to STATIC. A fixed transmitter poser must be set with the POWER slider. When the button at the sensor housing is pressed, or after a positive signal (+24V) at input IN0, the current color is taught to row 0.

DYN1:
In dynamic power mode, a color is taught to position 0 in the COLOR TEACH TABLE, and evaluation is then performed statically.
The POWER MODE is automatically set to STATIC. When the button at the sensor housing is pressed, or after a positive signal (+24V) at input IN0, the transmitter power is set such that the sensor is in the dynamic range, which is defined by DYN WIN LO and DYN WIN HI. The current color is then taught to position 0 in the COLOR TEACH TABLE.
The sensor then continues to operate statically with the established POWER value.

MAXCOL-No.	4

PARA
1
0

TEACH PROCESS WITH EXTEACH=ON:
Through IN0 or by way of the button at the sensor housing, the sensor can be taught up to 15 colors.
The example shows the external teaching of 4 colors.

Select the EXTERN TEACH = ON function.
Select how many colors you wish to teach externally.
Click on the "0" field in the PARA switch to change to the COLOR TEACH TABLE.
Then enter the corresponding tolerances for the colors you want to teach.

No.	COLOR TEACH TABLE					COLOR
	X	Y	CTO	INT	ITO	
0	1	1	150	1	150	
1	1	1	150	1	150	
2	1	1	150	1	150	
3	1	1	150	1	150	
4	1	1	1	1	1	
5	1	1	1	1	1	
6	1	1	1	1	1	

SEND

In this example, MAXCOL-No. = 4 was selected, i.e. the sensor should detect the color information that is stored in the first 4 rows 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 150 at all places) and must be stored in the EEPROM (see MEM) together with the MAXCOL-No. and with EVALMODE = ON.

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.
Colors that are taught by way of EXTERN TEACH will only be stored in the RAM memory, i.e. the information will be lost when the system is turned off. (The set parameters and tolerances are stored in the EEPROM memory, i.e. they will not be lost when the system is turned off.)

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 a certain number of 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 period of time, in which the user can teach the color information to the sensor depends on the value that is set in MAXCOL-No. (e.g. approx. 5 seconds when MAXCOL-No. = 5).

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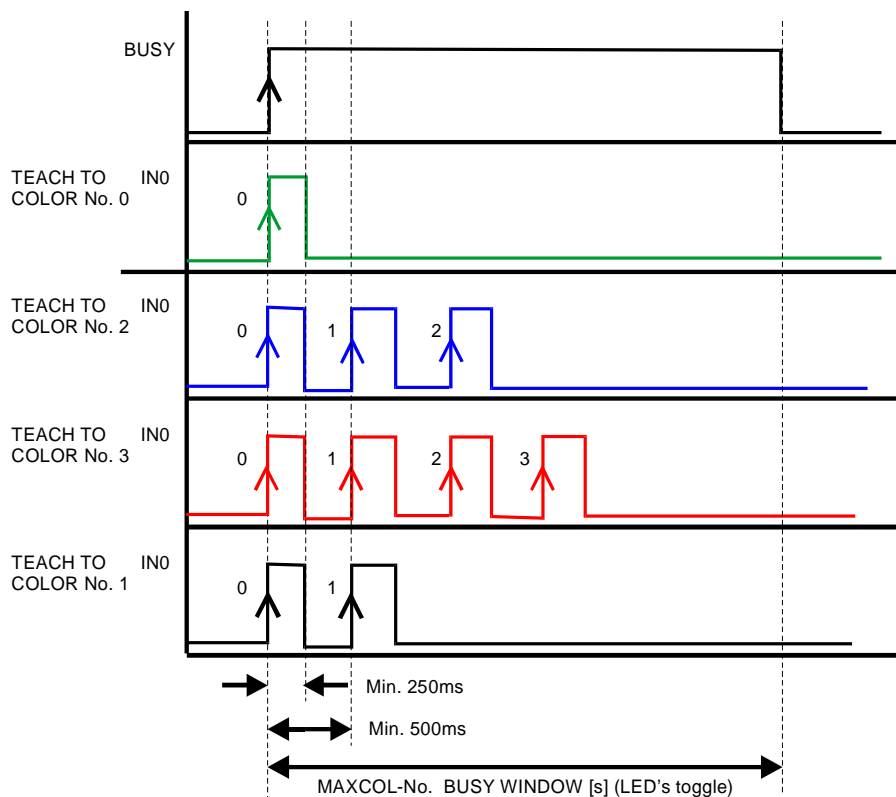
INTLIM:
This edit box is used for setting an intensity limit. Color evaluation is stopped, if the current intensity INT arriving at the receiver unit falls below this limit, and ERROR STATE is output.

Attention: ERROR STATE if: INT < INTLIM

MAXCOL-No.:
This function field serves for setting the number of colors to be checked.

In the BINARY mode the maximum number of colors to be checked is 15. In the DIRECT HI or DIRECT LO mode 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-COLO3 color sensor.
The numerical value set here refers to the number of rows (starting with row 0) in the COLOR TEACH TABLE (→ COLOR TEACH TABLE).

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 TEACH TABLE, this color in the COLOR TEACH 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 TEACH TABLE, this color in the color teach table is displayed as a color number (C-No.) and is sent **direct** to the digital outputs (OUT0 ... OUT3).

DIRECT HI:
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, all digital outputs are set to LOW (no LED is lighting).

DIRECT LO:
If DIRECT LO is activated, the specially digital output is set to LO, while the other ones 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 LEDs are lighting).

HOLD:
The SI-COLO3 color sensor operates with minimum scanning times in the magnitude of less than 150µs. 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-COLO3 color sensor pulse lengthening of up to 100 ms can be set by selecting the corresponding HOLD value.

PARA:
With this switch the display of the 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 TEACH TABLE for entering the individual parameters for the teach-in colors.

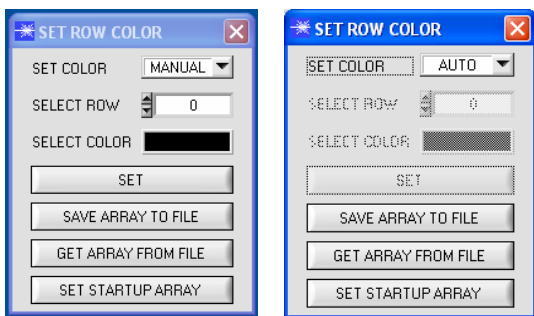| No. CTT	COLOR GROUPS	ROWCOLOR			
	X	Y	CTO	INT	ITO
0	1489	1523	150	2432	150
1	1466	2023	150	897	150
2	2843	827	150	1079	150
3	1097	1574	150	1467	150
4	1988	1841	150	1731	150
5	895	1066	150	767	150
6	2203	1426	150	1181	150
7	1792	1960	150	1736	150
8	1531	1136	150	3030	150
9	2310	734	150	1294	150
10	1	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

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 double click (or a click on shortcut key button F2) 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-COLO3 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.
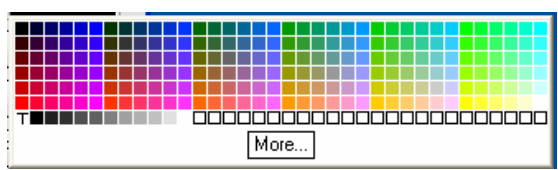
SET ROW COLOR

SET COLOR [MANUAL ▼]
SELECT ROW [0]
SELECT COLOR [■]
SET
SAVE ARRAY TO FILE
GET ARRAY FROM FILE
SET STARTUP ARRAY

SET ROW COLOR

SET COLOR [AUTO ▼]
SELECT ROW [0]
SELECT COLOR [▨]
SET
SAVE ARRAY TO FILE
GET ARRAY FROM FILE
SET STARTUP ARRAY

ROW COLOR:

A click on ROW COLOR opens a panel where the row color in which the individual tolerance circuits are represented can be individually chosen or these can be automatically replaced by the color detected by the system.

If SET COLOR is set to MANUAL, the row color that should be changed must be set under SELECT ROW.
A click on the colored area of SELECT COLOR opens a color palette where the desired color can be selected.
After a click on the SET button, the color will be displayed in the 6th column and the selected row of the COLOR TEACH TABLE.

If SET COLOR is set to AUTO, the system will automatically calculate the corresponding row color, display the color in a color display beside the graph and, after a click on TEACH DATA TO, automatically insert it in the corresponding row.

The SAVE ARRAY TO FILE and GET ARRAY FROM FILE functions allow you to save specified color-arrays on the hard disk, or to load previously saved color-arrays.

SET STARTUP ARRAY is used for setting the selected path of an existing ARRAY.
When the software is restarted, the corresponding ARRAY is automatically loaded and displayed in the COLOR TEACH TABLE.

No.: ⬍ 10 Inc ▣   No.:
Selection of the current number of the teach-in color (0 … 14) from the COLOR
TEACH 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 row 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.

TEACH MEAN VALUES   See chapter 2.6

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 or siTO).
The picture below shows 10 color tolerance circles with the teach-in values (X,Y) and CTO (tolerance radius)
preset in the COLOR TEACH TABLE.
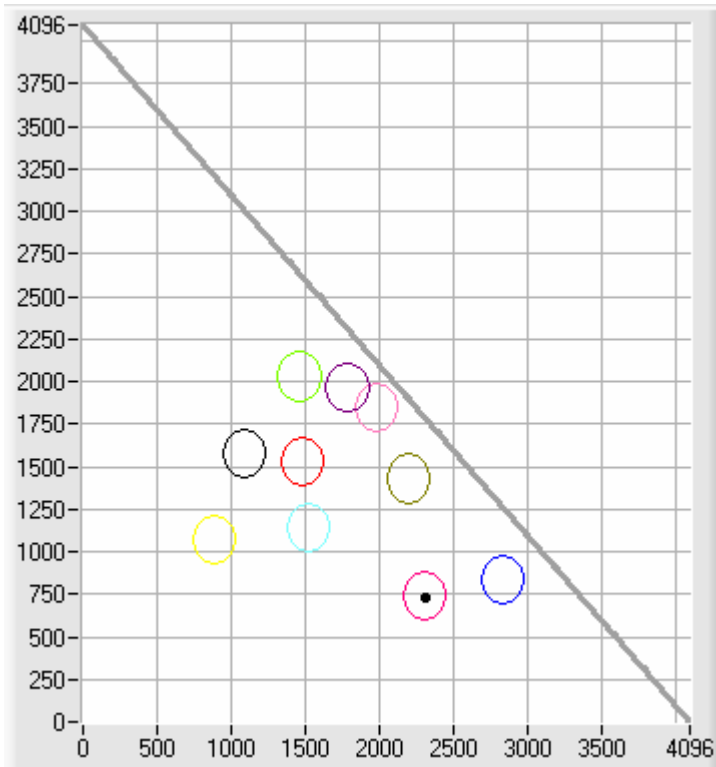
AUTO ADJUST:
A click on this button initiates automatic adjustment of the circle tolerances (CTO).
A circle tolerance of max. 200 DIGITS is allowed in calculation.
Circles may overlap if they are definitely separated by the intensity (please note: ITO must be set first!)
The number of circle tolerances to be calculated is determined by MAXCOL-No. (e.g. MAXCOL-No. = 5 → CTO adjustment up to and including row 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 with an automatic zoom function, i.e. the X/Y scale is dependent on the circle coordinates and the current cursor coordinates.
By pressing the left mouse button, the cursor can be positioned manually. The respective X/Y coordinates will be displayed in the X and Y edit boxes, and can then be taught via the TEACH DATA TO button as desired.
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).
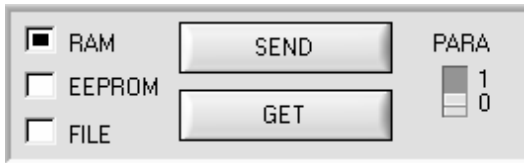
RAM, EEPROM, FILE :
This group of buttons controls parameter exchange between PC and sensor through the serial RS232 interface.

PARA:
With this switch the display of the 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 TEACH TABLE for entering the individual parameters for the teach-in vectors.

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

[F9]

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

[F10]

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

EEPROM: The current parameters are written into the non-volatile memory of the EEPROM in the sensor, or they are read from the EEPROM, **i.e. the parameters in the internal EEPROM are stored when the voltage at the 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.
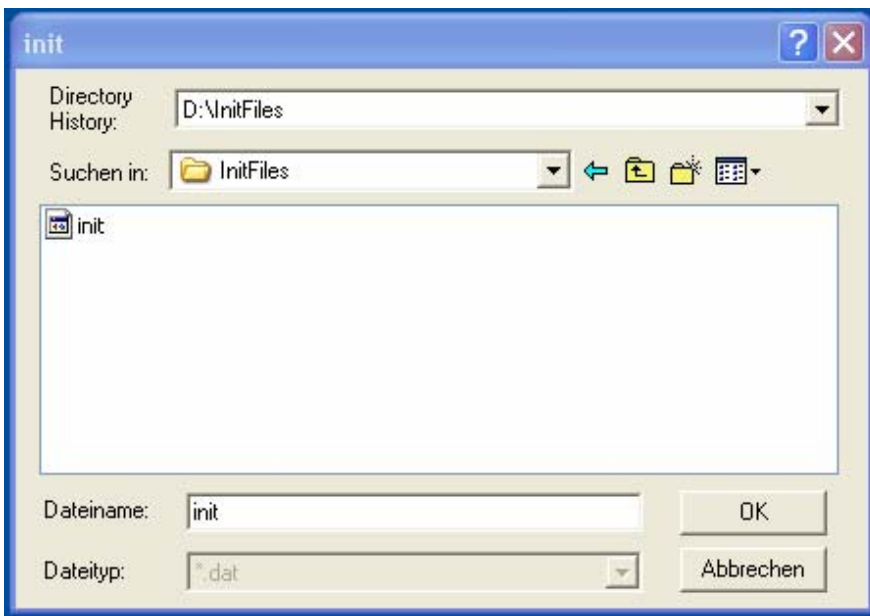
If another output file should be accessed, the file button must first be activated with the mouse pointer. Another dialog field then opens, in which an existing output file can be selected, or in which a file name for a new output file can be entered.
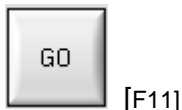
	GO:
GO [F11]	A click on this button (or pressing shortcut key button F11) starts data transfer from the SI-COLO3 color sensor to the PC through the serial RS232 interface.

If *X/Y* or *s/i* is selected under SOURCE, the X/Y coordinates of the current color are displayed in the graph.
If *INT* or *M* 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.

|	STOP:
STOP [F12]	A click on this button (or pressing shortcut key button F12) stops data transfer from the SI-COLO3 color sensor to the PC through the serial RS232 interface.

X or s:
This numerical value output field displays the RED content (x-axis) of the scattered light currently arriving at the receiver.

X	s
1179	4661

Y or i:
This numerical value output field displays the GREEN content (y-axis) of the scattered light currently arriving at the receiver.

Y	i
1481	2028

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

INT	M
3198	1101

TEMP:
TEMP 27
This display shows the temperature prevailing in the sensor housing.
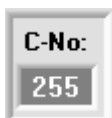
C-No.:
C-No: 255
This numerical value output field displays the currently detected color number in accordance with the entry in the COLOR TEACH TABLE. The currently detected color number is sent to the digital outputs OUT0 … OUT3 as a corresponding bit pattern.

Please note:	**The above-mentioned output fields are only updated when data transfer between PC and SI-COLO3 color sensor is active (GO button pressed).**

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

XY or s/i : 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.
INT or M: The currently determined intensity is displayed.

2.1.2 Evaluation modes

EVALUATION MODE	FIRST HIT

No. COLOR TEACH TABLE					COLOR
	X	Y	CTO	INT	ITO	
0	1317	1962	100	1441	100	(red)
1	2501	834	100	2007	100	(green)
2	866	1067	100	1120	100	(blue)
3	1	1	1	1	1	(black)
4	1	1	1	1	1	(pink)
5	1	1	1	1	1	(yellow)

FIRST HIT:
The currently measured color values are compared with the default values in the COLOR TEACH TABLE, starting with teach-color 0. If in the row-by-row comparison the current color values correspond with the teach-parameters entered in the COLOR TEACH TABLE, this first "hit" in the COLOR TEACH 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").

EVALUATION MODE	BEST HIT

No. COLOR TEACH TABLE					COLOR
	X	Y	CTO	INT	ITO	
0	1317	1962	100	1441	100	(red)
1	2501	834	100	2007	100	(green)
2	866	1067	100	1120	100	(blue)
3	1	1	1	1	1	(black)
4	1	1	1	1	1	(pink)
5	1	1	1	1	1	(yellow)

BEST HIT:
The currently measured color values are compared with the default values in the COLOR TEACH TABLE, starting with teach-color 0. If in the row-by-row comparison the current color values correspond with several of the teach parameters entered in the color table, the teach parameter that has the shortest x/y distance from the current color value will be a hit.
This "hit" in the COLOR TEACH 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-in colors, the color code C-No. = 255 will be set ("error status").

EVALUATION MODE	MIN DIST

No.	COLOR TEACH TABLE				COLOR
	X	Y		INT	ITO	
0	1832	1601	40	2120	100	(red)
1	1	1	1	1	1	(green)
2	1	1	1	1	1	(blue)

MIN DIST:
The individual teach-in colors defined in the COLOR TEACH 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-COLO3 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.
It is furthermore checked whether the intensity condition for this color also is true. If the intensity condition is not true, the second shortest distance will be checked, etc.

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).

Comment:
The value of 40 is only entered here in order to be able to represent the coordinates of the individual teach colours in the graph. It has no meaning for evaluation.

EVALUATION MODE   COL4   ▼

● 0
● 1
● 2
● 3

COL5:
In this evaluation mode the rows 0 to 3 in the COLOR TEACH TABLE are evaluated.
Every match of current color (row number) and teach vector is directly sent to the corresponding output.
Example.
If the result of evaluation is that both row 0 and row 3 is a hit, outputs OUT0 and OUT3 will be set to high (+24V).

No. CTT	COLOR GROUPS		ROWCOLOR	
	X	Y	CTO	INT	ITO	
0	1	1	1	1	1	

COLOR GROUPS:
It is possible to form color groups in evaluation modes FIRST HIT, BEST HIT, and MIN DIST. This means that in a special table the individual rows are assigned to a group.

※ GROUP PANEL _ □ ✕

COLOR GROUPS ON ▼

	GROUP
0	0
1	0
2	1
3	1
4	2
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0

RESET

CLOSE GROUP PANEL

C-No:
3

GRP
1

In this example, COLOR GROUPS has been set to ON, i.e. group evaluation is activated.
Rows 0 and 1 have been assigned to group 0.
Rows 2 and 3 have been assigned to group 1, and row 4 to group 2.
A GRP display is shown under the C-No: display.

If, as in this example, row 3 is detected in the evaluation, this row and the corresponding group will be visualised.

The group number will be output through outputs OUT0 … OUT3.

A maximum of 4 groups (group 0 to group 3) can be formed in evaluation mode DIRECT HI and LO.

A maximum of 15 groups (group 0 to group 14) can be formed in evaluation mode BINARY.

All the cell values can be set to 0 by pressing RESET.
The GROUP PANEL can be closed by clicking on CLOSE GROUP PANEL.

PLEASE NOTE:
Once you have formed groups, they must be reported to the sensor by pressing SEND.

2.2 COLOR3-Scope software as an aid for sensor adjustment

Prior to the use of the software aids (graphic display of sensor signals) the sensor must be manually adjusted to the respective target or background as accurately as possible. The reference distance of the sensor to the target is defined in the data sheet of the respective sensor.

ATTENTION! **By using the color sensor with fiber optic cable adaptor, there should be a working distance of approx. 2 … 10mm between the optical fiber head-end and the measuring object.**

Fine adjustment of the SI-COLO3 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-COLO3 color sensor to the PC must be activated by clicking on the GO button.

SOURCE ▼ INT	For this purpose the option 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.
GO	Activation of measurement data transfer between PC and SI-COLO3 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).
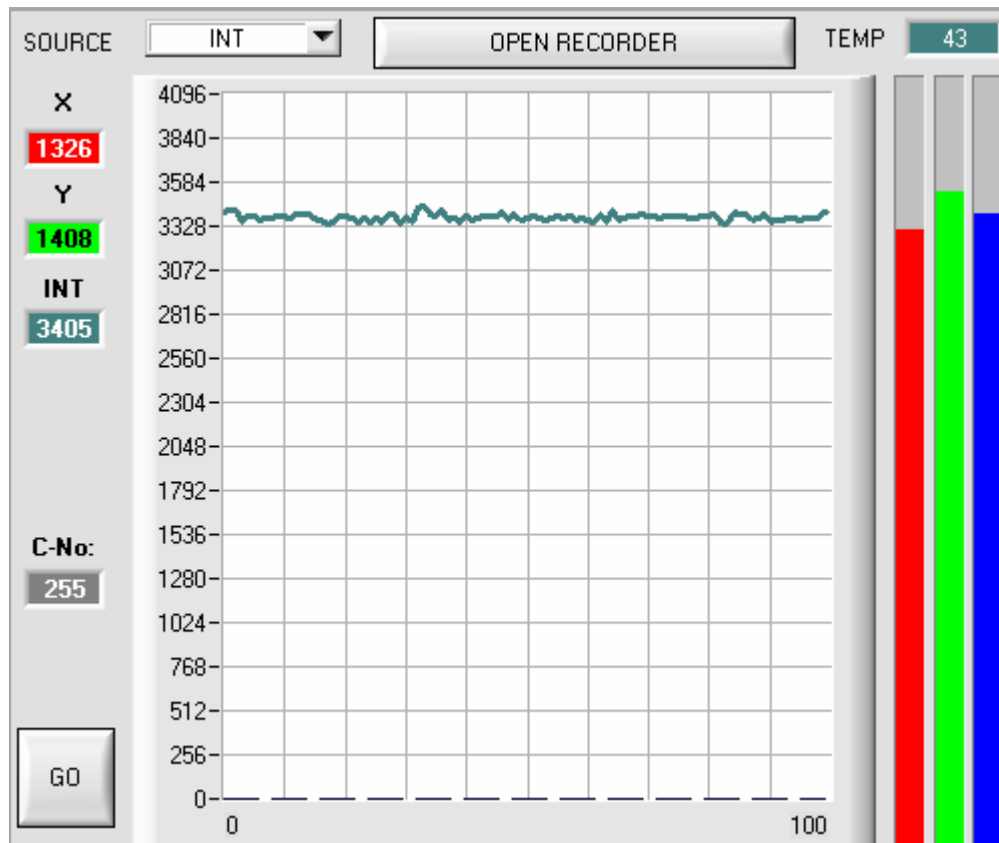
The measured intensity value from the receiver diode of the SI-COLO3 color sensor should now appear in "scroll mode" in the graphic display window (red). If one of the 3 measuring channels lies at the upper=4096 or lower=0 limit (observe the bar display), it must first be ascertained that the intensity of the transmitter LED is correctly set.

For this purpose the laser mode is set to STATIC in the POWER MODE function field, and the POWER slider is then adjusted until the intensity value INT (pink curve) ideally lies in the middle of the measuring range (0 … 4096 12-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:

      INT > INTLIM
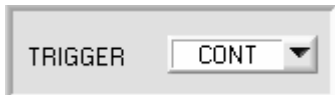
SEND

Please note: **The change of laser power only becomes active at the SI-COLO3 color sensor after a click on the SEND button !**

2.3   COLOR3-Scope software as an aid for teach-in

The SI-COLO3 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).
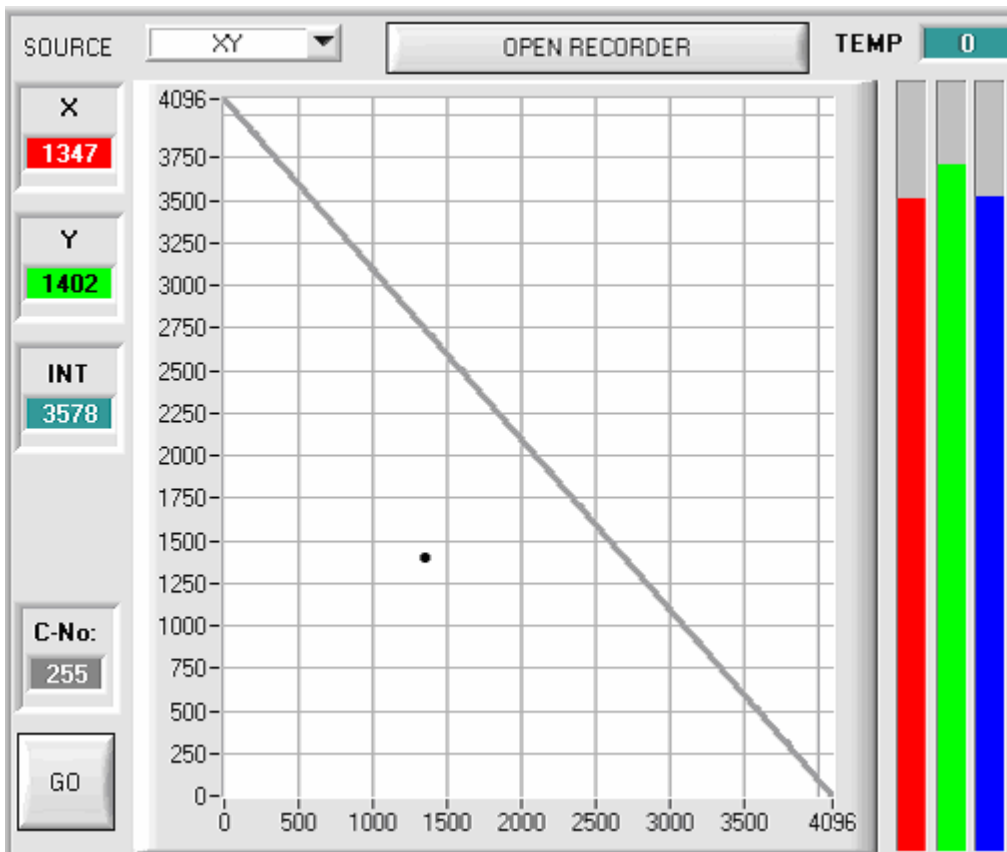
First the trigger mode should be set to CONT, which means that color detection is continuously active, also without external triggering.

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.

GO

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.

No.: 2

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.
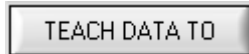
TEACH DATA TO

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 (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-color in the color triangle determines the possible choice of the tolerance circles (radius=CTO). They should be chosen so, that they don't overlap each other.

TEACH MEAN VALUES

After a click on the GO button, a TEACH panel will be opened which allows the user to combine several measurement values in a teach value.
See chapter 2.6.

No.	COLOR TEACH TABLE					
	X	Y	CTO	INT	ITO	
0	1648	1234	100	962	50	
1	2504	901	100	1753	50	
2	1738	1225	100	818	50	
3	1366	1020	100	1945	50	
4	1505	1551	100	2706	50	

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 19

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. 1

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-COLO3 color sensor by clicking on the SEND button.

⚠ ATTENTION !	**The selection button in the MEM field must be set to EE !**

When the parameters have been entered and the sensor has been adjusted with the help of the graphical representation provided by the COLOR3-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-COLO3 color sensor. The SI-COLO3 color sensor then performs the measuring task in STAND-ALONE operation.

2.4 External triggering of the SI-COLO3 color sensor
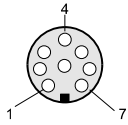
External triggering is performed through pin no. 3 (grn) at the 8-pole socket of the SI-COLO3/PLC connection.
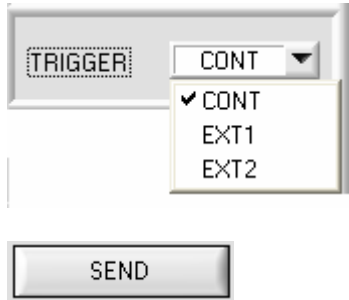
EXTERN:
First the external trigger mode must be set at the color sensor. For this purpose option EXT1 or EXT2 must be selected in the TRIGGER selection field.

TRIGGER CONT
✔ CONT
EXT1
EXT2

SEND

PLEASE NOTE:
The new setting is only activated at the SI-COLO3 control unit after a click on the SEND button!

Please note:	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).

IN0
(Pin3 grn) or
TEACH button

Triggering active !   No triggering !

HIGH (+24V)

LOW (0V, GND)

2.5 Function of the data recorder (OPEN RECORDER)

The COLOR3-Scope software features a data recorder that makes it possible to save a certain number of RED/GREEN/BLUE/X/Y/INT frames. The recorded file is saved to the hard disk of the PC and can then be evaluated with a spreadsheet program.

The file that is created has seven columns and as many rows as data frames were recorded.
A row is structured as follows: Date and time, RED, GREEN, BLUE, X, Y, INT.
Attention: When an EXCEL file is opened, date and time must be split in two columns.

The following steps describe how data frames are recorded with the recorder:

PLEASE NOTE:
Recording depends on the EVALUATION MODE that is chosen. Several EVALUATION MODES do not need certain data, therefore these data will be set to 0, i.e. for these data the value 0 will be recorded.
When TRIGGER=EXT1 or EXT2 is selected, only those data will be recorded which are calculated during triggering.

Step 1:
Press the OPEN RECORDER button. The following window will be displayed:

OPEN RECORDER
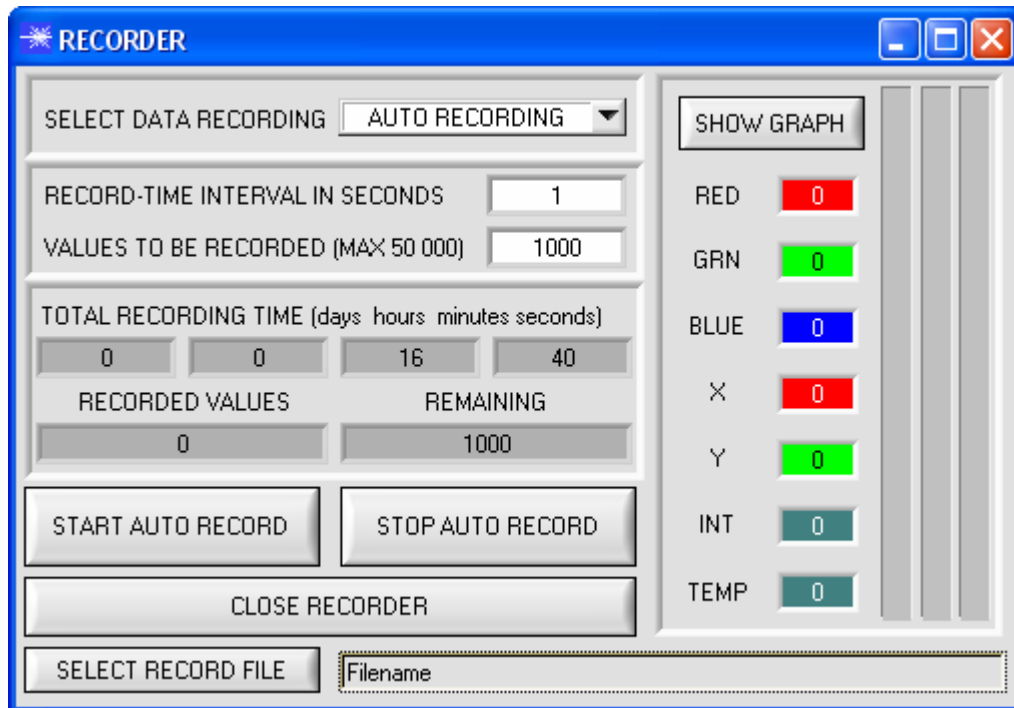
Step 2:
If you want to automatically record several data frames, please select AUTO RECORDING under SELECT DATA RECORDING.
Enter a time interval for recording (in this example: 1, i.e. a new value is called from the sensor every second). Then enter the maximum number of values you wish to record in the second input field.

Please note:
Recording can also be stopped earlier, the data recorded so far will not be lost.

These fields indicate how long recording will take (in days, hours, minutes, and seconds) if all data are recorded.

SELECT DATA RECORDING	AUTO RECORDING ▼

RECORD-TIME INTERVAL IN SECONDS	1
VALUES TO BE RECORDED (MAX 50 000)	1

TOTAL RECORDING TIME (days hours minutes seconds)			
0	0	0	1

Step 3:
By pressing the button SELECT RECORD FILE a file can be selected in which the data frame will be stored.
If you select an already existing file name, you will be asked whether you want to overwrite the existing file or not.

SELECT RECORD FILE

d:\Filename\record.dat

Step 4:
Pressing the START AUTO RECORD button starts automatic data recording.

START AUTO RECORD

The recorder starts to record data, and the button is red to indicate that recording is active.

The respective data frames are shown in the display windows.

In the two display fields RECORDED VALUES and REMAINING you can check how many data frames have been recorded, and how many frames remain to be recorded.

Pressing the SHOW GRAPH button opens a graphic window that displays the recorded values

Please note:
During recording the two input fields RECORD-TIME INTERVAL and VALUES TO BE RECORDED are inactive.

RED	0
GRN	0
BLUE	0
X	0
Y	0
INT	0
TEMP	0

RECORDED VALUES	REMAINING
6	994

Step 5:
When all the data frames set under VALUES TO BE RECORDED have been recorded, or when the STOP AUTO RECORD button is pressed, a pop-up window will appear which confirms that the file is stored.
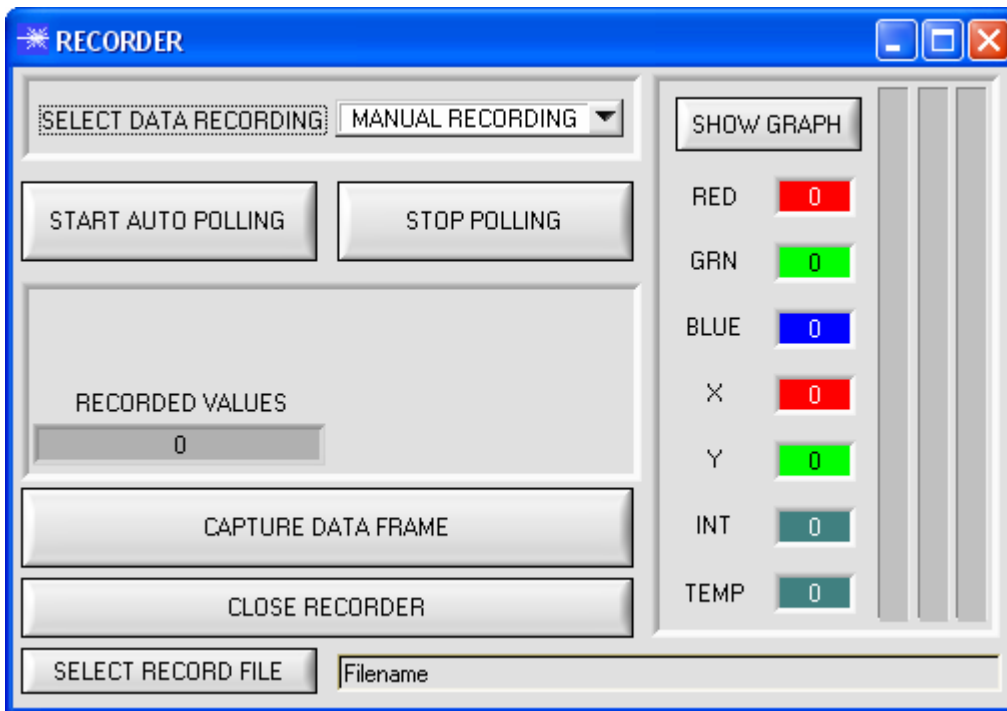
STOP AUTO RECORD

Step 6:
Press the CLOSE RECORDER button to close the
recorder and return to the main program.

CLOSE RECORDER

If you want to record data "manually", please select the MANUAL RECORDING function under SELECT DATA
RECORDING.
You can start reading data from the sensor by pressing the START AUTO POLLING button. These data are
visualised in the display window. Pressing the CAPTURE DATA FRAME button saves a data frame in the file that
was selected under SELECT RECORD FILE. The RECORDED VALUES field shows the sum of the frames
already recorded.

RECORDER

SELECT DATA RECORDING   MANUAL RECORDING ▼   SHOW GRAPH

START AUTO POLLING   STOP POLLING   RED   0

                                                 GRN   0

                                                 BLUE   0

RECORDED VALUES   X   0
        0
                                                 Y   0

CAPTURE DATA FRAME   INT   0

CLOSE RECORDER   TEMP   0

SELECT RECORD FILE   Filename

Please note:
**When you press START AUTO RECORD, the file that is selected under SELECT RECORD FILE will be
deleted. With RECORD FRAME MANUALLY, the file will be created if it does not already exist. If the file
already exists, the data are added to the existing file.**

SHOW GRAPH | When the SHOW GRAPH button is pressed, a panel will be displayed that allows the user to monitor the different signals. The individual signals can be activated from the SIGNAL drop-down menu.
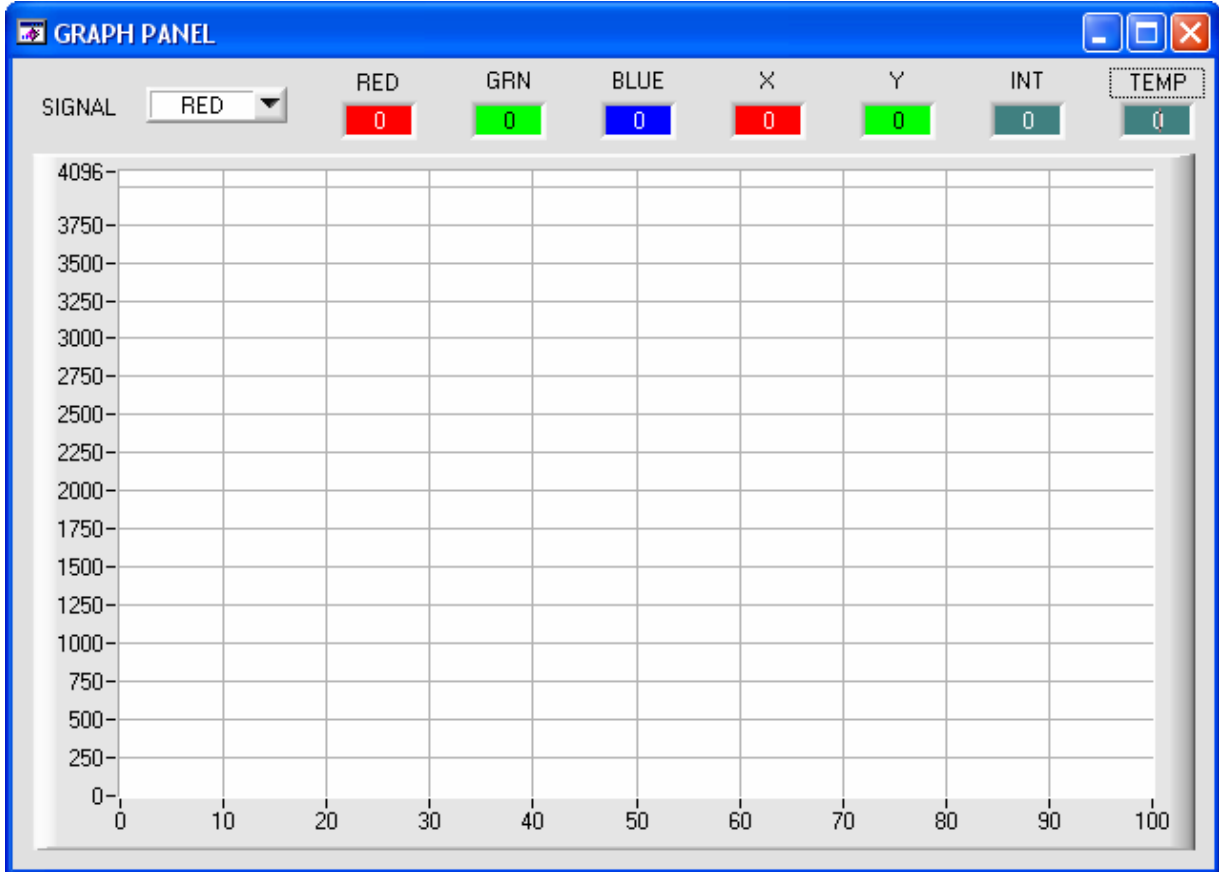
2.6 Function of the Teach Panel (TEACH MEAN VALUES)

The Teach Panel can be used in every evaluation mode. The explanation herein uses the FIRST HIT evaluation mode.

The following panel will be displayed after a click on TEACH MEAN VALUES.
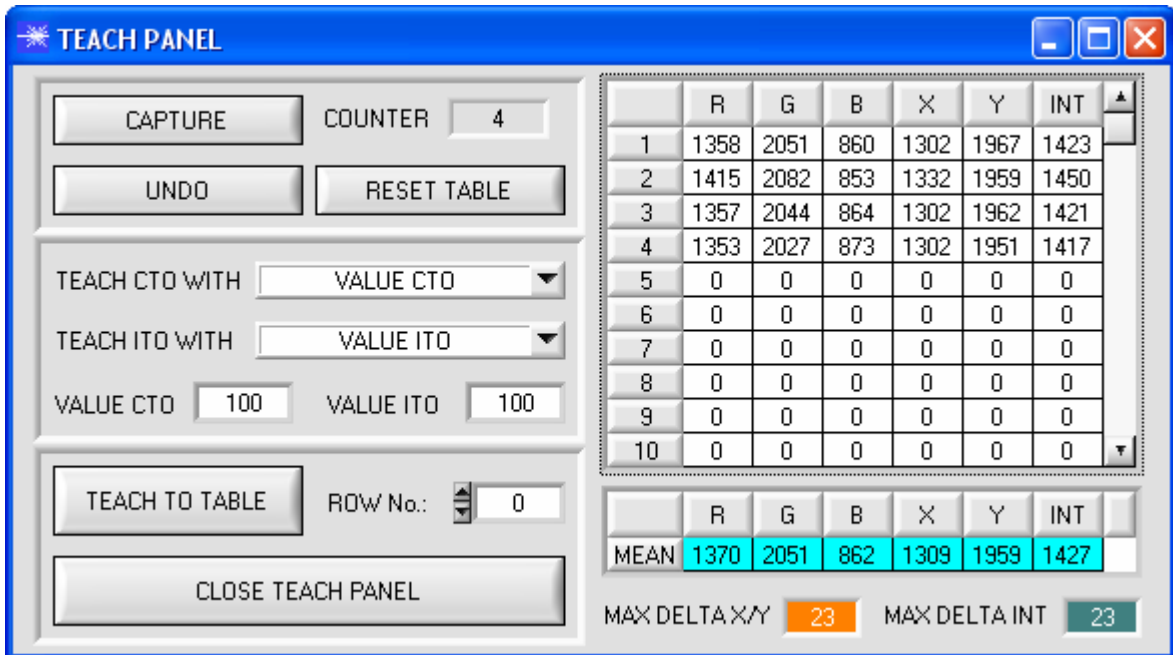
The main panel remains active, and data are automatically picked up from the sensor and are displayed.
A click on the CAPTURE button enters a parameter frame in the table.
The COUNTER display field shown how many frames have already been recorded.
The last frames that were entered in the table can be deleted again by pressing UNDO.
RESET TABLE sets the whole table back to 0.
After every activation of CAPTURE, UNDO, or RESET TABLE, the mean values for the individual parameters are calculated automatically and are displayed in the mean value table.
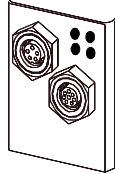A MAX DELTA X/Y and a MAX DELTA INT are calculated in addition to the mean values.

When the TEACH TO TABLE button is pressed, the respective mean values are taught to the row in the COLOR TEACH TABLE that is selected under ROW No.:.
Teaching of the circular tolerance and of the intensity tolerance can be set by way of TEACH CTO WITH and TEACH ITO WITH, respectively.
- If the setting is VALUE CTO, the value that is set under VALUE CTO will be taught (ditto tolerance).
- If the setting is MAX DELTA (X/Y), the value that is determined under MAX DELTA X/Y will be taught (ditto tolerance).
- If the setting is MAX DELTA + VALUE CTO, the value that is determined under MAX DELTA X/Y + VALUE CTO will be taught (ditto tolerance).
- With NO CHANGE, the value that is set in the COLOR TEACH TABLE will remain unchanged.

A click on the CLOSE TEACH PANEL button will take you back to the main panel.

2.7　Function of the LED display

| LED display: | |

BINARY

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

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, while the other 3 are set to LO. 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).
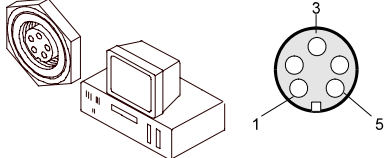

DIRECT HI

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).
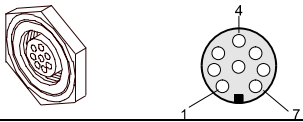

DIRECT LO

3 Connector assignment of the SI-COLO3 color sensor

Connection of SI-COLO3 to PC:

5-pole female connector (type Binder 712) *SI-COLO3/PC-RS232*		

Pin No.:		Assignment:
1		0V (GND)
2		TxD
3		RxD
4		Not connected
5		Not connected

Connection of SI-COLO3 to PLC:

8-pole female connector (type Binder 712) *SI-COLO3/PLC*		

Pin No.:	Color:	Assignment:
1	White	0V (GND)
2	Brown	+12VDC .. +30VDC
3	Green	IN0
4	Yellow	OUT0 (Digital 0: Type 0 … 1V, Digital 1: Type +Ub – 10%)
5	Grey	OUT1 (Digital 0: Type 0 … 1V, Digital 1: Type +Ub – 10%)
6	Pink	OUT2 (Digital 0: Type 0 … 1V, Digital 1: Type +Ub – 10%)
7	Blue	OUT3 (Digital 0: Type 0 … 1V, Digital 1: Type +Ub – 10%)
8	Red	Not connected

4   RS232 communication protocol

RS232 communication protocol PC ⇔ SI-COLO3 Sensor (COLOR3-Scope V6.1)
- Standard RS232 serial interface without hardware-handshake - 3-wire: GND, TX0, RX0 - Speed: 19200 baud, 8 data-bits, no parity-bit, 1 stop-bit in binary mode, us (unsigned), MSB (most significant byte) first. The control device (PC or PLC) has to send a data frame of 18 words to the Sensor. All bytes must be transmitted in binary format (us, MSB). The meaning of the parameters is described in the software manual. Info: 1 word = 2 bytes <u>Method:</u> The hardware is permanently reading (polling) the incoming byte at the RS232 connection. If the incoming word is 0x0055 (synch-word), then the 2. word (order-word) is read in, after this, 16 words (parameters) will be read. After reading in the completely data frame, the Sensor executes the order which is coded at the 2. word (order-word).

Format of the data frame:			
Word No.	*Format*	**Meaning**	**Comment:**
1	Word	sync-word = 0x0055	hex-code 0x0055, binary: 0000 0000 0101 0101, synchronisation word
2	Word	**ORDER NUMBER**	order word
3	Word	Para POWER	LED intensity (0 ... 1000) Attention intensity in thousendth!
4	Word	Para POWER MODE	LED mode: STATIC, DYNAMIC coded to (0, 1)
5	Word	Para AVERAGE	Signal averaging 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384 or 32768
6	Word	Para EVALUATION MODE	Evaluation mode: FIRST HIT, BEST HIT, MIN DIST, COL4 coded to (0,1,2,3)
7	Word	Para HOLD[ms]	Hold time 0,1,2,3,5,10,50 or 100ms
8	Word	Para INTLIM	Intensity limit (0 ... 4095)
9	Word	Para MAXCOL-No.	Number of the colours (1,2,3,…,15)
10	Word	Para OUTMODE	Function of the digital output: direct/HI, binary, direct/LO coded to (0,1,2)
11	Word	Para TRIGGER	Trigger mode: CONT, EXT1 or EXT2 coded to (0, 1, or 2)
12	Word	Para EXTEACH	External teach mode: OFF, ON, STAT1, DYN1 coded to (0,1,2,3)
13	Word	Para CALCULATION MODE	Calculation mode: X/Y INT, s/i M coded to (0,1)
14	Word	Para DYN WIN LO	Low limit for dynamic window when POWERMODE=dynamic (0…4095)
15	Word	Para DYN WIN HI	High limit for dynamic window when POWERMODE=dynamic (0…4095)
16	Word	Para COLOR GROUPS	Color groups enable: OFF, ON coded to (0,1)
17,18	Word	free	Must be sent as dummy (e.g. 6x value 0)

Value	ORDER NUMBER (parameter byte no. 2)	
0	nop	no operation
1	Save parameter from PC into RAM	volatile: 18 words PC⇒SENSOR
2	Save one selectable row of TEACH TABLE into RAM	volatile: 18 words PC⇒SENSOR
3	Send parameter from RAM to PC	18 words binary SENSOR ⇒ PC
4	Send one selectable Row of TEACH TABLE from RAM to PC	18 words binary SENSOR ⇒ PC
5	Send data from RAM to PC	18 words binary SENSOR ⇒ PC
6	Save parameter from RAM to EEPROM	18 words PC⇒SENSOR
7	Send connection OK to PC	18 words binary SENSOR ⇒ PC
19	Load Parameter from EEPROM to RAM	18 words PC⇒SENSOR
20	Same as order 5 if TRIGGER=0 If TRIGGER = 1 or 2 only triggered values are transmitted	18 words binary SENSOR ⇒ PC

Example 1: DATA FRAME with ORDER NUMBER = 1:

ORDER NUMBER (second word = 1): WRITE parameters from PC into RAM of the sensor!
The completely data frame = 18 words must be sent to the sensor hardware in binary form (sync-word / order-word / 16 parameter words).

DATA FRAME PC → sensor (18 WORDS)

0x0055	SYNC.-WORD
1	ORDER-WORD
200	POWER
0	POWER MODE
1024	AVERAGE
0	EVALUATION MODE
10	HOLD
10	INTLIM
5	MAXCOL-No.
0	OUTMODE
0	TRIGGER
0	EXTEACH
0	CALCULATION MODE
3000	DYN WIN LO
3500	DYN WIN HI
0	COLOR GROUPS
0	DUMMY
0	DUMMY

Example 2: DATA FRAME with ORDER NUMBER = 2:

ORDER NUMBER (second word = **2**): **WRITE one selectable row (vector) of TEACH TABLE into RAM of the sensor!**
The completely data frame = 18 words must be sent to the sensor in binary form (sync-word / order-word / ROW-NO / 4 parameter words = vector, 11 dummies).
Fill unused words of the TEACH VECTOR by value word=1 in binary form.

DATA FRAME PC → sensor (18 WORDS)

0x0055	SYNC.-WORD
2	ORDER-WORD
0	ROW-No. (0…14)
1200	X respectively s
1500	Y respectively i
100	CTO respectively siTO
2000	INT respectively M
100	ITO respectively MTO
0	Group
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY

Example 3: DATA FRAME with ORDER NUMBER = 3:

ORDER NUMBER (second word = 3): READ parameters out of sensor-RAM memory!
The same frame as example 1 must be sent to the sensor except of the order word that must be **3**.
The values for the parameters must be sent as Dummies.
The complete DATA FRAME which is responded by the sensor is 18 words.

DATA FRAME PC → sensor (18 WORDS)
DATA FRAME sensor → PC (18 WORDS)

0x0055	SYNC.-WORD
3	ORDER-WORD
200	POWER
0	POWER MODE
1024	AVERAGE
0	EVALUATION MODE
10	HOLD
10	INTLIM
5	MAXCOL-No.
0	OUTMODE
0	TRIGGER
0	EXTEACH
0	CALCULATION MODE
3000	DYN WIN LO
3500	DYN WIN HI
0	COLOR GROUPS
0	DUMMY
0	DUMMY

Example 4: DATA FRAME with ORDER NUMBER = 4:

ORDER NUMBER (second word = 4): READ one selectable row (vector) from RAM of the sensor!
The same frame as example 2 must be sent to the sensor except of the order word that must be **4**.
The values for the parameters must be sent as Dummies.
The complete DATA FRAME which is responded by the sensor is 18 words.

DATA FRAME PC → Sensor (18 WORDS)
DATA FRAME Sensor → PC (18 WORDS)

0x0055	SYNC.-WORD
4	ORDER-WORD
0	ROW-No. (0…14)
Value	X respectively s
Value	Y respectively i
Value	CTO respectively siTO
Value	INT respectively M
Value	ITO respectively MTO
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY
1	DUMMY

Example 5: DATA FRAME with ORDER NUMBER = 5:

ORDER NUMBER (second word = 5): READ SI-COLO3 RAW DATA
DATA FRAME PC → SI-COLO3 (18 WORDS)
Parameters must be sent for a constant parameter frame as dummies.
At order word **5** they do not affect the RAM or EEPROM.
ORDER NUMBER = 19 is similar but if TRIGGER=1 or 2 only triggered values are transmitted.

0x0055	SYNC.-WORD
5	ORDER-WORD
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

After sending this frame, the sensor writes back 18 RAW DATAS

0x55
5
R
G
B
X
Y
INT
C-No.
RAW R
RAW G
RAW B
TEMP
GRP
DUMMY
DUMMY
DUMMY
DUMMY

Example 6: DATA FRAME with ORDER NUMBER = 6:

ORDER NUMBER (second word = 6): SAVE parameters from RAM to EEPROM of the sensor!
The complete data frame = 18 words must be sent to the sensor in binary form (sync-word / order-word / 16 parameter words).

0x0055	SYNC.-WORD
6	ORDER-WORD
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

After sending this data frame, the sensor saves all the parameters and teach vectors from its RAM (volatile memory) to its EEPROM (non volatile memory).
ATTENTION: The right parameters and teach vectors must be in the RAM of the sensor.
To save the parameters and teach vectors into RAM see **Example 1** and **Example 2.**

After completing the sensor writes back an echo of the same frame.

Example 7: DATA FRAME with ORDER NUMBER = 8:

ORDER NUMBER (second word = 8): Load parameters from EEPROM to RAM of the sensor!
The complete data frame = 18 words must be sent to the sensor in binary form (sync-word / order-word / 16 parameter words).

0x0055	SYNC.-WORD
8	ORDER-WORD
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY
0	DUMMY

After sending this data frame, the sensor loads all the parameters and teach vectors from it's EEPROM (non volatile memory) to it's RAM (volatile memory).
ATTENTION: The EEPROM parameters must be load first to the RAM to read it from the sensor. To get the parameters and teach vectors from RAM see **Example 3** and **Example 4.**

After completing the sensor writes back an echo of the same frame.

Example 8: DATA FRAME with ORDER NUMBER = 7:

ORDER NUMBER (second word = 7): SEND CONNECTION OK from the sensor to PC!
Cf. example 1:
Send the same DATA FRAME but with ORDER NUMBER 7 to the sensor.
The sensor will reply with 18 words which tell the version of the sensor.

Example 9: DATA FRAME with ORDER NUMBER = 20:

ORDER NUMBER (second word = 20): SEND LINE OK from the sensor to PC!
Cf. example 1:
Send the same DATA FRAME but with ORDER NUMBER 20 to the sensor.
The sensor will reply with the same 18 words which tell that there is a connection.