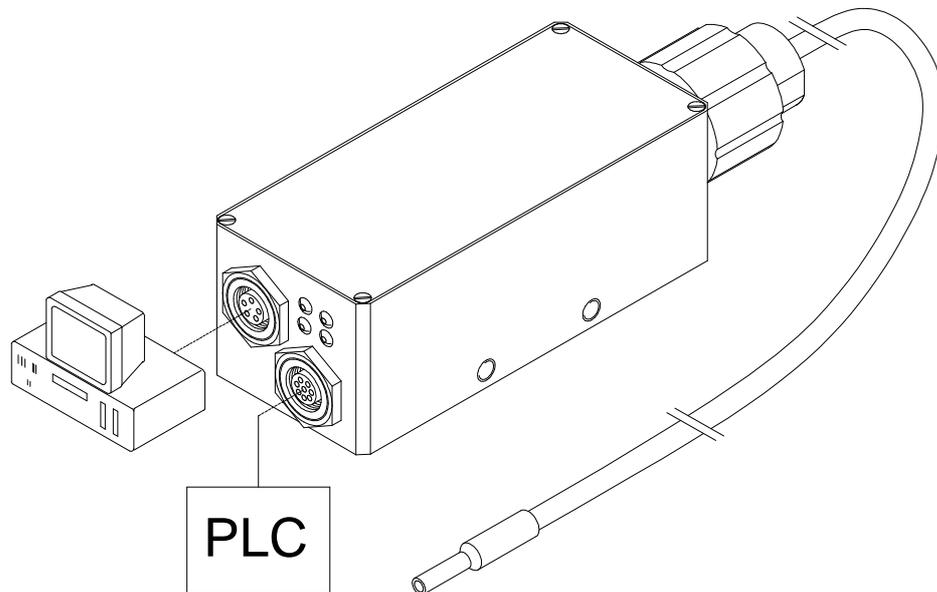


Manual

Software COLOR3-ACL-Scope V1.0

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

for color sensors of SI-COLO3-LWL-ACL Series



This manual describes the installation of the PC software for the SI-COLO3-LWL-ACL 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-LWL-ACL color sensor detects the radiation emanating from a light source. An integrated 3-fold receiver for the RED, GREEN, and BLUE content of the light given off by the light source is employed as a receiver.

The SI-COLO3-LWL-ACL operates with an internal integrator that collects the quantity of light of the light source over a certain time (exposure time). This exposure time can be set with the PC software. The sensor therefore also works with extremely strong or weak light sources.

The SI-COLO3-LWL-ACL color sensor can be "taught" up to 15 colors; 3 different color-detection modes and 3 contrast-detection modes for the respective primary color are available for selection. Evaluation always 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.

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

1 Installation of the COLOR3-ACL-Scope software

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

- IBM PC AT or compatible
- VGA graphics
- Microsoft® Windows® XP, 2000, NT® 4.0, Me, 98, 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-ACL-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:

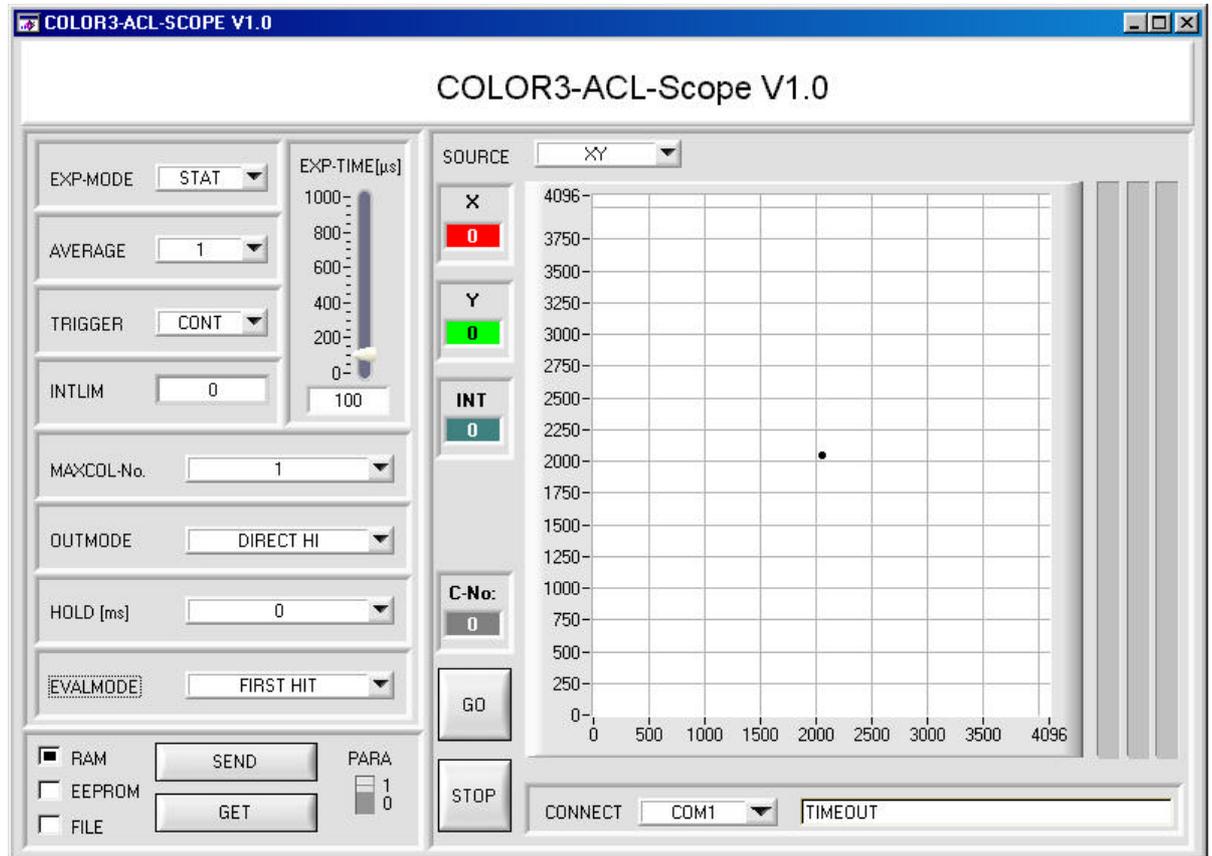
1. The software can be installed directly from the installation CD-ROM. To install the software, start the SETUP program in the INSTALL folder of the CD-ROM.
2. The installation program displays a dialog and suggests to install the software in the C:\COL3V10 directory on the hard disk. You may accept 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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VGA™ is a trademark of the International Business Machines Corp.

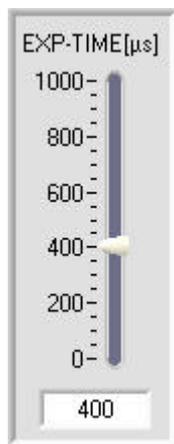
2 Installation of the COLOR3-ACL-Scope software

Please read this chapter first before you start to adjust and parameterise the SI-COLO3-LWL-ACL color sensor. **Pressing the right mouse button on an individual element will call up a short help text.**

When the COLOR3-ACL-Scope software is started, the following window appears on the Windows interface:



Functions of the individual COLOR3-ACL-Scope control elements:



EXP-TIME:

With this slider, the exposure time for the internal integrator can be adjusted. The higher the chosen exposure time, the longer the integrator is exposed to the external illumination, i.e. INT increases. The EXPOSURE TIME should be selected in a way that the three bars RED, GREEN, BLUE are lying in the dynamic range.

EXP-MODE

EXP-MODE:

In this function field the operating mode of the exposure time can be set.

STAT:

Exposure time is constantly kept at the EXP-TIME[μs] value.

DYN:

Exposure time is automatically and dynamically controlled by way of the quantity of light given off by the object..

ATTENTION!

The setting of the EXP-TIME[μs] slider has no effect in this operating mode.

AVERAGE

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

TRIGGER:

This function field serves for setting the trigger mode at the SI-COLO3-LWL-ACL color sensor.

TRIGGER

EXT:

Color detection is started through the external trigger input (IN0 pin3 green of 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

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.

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-COLO3-LWL-ACL color sensor.

The numerical value set here refers to the number of rows (starting with row 0) in the color table.

(→ COLOR TEACH TABLE).



OUTMODE

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 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 table, this color in the color teachtable 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. If the current color does not correspond with any of the teach-in colors, all digital outputs are set to LOW (no LED is lighting).

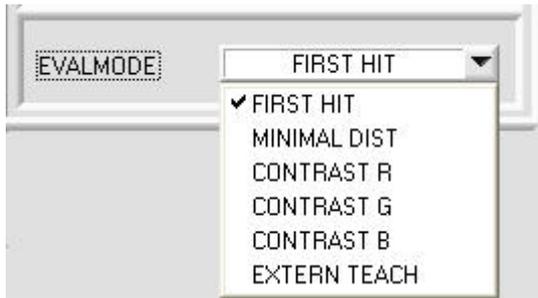
If DIRECT LO is activated, the specially digital output is set to LO, while the other ones are set to HI. If the current color does not correspond with any of the teach-in colors, all digital outputs are set to HIGH (all LEDs are lighting).



HOLD [ms]

HOLD:

The SI-COLO3-LWL-ACL 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-LWL-ACL color sensor pulse lengthening of up to 100 ms can be set by selecting the corresponding HOLD value.



EVALMODE:

This function field serves for setting the evaluation mode at the SI-COLO3-LWL-ACL 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-COLO3-LWL-ACL 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).

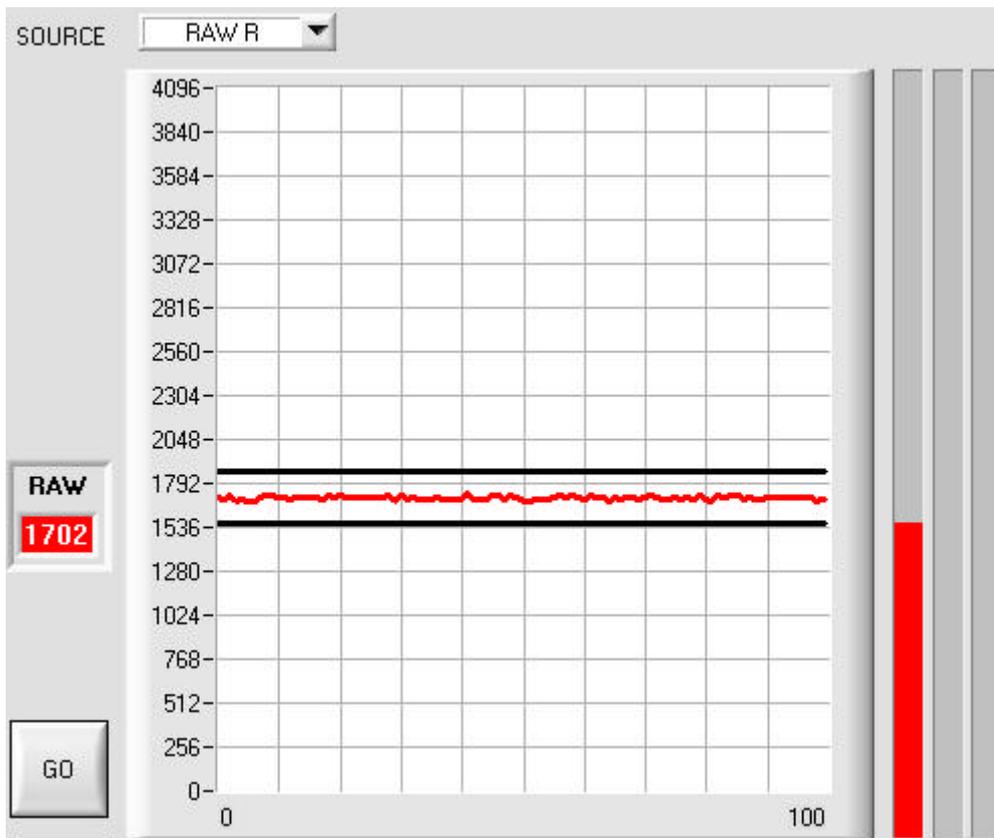
EVALMODE

No.	COLOR TEACH TABLE					
	UL	LL				
0	1860	1560	1	1	1	
1	1	1	1	1	1	
2	1	1	1	1	1	
3	1	1	1	1	1	
4	1	1	1	1	1	

CONTRAST R:
CONTRAST G:
CONTRAST B:

If one of these three function fields is selected, contrast evaluation is activated at the SI-COLO3-LWL-ACL 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 very high switching frequency can be maintained.



The upper limit (in graph = 1860) and the lower limit (in graph = 1560) 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

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”.

EVALMODE

Select how many colors you wish to teach externally.

MAXCOL-No.

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

PARA
 1
 0

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

(CTO = COLOR tolerance ITO = INTENSITY tolerance)

No.	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	

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.

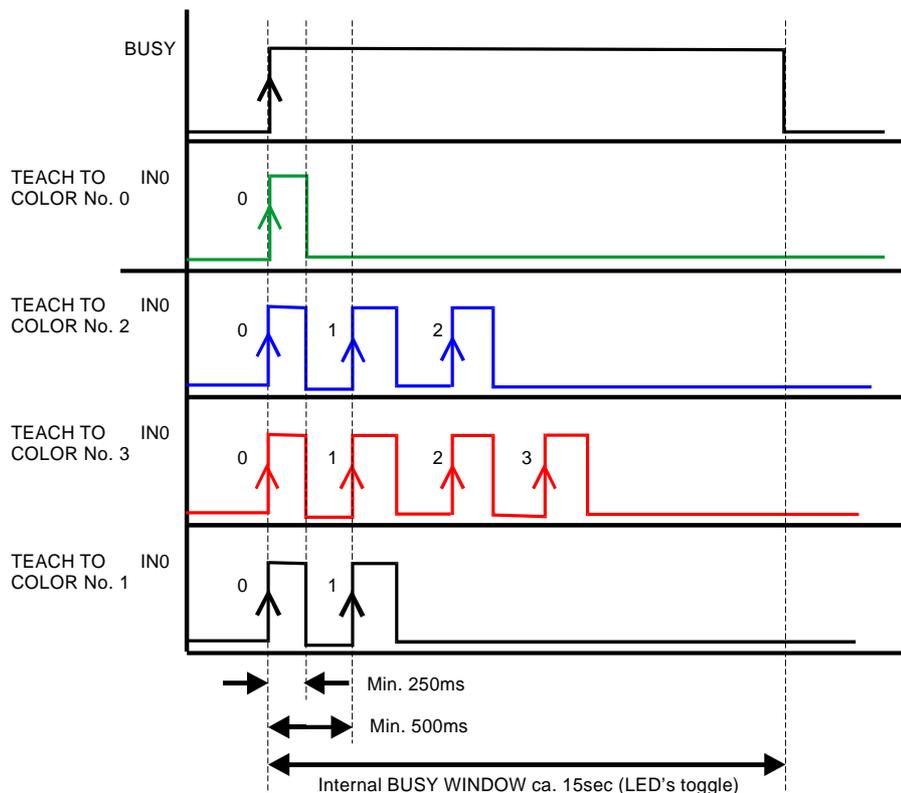
INFO: Of course the taught colours can be viewed at any time with the PC.

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





MEM :

This group of buttons controls parameter exchange between PC and SI-COLO3-LWL-ACL color sensor through the serial RS232 interface.



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.	X	Y	CTO	INT	ITO	
0	1397	1439	100	2909	50	
1	1955	841	100	1122	50	
2	1466	1130	100	2841	50	
3	1513	1712	100	1974	50	
4	1834	1340	100	1266	50	
5	1049	1031	100	614	50	
6	1638	1626	100	2066	50	
7	1179	1488	100	1536	50	
8	2263	907	100	1067	50	
9	1358	1762	100	822	50	
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 keybutton 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-LWL-ACL 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)

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

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

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

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.

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

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.

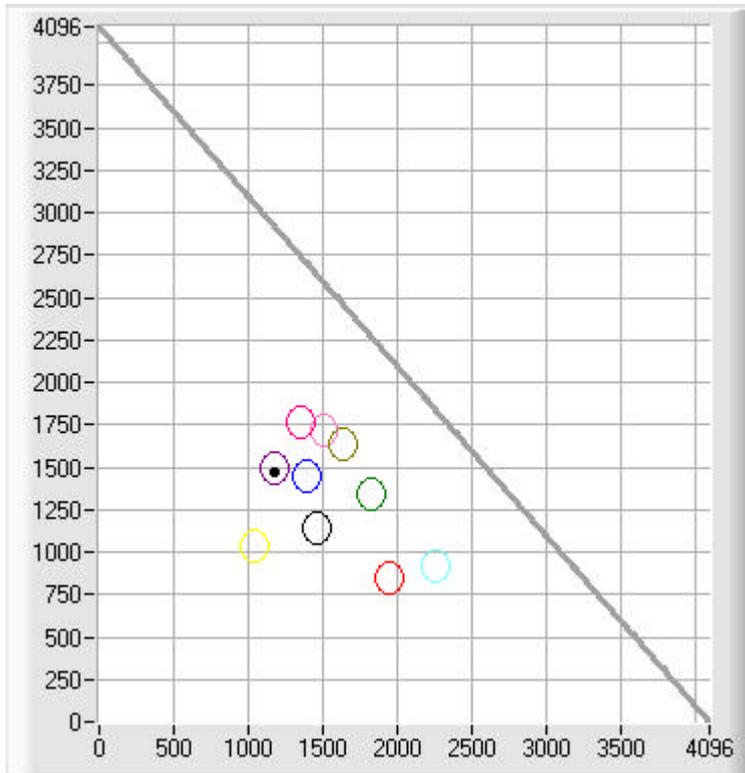
TEACH DATA TO:

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 below shows 10 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. 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 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

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

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-COLO3-LWL-ACL 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-COLO3-LWL-ACL 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-COLO3-LWL-ACL color sensors, or they are read from the RAM, **i.e. these parameters are lost when the voltage at the SI-COLO3-LWL-ACL color sensor is switched off.**

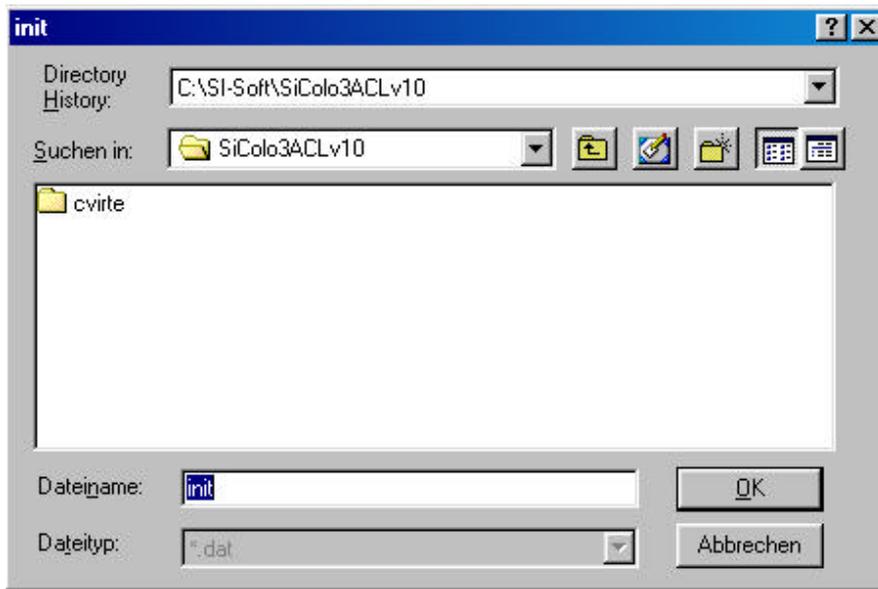
EEPROM: The current parameters are written into the non-volatile memory of the EEPROM in the SI-COLO3-LWL-ACL color sensor, or they are read from the EEPROM, **i.e. the parameters in the internal EEPROM are stored when the voltage at the SI-COLO3 sensor is switched off.**

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-COLO3-LWL-ACL 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 displayed 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-COLO3-LWL-ACL 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:
$$X = \frac{R}{R + G + B} * 4095$$



Y:

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

Formula for calculation:
$$Y = \frac{G}{R + G + B} * 4095$$



INT:

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

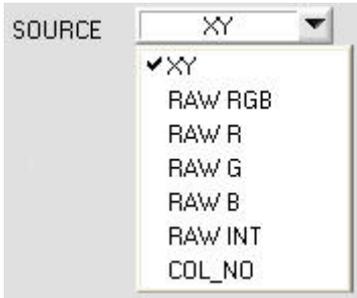
Formula for calculation:
$$INT = \frac{R + G + B}{3}$$



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-COLO3-LWL-ACL color sensor is active (POLL button pressed).

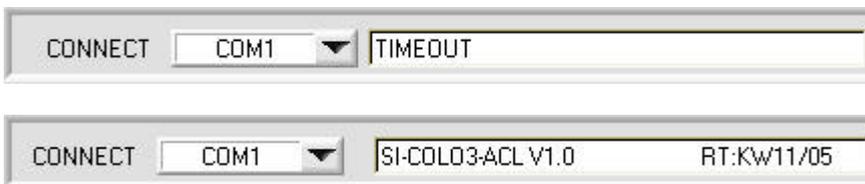


SOURCE:

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 COLOR3-ACL-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-COLO3-LWL-ACL color sensor through the respective selected interface.
- SI-COLO3 V1.0 RT:KW48/04 The connection between PC and SI-COLO3-LWL-ACL color sensor could be established successfully.
- TIMEOUT: A connection between SI-COLO3-LWL-ACL color sensor and PC could not be established, or the connection is faulty. **In this case it should first be checked whether the SI-COLO3-LWL-ACL 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 [↓] 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 („SI-COLO3-ACL V1.0 RT:KW11/05“ status message after program start) is a basic prerequisite for measured value transfer from the PC to the SI-COLO3-LWL-ACL 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.

ATTENTION !

For maintaining maximum switching frequency at the SI-COLO3-LWL-ACL color sensor data communication with the PC must be stopped (press the STOP button).

2.1 COLOR3-ACL-Scope software as an aid for sensor adjustment

ATTENTION! By using the SI-COLO3-LWL-... color sensor, there should be a working distance of approx. 2 ... 10mm between the optical fiber head-end and the measuring object.

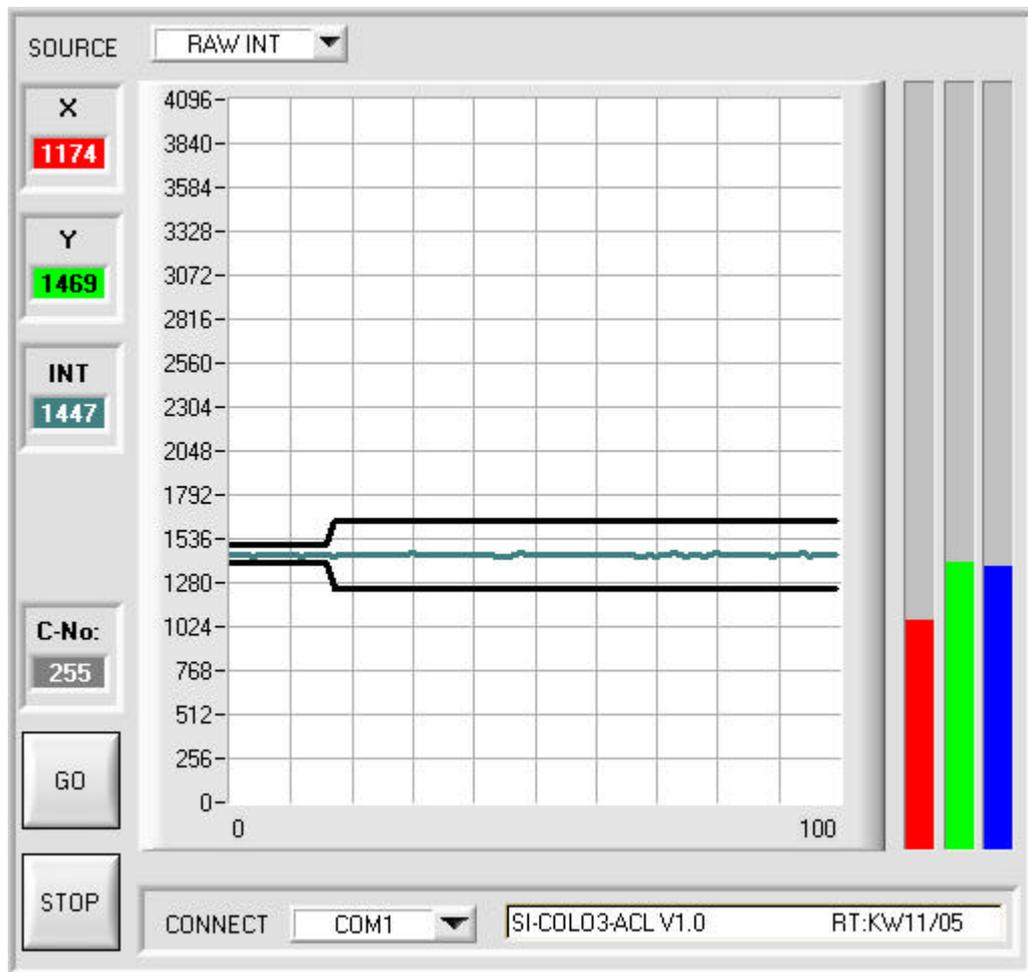
Fine adjustment of the SI-COLO3-LWL-ACL color sensor is facilitated by the graphic display of the analog signals (raw signals from the triple receiver diode). First of all measurement data transfer from the SI-COLO3-LWL-ACL color sensor to the PC must be activated by clicking on the GO button.



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-COLO3-LWL-ACL 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-LWL-ACL 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 exposure time is correctly set.

For this purpose the exposure mode is set to STAT (static) in the EXP-MODE function field, and the EXP-TIME[μs] 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:

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



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

2.2 COLOR3-ACL-Scope software as an aid for teach-in

The SI-COLO3-LWL-ACL 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 $EXP-TIME[\mu s]$).

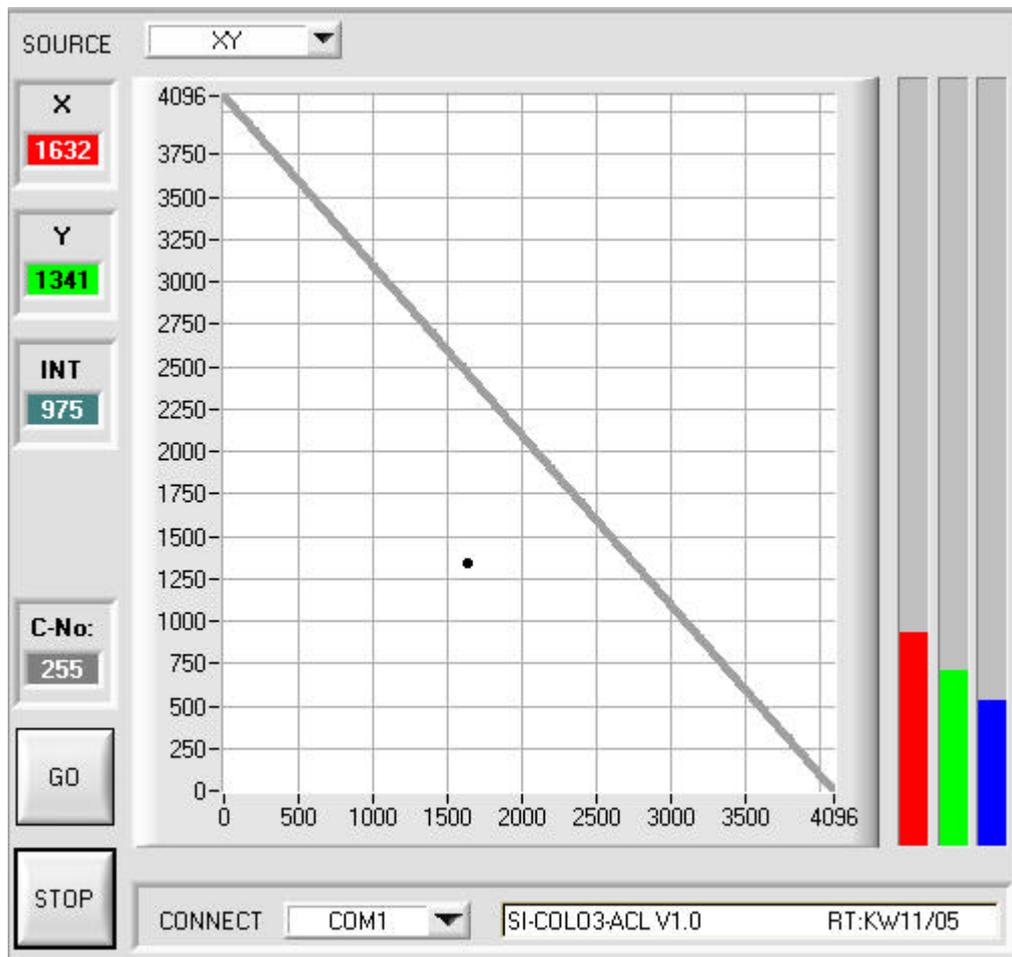


First the trigger mode should be set to CONT, which means that color detection is continuously active, also without external triggering.

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.



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.:

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.



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-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	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

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.

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

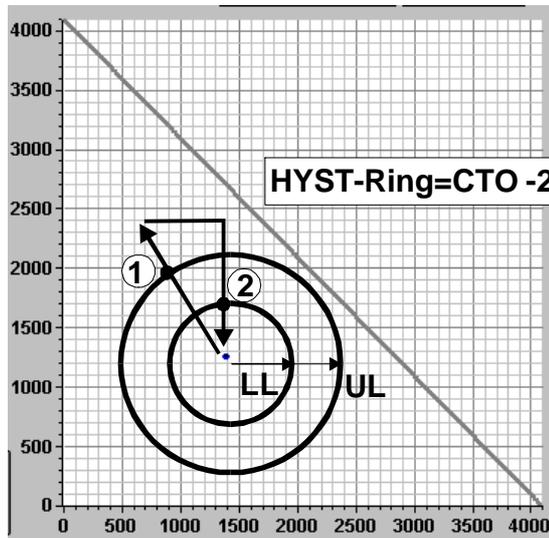
When suitable parameters for the respective color detection have been established by observing the signal characteristics, the current parameters must be written to the non-volatile EEPROM memory of the SI-COLO3-LWL-ACL color sensor by clicking on the SEND button.


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-ACL-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-LWL-ACL color sensor. The SI-COLO3-LWL-ACL color sensor then performs the measuring task in STAND-ALONE operation.

2.3 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: $HYST-RING = CTO - 2$.

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 value (X,Y value pair) enters the tolerance circle again, the teach-in color is only detected again when the value drops below the HYST-RING 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.

2.4 Contrast detection with SI-COLO3-LWL-ACL color sensor

In addition to the color evaluation modes the SI-COLO3-LWL-ACL color sensor also features a contrast evaluation mode, in this mode the color sensor operates with a switching frequency of up to 28 kHz.

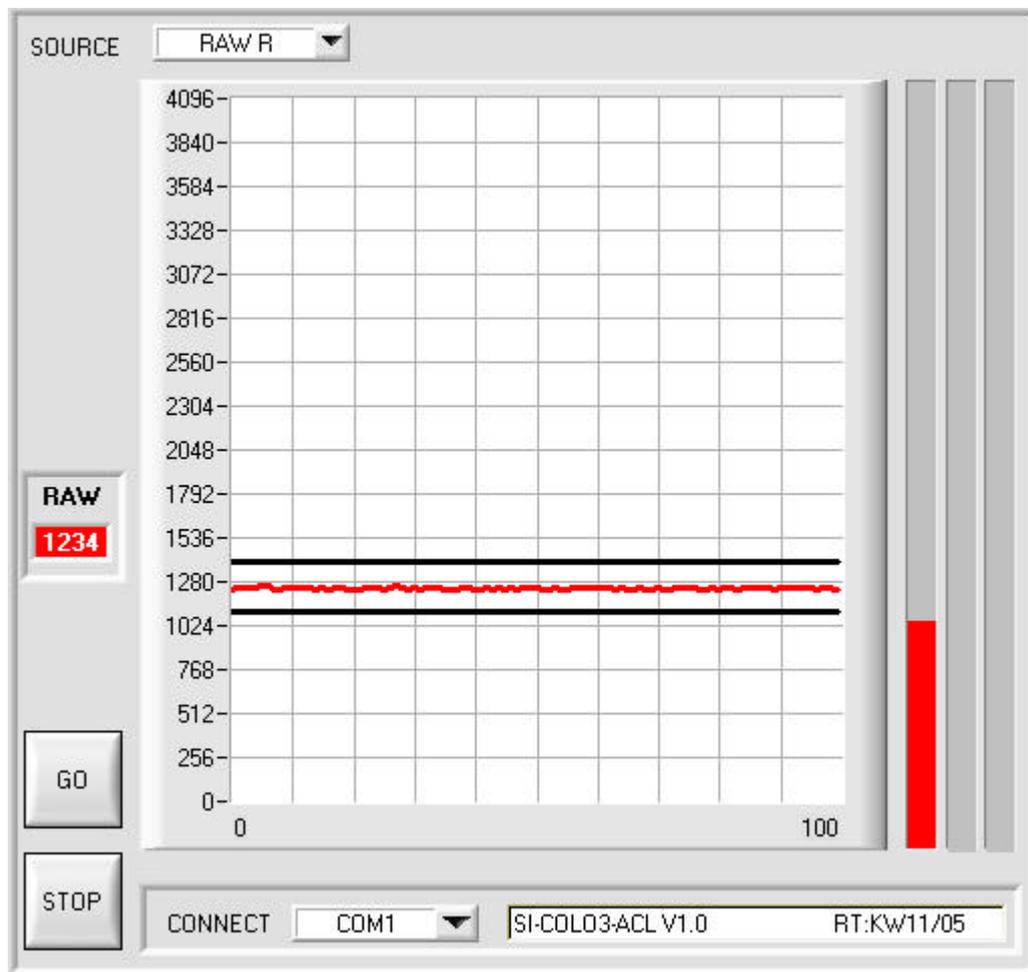
EXP-MODE

For contrast detection EXP-MODE must be set to static with EXP-MODE=STAT, i.e. the exposure time constantly keeps the value set by the operator with the EXP-TIME[μs] slide switch. The exposure time should be set such that the light intensity give off by the target approximately lies at the center of the dynamic range for the respective primary color.

EVALMODE

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-COLO3-LWL-ACL 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	1860	1560	1	1	1	
1	1	1	1	1	1	
2	1	1	1	1	1	
3	1	1	1	1	1	
4	1	1	1	1	1	

Next the setpoint value for the upper tolerance limit (UL=1860) and the lower tolerance limit (LL=1560) 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!

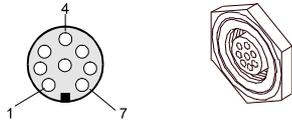


Finally the new evaluation parameters must be activated in the SI-COLO3-LWL-ACL color sensor by clicking on the SEND button.

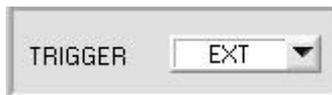
Evaluation:

- 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)

2.5 External triggering of the SI-COLO3-LWL-ACL color sensor



External triggering is performed through pin no. 3 (grn) at the 8-pin socket of the SI-COLO3/PLC connection.



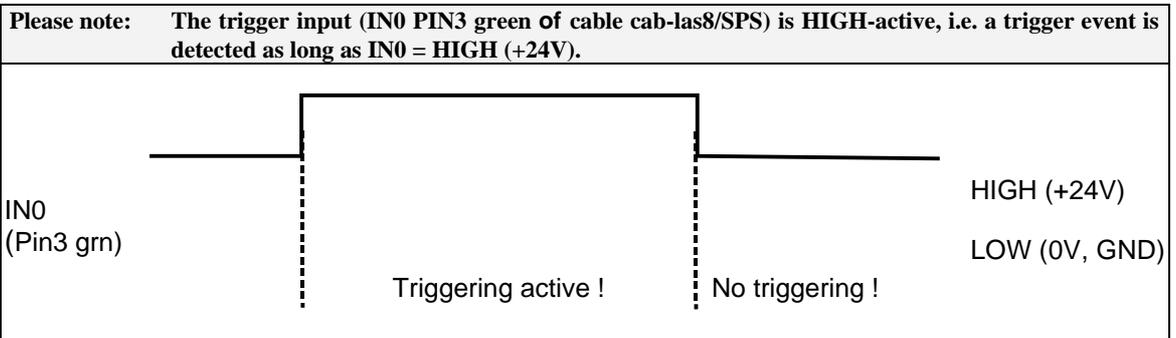
EXT:

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:

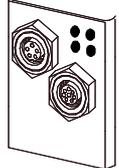
The new setting is only activated at the SI-COLO3-LWL-ACL control unit after a click on the SEND button!

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



2.6. Function of the LEDs

LED display (4 yellow LEDs):



BINARY

The color code is visualised by way of 4 yellow LEDs at the housing of the SI-COLO3-LWL-ACL 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 OUT4 of the 8-pin SI-COLO3/PLC socket.

The SI-COLO3-LWL-ACL 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).

0	1	2	3	4	15 Error
5	6	7	8	9	

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).

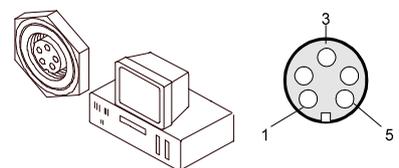
0	1	DIRECT HI
2	3	

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).

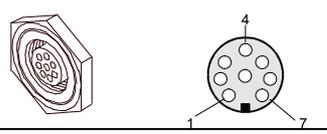
0	1	DIRECT LO
2	3	

2.7 Connector assignment of the SI-COLO3-LWL-ACL color sensor

Connection of SI-COLO3-LWL-ACL to PC:

5-pin female connector (type Binder 712) SI-COLO3-LWL-ACL / PC-RS232		
Pin No.:		Assignment:
1		0V (GND)
2		TX0
3		RX0
4		n.c.
5		n.c.

Connection of SI-COLO3-LWL-ACL to PLC:

8-pin female connector (type Binder 712) SI-COLO3-LWL-ACL / PLC		
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.

2.8 RS232 communication protocol

RS232 communication protocol PC \hat{U} SI-COLO3-LWL-ACL Sensor (COLOR3-ACL-Scope V1.0)
<ul style="list-style-type: none"> - 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. <p>The control device (PC or PLC) has to send a data frame of 92 words to the SI-COLO3 hardware. All bytes must be transmitted in binary format (us, MSB). The meaning of the parameters is described in the software manual COLOR3-ACL-Scope.</p> <p>Info: 1 word = 2 bytes</p> <p><u>Method:</u></p> <p>The SI-COLO3 hardware is permanently reading (polling) the incoming byte at the RS232 connection. If the incoming word = 0x0055 (synch-word), then the 2. word (order-word) is read in, after this, 15 words (parameters) and 15 teach vectors (a 5 words) will be read.</p> <p>After reading in the completely data frame, the SI-COLO3 hardware executes the order which is coded at the 2. word (order-word).</p>

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	parameter EXP-TIME	LED intensity (0 ... 1000) Attention intensity in thousandth!
4	Word	parameter EXP-MODE	LED mode STAT, DYN (0, 1)
5	Word	parameter AVERAGE	Signal averaging 1,2,4,8,16,32,64,128,256,512,1024,2048,4096,8192,16384 or 32768
6	Word	parameter EVAL MODE	Evaluation mode FIRST HIT, MINIMAL DIST, CONTRAST R, CONTRAST G, CONTRAST B, EXT TEACH, coded to (0,1,2,3,4,5)
7	Word	parameter HOLD[ms]	Hold time 0,1,2,3,5,10,50 or 100ms coded to (0,1,2,3,5,10,50 or 100)
8	Word	parameter INTLIM	Lower intensity limit (0 ... 4095)
9	Word	parameter MAXCOL-No.	Number of the colours (1,2,3,3,4,5,6,7,8,9,10,11,12,13,14,15)
10	Word	parameter OUTMODE	Function of the digital output (0=direct/HI, 1=binary, 2=direct/LO)
11	Word	parameter TRIGGER	Trigger mode CONT or EXT (0 or 1)
12 ... 17	Word	free	Must be sent as dummy (e.g. 6x value 0)
18 ... 92	Word	15 teach-vectors with each 5 words	Teach-vector 5-byte-format: X, Y, CTO, INT, ITO; value range of each parameter from 1 to 4095

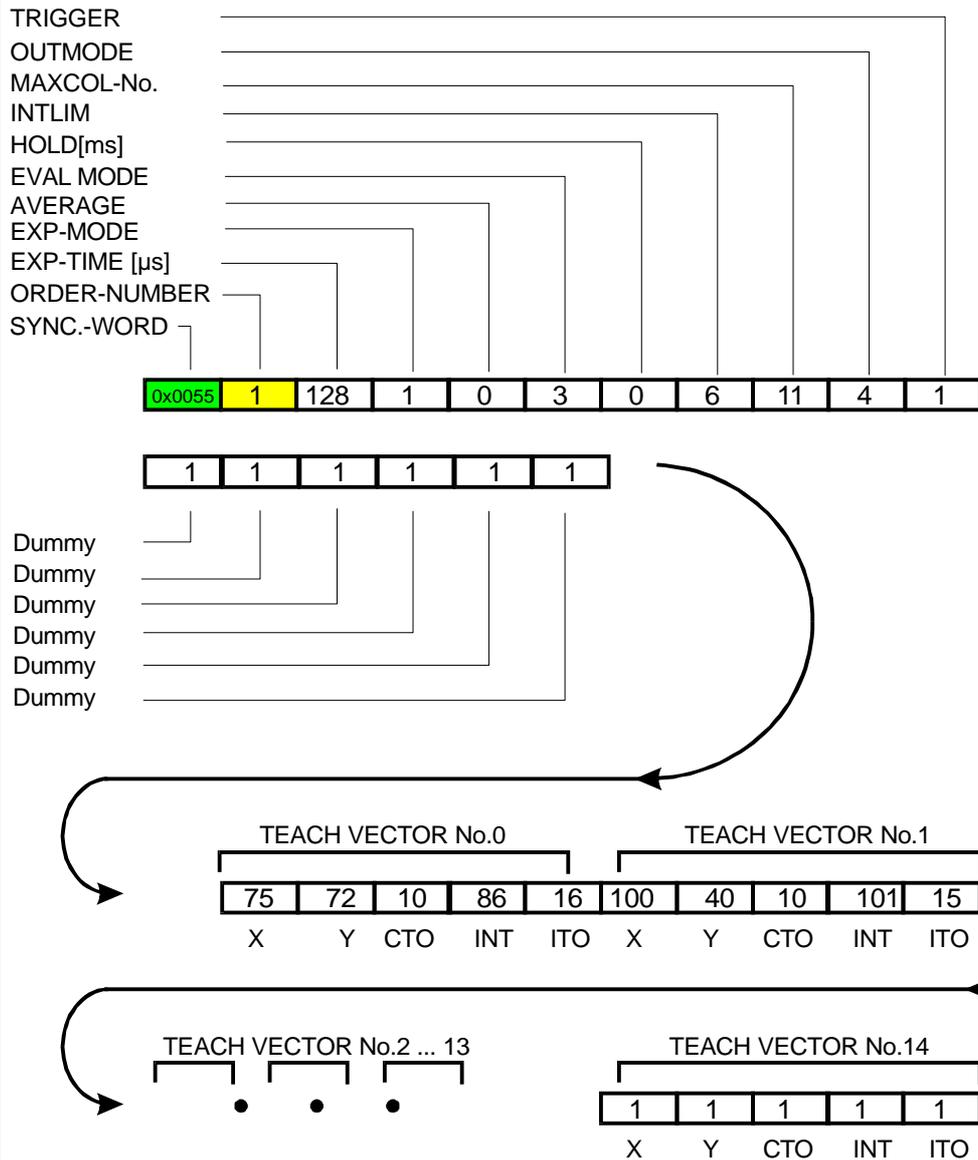
Value	ORDER NUMBER (parameter byte no. 2)	
0	nop	no operation
1	Save parameter from PC into RAM	volatile: 92 words PC \Rightarrow SI-COLO3
2	Save parameter from PC into RAM + EEPROM	nonvolatile: 92 words PC \Rightarrow SI-COLO3
3	Send parameter from RAM to PC	90 words binary SI-COLO3 \Rightarrow PC
4	Send parameter from EEPROM to RAM + to PC	90 words binary SI-COLO3 \Rightarrow PC
5	Send data from RAM to PC (R,G,B,X,Y,INT,COL)	7 words binary SI-COLO3 \Rightarrow PC
6	nop	no operation
7	Send connection OK to PC	48 words binary SI-COLO3 \Rightarrow PC
20	Send line ok = 0x0055, 0x0014, 0x00AA to PC	3 words binary SI-COLO3 \Rightarrow PC

Example 1: DATA FRAME with ORDER NUMBER = 1:

ORDER NUMBER (second word = 1): **WRITE** parameters from PC into RAM of the **SI-COLO3!**

The completely data frame = 92 words must be sent to the SI-COLO3 hardware in binary form (sync-word / order-word / 15 parameter words / 15 x 5 words teach-vectors).

Fill unused words of the TEACH VECTOR by value word=1 in binary form.

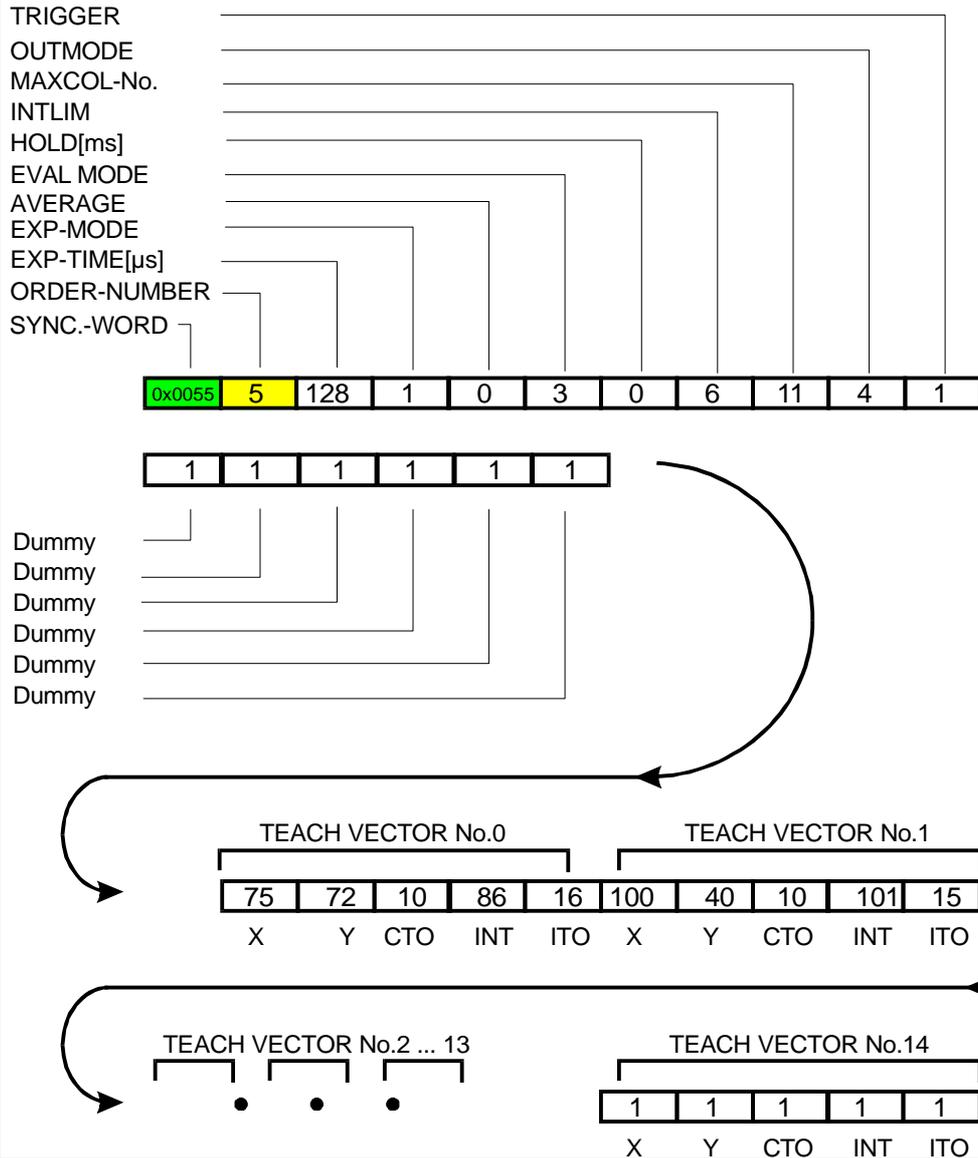


Example 2: DATA FRAME with ORDER NUMBER = 5:

ORDER NUMBER (second word = 5): **READ SI-COLO3 RAW DATA**

DATA FRAME PC → SI-COLO3 (92 WORDS)

Parameters and teach-vectors must be sent for a constant parameter frame as dummies.
At order word 5 they do not affect the RAM or EEPROM.



Example 3: DATA FRAME with ORDER NUMBER = 3:

ORDER NUMBER (second word = 3): **READ** parameters out of SI-COLO3 RAM memory!

The completely DATA FRAME which is responded by the SI-COLO3 hardware is **90 words** long:

DATA FRAME PC → SI-COLO3 (92 WORDS)

The same frame as example 2 must be sent to the SI-COLO3 hardware except of the order word that must be 3.

DATA FRAME SI-COLO3 → PC (90 WORDS)

