

# Manual

## Software L-LAS-TB-Scope V4.0

(PC software for Microsoft® Windows 8, Windows 7, Vista, XP)

**for laser line sensors of the L-LAS-TB series**



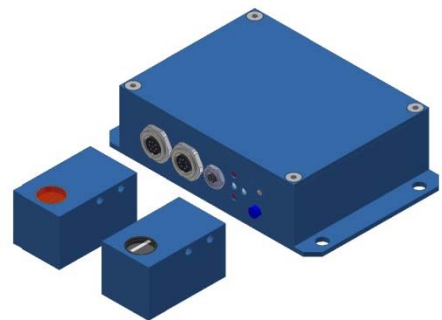
**Split version:**

L-LAS-TB-6-CL  
L-LAS-TB-16-CL  
L-LAS-TB-28-CL  
L-LAS-TB-50-CL  
L-LAS-TB-75-CL  
L-LAS-TB-100-CL



**Fork type version:**

L-LAS-TB-F-(6)-20/40-CL  
L-LAS-TB-F-(6)-40/40-CL  
L-LAS-TB-F-(16)-40/40-CL  
L-LAS-TB-F-(16)-100/100-CL



**Split version with separate  
electronic control unit**

L-LAS-TB-6-CON1  
L-LAS-TB-8-CON1

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# 1 Functional principle: L-LAS-TB line sensor

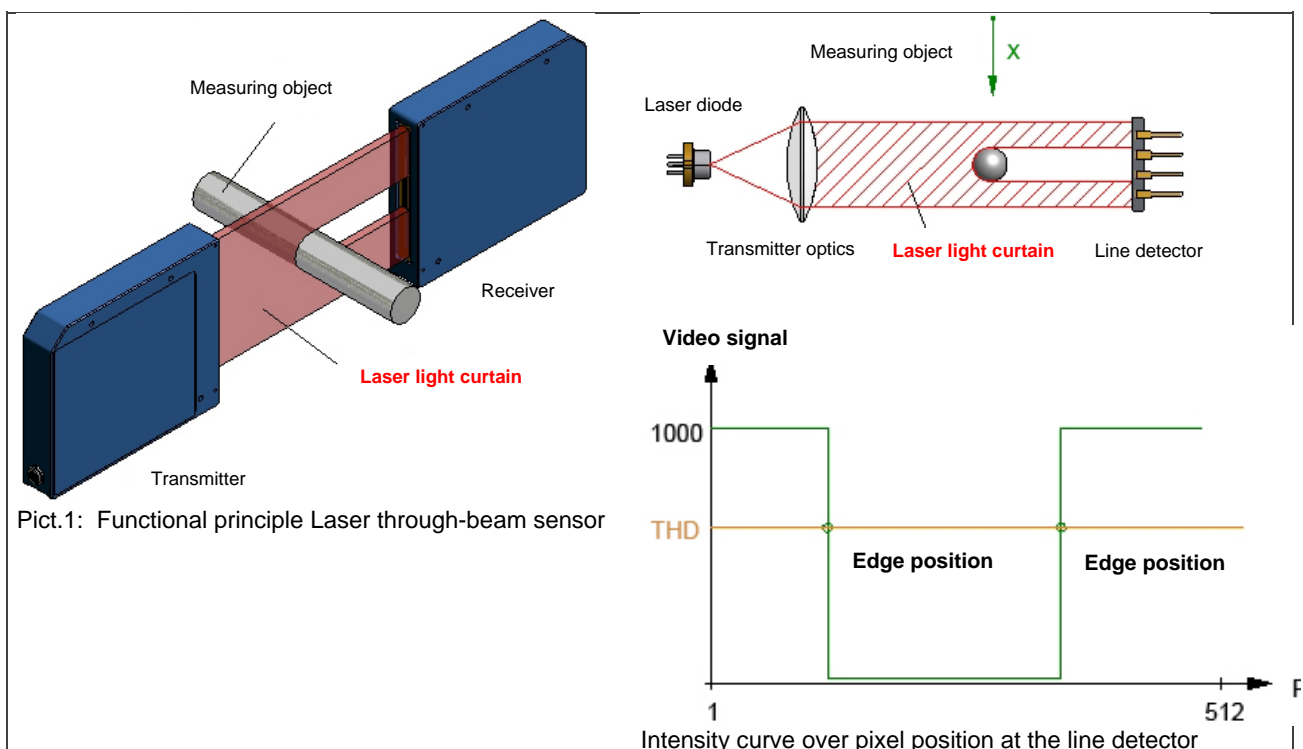
## 1.1 Technical description

In the laser line sensors of the L-LAS-TB series the laser beam of a laser diode ( $\lambda=670\text{nm}$ ,  $0,4\text{mW}$  max. opt. power, laser class 1) through suitable collimators and apertures is emitted from the optical transmitter unit as a laser line, i.e. as parallel laser light with homogeneous light distribution. In the optical receiver unit the laser line impinges on a CMOS line receiver. This CMOS line comprises many closely adjacent individual receiver elements (pixels) that are arranged in a line. The light quantity of each of these receiver elements that is collected during the integration time can be separately read out as an analog voltage (video signal) and, after performing analog digital conversion, can be stored in a data field as a digital value.

When there is a non-transparent measuring object in the laser line, the parallel laser light only illuminates those receiver elements (pixels) of the line that lie outside the shadow zone of the measuring object. As a result the pixels within the shadow zone give off a considerably lower analog voltage compared to the illuminated pixels (cf. pict. 1). By way of suitable software algorithms the areas of the shadow zones can be determined from the previously stored data field. Since the distance of the pixels on the line detector is known, the size and position of the measuring object can therefore be determined. The micro-controller of the L-LAS-TB sensor can be parameterized through the serial RS232 interface by means of a Windows PC software. The sensor can be set to operate with different evaluation modes. The housing of the control unit features a TEACH/RESET button [1] and a potentiometer for tolerance setting. Switching states are visualized by means of four LEDs (1x green, 1x yellow, and 2x red) that are integrated in the housing of the L-LAS-sensor. The L-LAS-TB control unit has three digital outputs [2] (OUT0, OUT1, OUT2), the output polarity of which can be set with the software. Two digital inputs (IN0, IN1) make it possible to realize an external TEACH/RESET functionality and an external TRIGGER functionality through a PLC. In addition the control unit features a high-speed analog output ( $0 \dots 10\text{V}$ ) with 12-bit digital/analog resolution.

[1] not available with all models of L-LAS-TB Series

[2] L-LAS-TB-CL Series has two digital outputs (OUT0, OUT1)







## 2 Installation of the *L-LAS-TB-Scope* software


Hardware requirements for successful installation of the *L-LAS-TB-Scope* software:

- 1GHz Pentium-compatible processor or better.
- CD-ROM or DVD-ROM drive
- Approx. 40 MByte of free hard disk space
- SVGA graphics card with at least 800x600 pixel resolution and 256 colors or better.
- Windows® XP, Windows® Vista, Windows® 7 or Windows® 8 operating system
- Free serial RS232 interface or USB port with USB-RS/232 adaptor at the PC

Please install the *L-LAS-TB-Scope* software as described below:

1.	 CD-Laufwerk (D:)	Insert the installation CD-ROM in your CD-ROM drive. In our example we suppose that this is drive "D".
2.		<p>Start the Windows Explorer and in the folder tree of your CD-ROM drive go to the installation folder D:\Install\ .</p> <p>Then start the installation program by double-clicking on the SETUP.EXE symbol.</p> <p>As an alternative, software installation can also be started by clicking on <b>START-Run...</b> and then entering "D:\Install\setup.exe", which must be confirmed by pressing the <b>OK</b> button.</p>
3.		During the installation process a new program group for the software is created in the Windows Program Manager. In this program group an icon for starting the software is created automatically. When installation is successfully completed the installation program displays a "Setup OK" message.
4.		<p>The <i>L-LAS-TB-Scope</i> software can now be started by clicking on the respective icon in the newly created program group under:</p> <p>Start &gt;All Programs &gt; L-LAS-TB –ScopeV4.0</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  L-LAS-TB-ScopeV400nn   L-LAS-TB-ScopeV400nn       </div>

Uninstalling the L-LAS-TB-Scope software:

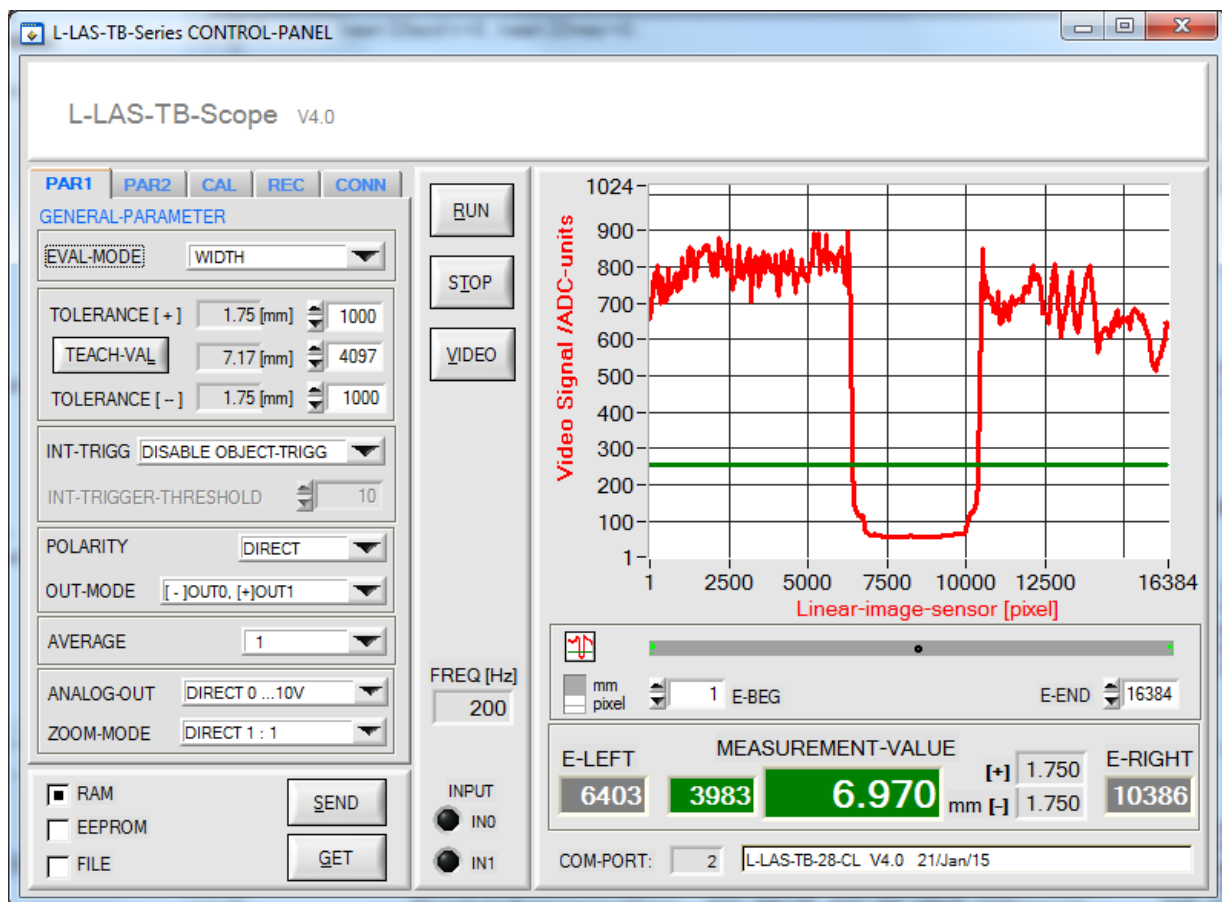
 <div style="background-color: #e0f0ff; padding: 5px; display: inline-block;"> <b>Programme und Funktionen</b> </div>	<p>Please use the Windows uninstall tool to remove the software.</p> <p>The Windows uninstall tool can be found under Start / Settings / Control Panel.</p>
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### 3 Operation of the *L-LAS-TB-Scope* software

The *L-LAS-TB-Scope* software is used for parameterizing the electronic control unit used for controlling the *L-LAS* line sensors. The measured values provided by the sensor can be visualized with the PC software, which means that the software among others can be used for adjustment purposes and for setting suitable tolerance limits for the inspection of the measuring object.

Data exchange between the PC user interface and the sensor system is effected through a standard RS232 interface. For this purpose the sensor is connected to the PC with the serial interface cable cab-las-4/PC. When parameterization is finished, the setting values can be permanently saved in an EEPROM memory of the *L-LAS-TB control unit*. The sensor system then continues to operate in "STAND-ALONE" mode without the PC.

When the *L-LAS-TB-Scope* software is started, the following Windows® user interface will be displayed:



The *L-LAS-TB-Scope* CONTROL PANEL provides a great variety of functions:

- Visualization of measurement data in numeric and graphic output fields.
- Setting of the laser power for the laser transmitter.
- Setting of the polarity of the digital switching outputs OUT0, OUT1, and OUT2. [1]
- [1] CL series offers only two digital outputs OUT0, OUT1
- Selection of a suitable evaluation mode.
- Presetting of setpoint value and tolerance band.
- Saving of parameters to the RAM, EEPROM memory of the control unit, or to a configuration file on the hard disk of the PC.

**The following chapters provide explanations of the individual control elements of the *L-LAS-TB-Scope* software.**

### 3.1 Control elements of the L-LAS-TB-Scope software:

#### Tab PAR1:

A click on PAR1 opens the PARAMETER-1 window, where various general parameters at the control unit can be set.



Attention !



**Changes that are made in the function fields described below only become active at the control unit of the L-LAS-TB sensor after a click on the SEND button!**

#### EVAL-MODE:

This list selection field serves for setting the evaluation mode at the L-LAS-TB sensor. Depending on the evaluation mode that is currently set, the edges created from the video signal (intensity profile) of the CMOS line will be assessed differently.

#### L-EDGE:

The 1st edge (left edge) of the CMOS line's intensity profile is used as measurement value, starting from the first pixel.

#### R-EDGE:

The 1st edge starting from the last pixel (right edge) of the CMOS line's intensity profile is used as measurement value.

#### WIDTH:

The difference between the last (right) edge and the first (left) edge is used as measurement value:  $WIDTH = R-EDGE - L-EDGE$

#### CENTER:

The mean value of the first edge and the last edge is used as measurement value:  $CENTER = (L-EDGE + R-EDGE) / 2$

If there are more than 2 edges in evaluation mode WIDTH or CENTER, the outer edges will be used for calculation.

TOLERANCE [ + ]	1.75 [mm]	1000
TEACH-VAL	7.17 [mm]	4097
TOLERANCE [ - ]	1.75 [mm]	1000

#### **TOLERANCE-HIGH[+], TOLERANCE-LOW [-]:**

In these input fields an upper and lower tolerance value for the tolerance window can be set by entering a numerical value or by clicking on the arrows. The tolerance window is applied symmetrically around the setpoint value (TEACH-VALUE) and is framed by the upper and lower tolerance threshold.

The tolerance values in [mm] that are currently set at the *L-LAS-TB sensor* are shown beside the pixel input elements. The [mm] values are calculated from the SLOPE-VALUE (pixel distance at the line sensor) by way of multiplication with the pixel default values:

e.g.  $SLOPE = 1.75 \mu\text{m/pixel}$   
 $TOL[\mu\text{m}] = SLOPE[\mu\text{m/pixel}] * TOL[\text{pixel}]$

INT-TRIGG	DISABLE OBJECT-TRIGG
INT-TRIGG	<input checked="" type="checkbox"/> DISABLE OBJECT-TRIGG <input type="checkbox"/> ENABLE DARK-PIX-TRIGG <input type="checkbox"/> ENABLE LIGHT-PIX-TRIGG <input type="checkbox"/> ENABLE DIRT-PART-TRIGG

#### **INT-TRIGG:**

In this list field internal object triggering can be activated or deactivated. Internal object triggering detects objects in the beam path on the basis of dark pixels. Object triggering is independent of the pixel position. The trigger threshold can be specified with the INT-TRIGGER-DARK-PIXEL parameter. The internal trigger is activated when the number of dark pixels exceeds this value. The trigger event is provided at digital output OUT0/pin5/gray. When the trigger condition is true, the multi-functional LED at the sensor housing lights up in orange.

#### **DISABLE OBJECT-TRIGG:**

Internal object triggering is deactivated.

#### **ENABLE DARK-PIX-TRIGG:**

Internal object triggering is activated. Pixels with a video intensity below the video threshold are used for triggering.

#### **ENABLE LIGHT-PIX-TRIGG:**

Internal object triggering is activated. Pixels with a video intensity above the video threshold are used for triggering.

#### **ENABLE DIRT-PART-TRIGG:**

Internal object triggering is activated. Pixels with a video intensity below the video threshold are used for triggering.

This mode is used to detect and suppress dirt particles, or to detect inadmissibly high dirt accumulation at the optics.



INT-TRIGGER-THRESHOLD

### INT-TRIGGER-THRESHOLD:

Numeric input field for specifying the trigger threshold for the internal object trigger function.

The trigger condition is true if the number of dark pixels exceeds this threshold.

$if(DARK\_PIX > INT\_TRIGGER\_THRESHOLD) thenTrigger = 1$



The current number of dark pixels is shown in a numeric display field. An orange LED furthermore indicates whether the trigger condition is true.

LED off = no trigger / OUT0/pin5/gray = 0V  
LED orange = trigger / OUT0/pin5/gray = HIGH 24VDC

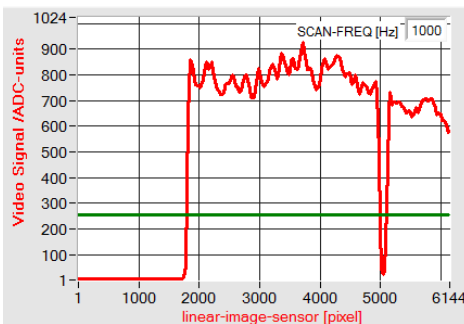
INT-TRIGG

This setting is used to detect dirt particles or dirt accumulation at the optics.

In each case the objective is to activate an error output:

OUT0: DIRT-ACCUMULATION

OUT1: PARTICLE DETECTED



The current number of DARK PIXELS is shown in a numeric display field. A red LED indicates that a dirt particle was detected.

LED off = no trigger / OUT1/pin6/ = 0V

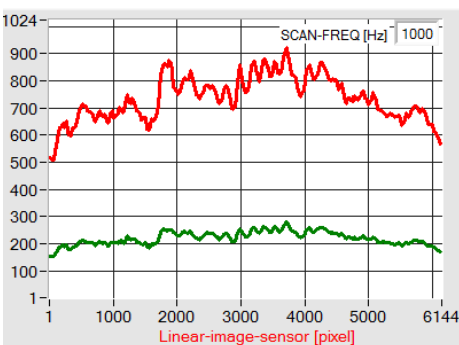
LED on = trigger / OUT1/pin6/ = 24VDC

Video image with darkening by an object (left edge at approx. pixel = 1796). Signal drop due to a particle at pixel = 5000. The actual measurement value, for example at pixel = 1796 = 14.26mm, is correctly provided at the analog output!

OUT1=0  
OUT1=1

MEASUREMENT-VALUE  
1796 14.26 mm

The digital error output will be activated. If necessary, the optics must be checked / cleaned.



The lower threshold for dirt-accumulation-detection is set by specifying an AUTO-VIDEO-THRESHOLD e.g. at 30%.

For this purpose, first set VIDEO-THD-MODE = AUTO, and then set the current lower dirt threshold with the software button REFRESH V-THD. The VIDEO-THD-MODE can then be set back to VIDEO-THD-MODE = FIXED. Use the V-THD slider to set the position of the dirt threshold to e.g. 30%.

LED off = no trigger / OUT0/pin5/ = 0V

LED on = trigger / OUT0/pin5/ = 24VDC

OUT0=1  
OUT1=1

### Dirt accumulation detection:

Integral formation SUM\_Video over the complete video signal (red curve)

Integral formation SUM\_Thd over the taught video threshold (green curve).

$if(SUM\_Video \leq SUM\_Thd) thenTrigger = 1$



POLARITY DIRECT

#### POLARITY:

In this function field the output polarity at the *L-LAS-TB* sensor can be set with a mouse-click on the input field or by clicking on the arrow button. *L-LAS-TB* sensors of the –CL series have 2 digital outputs (OUT0, OUT1), sensors of the standard series have 3 digital outputs (OUT0, OUT1, and OUT2) through which error states can be sent to the PLC.

#### DIRECT:

In case of an error the respective digital output is set to +Ub (+24VDC), (red LED on).

#### INVERSE:

In case of an error the respective digital output is set to the reference potential (GND,0V), (red LED on).

OUT-MODE [TRG]OUT0, OK[OUT1]

[ - ]OUT0, [ + ]OUT1

[ - ]OUT0, [OK]OUT1

[OK]OUT0, [ + ]OUT1

✓ [TRG]OUT0, OK[OUT1]

#### OUTPUT-MODE:

In this function field the functionality of the digital outputs at the *L-LAS-TB-CL* sensors (Compact-Line) can be set by clicking on the input field with the mouse or by clicking on the arrow button. The *L-LAS-TB-CL* sensors have two digital outputs (OUT0 and OUT1). This function is used to set which states (HIGH=[+], LOW= [-] ,GO=[OK], or trigger output [TRG]) are provided at the respective digital output.

AVERAGE 2

#### AVERAGE:

In this function field the averaging at the *L-LAS-TB* sensor can be selected with a mouse-click on the respective list item. With every cycle of the main program the current measurement value is stored in a ring memory field, and then the average of these values in the ring memory field is calculated.

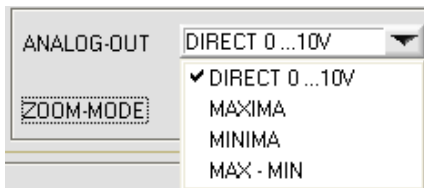
The average of the ring memory field is used as the MEASUREMENT\_VALUE. With the AVERAGE value the size of the ring memory can be set from 1 to 1024. The measurement value determined after averaging is output at the analog output pin8/red/.

Averaging reduces the switching frequency at the *L-LAS-TB* sensor by a factor of 1/AVERAGE.

The current switching frequency is shown in a numeric display element.

FREQ [Hz]

200



### ANALOG-OUT (Analog-Output-Mode):

Function element for selecting the output mode of the analog voltage at the L-LAS sensor (pin8/red 8-pol. PLC/POWER female connector). The analog voltage is output in the range from 0 to 10V with a resolution of 12 bit.

#### DIRECT 0...10V:

A voltage (0 ... 10V) that is proportional to the current measurement value is provided at the analog output pin8/red.

#### MAXIMA:

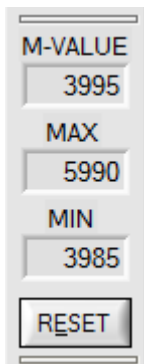
The current maximum value is provided at the analog output pin8/red/ (drag pointer principle, resetting by input IN1/pin4/yellow pulse of <750ms length, or by pressing the TEACH/RESET button).

#### MINIMA:

The current minimum value is provided at the analog output pin8/red/ (drag pointer principle, resetting by input IN1/pin4/yellow pulse of <750ms length, or by pressing the TEACH/RESET button).

#### MAX-MIN:

The current difference between maximum and minimum value is provided at the analog output pin8/red/ (drag pointer principle, resetting by input IN1/pin4/yellow pulse of <750ms length, or by pressing the TEACH/RESET button).



### Reset button (Maximum-Minimum Values):

These display elements only appear after one of the three operating modes MAXIMA, MINIMA, or MAXMIN has been selected and activated in the ANALOG-OUT function field.

A click on the RESET button resets the current maximum and minimum values that are detected by the L-LAS sensor. The numeric display fields show the respective current maximum and minimum value.

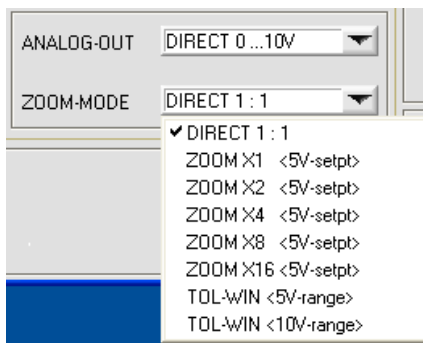
Resetting of the maximum and minimum values also can be triggered by a short pulse (duration  $t < 750$  ms) at digital input IN1/yellow/pin4 from the PLC. The maximum and minimum values also can be reset by pressing the hardware button at the housing of the L-LAS sensor.

#### Please note:

This RESET function does not perform a hardware/software reset at the L-LAS sensor, it only resets the maximum and minimum values at the analog output [0...10V]!



A double-click with the left mouse button on the rectangular function element hides or shows the numeric display fields for M-VALUE, MAX, MIN and the RESET button.



### ZOOM-MODE (Analog-Output):

Function element for setting various zoom modes at the analog output of the *L-LAS-TB* sensor.

#### DIRECT 1:1:

At the analog output pin8/red/ the full measuring range of the sensor is provided as a 0 to +10V voltage swing.

#### ZOOM X1, ZOOM X2 ... ZOOM X16:

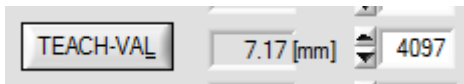
The difference between the current measurement value (pixels) and the teach position (TEACH value in pixels) is provided at the analog output pin8/red/. At the teach position a voltage of +5V is always provided at the analog output. If the current measurement value is lower than the teach position, a voltage < 5V is output, if the current measurement value is higher than the teach value, a voltage > 5V is output. The deviation from the 5V teach position can be amplified with a zoom factor of X2 to X16.

#### TOL-WIN <5V-range>:

A voltage swing of 5V over the current tolerance window is provided at the analog output pin8/red/. At the lower tolerance limit the voltage value is 2.5V, at the upper tolerance limit 7.5V. A voltage of 5V is provided at the teach position.

#### TOL-WIN <10V-range>:

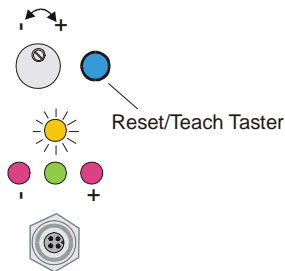
A voltage swing of 10V over the current tolerance window is provided at the analog output pin8/red/. A voltage of 5V is provided at the teach position, at the lower tolerance limit the voltage at the analog output is 0V, at the upper tolerance limit 10V.



### TEACH-VAL:

Numeric input field for setting the current teach value (setpoint value) in pixels. The teach value that is set here only is activated at the *L-LAS-TB* sensor after a click on the SEND button.

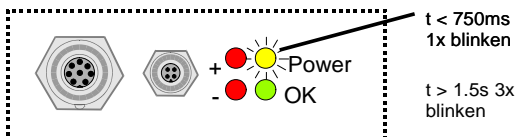
The teach value is specified in pixels. Conversion into [mm] is performed by way of the SLOPE-VALUE (sensitivity –  $\mu\text{m}/\text{pixel}$ ) and the OFFSET value of the sensor's calibration data.



After a click on the **TEACH** button the current edge information is automatically stored as a teach value to the RAM memory of the *L-LAS-TB* sensor.

When the teach process is completed, the yellow LED at the housing of the *L-LAS-TB* sensor quickly blinks 3 times.

The teach process also can be started by means of the **TEACH/RESET** button [1] at the housing (pressing the button for  $t > 1.5\text{s}$ ) or by way of a high level at digital input IN1/yellow/pin4 ( $t > 1.5\text{s}$ ).



*L-LAS-TB-CL model*

PLC / PC /  
POWER RS-232

[1] not available in case of a model of L-LAS-TB-CL series

PAR1 **PAR2** CAL REC CONN

GENERAL-PARAMETER

POWER 1000 0 400

V-THD[%] 100 1 25

SMOOTH-VIDEO-SIGNAL AVG\_8

VIDEO-THD-MODE FIX\_VTHD

REFRESH V-THD RAM EE

HW-MODE DISABLE ALL

CCD-OP-MODE NORMAL-SPEED

EXT-IN0-MODE NOT USED

EXT-IN1-MODE TEACH/RESET L/H

### Tab PAR2:

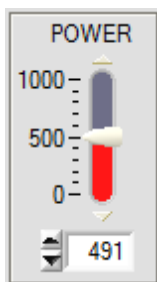
A click on the PAR2 button opens the PARAMETER-2 window, where additional parameters at the control unit can be set.



Attention !

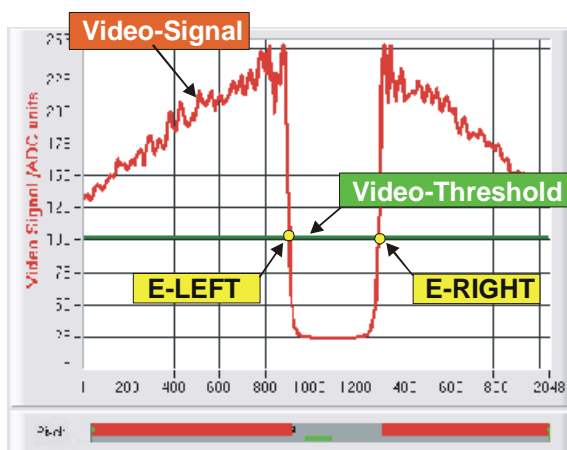
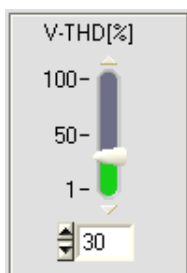


Changes that are made in the function fields described below only become active at the control unit of the *L-LAS-TB* sensor after a click on the SEND button!



### POWER:

In this function field the transmitter power at the laser transmitter unit of the *L-LAS-TB* sensor can be set by using the arrows or the slider, or by entering a numerical value in the respective input field.



### FIXED-VIDEO-THD[%]:

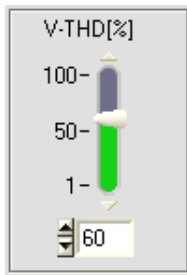
In this function field the video threshold at the *L-LAS-TB* sensor can be set by entering a numerical value or by using the slider or the arrows. With the help of this video threshold the measurement values can be derived from the intensity characteristic (video signal) of the CMOS line from the bright/dark transitions.

For this purpose the intersection points between the intensity profile (red curve) and the adjustable video threshold (green horizontal line) are calculated and stored.

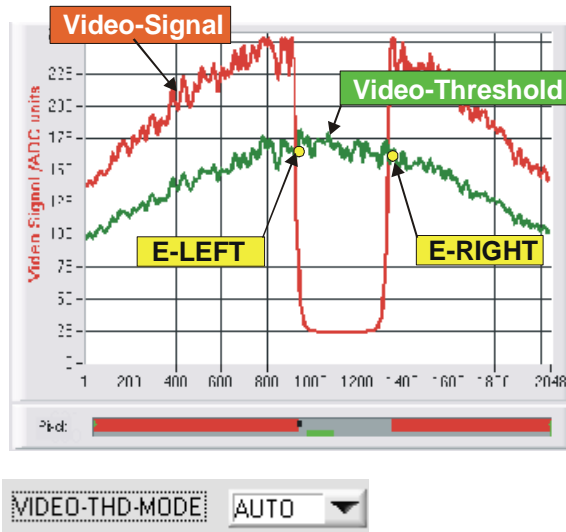
### FIXED-Video Threshold

VIDEO-THD-MODE FIX\_VTHD

The x-value of the respective intersection point is assigned to a pixel on the CMOS line. The measurement value can be calculated from this information and from the known distances of the pixels on the CMOS line. The intersection points between intensity profile and video threshold that are provided by this method are hereinafter referred to as edges.



**AUTO-Video threshold**

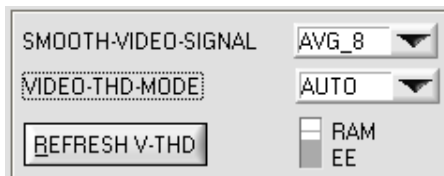


### **AUTO-VIDEO-THD[%]:**

When the toggle switch is in AUTO position, the threshold that is stored in the non-volatile RAM of the sensor is used as video threshold.

This threshold (green curve) is not a horizontal line, but is derived from the intensity characteristic of the laser transmitter and thus "tracks" the intensity profile.

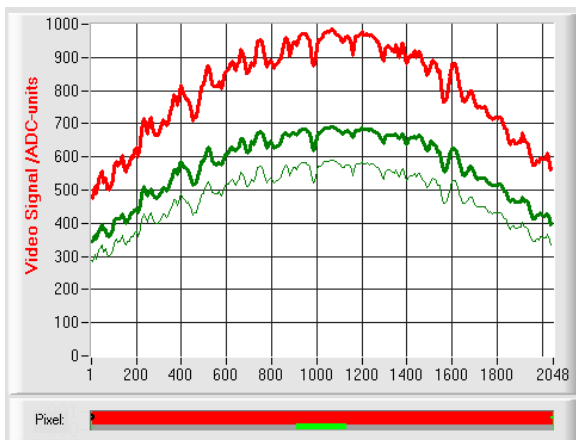
As before the measurement values are derived from the intensity characteristic of the CMOS line (red curve) and the tracked video threshold (green curve). For this purpose the intersection points between intensity profile and tracked video threshold are calculated again.



### **VIDEO-THD-MODE AUTO:**

The automatic follow-up threshold mode is activated by selecting AUTO from the VIDEO-THD-MODE drop-down list field.

A click on the SEND button activates the selected mode at the sensor!



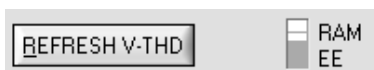
The current threshold can be changed by clicking on the arrow keys in the V-THD[%] slider.

The new video threshold first is shown as a thin green curve. This threshold (green curve) is not a horizontal line but is derived from the intensity characteristic of the laser transmitter (red curve) and thus "follows" the intensity profile. As before, the measurement values are derived from the intensity characteristic of the CMOS line (red curve) and the follow-up video threshold (green curve) by calculating the intersection points between intensity profile and follow-up video threshold.



**Attention !**

**Before the new video threshold is saved there must be no measurement object in the beam path between transmitter and receiver!**



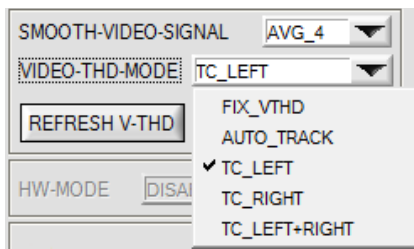
### **REFRESH V-THD:**

Only a click on this software button saves the current intensity profile as a new video threshold to the non-volatile EEPROM of the L-LAS-TB sensor.



### **GET:**

After a click on this software button the video threshold that is currently saved in the EEPROM will be automatically shown in the graphic display window.



### VIDEO-THD-MODE THRESHOLD-CORRECTION:

As from firmware version 4.0.4 additional operating modes for threshold correction can be set when you click on the VIDEO-THD-MODE drop-down list field:

TC\_LEFT:  
 TC\_RIGHT:  
 TC\_LEFT+RIGHT:

### TC LEFT, TC RIGHT, TC LEFT+RIGHT:

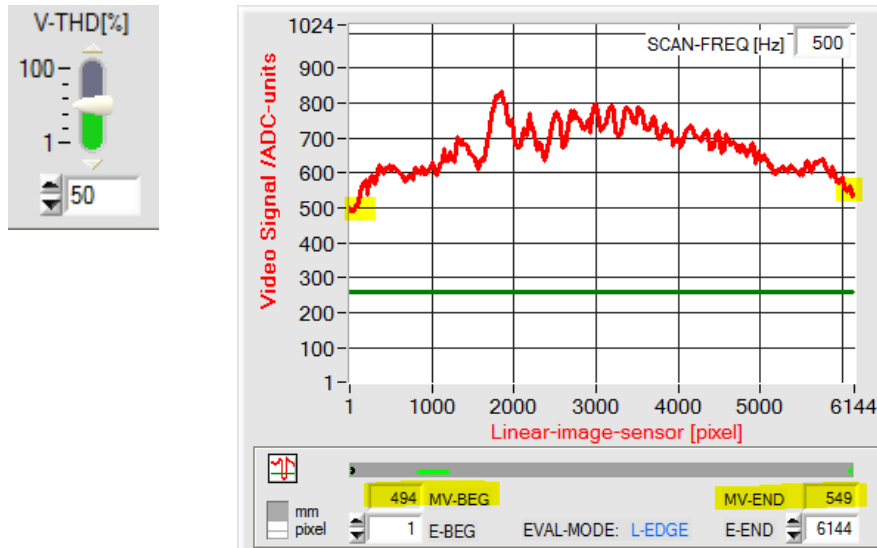
When one of the three TC (= Threshold Correction) modes is selected the position of the video threshold (green horizontal line) is automatically controlled and corrected.

For this purpose a mean value is calculated from the current video signal (red curve) in the area of the first (min. 8 pixels) and the last (min. 8 pixels).

MV-BEG: Mean value of the first 8 pixels (or from pixel 1 to E-BEG)

MV-END: Mean value of the last 8 pixels (or from pixel E-END to the last pixel)

With these mean values the current video threshold is calculated as a percentage and is corrected when necessary, using the value that is set with the V-THD [%] slider.



TC\_LEFT:

494 MV-BEG

The mean value is calculated from the first 8 pixels of the video signal.

As an alternative a higher value can be set for E-BEG (e.g. 100), which means that the mean value will be calculated from pixel 1 to E-BEG. The currently determined mean value is displayed in the numeric display field MV\_BEG.

TC\_RIGHT:

MV-END 549

The mean value is calculated from the last 8 pixels of the video signal.

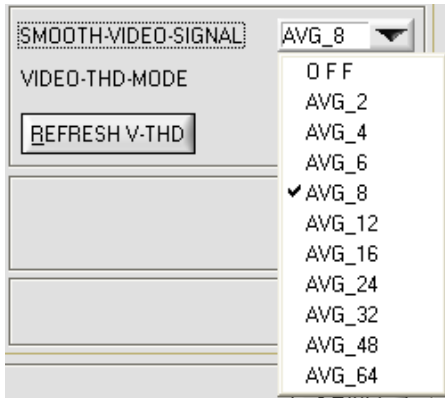
As an alternative a larger area can be set. For this purpose the value of E-END must be set correspondingly lower. The mean value will then be calculated from pixel E-END to the last pixel of the line sensor. The calculated mean value is displayed in the MV\_END field.

TC\_LEFT+TC\_RIGHT:

The mean value is calculated from the areas described above, and is then derived from  $(MV\_BEG + MV\_END)/2$ .

In this case both areas are used for automatic correction of the video threshold.





### SMOOTH-VIDEO-SIGNAL:

A click on the SMOOTH-VIDEO-SIGNAL drop-down list field opens the setting options for the activation of a software filter for the video signal characteristic. If a software filter is activated, corresponding filtering of the video signal will be performed after every scan in the main program run.

With digital software filtering the video signal characteristic can be smoothed, if necessary

#### OFF:

The video signal is not filtered.

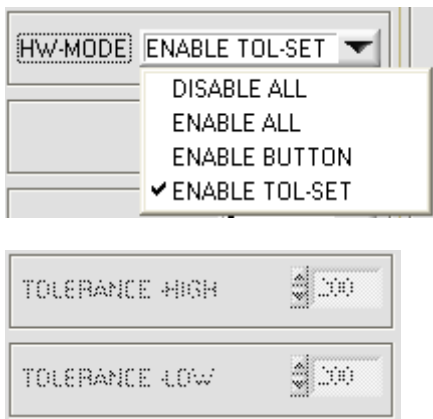
#### AVG 2:

The video signal is subjected to a 2nd-order moving average filter. Over the full video profile two adjacent values (pixels) each are used for averaging.

• • •

#### AVG 64:

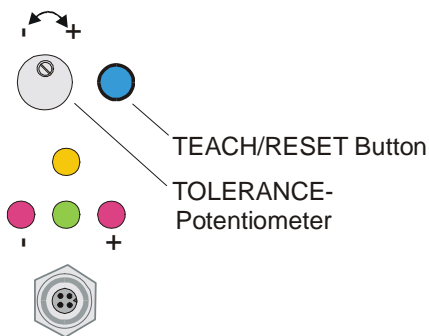
The video signal is subjected to a 64th-order moving average filter. For this purpose 64 adjacent values (pixels) each are used for averaging.



### HARDWARE (Hardware-Mode) [1]:

The TOLERANCE potentiometer and/or the TEACH/RESET button at the housing of the L-LAS-TB sensor can be activated (ENABLE) or deactivated (DISABLE) by clicking on the respective item in the list selection field.

The TOLERANCE potentiometer allows the presetting of a tolerance window around the setpoint value. If the function field is set to ENABLE ALL or ENABLE TOL-SET, it is not possible to enter numerical values in the TOLERANCE-VALUE input field of the PC software. The respective function fields will be grayed.



#### DISABLE ALL

Both the TEACH/RESET button and the TOLERANCE potentiometer at the housing are deactivated.

#### ENABLE ALL:

The TOLERANCE potentiometer at the housing is activated (clockwise turning increases the tolerance bandwidth).

The TEACH/RESET button at the housing is activated.

Button pressed for a short time ( $t < 0.7s$ ) : RESET function.

Button pressed for a long time ( $t > 1.5s$ ) : TEACH function.

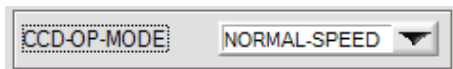
#### ENABLE BUTTON:

Only the TEACH/RESET button at the housing is activated.

#### ENABLE TOL-SET:

Only the TOLERANCE potentiometer at the housing is activated.

[1] not available in case of a model of CL series

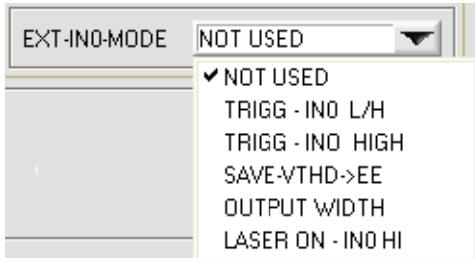


### CMOS line sensor OP-MODE:

List selection field for setting the operating mode at the CMOS pixel line sensor.

**NORMAL-SPEED:** Normal read frequency -> Full resolution

**DOUBLE-SPEED:** Double read frequency -> Half resolution



### EXT-IN0-MODE:

This drop-down function field can be used to set the operating mode of the external trigger input (IN0/pin3/green, 8-pole PLC socket) at the *L-LAS-TB* sensor.

#### NOT USED:

Continuous evaluation of current measurement values. No external trigger functionality.

#### TRIGG – IN0 L/H:

External edge-controlled triggering of measurement value evaluation through digital input IN0/pin3/green at the 8-pole PLC socket. The measurement value at the moment of the L/H edge is saved and applied at the digital outputs/analog output.

#### TRIGG – IN0 HIGH:

External triggering of measurement value evaluation through a high level (+Ub) at digital input IN0/pin3/green. Measurement value evaluation / analog output is enabled as long as digital input IN0 is at HIGH level (time window function).

#### SAVE VTHD ->RAM:

The external trigger input IN0 is used to save the current video threshold to the RAM memory of the *L-LAS-TB* sensor at the L/H edge. The "follow-up" video threshold is calculated as a percentage value from the current intensity profile over the CMOS line. The parameter V-TDH[%] is used to calculate the new threshold.

#### OUTPUT WIDTH:

The external trigger input IN0 is used to switch the evaluation mode to WIDTH.

IN0 = HIGH -> EVAL-MODE = WIDTH

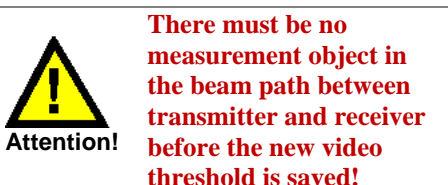
IN0 = LOW -> EVAL-MODE = LEFT, RIGHT or CENTER

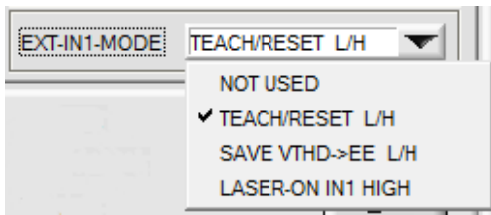
#### LASER ON – IN0 HI:

The laser transmitter can be turned on and off through the external trigger input IN0.

IN0/pin3/green      0V or open      LASER OFF

IN0/pin3/green:      +24VDC      LASER ON





#### EXT-IN1-MODE:

This drop-down function field can be used to set the operating mode of the external trigger input (IN1/pin4/yellow, 8-pole PLC socket) at the *L-LAS-TB* sensor.

#### NOT USED:

Continuous evaluation of current measurement values. No external trigger functionality.

#### TEACH/RESET – IN1 L/H:

##### RESET:

When a IN1 HIGH pulse of **less than 750 ms** duration is applied, the RESET function is performed at the *L-LAS-TB* sensor. This resets the current maximum and minimum values (drag pointer).

##### TEACH:

When a IN1 HIGH pulse of **more than 1.5s** duration is applied, the TEACH function is performed at the *L-LAS-TB* sensor. When a TEACH pulse is detected, the green LED at the housing flashes shortly three times.



**Attention !**

**There must be no measurement object in the beam path between transmitter and receiver before the new video threshold is saved! Error output OUT0 will be activated if the beam path is not free.**



#### SAVE VTHD ->RAM:

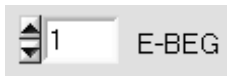
The external trigger input IN1 is used to save the current video threshold to the RAM memory of the *L-LAS-TB* sensor at the L/H edge. The "follow-up" video threshold is calculated as a percentage value from the current intensity profile over the CMOS line. The parameter V-TDH[%] is used to calculate the new threshold.

#### LASER ON – IN1 HI:

The laser transmitter can be turned on and off through the external trigger input IN1.

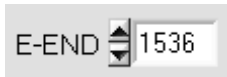
IN1/pin4/yellow	0V or open	LASER OFF
IN1/pin4/yellow:	+24VDC	LASER ON

## GENERAL control elements:



### E-BEG:

Numeric input field for setting the evaluation beginning. The CMOS line is evaluated starting from the pixel that is entered here (evaluation-beginning). (Default value = 1).



### E-END:

Numeric input field for setting the evaluation end. The CMOS line is evaluated up to this pixel. Pixels that lie on the right side of the pixel value specified here will not be evaluated.



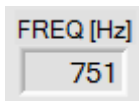
### Reset button (Maximum-Minimum-Values):

A click on the RESET software button resets the current maximum and minimum values detected by the *L-LAS-TB sensor*. The respective current maximum and minimum values are shown in the numeric display fields. Resetting of the maximum and minimum values also can be triggered from the PLC by a short pulse (time  $t < 750$  ms) at digital input IN1/yellow/pin4, and by pressing the hardware button at the housing of the *L-LAS-TB sensor*.



#### **Please note:**

This RESET function does not perform a hardware/software RESET at the *L-LAS-TB sensor*, it only resets the maximum and minimum values at the analog output pin8/red/!



### FREQ [Hz]:

This field displays the current switching frequency of the sensor.

The switching frequency depends on the currently set exposure time EXP-TIME[ms] and on the value of averaging AVERAGE. The switching frequency is reduced by a factor of 1/AVERAGE.



### [MM] [PIXEL]:

This switch is used to select the measurement value output in the graphic display window.

mm := Display in [mm]

pixel := Display in [pixel].



### Status display of digital inputs:

This LED display visualises the states of digital inputs IN0 and IN1.



#### **Please note:**

The LED display elements only are updated when RUN mode (data exchange through RS232) is active. IN0=HIGH< >LED(green), IN1=HIGH< >LED(yellow)

☒ RAM  
☐ EEPROM  
☐ FILE

SEND

GET

### PARAMETER TRANSFER:

This group of function buttons is used for transferring parameters between the PC and the *L-LAS-TB control unit* through the serial RS232 interface.

SEND

#### SEND:

When the SEND button is clicked, the parameters currently set on the user interface are transferred to the *L-LAS-TB control unit*.

The target of data transfer is determined by the selected radio-button (RAM, EEPROM, or FILE).

GET

#### GET:

When the GET button is clicked, the setting parameters are transferred from the *L-LAS-TB control unit* to the PC and are updated on the user interface. The source of data transfer again is determined by the selected radio-button:

#### RAM:

The currently set parameters are written to the volatile RAM memory of the *L-LAS-TB control unit*, or they are read from the RAM and transferred to the PC. Please note: The parameters set in the RAM will be lost when the power supply at the *L-LAS-TB control unit* is turned off.

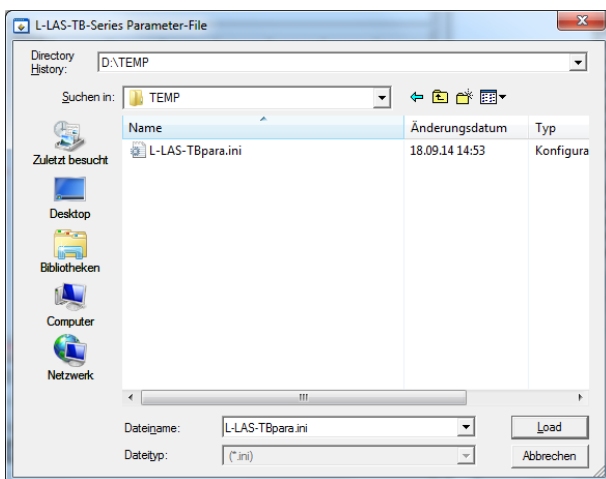
#### EEPROM:

The currently set parameters are written to the non-volatile EEPROM memory of the *L-LAS-TB control unit*, or they are read from the EEPROM and transferred to the PC. Parameters that are saved in the EEPROM will not be lost when the power supply is turned off.

If parameters are read from the EEPROM of the *L-LAS-TB control unit*, these must be written to the RAM of the *L-LAS-TB control unit* by selecting the RAM button and then clicking on SEND. The *L-LAS-TB control unit* then continues to operate with the set RAM parameters.

#### FILE:

When the FILE radio-button is selected, a click on the SEND/GET button opens a new file dialog on the user interface. The current parameters can be written to a freely selectable file on the hard disk of the PC, or parameters can be read from such a file.



### FILE dialog window:

The standard output file for the parameter values has the file name „L-LAS-TBpara.ini“.

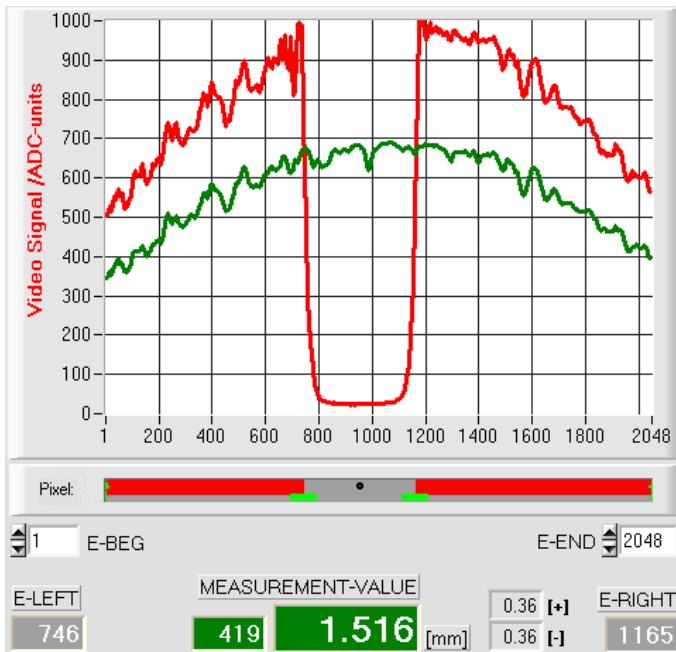
The output file can be opened e.g. with the standard Windows "EDITOR" program.

### 3.2 Numeric and graphic display elements:



#### VIDEO button:

After a click on the VIDEO button, the intensity profile measured at the CMOS line receiver is transferred to the PC and is shown as a red curve in the graphic display window.



The y-axis shows the analog signals of the individual pixels. The analog values (video signals) of the CMOS line are converted by means of an AD converter with 10-bit resolution, which results in a y-axis value range of 0 ... 1023.

The currently set video threshold (V-THD) is shown as a green horizontal line in the graphic display. The edge values (pixels) are derived from the intersection points of the intensity profile (red line) with the video threshold (green line).

The x-axis shows a virtual representation of the individual pixels of the CMOS line (for example: Pixel 1 ... 2048).

Because of the limited data transfer rate of the serial interface (19200 Baud/s) the graphic display window can only be updated every second.

Beneath the graphic display window there is another display element that shows the currently detected shadowed areas and the illuminated areas of the CMOS line. Furthermore the currently detected edge position is indicated in this display element by way of a black circular cursor. A green horizontal bar represents the width of the tolerance band that is currently set around the teach value.



Beneath the graphic display window there is another display element that shows the currently detected shadowed areas (gray) and the illuminated areas (red) of the CMOS line. Furthermore the currently detected edge position is indicated by way of a black circle.



#### E-LEFT:

Numeric display field that shows the current pixel position of the left bright/dark transition that is calculated from the intensity profile (red curve) of the CMOS line.



#### E-RIGHT:

Numeric display field that shows the current pixel position of the right bright/dark transition that is calculated from the intensity profile (red curve) of the CMOS line.



#### MEASUREMENT-VALUE:

Numeric display field that shows the current measurement value (depending on the set evaluation mode).

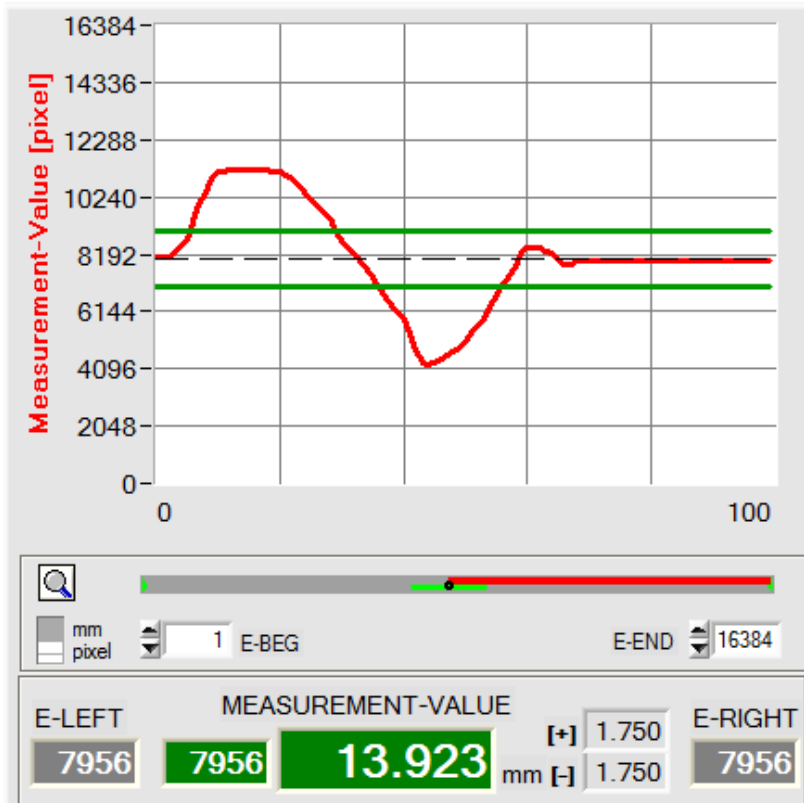
The left numeric display field shows the current measurement value in pixels, whereas the right display field shows the measurement value converted into millimeters.

If the current measurement value lies within the tolerance band around the teach value, the display fields are shown with a green background. If the measurement value lies outside the tolerance band, the display elements are shown with a red background. The measurement value in pixels or in [mm] does not directly result from the pixel edge values E-LEFT and E-RIGHT, it is rather the measurement values linearised by way of a conversion table that are output.



### RUN button:

After a click on the RUN button, the current measurement data will be transferred from the L-LAS-TB sensor to the PC via the serial interface.



In the form of a red curve the measurement values pass through the graphic display window from the right to the left.

The division of the y-axis corresponds with the pixels of the CMOS line, or with the virtual number of sub-pixels of the line. In the graphic display the current measurement value (M-VALUE=717) is shown at the right end at the x-value of 100.

The current setpoint value (TEACH value) is shown as a broken horizontal line.

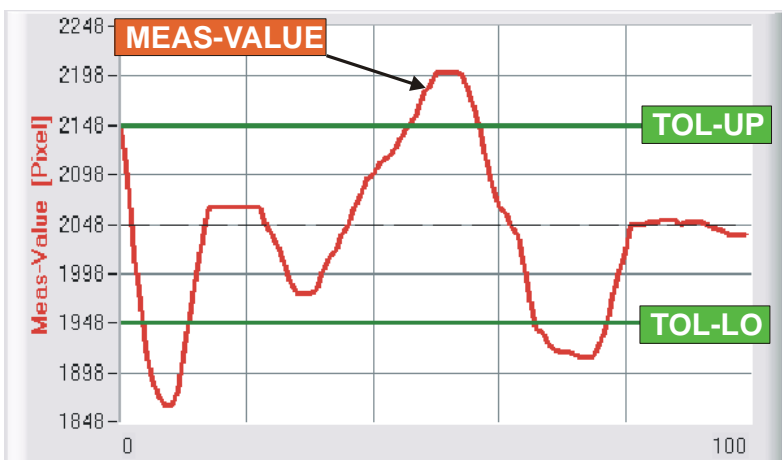
In addition, the current tolerance window is represented by two horizontal green lines that are applied symmetrically around the setpoint value.



Graphic measurement value scaling can be selected with this binary switch [mm]-[pixel].

In "RUN mode" the length of the data frame is limited to 18 words (36 bytes), which allows faster updating of the numeric and graphic display elements.

Compared to "VIDEO mode", data transfer through the serial RS232 interface therefore does not take so much time (in VIDEO mode the intensity information for every pixel must be transferred).



### ZOOM

With a click on the ZOOM button the Y-axis of the graphic window is automatically rescaled to provide a clearer representation of the measurement value changes.

In this picture the time characteristic of the measurement value changes is shown as a red curve. The tolerance band is represented by two green lines. The teach value is shown as a dashed horizontal line.



### 3.3 Serial RS232 data transfer:

#### RS232 COMMUNICATION:

- Standard RS232 serial interface without hardware-handshake.
- 3-line-connection: GND, TXD, RXD.
- Speed: Adjustable from 9600 Baud to 115200 Baud, 8 data bits, no parity bit, 1 stop bit in binary mode, MSB first.

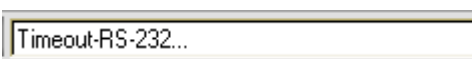
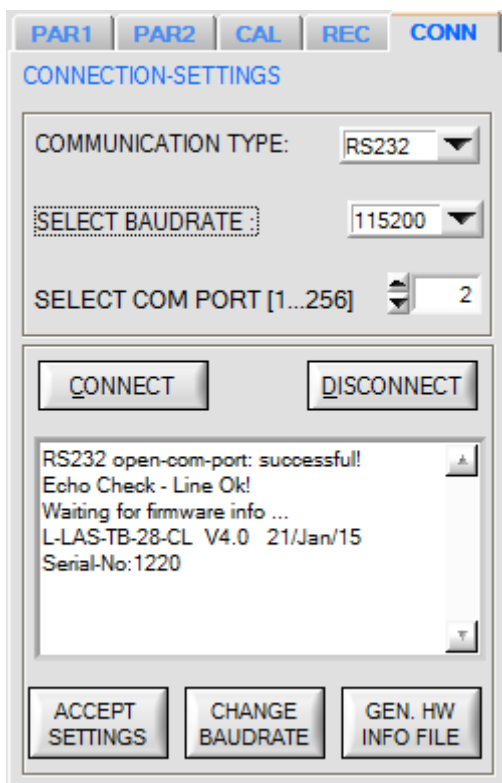


**Attention !**

The stable function of the RS232 interface (status message after program start) is a basic prerequisite for data transfer between the PC and the *L-LAS-TB control unit*. Due to the low data transfer rate of the serial RS232 interface (19200 bit/s) only slow changes of the analog values can be observed in the graphic display at the PC. In order to guarantee the maximum switching frequency of the *L-LAS-TB control unit* it is therefore necessary to stop the data exchange during the normal monitoring process (click on the STOP button).

#### CONN:

When the software is started it attempts to establish a connection to the *L-LAS-TB sensor* through the COM interface that was last used. If connection could be established successfully, the current firmware version and the number of the COM port are displayed in the status line.

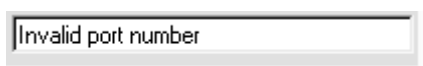


The serial connection between the PC and the *L-LAS-TB control unit* could not be established, or the connection is faulty.

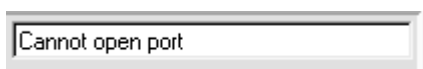
In this case it should first be checked whether the *L-LAS-TB control unit* is connected to the power supply, and whether the serial interface cable is correctly connected to PC and control unit.



Click on the CONNECT button to establish the connection to the sensor. When this connection is successfully established, a status message showing serial number and firmware will be displayed. Click on the DISCONNECT button to close the RS-232 connection to the sensor.



If there is an “Invalid port number” status message, the selected interface, e.g. COM2, is not available at your PC.



If there is a “Cannot open port” status message, the selected interface, e.g. COM2, may already be used by another device.

COMMUNICATION TYPE:

### COMMUNICATION TYPE:

The type of data communication can be set in this function field:

#### RS232:

Data communication through the standard RS232 interface.

#### TCP/IP:

Data communication through a RS232-TCP/IP Ethernet converter module.

SELECT BAUDRATE:

### SELECT BAUDRATE:

The baud rate of the serial interface can be set in this function field:

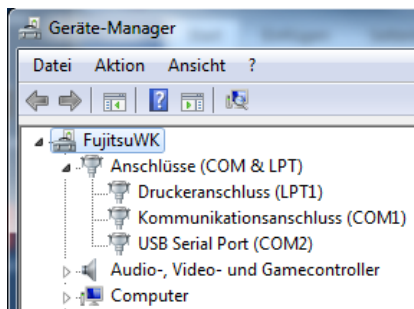
Possible values: 9600Baud, 19200Baud, 38400Baud, 57600Baud or 115200Baud. (Setting when delivered = 115200 Baud).

SELECT COM PORT [1...256]

### SELECT COM PORT [1...256]:

The number of the communication port can be set in this function field. Possible values are COM 1 to 255.

The communication port number can be found in the Windows® operating system under START/Control Panel/Device Manager.



CHANGE BAUDRATE  Attention!

RS232 open-com-port: successful!  
 Try to change baudrate...  
 Baudrate-change OK!  
 RS232 open-com-port: successful!

### CHANGE BAUDRATE:

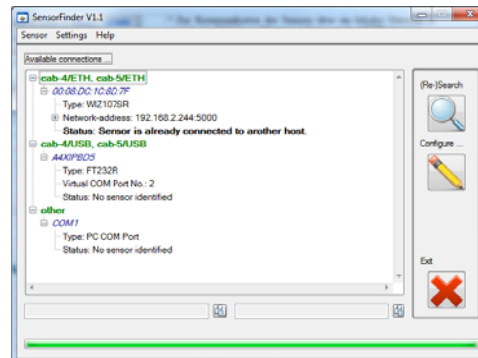
With a click on this button the baud rate of the serial interface at the sensor hardware is changed to the value selected in the SELECT-BAUDRATE list field. A corresponding status message will be displayed when the change of baud rate at the sensor was successful.

The baud rate change is performed in the volatile RAM memory of the L-LAS-TB sensor. If the baud rate should be changed permanently, the new baud rate value must be saved to the EEPROM by clicking on the SEND + EE button!

### 3.4 Data transfer through the external RS232 to Ethernet adapter:

An RS232 to Ethernet adapter (*cab-4/ETH*) is needed if the sensor should communicate through a local network. With this adapter a connection to the sensor can be established using the **TCP/IP** protocol.

Parameterisation of the *cab-4/ETH* adapter (assigning of IP address, baudrate setting, ...) can be done with the SensorFinder V1.1 software that is available free of charge on the internet.



RS232/Ethernet converter

IP ADDRESS (xxx.xxx.xxx.xxx)  
192.168.2.150

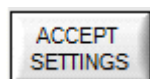
#### IP ADDRESS:

Input mask for entering the IP address.

PORT NUMBER [Default: 10001] 10001

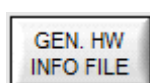
#### PORT NUMBER:

The **PORT NUMBER** for the (*cab-4/ETH*) network adapter is set to 5000. This value must not be changed.



#### ACCEPT SETTINGS:

With a click on the ACCEPT SETTINGS button the current setting values of the *L-LAS-TB-Scope* PC software are saved in the TB-Scope.ini file. The popup window will then be closed. When the *L-LAS-TB-Scope* software is restarted, the parameters saved in the INI file will be loaded.



#### GEN. HW INFO FILE:

A click on this button generates a file in which all the important sensor data are stored in encrypted form. This file can be sent to the sensor manufacturer for diagnostic purposes.

### 3.5 L-LAS-TB-Scope as an aid for sensor adjustment:



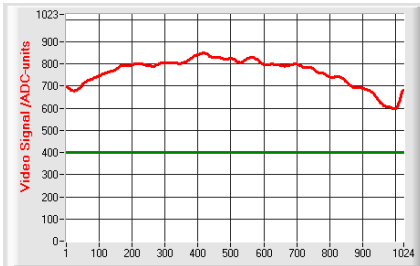
#### VIDEO:

After a click on the VIDEO button, the fine adjustment between the *L-LAS-TB transmitter unit and the receiver* can be observed in the graphic display window. Because of the limited data transfer rate of the RS232 interface the display window can only be updated every second.



#### STOP:

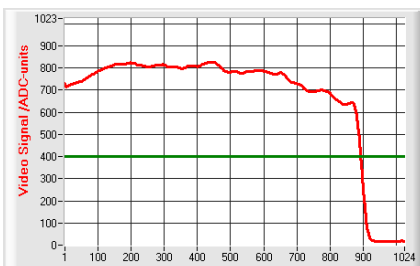
A mouse-click on the STOP button stops the data transfer between the *L-LAS-TB control unit* and the PC.



#### Optimal adjustment:

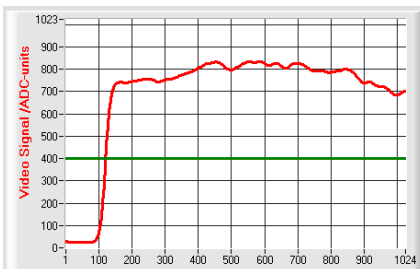
In the graphic display window the intensity profile is shown as a red curve. The numerical values 1 ... 1024 on the x-axis represent the individual pixels of the CMOS line sensor. The analog values of the CMOS line are converted by way of an AD converter with 10-bit resolution, which results in a y-axis value range of 0 ... 1023.

This picture shows that pixels 1 to 1024 at the line sensor are uniformly illuminated by the transmitter beam.



#### Wrong adjustment - right:

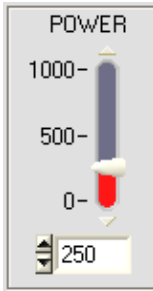
The transmitter beam no longer sufficiently illuminates the pixels at the right end of the CMOS line sensor. The red curve (intensity profile) in this part clearly is under the video threshold. The alignment of the laser transmitter unit or the receiver unit must be readjusted in such a way that the pixels at the right end are illuminated again.



#### Wrong adjustment - left:

The transmitter beam no longer sufficiently illuminates the pixels at the left end of the CMOS line sensor. The alignment of the laser transmitter unit or the receiver unit must be readjusted in such a way that the pixels at the left end are illuminated again.

### 3.6 L-LAS-TB-Scope as an aid for transmitter power adjustment:



#### **POWER:**

In this field the laser power at the laser transmitter unit of the *L-LAS-TB sensor* can be set by using the slider or by entering a numerical value in the respective input field.

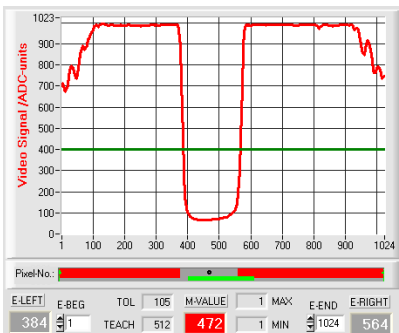


The laser power at the transmitter unit of the *L-LAS-TB sensor* is only updated when the **SEND** button is pressed.



#### **VIDEO:**

After a click on the **VIDEO** button, the current intensity profile is transferred from the *L-LAS-TB sensor* to the PC and is shown in the graphic display window. When the **VIDEO** function is active, the sensor's laser power can be changed (press the **SEND** button), and the effect of such a change can be observed in the intensity profile.

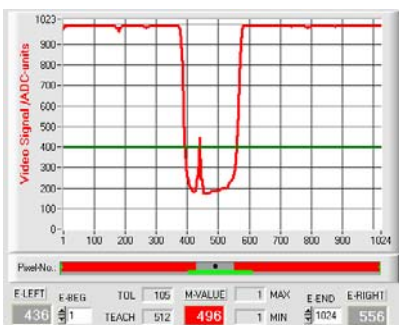


#### Optimal adjustment:

In the graphic display window the intensity profile is shown as a red curve. Through the complete CMOS line the intensity characteristic lies above the video threshold (green line).

In the shadowed area the intensity characteristic is at low ADC values (offset < 120).

In the shadowed areas the intensity characteristic does not show any sporadic "spikes".



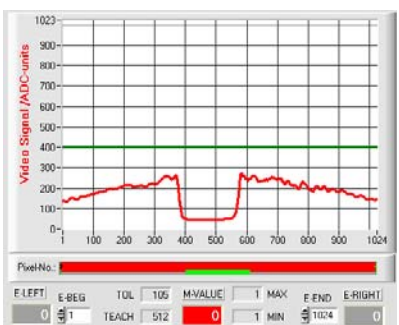
#### Transmitter power too high:

The transmitter beam overloads individual pixels of the CMOS line. There are sporadic short upward "spikes" in the shadowed areas.

**If such "spikes" intersect with the green horizontal video threshold, there will be incorrect measurements!**

#### Remedy:

Reduce the laser power in steps, until such "spikes" in the shadowed area do not occur any more.



#### Transmitter power too low:

The intensity profile of the CMOS line completely lies under the video threshold (green horizontal line).

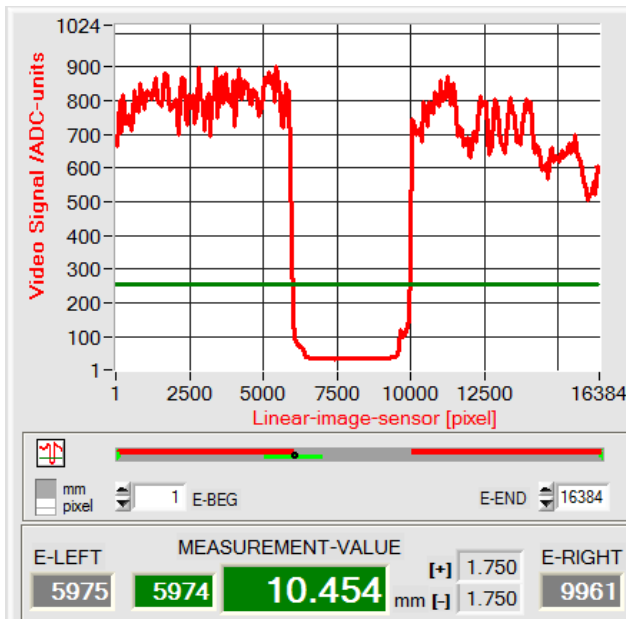
The *L-LAS-TB sensor* does not detect any edges (bright/dark transitions, i.e. intersections between red curve and green video threshold) in the image of the beam.

#### Remedy:

Increase the laser power in steps, at the same time observing the intensity characteristic, until the red curve (intensity profile) from pixel 1 to pixel 1024 lies above the video threshold.

## 4 Evaluation modes

### 4.1 LEFT-EDGE



The first detected edge in the intensity profile of the CMOS line sensor is evaluated. Search direction: Left to right!

The criterion for edge detection is the transition between illuminated and shadowed areas in the intensity characteristic of the line sensor.

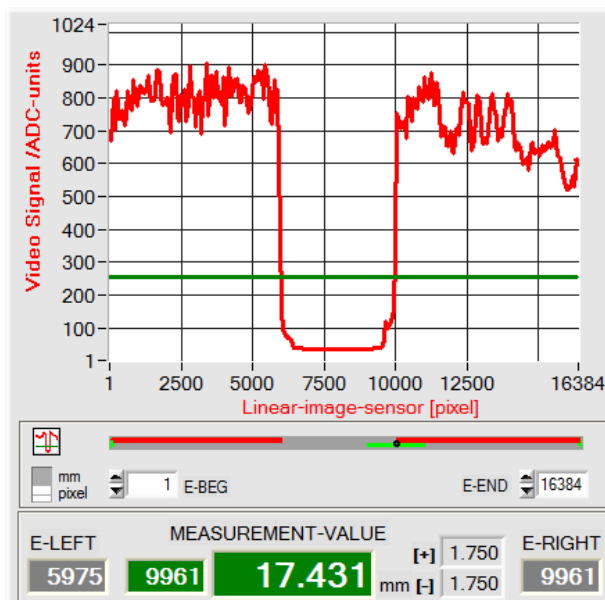
The one pixel of the CMOS line at which this bright/dark transition takes place can be determined from the intersection between the video threshold (green horizontal line) and the intensity characteristic (red curve).

In the example picture on the left, the first bright/dark transition is detected at pixel no. 5975.

$$MVAL[pixel] = E\_LEFT \quad \text{here: } 5975$$

The measurement value in [mm] is determined by way of multiplication of the pixel value of the CMOS line with the pixel-to-pixel distance SLOPE-VALUE of the CMOS line.

### 4.2 RIGHT-EDGE



The first detected edge in the intensity profile of the CMOS line sensor is evaluated.

Search direction: Right to left!  
 (high pixel values to low pixel values).

The one pixel of the CMOS line at which the second bright/dark transition takes place can be determined from the intersection between the video threshold (green horizontal line) and the intensity characteristic (red curve).

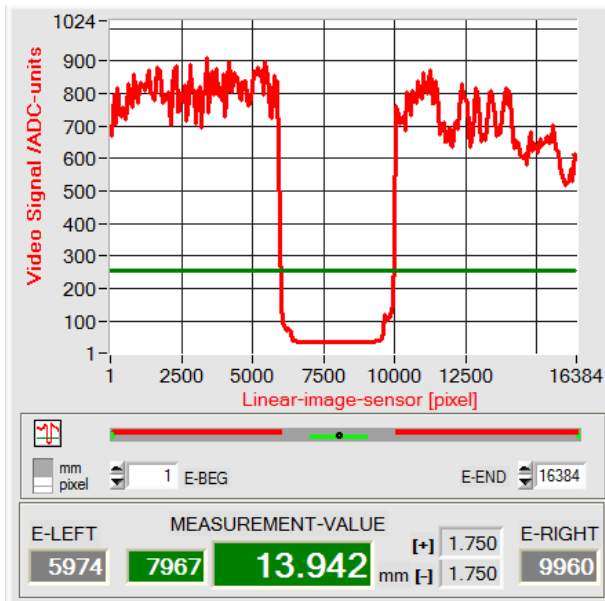
In the example picture on the left, the second bright/dark transition is detected at pixel no. 9961.

The black dot-shaped cursor beneath the graphic display window represents the current right edge (R-EDGE) of the shadowed area.

$$MVAL[pixel] = E\_RIGHT \quad \text{here: } 9961$$

The measurement value in [mm] is determined by way of multiplication of the pixel value of the CMOS line with the pixel-to-pixel distance SLOPE-VALUE of the CMOS line.

### 4.3 CENTER



EVAL-MODE CENTER

The mean value of the first and the second edge is used as measurement value:  $CENTER = (R-EDGE + L-EDGE) / 2$

The two pixels where the bright/dark transition occurs can be determined from the two intersections between the video threshold (green horizontal line) and the intensity characteristic (red curve).

In the example picture on the left, the second bright/dark transition is detected at pixel no. 9960, and the first bright/dark transition at pixel no. 5974.

The measurement value in [mm] is determined by way of multiplication of the pixel value of the CMOS line with the pixel-to-pixel distance of the CMOS line.

(e.g. L-LAS-TB-28-CL, pixel distance =  $1.75\mu m$ )  
 $7967[pixel] * 1.75[\mu m/pixel] = 13942\mu m$

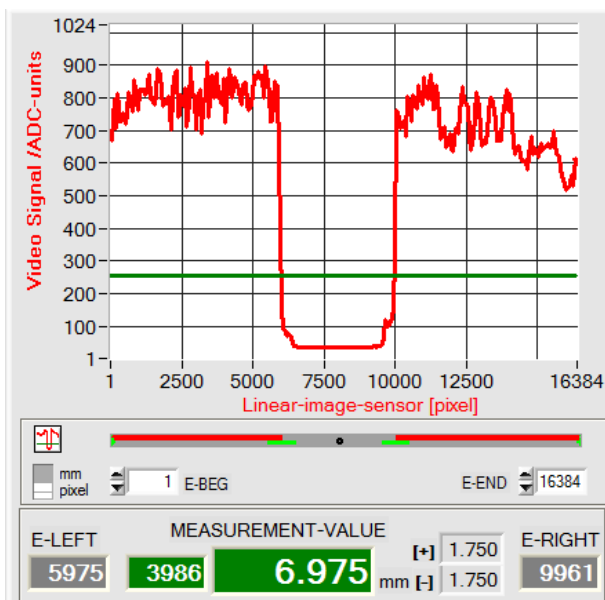
Averaging results in

$$CENTER = \frac{(E\_RIGHT + E\_LEFT)}{2}$$

MVAL[pixel] = 7967

MVAL[mm] = 13.942

### 4.4 WIDTH



EVAL-MODE WIDTH

The difference between the second edge and the first edge in the intensity profile of the CMOS line is evaluated.

The two pixels where the bright/dark transition occurs can be determined from the two intersections between the video threshold (green horizontal line) and the intensity characteristic (red curve).

In the example picture on the left, the second bright/dark transition is detected at pixel no. 9961, and the first bright/dark transition at pixel no. 5975.

Differentiation results in

$$MVAL[pixel] = E\_RIGHT - E\_LEFT$$

here:  $MVAL = 3986 = 9961 - 5975$

$3986[pixel] * 1.75[\mu m/pixel] = 6975\mu m$



## 5 Function of the data recorder

### REC: DATA RECORDER:

A click on the REC tab opens the DATA-RECORDER window on the user interface.

### RS232-MODE:

Drop-down function field for setting the data request at the *L-LAS-TB* sensor hardware.

### STATIC(REC):

The sensor does not automatically send measurement data through the RS-232 interface. Every individual data transfer is started by the PC/PLC with command no. 18. Upon this request the sensor sends a single data frame (36 bytes) to the PC/PLC.

### TRIG-IN0 L/H (REC):

A single data frame (36 bytes) is sent to the PC/PLC at every LOW/HIGH edge at digital input IN0/pin3/green.

### TRIG-IN0 L/H (3-BYTE), CONTINUOUS (3-BYTE):

**Cannot be used with the data recorder!**

High-speed 3-BYTE data transfer -> see chapter 5.2.

### TIME-INTERVAL [sec]:

This numeric input field can be used to set a time interval in seconds. When this time interval is over, the PC software automatically requests measurement data from the sensor (command 18). The PC/PLC waits until the complete data frame (36 bytes) from the sensor has arrived in the input buffer of the serial interface of the PC. Then the PC saves the new measurement data in an output file on the hard disk.

Minimum value: 0.1 [sec].

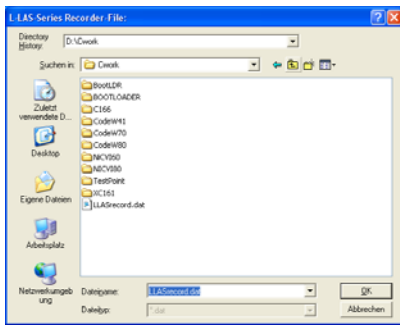
When the TIME-INTERVAL [sec] is over, the PC/PLC initiates a new transfer.

### SAMPLES [MAX 32000]:

Numeric input field for presetting the maximum number of measurement values that should be saved. The value range is 10 to 32000.

Numeric display fields providing information about the start date and start time. These displays are updated when the START button is pressed.

Numeric display elements showing the time interval in seconds that has passed since the recorder function was started.



### FILE button

A click on the FILE button opens a new dialog window for entering the file name and for setting the directory for the output file.

The currently selected directory and the file name of the output file are shown in a text display beside the FILE button.

d:\Programme\RECORD.DAT



START



STOP

Automatic recording can be started by pressing the START button. If recording should be stopped before the maximum number defined by SAMPLES is reached, this can be done by clicking on the STOP button.

## 5.1 Data format of the output file

The output file of the data recorder consists of 7 header lines, followed by the actual measurement data.

The measurement data are written to the output file line-by-line. Each line comprises 6 columns that are separated from each other by a TAB control character.

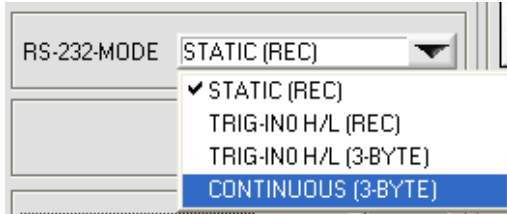
The output file can be opened with a simple text editor or a spreadsheet program (e.g. Microsoft EXCEL).

TIME	M-VALUE	E-LEFT	E-RIGHT	EDGES	M-VAL [um]
15:08:13	3985	5979	9965	2	6973
15:08:14	3987	5978	9966	2	6977
15:08:15	3986	5979	9965	2	6975
15:08:16	3986	5979	9965	2	6975
15:08:17	3979	6275	10254	2	6963
15:08:18	3973	6705	10678	2	6952
15:08:19	3984	7074	11057	2	6972
15:08:20	3975	7175	11150	2	6956
15:08:21	3992	6235	10235	2	6986
15:08:22	3977	5548	9526	2	6959
15:08:23	3971	5418	9389	2	6949
15:08:24	3970	5418	9388	2	6947
15:08:25	3970	5418	9388	2	6947
15:08:26	3970	5418	9389	2	6947
15:08:27	3970	5418	9388	2	6947
15:08:28	3970	5418	9388	2	6947

1. column = Time of measurement value acquisition
2. column = Measurement value (pixel) M-VALUE
3. column = Measurement value (pixel) E-LEFT
4. column = Measurement value (pixel) E-RIGHT
5. column = Number of EDGES
6. column = Meas. value (micrometer) M-VAL [um]

## 5.2 3-Byte RS232 data transfer

Fast data transfer of digital values (pixel values) from the *L-LAS-TB sensor* to the PLC can be realised by way of two RS-232-MODE (3-byte) operating modes. With a baud rate of 19200 kBit/s the transfer of a 3-byte data frame takes approx. 1.0ms, with 115.2 kBit/s data exchanged takes approx. 0.2ms.



### 3-byte data transfer:

#### EXT-IN0-L/H (3-Byte):

3-byte data transfer is triggered by a low/high or high/low edge (hardware specific) at IN0/pin3/green/ at the 8-pole PLC connector.

#### CONTINUOUS (3-Byte):

Continuous 3-byte data transfer during the main program run.

### Setting of the RS232 interface:

- Standard RS232 serial interface, no hardware handshake
- 3-wire-connection: GND, TXD, RXD
- Speed: 9600 baud, 19200 baud, 38400 baud, 57600 baud or 115200 baud
- 8 data-bits, NO parity-bit, 1 stop-bit, binary-mode.

### Transmission format of 3-byte data transfer:

START	0	0	6-Bit (D5 ... D0)	STOP	START	0	1	6-Bit (D11 ... D6)	STOP	START	1	0	6-Bit (S1, S0, D15 ... D12)	STOP
L-BYTE					M-BYTE					H-BYTE				

#### L-BYTE

0	0	D5	D4	D3	D2	D1	D0
---	---	----	----	----	----	----	----

#### M-BYTE

0	1	D11	D10	D9	D8	D7	D6
---	---	-----	-----	----	----	----	----

#### H-BYTE

1	0	S1	S0	D15	D14	D13	D12
---	---	----	----	-----	-----	-----	-----

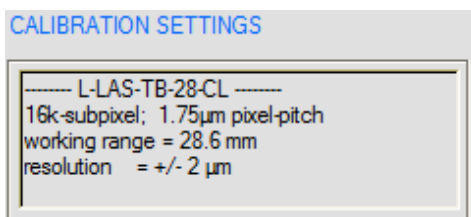
### Extraction of the digital value (D0 – D15):

The first two bits are used for recognising the LOW-byte (0|0), Middle-byte (0|1) and High-byte (1|1). The High-byte also transfers two status bits (S1|S0).

### Digital value DW = D0 ... D15

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
-----	-----	-----	-----	-----	-----	----	----	----	----	----	----	----	----	----	----

### Conversion of digital value into mm – value:



The millimetre value can be determined from the digital value **DW** (measurement value) and the pixel pitch.

Example: L-LAS-TB-28-CL

Pixel-Pitch [µm] = 1.75µm

$$\text{Measurement value [mm]} = \text{DW} * 0.0017\text{mm}$$

Examples for the extraction of the digital value:

Output of a typical hyperterminal program – The object is placed at two different positions in the operating range:

The screenshot shows the HTerm 0.8.1beta interface with the following settings: Port COM1, Baud 19200, Data 8, Stop 1, Parity None. The received data is displayed in a table with columns 1 to 11. The data is as follows:

1	2	3	4	5	6	7	8	9	10	11
00	40	80								
000	064	128								
00000000	01000000	10000000								
08	48	80								
008	072	128								
00001000	01001000	10000000								
2A	45	80								
042	069	128								
00101010	01000101	10000000								
3E	4F	80								
062	079	128								
00111110	01001111	10000000								

The following calculations are shown in the interface:

- Digital-Word DW = Pixel-Value = 0 (Sensor uncovered)**
- Digital-Word DW = Pixel-Value = 520 (position 1)**  
 $0+0+0+8+0+0 + 0+0+0+0+512+0 + 0+0+0+0 = 520$
- Digital-Word DW = Pixel-Value = 362 (position 2)**  
 $0+2+0+8+0+32 + 64+0+256+0+0+0 + 0+0+0+0 = 362$
- Digital-Word DW = Pixel-Value = 1022 (Sensor full covered)**  
 $0+2+4+8+16+32 + 64+128+256+512+0+0 + 0+0+0+0 = 1022$

## 6 Two-point calibration

### Tab CAL-CALIBRATION:

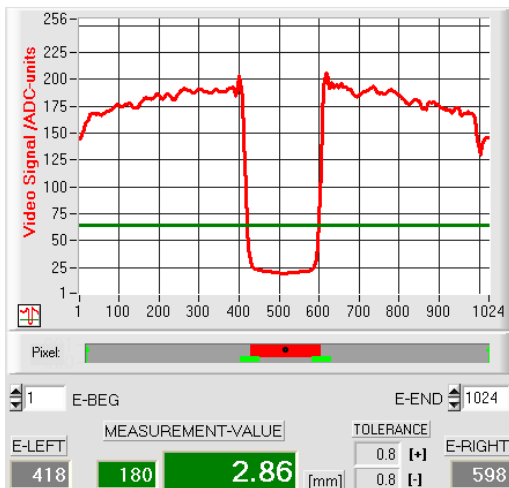
A click on the CAL button opens the CALIBRATION window.

After a click on the CONNECT function field information about the currently detected sensor hardware is automatically exchanged through the serial RS232 interface. This hardware information is displayed in the INFO text field.

### CAL1-CALIBRATION:

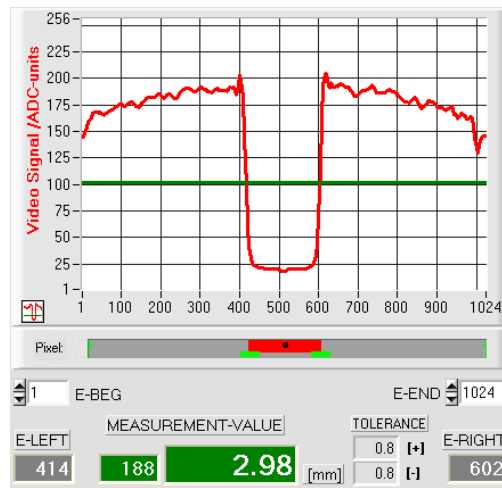
A click on the CAL1 tab opens the CAL1 window, where two-point calibration can be performed at the sensor. The purpose of two-point calibration is to output and display an exact width measurement value in micrometres at the sensor in evaluation mode EVALMODE=WIDTH.

The problem with width measurement is that depending on the set video threshold and the set transmitter power, the measurement value for the width information will be calculated differently. This is caused by the constantly rising analog characteristic (slope) of the video signal in the transition area between object shading and direct laser light impingement on the pixels of the CMOS line. The object width is calculated indirectly from the two intersection points of the video signal characteristic (red curve) with the green horizontal video threshold.



High video threshold, the object appears wider in the "shadow zone". Measured value = 180 pixel. The measured value in  $\mu\text{m}$  is calculated from this by multiplying the number of pixels with the respective pixel pitch.

$$\text{M-VALUE} = 180 \text{ pixel} \times 15.875\mu\text{m} = 2.86 \text{ mm}$$

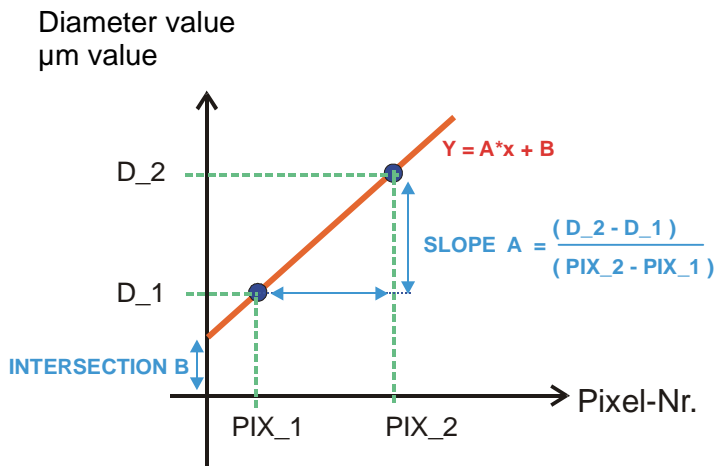


Low video threshold, the object appears somewhat narrower in the "shadow zone". Measured value = 188 pixel.

The measured value in  $\mu\text{m}$  is calculated from this by multiplying the number of pixels with the respective pixel pitch.

$$\text{M-VALUE} = 188 \text{ pixel} \times 15.875\mu\text{m} = 2.98 \text{ mm}$$

**In order to compensate this problem, two-point calibration can be performed with a fixed transmitter power (POWER) and a fixed video threshold (V-THD).**



In two-point calibration, a mean straight line through two points is calculated on the basis of two known objects (dimensions in µm are known) of different width.

The most important parameters of this mean straight line are its slope (SLOPE-VALUE A) and, if applicable, the Y-axis section B.

The slope A indicates the change in micrometers per change of pixel. The Y-axis section B (INTERSECTION-VALUE B) defines the zero-point offset.

☒ **DIAMETER 1** PIXEL\_1:

[µm]

e.g. object of 2.5mm diameter results in 160 pixels covering

#### DIAMETER 1

When the ON/OFF checkmark is activated, the object with the smaller diameter should be placed in the center of the operating range. The smaller object for example should cover 20-40% of the maximum operating range.

The known diameter value in micrometers must then be entered in the numerical input field.

A click on the Accept button saves the first value pair (DIAMETER 1, PIXEL\_1).

☒ **DIAMETER 2** PIXEL\_2:

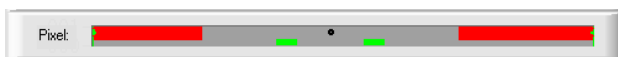
e.g. object of 7.1mm diameter results in 448 pixels covering

#### DIAMETER 2:

When the ON/OFF checkmark is activated, the object with the bigger diameter should be placed in the center of the operating range. The bigger measuring object for example should cover 60-80% of the maximum operating range.

The known diameter value in micrometers must then be entered in the numerical input field.

A click on the Accept button saves the second value pair (DIAMETER 2, PIXEL\_2).



When calibration is started, the actions of the RUN button on the user interface are performed automatically. In the graphic display section under the large "scroll graph" the centered placing of the objects in the operating range of the sensor can be checked. The area with the grey background (shadow area) represents the position of the object. The pixels that are hit by the laser beam are represented as red areas.

**CALC**

After a click on the CALC button, the slope and the Y-axis section are calculated anew from the two known point pairs of the objects.

The newly calculated values for the slope (SLOPE-VALUE A) and for the offset (INTERSECTION B) are shown in the display fields with gray background.

The previously set values are shown in the numerical input fields with white background.

**WRITE-XF**

### WRITE-XF

If the newly calculated values make sense they can be saved to the non-volatile FLASH memory of the control unit in the sensor by clicking on the WRITE-XF button.

**DISCARD**

### DISCARD

Click on the DISCARD button to discard the last calibration.

### Manual entering of calibration data:

The calibration data also can be modified manually at the control unit of the sensor. For this purpose, the numerical values can at any time be changed manually in the corresponding numerical input fields (SLOPE and OFFSET), without having to go through the calibration procedure.

The newly entered calibration values must first be activated at the control unit by clicking on the WRITE-XF button.

Instead of the above-described two-point calibration it is also possible to perform one-point calibration (if only one object with known diameter is available).

### **CAL2:**


This tab displays sensor-specific settings that can only be changed by the manufacturer.

SERIAL-NO:	4-digit serial number
HARDW-TYPE:	Hardware designation of the sensor
XF-SIZE:	Size of the look-up table
XF-DIVISOR:	Conversion of the look-up values.
OFFSET [µm]:	Measurement range start
SLOPE-VALUE [µm/pixel]:	Sensitivity
RANGE [µm]:	Measurement range



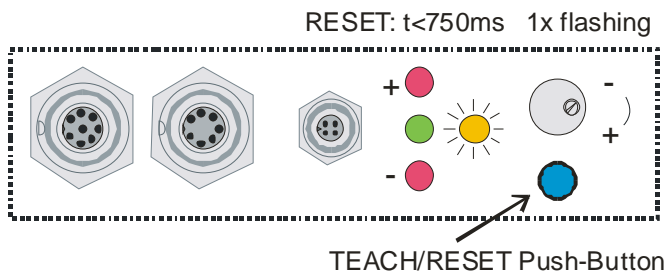
## 7 Annex

### 7.1 Laser warning

Laser warning
<p style="text-align: center;">Solid-state laser, <math>\lambda=670</math> nm, 0.4mW max. optical power. Laser class 1 acc. to EN 60825-1</p> <p>The accessible laser radiation is harmless under reasonably foreseeable conditions. The reasonably foreseeable conditions are kept during correct operation. The use of these laser transmitters therefore requires no additional protective measures.</p> <p>The laser line sensors of L-LAS-TB Series are supplied with a laser warning label type „CLASS 1 LASER PRODUCT“.</p> <div style="text-align: center; margin-top: 20px;">  </div>

### 7.2 Function of the Teach/Reset button

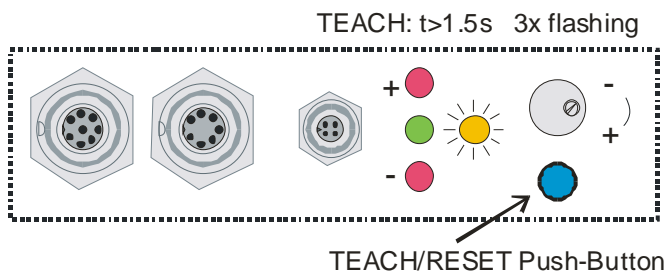
The housing of the *L-LAS-TB* sensor features a pushbutton with two functions [1].



#### RESET function:

When the button is pressed for a short time ( $t < 750\text{ms}$ ), the current maximum and minimum values are reset.

A hardware/software RESET is not performed!



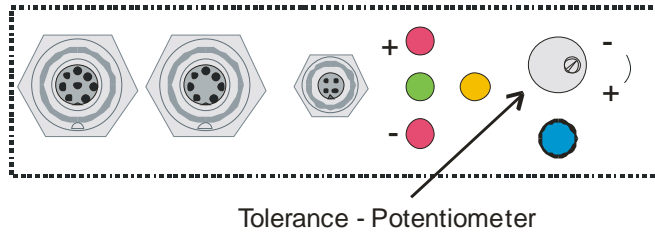
#### TEACH function:

When the button is pressed for a longer time ( $t > 1.5\text{s}$ ), the current edge coverings are stored as teach value in the RAM memory. When the teach process has been performed successfully, the green LED blinks three times.

[1] not available in case of a model of L-LAS-TB-CL series

### 7.3 Function of the Tolerance potentiometer:

The housing of the *L-LAS-TB* sensor features a potentiometer for setting the tolerance band width.



#### TOLERANCE potentiometer:

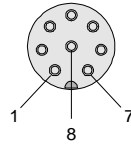
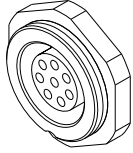
Turning the potentiometer clockwise increases the tolerance band width. Turning it counter-clockwise decreases the tolerance band width.

The potentiometer must be activated in order to use it for setting the tolerance band width at the *L-LAS-TB* sensor (switch HW-MODE to position ENABLE ALL or ENABLE TOL SET).

[1] not available in case of a model of L-LAS-TB-CL series

## 7.4 Function of digital inputs IN0 and IN1

The *L-LAS-TB* sensor has two digital inputs IN0 and IN1 that can be contacted through the 8-pole female connector (type Binder 712).



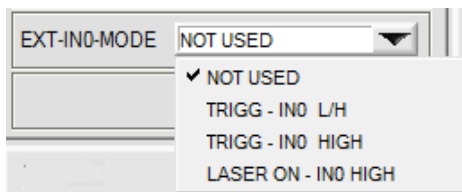
### L-LAS-TB model (STANDARD) and L-LAS-TB-CL model

Pin:	Color:	Assignment:
1	white	0V (GND)
2	brown	+Ub (+24VDC $\pm$ 10%)
3	<b>green</b>	<b>IN0 (EXT TRIGGER)</b>
4	<b>yellow</b>	<b>IN1 (TEACH/RESET)</b>
5	gray	OUT0
6	pink	OUT1
7	blue	OUT2 (OK) [1]
8	red	ANALOG (0...+10V)

[1] not available in case of a model of L-LAS-TB-CL series

### DIGITAL INPUT IN0 (pin3/green) EXT-TRIGGER:

The function of digital input IN0/pin3/green depends on the operating mode that is set in the EXT-IN0-MODE function field:



#### EXT-IN0-MODE:

##### NOT USED:

Digital input IN0/pin3/green is not used.

##### TRIGG-IN0 L/H:

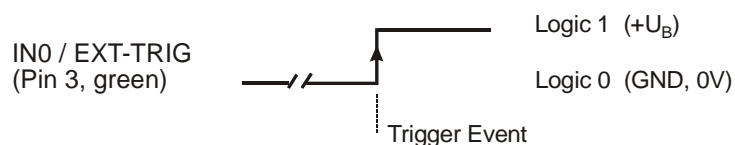
External edge-controlled triggering of measurement value evaluation through digital input IN0/pin3/green.

##### TRIGG-IN0 HIGH:

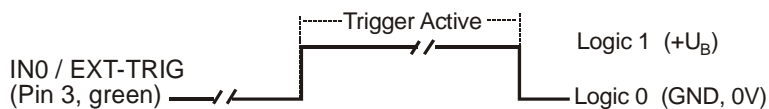
External triggering of measurement value evaluation by a high-level (+Ub) at digital input IN0/pin3/green.

##### LASER ON – IN0 HIGH:

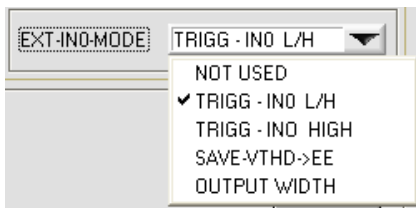
The laser transmitter unit only is switched on when there is a high-level at digital input IN0/pin3/green.



External edge-controlled (LOW/HIGH) triggering of measurement value evaluation through digital input IN0.

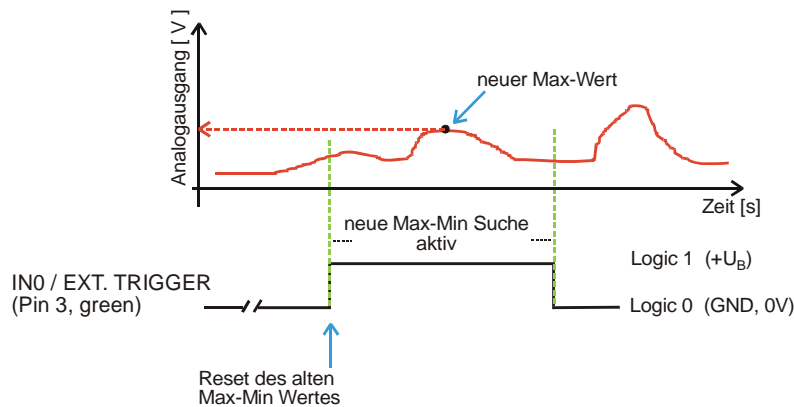


External triggering of measurement value evaluation through a HIGH level (+Ub) at digital input IN0.



The triggered mode only is possible in the two trigger modes "TRIGG-INO L/H" and "TRIGG-INO HIGH".

With a new LOW/HIGH edge at IN0 the control unit resets the MAX/MIN value. As long as the HIGH level is present at IN0 (time window), the MAX/MIN search according to the drag pointer principle is active. In this time window the respective current MAX/MIN value is provided at the analog output pin 8/red. If the HIGH level at IN0 drops, the MAX/MIN value that is detected during the time window remains present at the analog output.

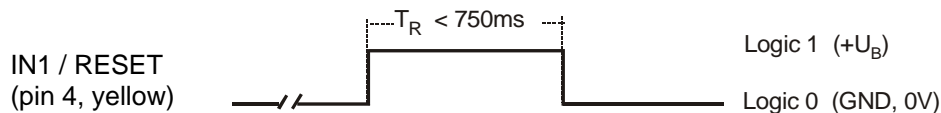


Only the next LOW/HIGH edge of the following time window resets the analog value again!

### DIGITAL INPUT IN1 (pin4/yellow) TEACH/RESET:

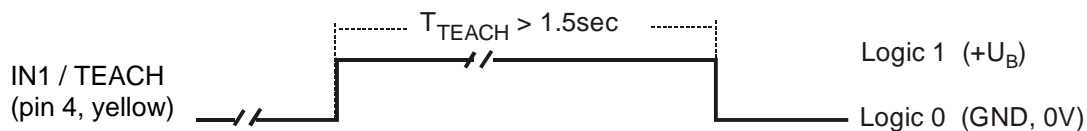
#### RESET function:

When a HIGH pulse of **less than 750 ms** duration is applied, the RESET function is performed at the L-LAS-TB sensor. This resets the current maximum and minimum values (drag pointer). A hardware/software RESET is not performed! When a RESET pulse is detected, the yellow LED flashes shortly one time.

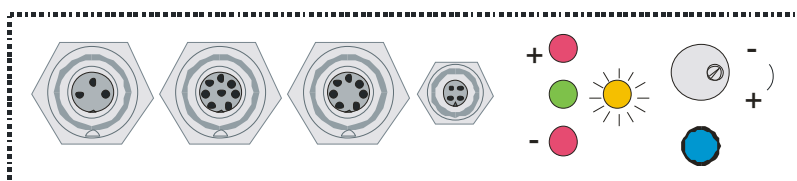


#### TEACH function:

When a HIGH pulse of **more than 1.5s** duration is applied, the TEACH function is performed at the L-LAS-TB sensor. When a TEACH pulse is detected, the yellow LED at the housing flashes shortly three times.

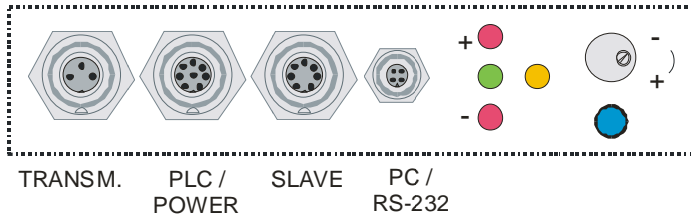


#### Multi-function LED:



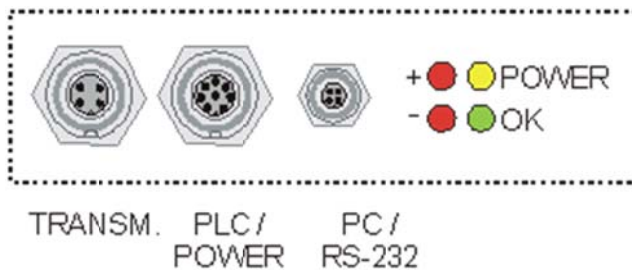
Yellow multi-function LED at the housing.  
LED on:  
Visualisation of operating voltage  
1x short flash: Reset MAX/MIN function  
3x short flash: Teach function

## 7.5 Connector assignment



### *L-LAS-TB model (standard)*

At the housing of the *L-LAS-TB* sensor there is a female connector for power supply connection (8-pol. type Binder 712) and a second female connector for connecting a serial RS232 connecting cable (4-pol. type M5 Binder 707). A third female connector (7-pol. type Binder 712) can be used to establish a connection to SLAVE sensors.

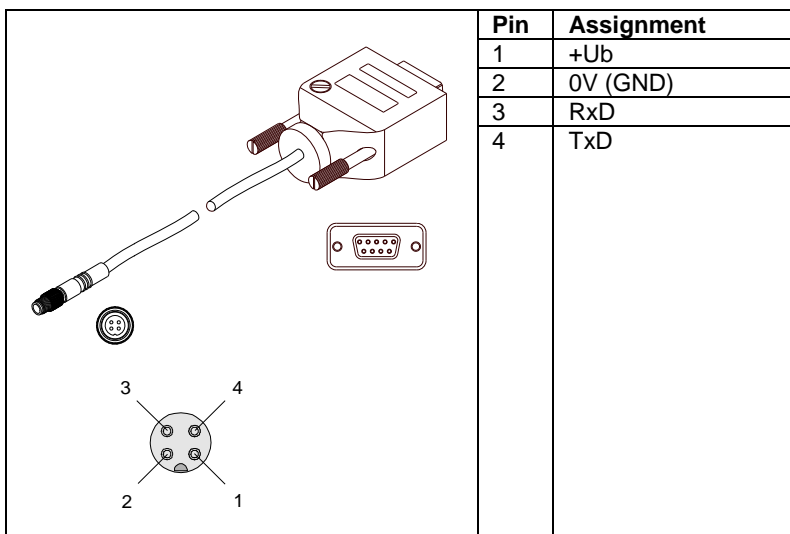


### *L-LAS-TB-CL model (Compact Line)*

At the housing of the *L-LAS-TB-...-CL* sensor there is a female connector for power supply connection (8-pol. type Binder 712) and a second female connector for connecting a serial RS232 connecting cable (4-pol. type M5 Binder 707). A third female connector (7-pol. type Binder 712) can be used to establish a connection to SLAVE sensors.

### RS232 connection to the PC:

4-pole female M5 connector type Binder 707



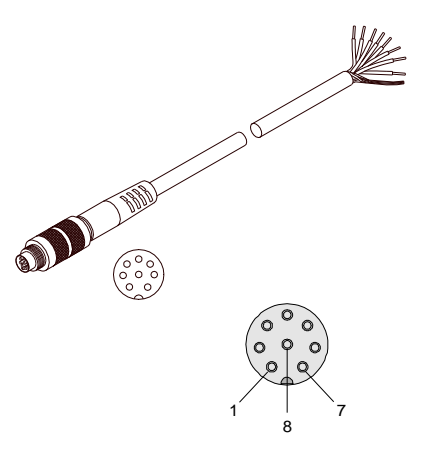
### Connecting cable:

cab-las4/PC (length 2m, cable jacket: PUR)

also available:  
cab-4/USB

**Interface to PLC/voltage supply:**

8-pole female connector type Binder 712

	Pin	Color	Assignment L-LAS-TB Standard	Assignment L-LAS-TB-CL
	1	White	0V (GND)	0V (GND)
	2	Brown	+24VDC $\pm 10\%$	+24 VDC $\pm 10\%$
	3	Green	IN0	IN1
	4	Yellow	IN1	IN1
	5	Grey	OUT0 (-)	OUT0 (-)
	6	Pink	OUT1 (+)	OUT1 (+)
	7	Blue	OUT2 (OK)	0V (GND) <b>optional in case of type 4/20: 4...20mA</b>
	8	Red	Analog (0...+10V) <b>optional in case of type 4/20: 4...20mA</b>	Analog (0...+10V)

**Connecting cable:**

cab-las8/SPS (length 2m, cable sheath: PUR)

## 7.6 RS232 interface protocol

- Standard RS232 serial interface, no hardware handshake
- 3-wire-connection: GND, TXD, RXD
- Speed: 9600 baud, 19200 baud, 38400 baud, 57600 baud or 115200 baud
- 8 data-bits
- NO parity-bit
- 1 STOP-bit
- binary-mode.

### METHOD:

The sensor control unit always behaves passively. Data exchange therefore is initiated by the PC (or PLC). The PC sends a data package ("frame") either with or without appended data, to which the sensor control unit responds with a frame that matches the request. The data package comprises a **HEADER** and the optional **DATA**.

### HEADER

- 1. Byte** : Synchronisation byte <SYNC> (85<sub>dez</sub> = 0x55<sub>hex</sub>)
- 2. Byte** : Order byte <ORDER>
3. Byte : Argument <ARG LO>
4. Byte : Argument <ARG HI>
5. Byte : Data length <LEN LO>
6. Byte : Data length <LEN HI>
7. Byte : Checksum Header <CRC8 HEAD>
8. Byte : Checksum Data <CRC8 DATA>

The first byte is a synchronisation byte and always is 85<sub>dez</sub> (55<sub>hex</sub>). The second byte is the so-called order byte <ORDER>, it determines the action that should be performed (send data, save data, etc.).

A 16-bit value <ARG> follows as the third and fourth byte. Depending on the order the argument is assigned a corresponding value. The fifth and sixth byte again form a 16-bit value <LEN>. This value states the number of appended data bytes. Without appended data <LEN=0>, the maximum data length is 512 bytes <LEN=512>. The seventh byte is formed with the CRC8 checksum over all data bytes.

The eighth byte is the CRC8 checksum for the header and is formed from bytes 0 up to and incl. 7.

The header always has a total length of 8 bytes. The complete frame may contain between 8 and 520 bytes.

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header	Byte9 Data	Byte10 Data	...	Byte n+7 Data	Byte n+8 Data
<b>0x55</b>	<b>&lt;ORDER&gt;</b>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)	Data1 (lo byte)	Data1 (hi byte)	...	Data n/2 (lo byte)	Data n/2 (hi byte)

<ORDER>	Meaning of the 2.nd byte <order>:	ORDER-TABLE
<b>0</b>	NOP	no operation
<b>1</b>	Send parameter from PC to L-LAS-RAM	PC ⇒ L-LAS-RAM
<b>2</b>	Get parameter from L-LAS-RAM	L-LAS-RAM ⇒ PC
<b>3</b>	Send parameter from PC to EEPROM	PC ⇒ L-LAS-EEPROM
<b>4</b>	Get parameter from EEPROM of L-LAS	L-LAS-EEPROM ⇒ PC
<b>5</b>	Echo check: Get echo of L-LAS	first word=0x00AA=170dec
<b>6</b>	Activate teach at L-LAS, store in RAM	PC ⇒ L-LAS-RAM
<b>7</b>	Get software version info of L-LAS	L-LAS ⇒ PC
<b>8</b>	<b>Get measured values from L-LAS-RAM</b>	<b>L-LAS-RAM ⇒ PC</b>
<b>9</b>	Get video-buffer info from L-LAS	L-LAS-RAM ⇒ PC
<b>11</b>	Reset maximum/minimum values at analog-output	PC ⇒ L-LAS-RAM
<b>190</b>	Change RS232-baud-rate (L-LAS-RAM)	PC ⇒ L-LAS-RAM



## CRC8 checksum

The so-called "Cyclic Redundancy Check" or CRC is used to verify data integrity. This algorithm makes it possible to detect individual bit errors, missing bytes, and faulty frames. For this purpose a value - the so-called checksum - is calculated over the data (bytes) to be checked and is transmitted together with the data package. Calculation is performed according to an exactly specified method based on a generator polynomial. The length of the checksum is 8 bit (= 1 byte). The generator polynomial is

$$X^8 + X^5 + X^4 + X^0$$

To verify the data after they have been received, CRC calculation is performed once again. If the sent and the newly calculated CRC values are identical, the data are without error.

The following pseudo code can be used for checksum calculation:

```
calcCRC8 (data[ ], table[ ])
Input: data[ ], n data of unsigned 8bit
        table[ ], 256 table entries of unsigned 8bit
Output: crc8, unsigned 8bit

crc8 := AAhex
for I := 1 to n do
    idx := crc8 EXOR data[ i ]
    crc8 := table[ idx ]
endfor
return crc8
```

### table[ ]

0	94	188	226	97	63	221	131	194	156	126	32	163	253	31	65
157	195	33	127	252	162	64	30	95	1	227	189	62	96	130	220
35	125	159	193	66	28	254	160	225	191	93	3	128	222	60	98
190	224	2	92	223	129	99	61	124	34	192	158	29	67	161	255
70	24	250	164	39	121	155	197	132	218	56	102	229	187	89	7
219	133	103	57	186	228	6	88	25	71	165	251	120	38	196	154
101	59	217	135	4	90	184	230	167	249	27	69	198	152	122	36
248	166	68	26	153	199	37	123	58	100	134	216	91	5	231	185
140	210	48	110	237	179	81	15	78	16	242	172	47	113	147	205
17	79	173	243	112	46	204	146	211	141	111	49	178	236	14	80
175	241	19	77	206	144	114	44	109	51	209	143	12	82	176	238
50	108	142	208	83	13	239	177	240	174	76	18	145	207	45	115
202	148	118	40	171	245	23	73	8	86	180	234	105	55	213	139
87	9	235	181	54	104	138	212	149	203	41	119	244	170	72	22
233	183	85	11	136	214	52	106	43	117	151	201	74	20	246	168
116	42	200	150	21	75	169	247	182	232	10	84	215	137	107	53

## Appended data: Parameter set

The sensors of the *L-LAS-TB series* operate with the following parameters that are sent to the sensor or read from the sensor as appended data in the stated sequence:

DATA-FRAME: <parameter-set>		
Para	Meaning	Comment
1	POWER	Laser intensity (0 ... 1000)
2	POWER-MODE	Laser power mode: ( 0 = STATIC), (1=DYNAMIC), (2=DYN-EXPOSE)
3	POLARITY	Polarity for OUT0, OUT1 und OUT2 (0=DIRECT, 1=INVERT)
4	EVAL-MODE	Evaluation mode (0=L-EDGE, 1=R-EDGE, 2=WIDTH, 3=CENTER)
5	E-BEG	Evaluation start-pixel ( 1 ... E_END - 1)
6	E-END	Evaluation end -pixel ( E_BEG+1 ... SUBPIXEL)
7	TEACH-VALUE	Teach-value (1 ... SUBPIXEL)
8	TOLERANCE-HI-VALUE	Upper-tolerance (0 ... SUBPIXEL/2)
9	TOLERANCE-LO-VALUE	Lower-tolerance ( 0 ... SUBPIXEL/2)
10	AVERAGE	Average-setting (1,2,4,5,16,32,64,128,256, 512 or 1024)
11	EX-TRIGG-MODE	External-trigger-mode:( 0=CONTINUOUS, 1=IN0 L/H, 2=IN0 HI, 3=SAVE-VTHD, 4=OUTPUT-WIDTH, 5=LIGHT-ON)
12	ANA-MODE	Analog-mode (0=DIRECT,1=MAXIMA,2=MINIMA,3=MAX_MIN)
13	OP-MODE	CMOS-operation-mode (0=FULL_RES, 1=HALF_RES/DOUBLE-SPEED)
14	HW-MODE	Enable/disable TOL-potentiometer and button at housing (DISABLE-ALL=0, ENABLE-ALL=1,ENABLE-BTN=2, ENABLE POTI=3)
15	VTHDMODE	Video-threshold-mode: (0=FIX, 1=AUTO)
16	VIDEO-THRESHD FIX	Video-threshold FIX (0 ... 100)
17	VIDEO-THRESHD AUTO	Video-threshold AUTO (0 ... 100)
18	RS232-MODE	RS232 mode: (0=STAT,1=IN0-L/H,2=IN0-HI[3-byte],3=CONT[3-byte])
19	RS232-BAUDRATE	Baudrate: (0=9600,1=19200,2=38400,3=57600,4=115200) baud
20	VIDEO-SMOOTH	Smooth video signal over (1,2,4,6,8,12,14,16,32,or 64) pixel
21	ANA-ZOOM	Analog-output-zoom-mode: output (0=DIRECT, 1=ZOOMx1, 2=ZOOMx2, 3=ZOOMx4, 4=ZOOMx8, 5=ZOOMx16, 6=WIN_5V, 7=WIN_10V)
22	INT-TRIGG-MODE	Internal-trigger-mode (0=DISABLE, 1=ENABLE-DARK, 2=ENABLE-LIGHT)
23	INT-TRIGG-THD	Internal-trigger-threshold pixel ( 1 ... SUBPIXEL)
24	OUT-MODE	Mode for digital outputs (0, 1 or 2)
25	FREE-USE	Free-use
26	FREE-USE	Free-use
27	FREE-USE	Free-use

## RS232 data-transfer-examples:

**< ORDER = 5 >** : READ CONNECTION OK from sensor.

DATA FRAME PC → Sensor

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85	5	0	0	0	0	170	60
ARG=0				LEN=0			

DATA FRAME Sensor → PC

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85	5	170	0	0	0	170	178
ARG=170				LEN=0			

ARG=Serial-Number

**< ORDER = 7 >** : Read FIRMWARE-STRING from sensor.

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85 (dec)	7	0	0	0	0	170	82
ARG=0				LEN=0			

DATA FRAME Sensor → PC

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header	Byte9 Data	Byte10 Data	Byte11 Data	Byte12 Data
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)	ASCII	ASCII	ASCII	ASCII
85 (dec)	7	0	0	72	0	178	82	L	-	L	A
ARG=0				LEN=72							

Byte13 Data	Byte14 Data	Byte15 Data	Byte16 Data	Byte17 Data	Byte18 Data	Byte19 Data	Byte20 Data	Byte21 Data	Byte22 Data	Byte23 Data	Byte24 Data
ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII
S	-	T	B	-	C	L	-	V	4	.	0

Byte25 Data	Byte26 Data	Byte27 Data	Byte28 Data	Byte29 Data	Byte30 Data	Byte31 Data	Byte32 Data	Byte33 Data	Byte34 Data	Byte35 Data	Byte36 Data
ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII
.	0			2	1	/	J	a	n	/	1

Byte37 Data	Byte38 Data	Byte39 Data	Byte40 Data	Byte41 Data	Byte42 Data	Byte43 Data	Byte44 Data	Byte45 Data	Byte46 Data	Byte47 Data	Byte48 Data
ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII
5											

Byte49 Data	Byte50 Data	Byte51 Data	Byte52 Data	Byte53 Data	Byte54 Data	Byte55 Data	Byte56 Data	Byte57 Data	Byte58 Data	Byte59 Data	Byte60 Data
ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII

Byte61 Data	Byte62 Data	Byte63 Data	Byte64 Data	Byte65 Data	Byte66 Data	Byte67 Data	Byte68 Data	Byte69 Data	Byte70 Data	Byte71 Data	Byte72 Data
ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII

Byte73 Data	Byte74 Data	Byte75 Data	Byte76 Data	Byte77 Data	Byte78 Data	Byte79 Data	Byte80 Data
ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII	ASCII

**< ORDER = 1 >** : SEND PARAMETER-SET TO RAM of the sensor

DATA FRAME PC → Sensor

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header	Byte9 Data	Byte10 Data	Byte11 Data	Byte12 Data
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)	Para1 (lo byte)	Para1 (hi byte)	Para2 (lo byte)	Para2 (hi byte)
85 (dec)	1	0	0	52	0	0	81	144	1	0	0
ARG=0				LEN=52				POWER=400		PMODE=0	

Byte13 Data	Byte14 Data	Byte15 Data	Byte16 Data	Byte17 Data	Byte18 Data	Byte19 Data	Byte20 Data	Byte21 Data	Byte22 Data	Byte23 Data	Byte24 Data
Para3	Para3	Para4	Para4	Para5	Para5	Para6	Para6	Para7	Para7	Para8	Para8
0	0	1	0	1	0	0	16	0	8	100	0
POLARITY=0		EMODE=1		EBEG=1		EEND=4096		TEACH-VAL=2048		TOL-HI=100	

Byte25 Data	Byte26 Data	Byte27 Data	Byte28 Data	Byte29 Data	Byte30 Data	Byte31 Data	Byte32 Data	Byte33 Data	Byte34 Data	Byte35 Data	Byte36 Data
Para9	Para9	Para10	Para10	Para11	Para11	Para12	Para12	Para13	Para13	Para14	Para14
100	0	2	0	0	0	0	0	0	0	0	0
TOL-LO=100		AVERAGE=2		TRIGMODE=0		ANAMODE=0		OPMODE=0		HWMODE=0	

Byte37 Data	Byte38 Data	Byte39 Data	Byte40 Data	Byte41 Data	Byte42 Data	Byte43 Data	Byte44 Data	Byte45 Data	Byte46 Data	Byte47 Data	Byte48 Data
Para15	Para15	Para16	Para16	Para17	Para17	Para18	Para18	Para19	Para19	Para20	Para20
0	0	20	0	60	0	0	0	4	0	8	0
VTHDMODE=0		VTHD-FIX=20		VTHD-AUTO=60		RS232MODE=0		RS232BAUD=4		SMOOTH=8	

Byte49 Data	Byte50 Data	Byte51 Data	Byte52 Data	Byte53 Data	Byte54 Data	Byte55 Data	Byte56 Data	Byte57 Data	Byte58 Data	Byte59 Data	Byte60 Data
Para21	Para21	Para22	Para22	Para23	Para23	Para24	Para24	Para25	Para25	Para26	Para26
0	0	10	0	0	0	0	0	0	0	0	0
INT-TRIGMODE=0		TRIG-PIX=10		OUTMODE=0		FREEPARA=0		FREEPARA=0		FREEPARA=0	

DATA FRAME Sensor → PC

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85 (dec)	1	0	0	0	0	170	81
ARG=0				LEN=0			

**< ORDER = 2 >** : READ PARAMETER-SET FROM RAM of the sensor

DATA FRAME PC → Sensor

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85 (dec)	2	0	0	0	0	170	185
ARG=0				LEN=0			

DATA FRAME Sensor → PC

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header	Byte9 Data	Byte10 Data	Byte11 Data	Byte12 Data
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)	Para1 (lo byte)	Para1 (hi byte)	Para2 (lo byte)	Para2 (hi byte)
85 (dec)	1	0	0	52	0	0	81	144	1	0	0
ARG=0				LEN=52				POWER=400		PMODE=0	

Byte13 Data	Byte14 Data	Byte15 Data	Byte16 Data	Byte17 Data	Byte18 Data	Byte19 Data	Byte20 Data	Byte21 Data	Byte22 Data	Byte23 Data	Byte24 Data
Para3	Para3	Para4	Para4	Para5	Para5	Para6	Para6	Para7	Para7	Para8	Para8
0	0	1	0	1	0	0	16	0	8	100	0
POLARITY=0		EMODE=1		EBEG=1		EEND=4096		TEACH-VAL=2048		TOL-HI=100	

Byte25 Data	Byte26 Data	Byte27 Data	Byte28 Data	Byte29 Data	Byte30 Data	Byte31 Data	Byte32 Data	Byte33 Data	Byte34 Data	Byte35 Data	Byte36 Data
Para9	Para9	Para10	Para10	Para11	Para11	Para12	Para12	Para13	Para13	Para14	Para14
100	0	2	0	0	0	0	0	0	0	0	0
TOL-LO=100		AVERAGE=2		TRIGMODE=0		ANAMODE=0		OPMODE=0		HWMODE=0	

Byte37 Data	Byte38 Data	Byte39 Data	Byte40 Data	Byte41 Data	Byte42 Data	Byte43 Data	Byte44 Data	Byte45 Data	Byte46 Data	Byte47 Data	Byte48 Data
Para15	Para15	Para16	Para16	Para17	Para17	Para18	Para18	Para19	Para19	Para20	Para20
0	0	20	0	60	0	0	0	4	0	8	0
VTHDMODE=0		VTHD-FIX=20		VTHD-AUTO=60		RS232MODE=0		RS232BAUD=4		SMOOTH=8	

Byte49 Data	Byte50 Data	Byte51 Data	Byte52 Data	Byte53 Data	Byte54 Data	Byte55 Data	Byte56 Data	Byte57 Data	Byte58 Data	Byte59 Data	Byte60 Data
Para21	Para21	Para22	Para22	Para23	Para23	Para24	Para24	Para25	Para25	Para26	Para26
0	0	10	0	0	0	0	0	0	0	0	0
INT-TRIGMODE=0		TRIG-PIX=10		OUTMODE=0		FREEPARA=0		FREEPARA=0		FREEPARA=0	

**< ORDER = 8 > : READ MEASUREMENT DATA from sensor**

DATA FRAME PC → Sensor

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85 (dec)	8	0	0	0	0	170	118
ARG=0				LEN=0			

DATA FRAME Sensor → PC

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header	Byte9 Data	Byte10 Data	Byte11 Data	Byte12 Data
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)	Raw1 (lo byte)	Raw1 (hi byte)	Raw2 (lo byte)	Raw2 (hi byte)
85 (dec)	8	0	0	44	0	36	118	208	7	160	15
ARG=0				LEN=44				E_LEFT = 2000		E_RIGHT = 4000	

Byte13 Data	Byte14 Data	Byte15 Data	Byte16 Data	Byte17 Data	Byte18 Data	Byte19 Data	Byte20 Data	Byte21 Data	Byte22 Data	Byte23 Data	Byte24 Data
Raw3	Raw3	Raw4	Raw4	Raw5	Raw5	Raw6	Raw6	Raw7	Raw7	Raw8	Raw8
208	7	2	0	172	13	0	0	0	8	108	7
M_VAL = 2000		EDGE_CNT=2		UM-VALUE=3500				TEACH_VAL = 2048		MV_FIRST = 1900	

Byte25 Data	Byte26 Data	Byte27 Data	Byte28 Data	Byte29 Data	Byte30 Data	Byte31 Data	Byte32 Data	Byte33 Data	Byte34 Data	Byte35 Data	Byte36 Data
Raw9	Raw9	Raw10	Raw10	Raw11	Raw11	Raw12	Raw12	Raw13	Raw13	Raw14	Raw14
52	8	185	7	17	176	0	0	7	4	100	0
MV_LAST = 2100		ANA_MAX = 1977		ANA_MIN = 1968		IN_STATE = 0		VIDEO_MAX = 1017		DARKPIX=100	

Byte37 Data	Byte38 Data	Byte39 Data	Byte40 Data	Byte41 Data	Byte42 Data	Byte43 Data	Byte44 Data
Raw15	Raw15	Raw16	Raw16	Raw17	Raw17	Raw18	Raw18
104	10	0	0	0	0	0	0
SCAN_TIME=1332				OUT_STATE=0		RAW18	

**< ORDER = 11 > : RESET MAX/MIN VALUE OF ANALOG-OUTPUT at sensor**

DATA FRAME PC → Sensor

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85 (dec)	11	0	0	0	0	170	118
ARG=0				LEN=0			

DATA FRAME Sensor → PC

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85 (dec)	190	0	0	0	0	170	195
ARG=0				LEN=0			

**< ORDER = 6 > : INITIATE TEACH-PROCEDURE at sensor (RAM)**

The actual measurement value is set as new TEACH-IN value

DATA FRAME PC → Sensor

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85	6	0	0	0	0	170	101
ARG=0				LEN=0			

DATA FRAME Sensor → PC

New TEACH-value is sent back

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header	Byte9 Data	Byte9 Data
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)	Para1 (lo byte)	Para1 (hi byte)
85 (dec)	7	0	0	1	0	170	195	232	3
ARG=0				LEN=1				TVAL=1000	

**< ORDER = 190 > : CHANGE BAUDRATE at sensor (RAM)**

DATA FRAME PC → Sensor

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header )
85 (dec)	190	1	0	0	0	170	14
ARG=1				LEN=0			

New baud rate is set by <ARG> value:

ARG=0: baud rate = 9600

ARG=1: baud rate = 19200

ARG=2: baud rate = 38400

ARG=3: baud rate = 57600

ARG=4: baud rate = 115200

DATA FRAME Sensor → PC

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header )
85 (dec)	190	0	0	0	0	170	195
ARG=0				LEN=0			



**< ORDER = 9 > : GET VIDEO-DATA INFORMATION of sensor**

ATTENTION: Only 256 pixel of the CMOS line-sensor are transferred!

The <ARG> value determines the source of the VIDEO-DATA-INFORMATION

ARG = 0 : CMOS-VIDEO-RAM-DATA

DATA FRAME PC → Sensor

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)
85 (dec)	9	0	0	0	0	170	185
ARG=0				LEN=0			

DATA FRAME Sensor → PC

Byte1 Header	Byte2 Header	Byte3 Header	Byte4 Header	Byte5 Header	Byte6 Header	Byte7 Header	Byte8 Header	Byte9 Data	Byte10 Data	Byte11 Data	Byte12 Data
0x55	<order>	<ARG> (lo byte)	<ARG> (hi byte)	<LEN> (lo byte)	<LEN> (hi byte)	CRC8 (Data)	CRC8 (Header)	Para1 (lo byte)	Para1 (hi byte)	Para2 (lo byte)	Para2 (hi byte)
85 (dec)	9	0	0	0	1	xxx	185	200	0	220	0
ARG=0				LEN=256				PIX1=200		PIX2=220	

Byte13 Data	Byte14 Data	Byte15 Data	Byte16 Data	Byte17 Data	Byte18 Data	Byte19 Data	Byte20 Data	Byte21 Data	Byte22 Data	Byte23 Data	Byte24 Data
Para3	Para3	Para4	Para4	Para5	Para5	Para6	Para6	Para7	Para7	Para8	Para8
240	0	0	1	44	1	124	1	0	2	88	2
PIX3=240		PIX4=256		PIX5=300		PIX6=380		PIX7=512		PIX8=600	

Byte25 Data	Byte26 Data	Byte27 Data	Byte28 Data	Byte29 Data	Byte30 Data	Byte31 Data	Byte32 Data	Byte33 Data	Byte34 Data	Byte35 Data	Byte36 Data
Para9	Para9	Para10	Para10	Para11	Para11	Para12	Para12	Para13	Para13	Para14	Para14
168	2	170	2	188	2	188	2	198	2	208	2
PIX9=680		PIX10=682		PIX11=700		PIX12=700		PIX13=710		PIX14=720	

Byte37 Data	Byte38 Data	Byte39 Data	Byte40 Data	Byte41 Data	Byte42 Data	Byte43 Data	Byte44 Data	Byte45 Data	Byte46 Data	Byte47 Data	Byte48 Data
Para15	Para15	Para16	Para16	Para17	Para17	Para18	Para18	Para19	Para19	Para20	Para20
34	3	32	3	32	3	22	3	19	3	20	3
PIX15=802		PIX16=800		PIX17=800		PIX18=790		PIX19=787		PIX20=788	

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Byte49 Data	Byte50 Data	Byte51 Data	Byte52 Data	Byte53 Data	Byte54 Data	Byte55 Data	Byte56 Data	Byte57 Data	Byte58 Data	Byte59 Data	Byte60 Data
Para251	Para251	Para252	Para252	Para253	Para253	Para254	Para254	Para255	Para255	Para256	Para256
124	1	44	1	0	1	240	0	220	0	200	0
PIX251=380		PIX252=300		PIX253=256		PIX254=240		PIX255=220		PIX256=200	