

Manual

Software L-LAS-RL-Scope V3.14

(PC software for Microsoft® Windows 7, Vista, XP, 2000, NT® 4.0, 98)

for laser line sensors of the L-LAS-RL Series (OY34 / OY65 Series)

L-LAS-RL-CON1 + L-LAS-RL-15-FE

L-LAS-RL-CON1 + L-LAS-RL-30-FE

L-LAS-RL-10- ...

L-LAS-RL-20- ...

L-LAS-RL-30- ...

L-LAS-RL-40- ...

L-LAS-RL-50- ...

L-LAS-RL-150- ...

L-LAS-CAM-256

L-LAS-CAM-512

L-LAS-CAM-1024

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1 Functional principle: L-LAS-RL line sensors

1.1 Technical description

In the sensors of the *L-LAS-RL* series the measurement object is illuminated with best possible homogeneous light distribution by means of a ring light comprising several LEDs. The transmitter light sources (LEDs) are available in various wavelength ranges (W:=white light LED, R:=red light LED (640nm), B:=blue light LED (520nm), and UV:=ultraviolet LED).

The sensor's receiver optics unit is equipped with a CCD line that comprises many closely adjacent, individual receiver elements (pixels) that are arranged in a line. The light quantity of each of these receiver elements that accumulates during the exposure time can be separately read out as an analog voltage, and after analog-digital conversion can be stored as a digital value in a data field (video information).

If there is a non-transparent measurement object in the sensor's reference distance, the light that is reflected from the object surface is mapped on the individual pixels of the CCD line. Depending on the reflectance of the object surface certain areas of the line's receiver elements (pixels) will be more illuminated, and other areas of the line will be less illuminated. As a result the pixels within the less illuminated zone will provide a considerably lower analog voltage than pixels that are better illuminated.

Suitable software algorithms are used to determine the shadow zones and the better illuminated zones from the video image. Since the distance of the pixels on the CCD line and the distance from the measurement object are known, the size and position of the differently well reflecting areas of the measurement object can be determined.

The sensors of the *L-LAS-RL* series feature a microcontroller that can be parameterised with a Windows PC software through the serial RS232 interface. Various evaluation modes can be set at the sensor. The housing of the control unit features a TEACH/RESET button and a potentiometer [1] for tolerance setting. Switching states are visualised by several LEDs (red, yellow, green) that are integrated at the housing of the *L-LAS-RL* sensor. The *L-LAS-RL* control unit has three digital outputs (OUT0, OUT1, OUT2) with software-adjustable output polarity. Two digital inputs (IN0, IN1) can be used to provide an external TEACH/RESET functionality and an external TRIGGER functionality by means of a PLC. The control unit also provides a high-speed analog output (0 ... 10V) and a current output (4 ... 20mA) with 12-bit digital/analog resolution.

[1] not available with all model ranges






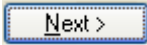
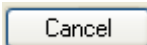
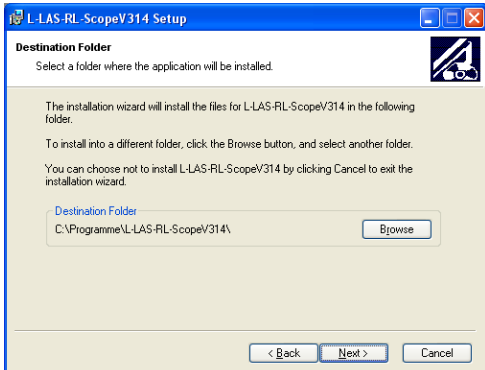
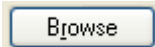
Abb.: L-LAS-RL-20-W

2 Installation of the *L-LAS-RL-Scope* software

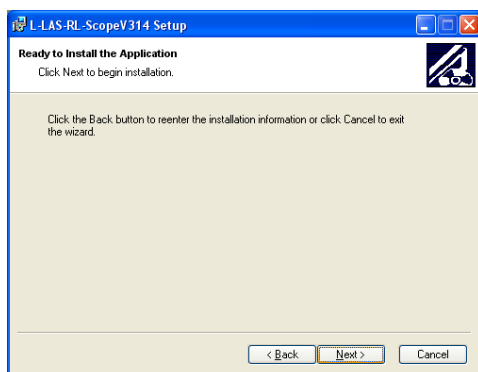
Hardware requirements for successful installation of the *L-LAS-TB-Scope* software:

- 800 MHz Pentium-compatible processor or better.
- CD-ROM or DVD-ROM drive
- Approx. 10 MByte of free hard disk space
- SVGA graphics card with at least 800x600 pixel resolution and 256 colors or better.
- Windows 98, Windows NT4.0, Windows XP, Windows Vista, or Windows 7 operating system
- Free serial RS232 interface or USB port with USB-RS/232 adaptor at the PC

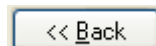
Please install the *L-LAS-TB-Scope* software as described below:

<p>1.  CD-Laufwerk (D:)</p>	<p>Insert the installation CD-ROM in your CD-ROM drive. In our example we suppose that this is drive "D".</p>
<p>2.  setup.exe</p>	<p>Start the Windows Explorer and in the folder tree of your CD-ROM drive go to the installation folder D:\Install\ . 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 START-Run... and then entering "D:\Install\setup.exe", which must be confirmed by pressing the OK button.</p>
<p>3. </p>	<p>The installation program then displays a dialog box for <i>L-LAS-RL-Scope</i> installation. This dialog box shows some general information about installation.</p> <p>Click on Next> to start the installation</p> <p></p> <p>or on Cancel to quit the installation of the <i>L-LAS-RL-Scope</i> software</p> <p></p>
<p></p>	<p>When you click on the Next> button, a new dialog appears for selecting the folder where the application will be installed (destination folder).</p> <p>You may accept the suggested folder with Next>, or you may change the installation folder as desired by clicking on the Browse button</p> <p></p>

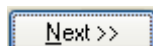
4.



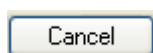
Another *L-LAS-RL-Scope* Setup dialog will be displayed.



Click on the **Back** button if you want to change the installation folder again.

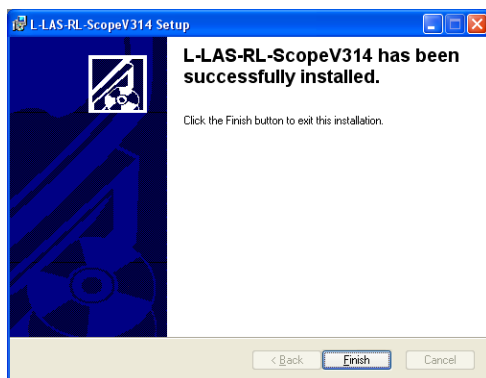


Click on **Next>>** to start the installation, or



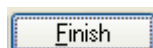
click on **Cancel** to quit the installation process.

5.



When installation is completed, a dialog box informs you about successful installation.

A new *L-LAS-RL-Scope* program group has been created under Start-All-Programs.



Click on the **Finish** button to finish the installation.

The *L-LAS-RL-Scope* software can now be started by clicking on the respective icon in the newly created program group under:

Start >All Programs > L-LAS-RL -ScopeV3.14



Deinstallation of the *L-LAS-RL-Scope* software:



Software

Please use the Windows deinstallation tool to remove the software.

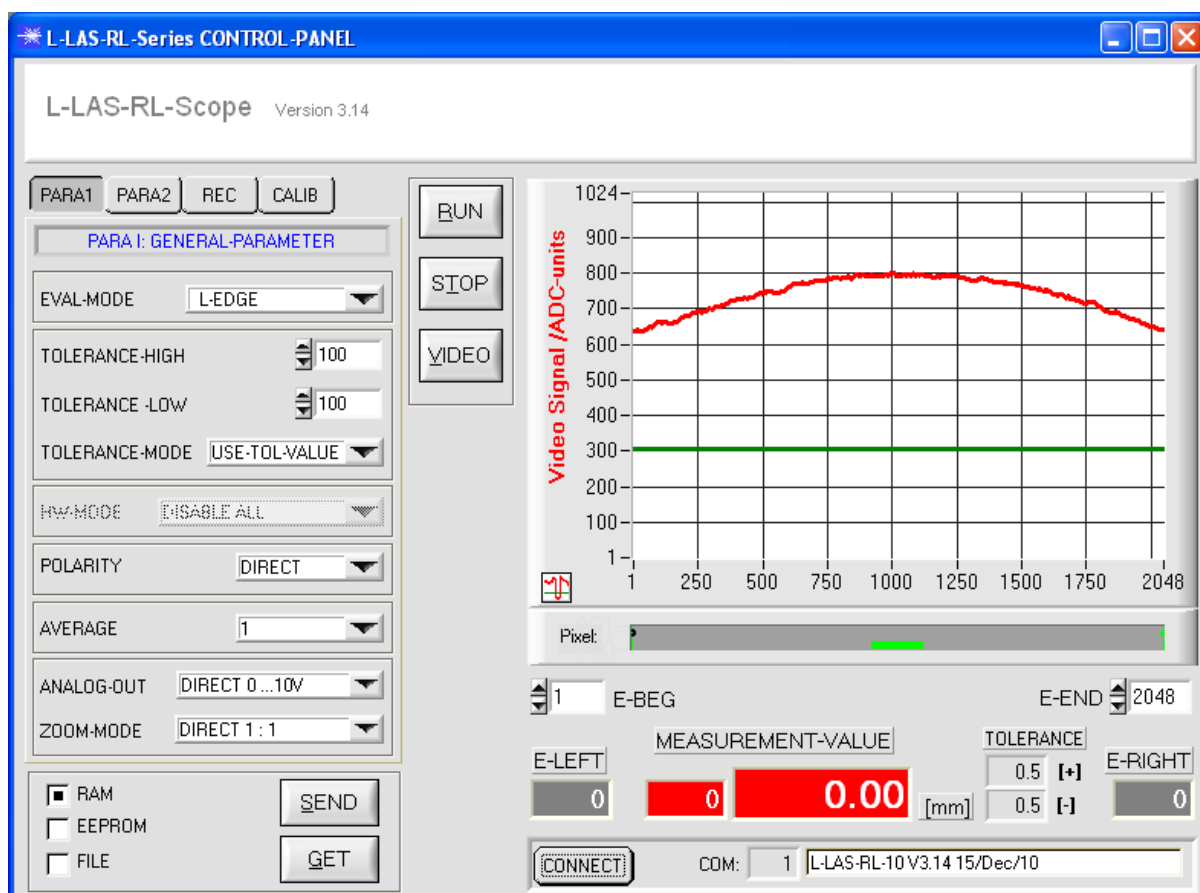
The Windows deinstallation tool can be found under Start / Settings / Control Panel.

3 Operation of the *L-LAS-RL-Scope* software

The *L-LAS-RL-Scope* software is used for parameterizing the electronic control unit used for controlling the *L-LAS-RL* 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-RL control unit*. The sensor system then continues to operate in "STAND-ALONE" mode without the PC.

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

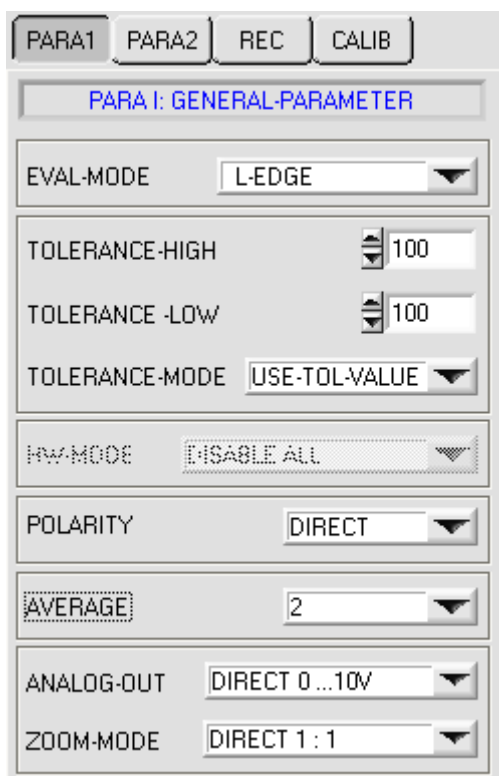
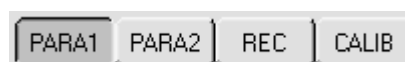


The *L-LAS-RL-Scope* CONTROL PANEL provides a great variety of functions:

- 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.
- 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-RL-Scope* software.

3.1 Control elements of the L-LAS-RL-Scope software:

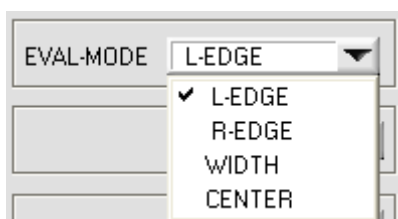
A click on the PARA1 button opens the PARAMETER I (PARA I) window, where various general parameters at the control unit can be set.



Attention !



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



EVAL-MODE:

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

L-EDGE:

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

R-EDGE:

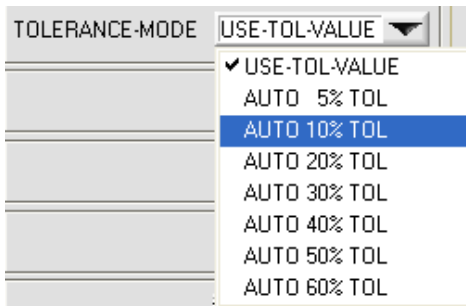
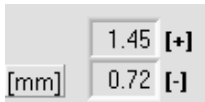
The 1st edge (right edge) of the CCD line's intensity profile, starting with the last pixel, is used as measurement value.

WIDTH:

The difference between the second and the first edge is used as measurement value: $WIDTH = R-EDGE - L-EDGE$

CENTER:

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



TOLERANCE-HIGH, -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 that are currently set at the sensor are shown in a numerical display field below the graphic display area in [mm].

TOLERANCE-MODE:

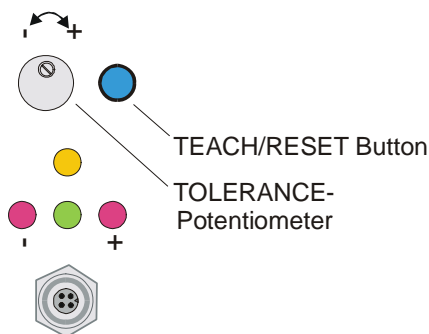
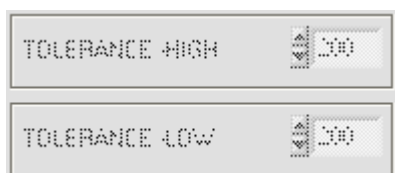
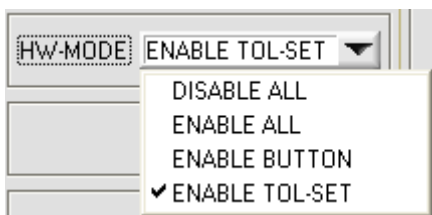
In this list selection field the operating mode for tolerance window setting can be preset.

USE-TOL-VALUE:

The values that are preset in the two numeric function fields TOLERANCE-HIGH and TOLERANCE-LOW are used for the upper and lower tolerance limits.

AUTO xx% TOL:

Automatic setting of upper and lower tolerance limits. The tolerance limits are calculated as a percentage value of the respective active TEACH-VALUE.



HARDWARE (Hardware-Mode) [1]:

The TOLERANCE potentiometer and the TEACH/RESET button at the housing of the *L-LAS-RL 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.

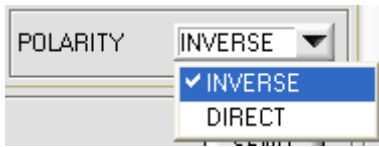
ENABLE BUTTON:

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 all models



POLARITY:

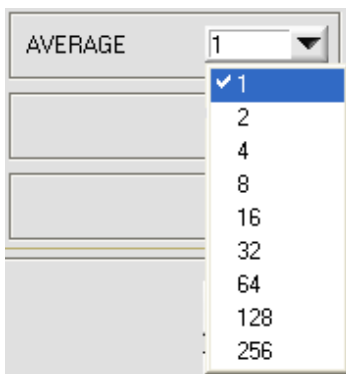
In this function field the output polarity at the *L-LAS-RL* sensor can be set with a mouse-click. The *L-LAS-RL* sensor has 3 digital outputs (OUT0, OUT1, OUT2) through which error states can be sent to the PLC.

DIRECT:

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

INVERSE:

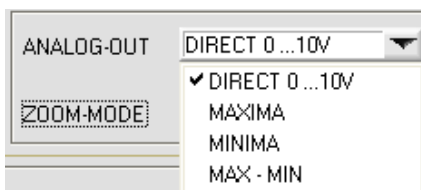
In case of an error, the respective digital output is set to the reference potential (GND/0V, red LED on).



AVERAGE:

In this function field the averaging at the *L-LAS-RL* 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 256. The measurement value that is determined by this also is provided at the analog output pin8/red/.



ANALOG-OUT (Analog-Output-Mode):

Function element for selecting the output mode of the analog voltage at the *L-LAS-RL* 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:

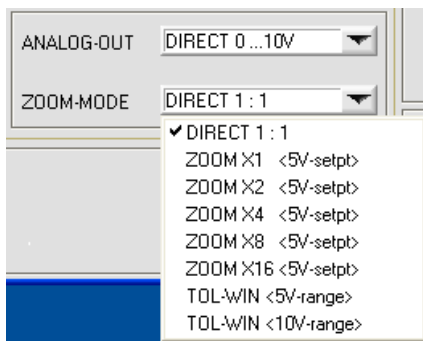
The current maximum value is provided at the analog output pin8/red/ (drag pointer principle, resetting by input IN1/pin4/yellow pulse of <750ms length, or by pressing the TEACH/RESET button).

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).



ZOOM-MODE (Analog-Output):

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

PARA1 PARA2 REC CALIB

PARA II: GENERAL-PARAMETER

POWER EXP-TIME[ms] V-THD[%]

1000 500 0 200

20 10 1 2

100 50 1 30

POWER-MODE STAT

SMOOTH-VIDEO-SIGNAL OFF

VIDEO-THD-MODE FIXED

REFRESH V-THD

RAM EE

1024 TEACH-VALUE[Pixel] TEACH

EXT-INO-MODE TEACH/RESET

PARA1 PARA2 REC CALIB

A click on the PARA2 button opens the PARAMETER II (PARA II) window, where additional parameters at the control unit can be set.



Attention !

SEND

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

POWER

1000 500 0 150

POWER:

In this function field the transmitter power at the lighting unit of the *L-LAS-RL* sensor (LED ring illumination) can be set by using the arrows or the slider, or by entering a numerical value in the respective input field.

EXP-TIME[ms]

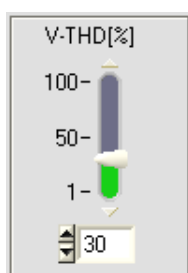
20 10 1 2

EXPOSURE-TIME[ms]:

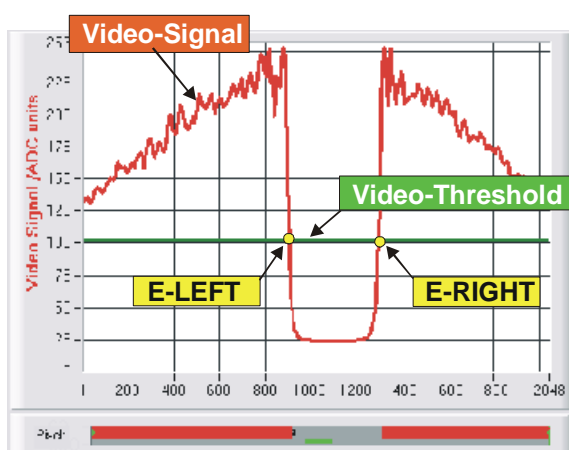
In this function field the exposure time at the *L-LAS-RL* sensor can be set by using the arrows or the slider or by entering a numeric value in the respective input field.

With very dark or matt surfaces, increasing the exposure time may help to ensure that sufficient light intensity arrives at the CCD line.

A longer exposure time reduces the scan frequency of the sensor.
(e.g. 2ms=500Hz, 10ms=100Hz).



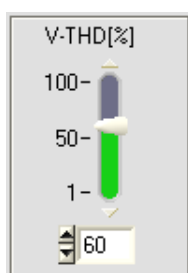
FIXED-Video Threshold



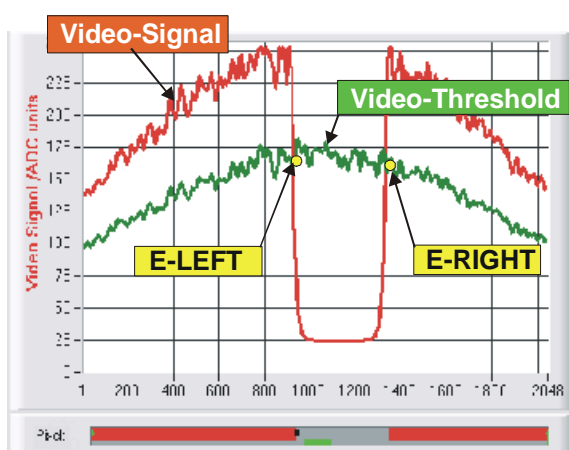
FIXED-VIDEO-THD[%]:

In this function field the video threshold at the *L-LAS-RL* 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 CCD 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.

The x-value of the respective intersection point is assigned to a pixel on the CCD line. The measurement value can be calculated from this information and from the known distances of the pixels on the CCD 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

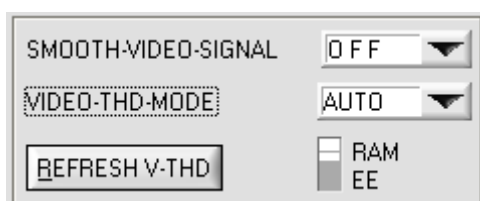


AUTO-VIDEO-THD[%]:

When the toggle switch is in AUTO position, the threshold that is stored in the non-volatile EEPROM/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 CCD 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.

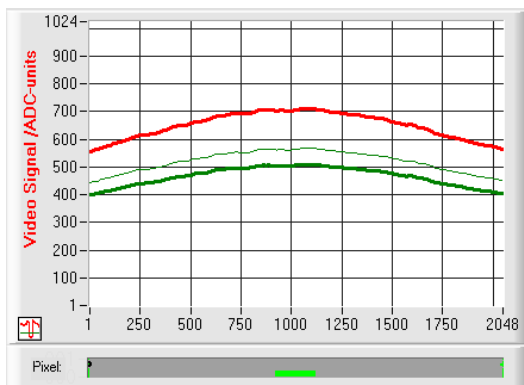


VIDEO-THD-MODE AUTO:

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

RAM: The video threshold is saved in the volatile RAM memory.

EE: The video threshold is saved in the non-volatile EEPROM memory.



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 video signal (red curve) and thus "follows" the intensity profile.

The distance between follow-up video threshold and intensity profile can be chosen very small, which is helpful for the measurement of semi-transparent objects (e.g. foils).



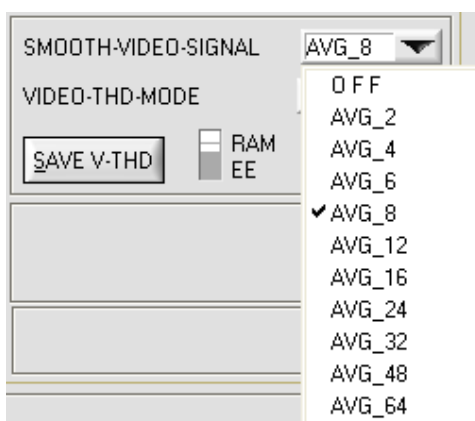
Attention !

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 new video threshold in the volatile RAM or permanently in the non-volatile EEPROM memory at the *L-LAS-RL* sensor.



SMOOTH-VIDEO-SIGNAL:

A click on the SMOOTH-VIDEO-SIGNAL drop-down list field opens the setting options for the activation of a digital 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.

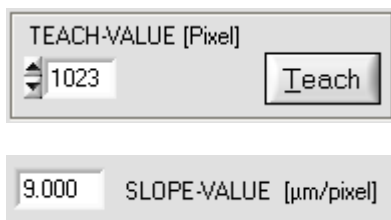
AVG 2:

The video signal of two adjacent pixels is subjected to averaging.

...

AVG 64:

The video signal of 64 adjacent pixels is subjected to averaging.



TEACH-VALUE [Pixel]:

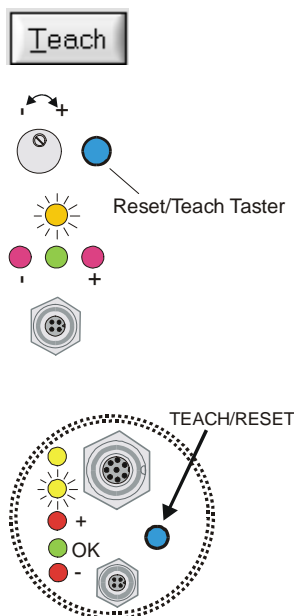
Numeric input field for setting the current teach value (setpoint value) in pixels. The teach value that is set here only is activated at the *L-LAS-RL sensor* after a click on the SEND button.

The teach value is set in pixels. As with the tolerance value, conversion into µm can be done by means of the SLOPE-VALUE (sensitivity – µm/pixel).

Example for the teach value with the values shown in the screenshots:

$$TEACH_VALUE [mm] = SLOPE * TEACH [Pixel]$$

$$TEACH_VALUE [mm] = 9.000[\mu m/Pixel] * 1024[Pixel] = 9.216 mm$$

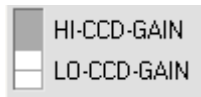


After a click on the TEACH button the current edge information is stored as a teach value to the RAM memory of the *L-LAS-TB sensor*. Depending on the evaluation mode that has been set (E-MODE), the left edge, the right edge, the width (WIDTH), or the center position (CENTER) will be stored as a teach value in the RAM memory of the L-LAS 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 at the housing (pressing the button for $t > 1.5s$) or by way of a high level at digital input IN1/yellow/pin4 ($t > 1.5s$).

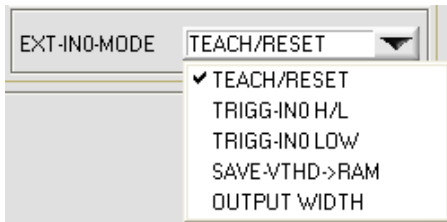
With sensors of type RL-20 (M34) the teach process can be started by pressing the button at the housing or by applying a LOW voltage (GND) at digital input IN0/green/pin3.



CCD-GAIN:

With this toggle switch the gain stage at the CCD pre-amplifier electronics can be set in 2 steps.

This function field is not applicable for any *L-LAS-RL* sensor type!



EXT-IN0-MODE:

TEACH/RESET:

Reset of maximum values by a pulse of duration $t < 750\text{ms}$. Teach function at the sensor by a pulse of duration $t > 1.5\text{s}$.

TRIGG-IN0 H/L (for type RL-20) or L/H:

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

TRIGG-IN0 LOW (for type RL-20) or HIGH:

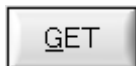
External triggering of measurement value evaluation through a high level ($+U_b$) at digital input IN0/pin3/green.

SAVE-VTHD ->RAM:

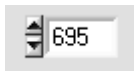
Saving of the follow-up video threshold to the volatile RAM memory upon an edge change at digital input IN0/pin3/green.

OUTPUT WIDTH:

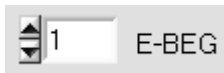
Output of width information upon a level change at input IN0.



The newly taught setpoint value can be read out through the serial interface by clicking on the GET button.



The new teach value is then shown in the TEACH display field.



E-BEG:

Numeric input field for entering the beginning of evaluation. The CCD line is evaluated starting from the pixel that is set here (Evaluation-Begin). (Default value = 1).



E-END:

Numeric input field for entering the end of evaluation. The CCD line is evaluated up to this pixel. Pixels on the right side of the pixel value that is set here will not be evaluated.



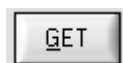
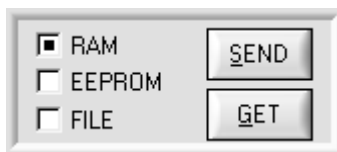
Reset button (maximum-minimum values):

A click on the RESET button resets the current maximum and minimum values that are detected by the *L-LAS-RL* 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 $t < 750\text{ms}$) 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-RL* sensor.

Please note:

This RESET function does not perform a hardware/software reset at the *L-LAS-RL* sensor, it only resets the maximum and minimum values!



PARAMETER TRANSFER:

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

SEND:

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

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

GET:

When the GET button is clicked, the setting parameters are transferred from the *L-LAS-RL sensor* 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-RL sensor*, 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-RL sensor* is turned off.

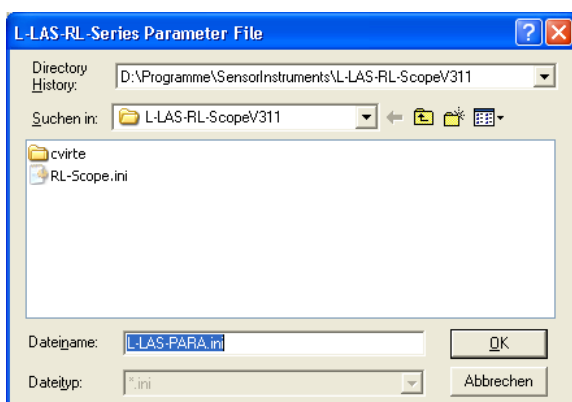
EEPROM:

The currently set parameters are written to the non-volatile EEPROM memory of the *L-LAS-RL sensor*, 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-RL sensor*, these must be written to the RAM of the *L-LAS-RL sensor* by selecting the RAM button and then clicking on SEND. The *L-LAS-RL sensor* 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-PARA.ini".

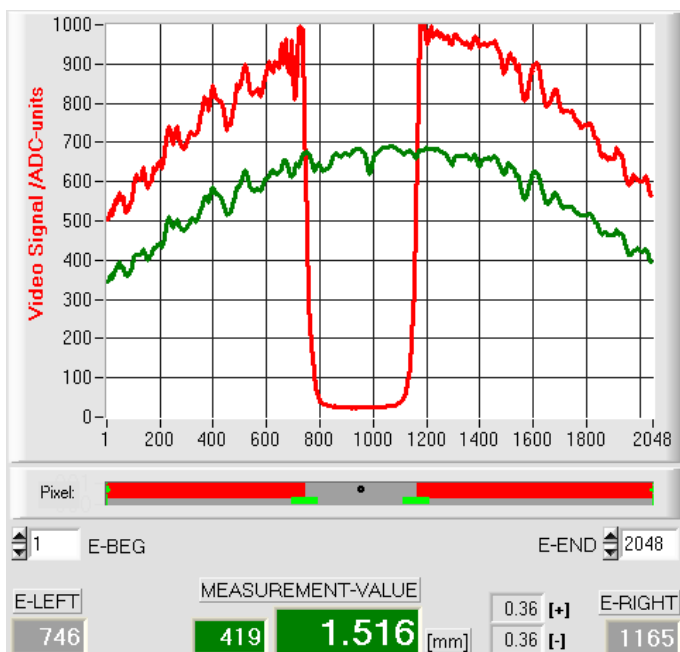
The output file can be opened e.g. with the standard Windows "Editor" program.

3.2 Numeric and graphic display elements:



VIDEO button:

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



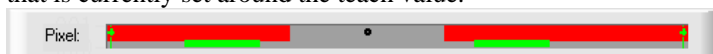
The y-axis shows the analog signals of the individual pixels. The analog values (video signals) of the CCD line are converted by means of an AD converter with 10-bit resolution, which results in a y-axis value range of 0 ... 1023.

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 CCD 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 CCD 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.



E-LEFT:

Numeric display field that shows the current left edge position.



E-RIGHT:

Numeric display field that shows the current right edge position.



M-VALUE:

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

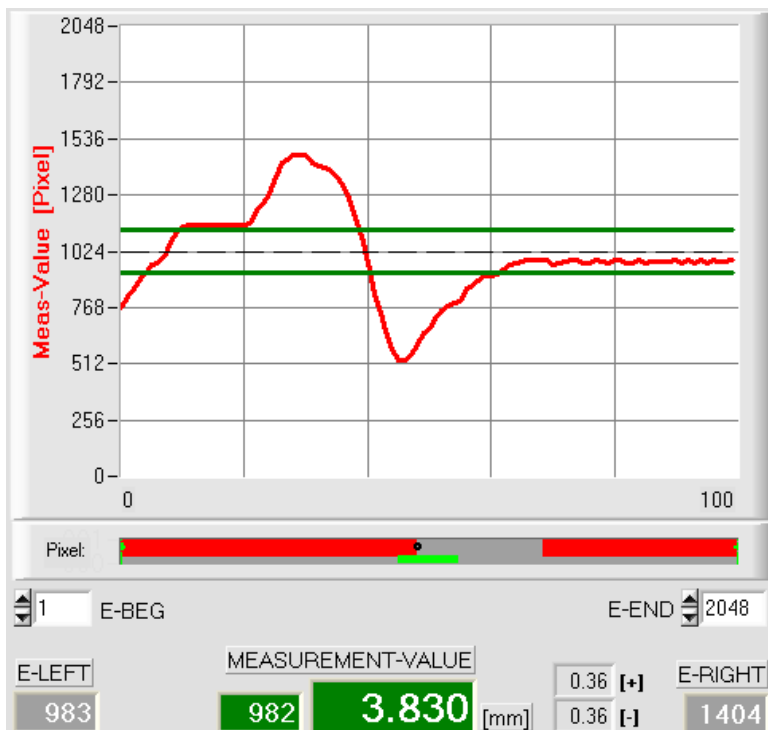
The left numeric display field shows the current measurement value in pixels, whereas the middle big display field shows the measurement value converted into millimeters.

Besides, the upper and lower tolerance limits are displayed.



RUN button:

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



After a click on the RUN button the current measurement value is shown in the graphic display window in "scroll mode". In the form of a red curve the measurement values pass through the graphic display window from the right to the left.

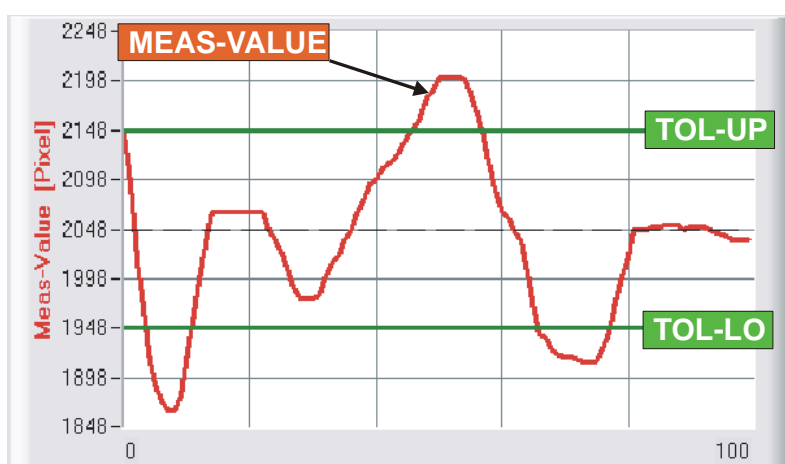
The division of the y-axis corresponds with the pixels of the CCD line, or with the virtual number of sub-pixels of the line. In the graphic display the current measurement value (M-VALUE=717) is shown at the right end at the x-value of 100.

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.

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



ZOOM

A click on the ZOOM button automatically rescales the y-axis of the graphic window, which provides a clearer display of measurement value changes.

The picture on the left shows the time characteristic of the measurement value changes as a red curve, and the tolerance band as two green lines. The teach value is shown as a broken horizontal line.

3.3 Serial RS232 data transfer:

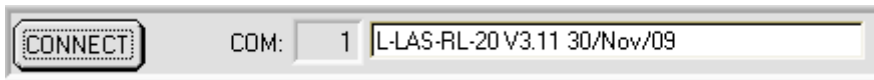
RS232 COMMUNICATION:

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



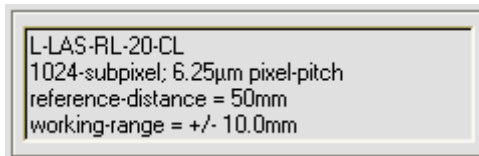
Attention !

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-RL sensor*. 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-RL sensor* it is therefore necessary to stop the data exchange during the normal monitoring process (click on the STOP button).

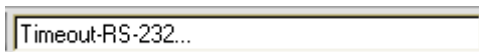


CONNECT:

When the software is started, it attempts to establish a connection to the *L-LAS-RL control unit* through the standard COM1 interface. If connection could be established successfully, the current firmware version is displayed in the status line.



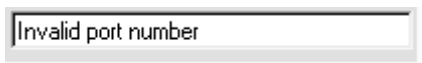
In an information field the CALIB panel furthermore shows the current sensor type as detected by the software as well as other parameters. If another sensor type is connected to the RS-232 interface, the CONNECT function field must always be selected again so that the PC software can properly detect the current sensor type.



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

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

If the number of the serial interface that is assigned at the PC should not be known, interfaces COM1 to COM9 can be selected by using the CONNECT drop-down list.



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.

3.4 L-LAS-RL-Scope as an aid for sensor adjustment:



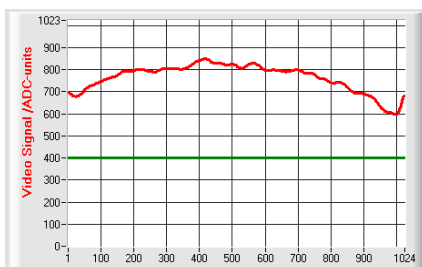
VIDEO:

After a click on the VIDEO button, the fine adjustment between the *L-LAS-RL 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:

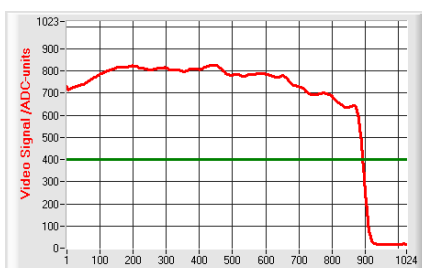
A mouse-click on the STOP button stops the data transfer between the *L-LAS-RL sensor* and the PC.



Optimal adjustment:

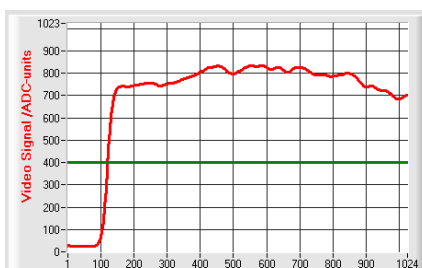
In the graphic display window the intensity profile is shown as a red curve. The numerical values 1 ... 1024 on the x-axis represent the individual pixels of the CCD line. The analog values of the CCD line are converted by way of an AD converter with 10-bit resolution, which results in a y-axis value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

As can be seen in the picture on the left, the CCD pixels 1 to 1024 are uniformly illuminated by the transmitter beam.



Wrong adjustment - right:

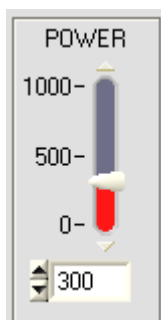
The transmitter beam no longer sufficiently illuminates the pixels at the right end of the CCD line. The red curve (intensity profile) in this part clearly is under way of the video threshold. The alignment of the laser transmitter unit or the CCD receiver unit must be readjusted in such a way that the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

3.5 L-LAS-RL-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.



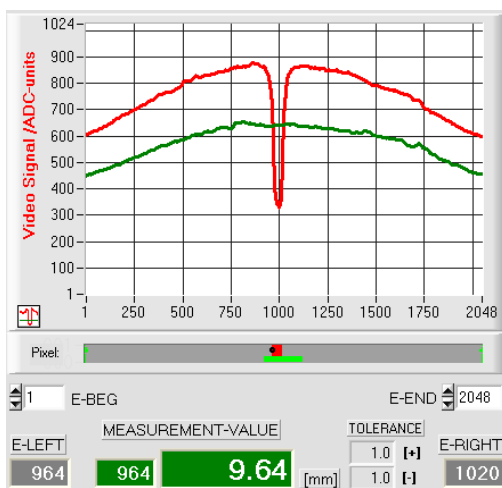
Attention !

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-RL 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.

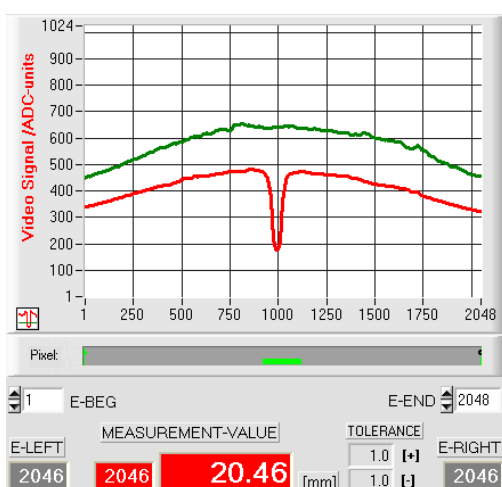


Optimal adjustment:

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

In the shadowed area (low reflection at the measurement object) the intensity profile lies below the green video threshold. (ADC-values < video threshold).

A meaningful measurement value can be derived from the intersection points of video threshold (green) and intensity profile (red).



Transmitter power too low:

The intensity profile (red line) of the CCD line completely lies under the video threshold (green line).

The *L-LAS-RL 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 2048 lies above the video threshold.

4 Evaluation modes

4.1 LEFT-EDGE



L-EDGE:

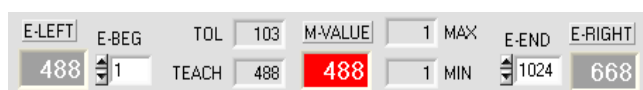
The first detected edge in the intensity profile of the CCD line is evaluated.



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

The one pixel of the CCD 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. 488.



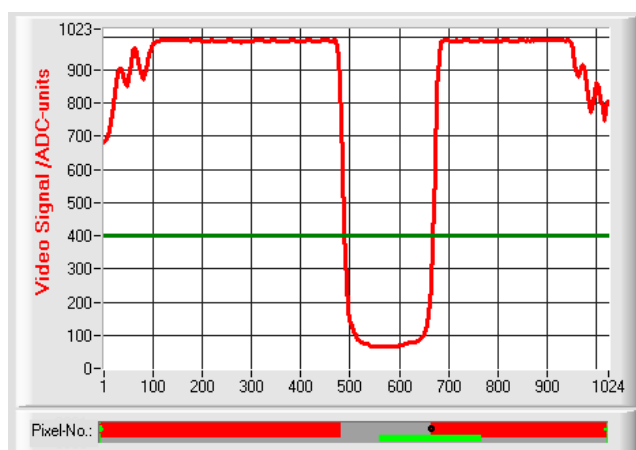
The current measurement value M-VALUE = E-LEFT is shown in the red numeric display element.

4.2 RIGHT-EDGE



R-EDGE:

The second detected edge in the intensity profile of the CCD line is evaluated.



The one pixel of the CCD 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. 668.

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



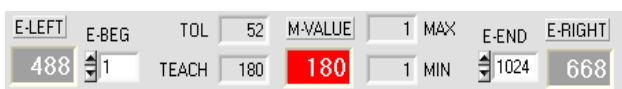
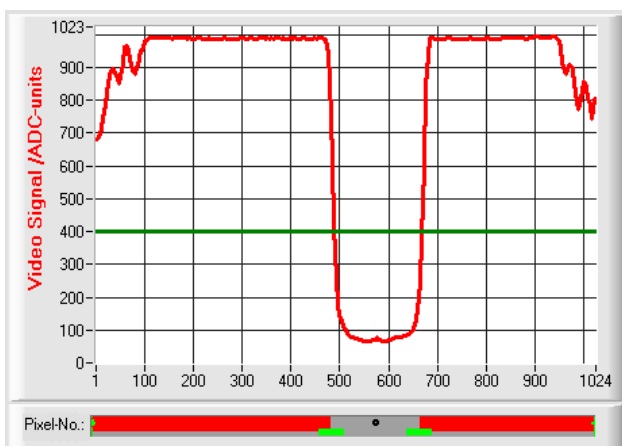
The current measurement value M-VALUE = E-RIGHT is shown in the red numeric display element.

4.3 WIDTH



WIDTH:

The difference between the second edge and the first edge in the intensity profile of the CCD 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. 668, and the first bright/dark transition at pixel no. 488.

The difference is calculated as follows:

$$WIDTH = E_RIGHT - E_LEFT$$

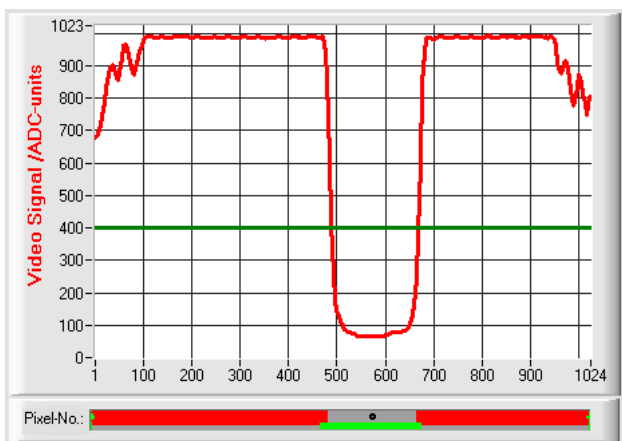
The current measurement value M-VALUE = WIDTH is shown in the red numeric display element.

4.4 CENTER



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).

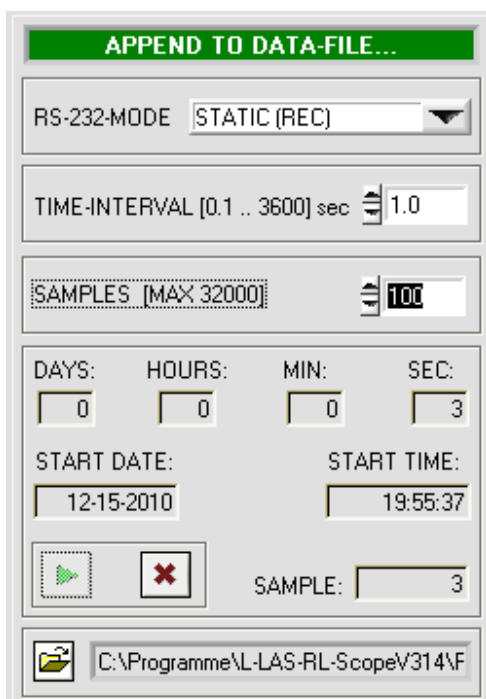
In the example picture on the left, the second bright/dark transition is detected at pixel no. 668, and the first bright/dark transition at pixel no. 488.

The mean value is calculated as follows:

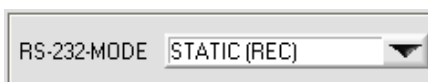
$$CENTER = \frac{(E_RIGHT + E_LEFT)}{2}$$

The current measurement value M-VALUE = CENTER is shown in the red numeric display element.

5 Function of the data recorder




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



RS-232-MODE:

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

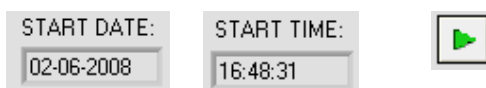
TRIG-IN0 L/H (REC):

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

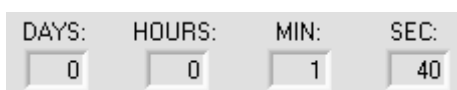
TRIG-IN0 L/H (3-BYTE), CONTINUOUS (3-BYTE):

Cannot be used with the data recorder!

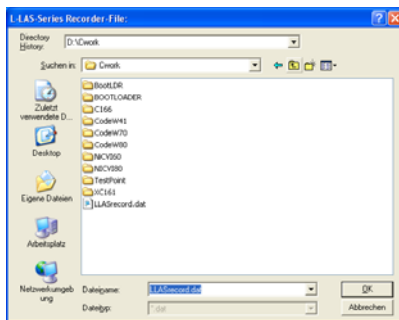
High-speed 3-BYTE data transfer -> see chapter 5.2.



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



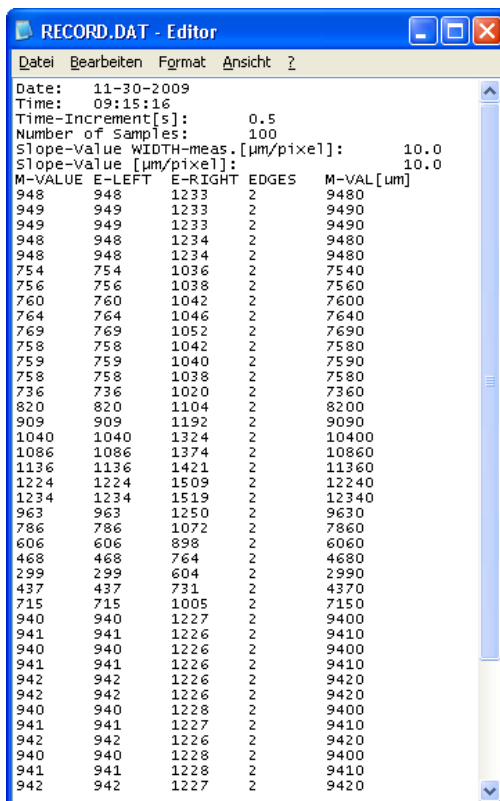
STOP

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 5 columns that are separated from each other by a TAB control character.

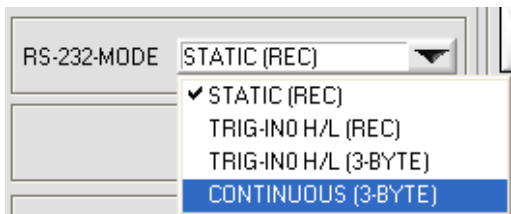
The output file can be opened with a simple text editor or a spreadsheet program (e.g. Microsoft EXCEL).



1. column = Measurement value (pixel) M-VALUE
2. column = Measurement value (pixel) E-LEFT
3. column = Measurement value (pixel) E-RIGHT
4. column = Number of EDGES
5. column = Measurement value (micrometer) M-VAL [μm]

5.2 3-Byte RS232 data transfer

Fast data transfer of digital values (pixel values) from the *L-LAS-RL 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.

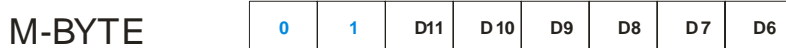
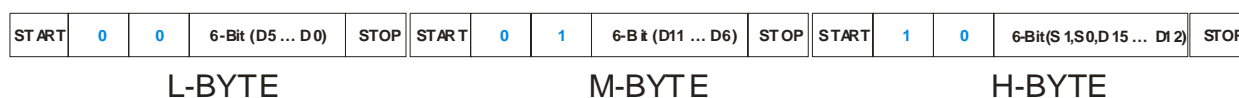
CONTINUOUS (3-Byte):

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

Setting of the RS-232 interface:

- Standard RS-232 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.

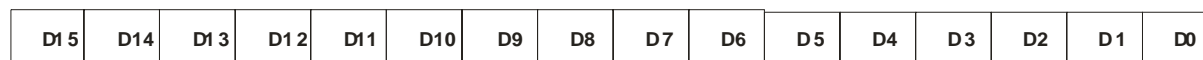
Transmission format of 3-byte data transfer:



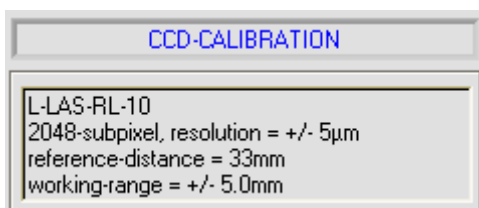
Extraction of the digital value (D0 – D15):

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



Conversion of digital value into mm – value:

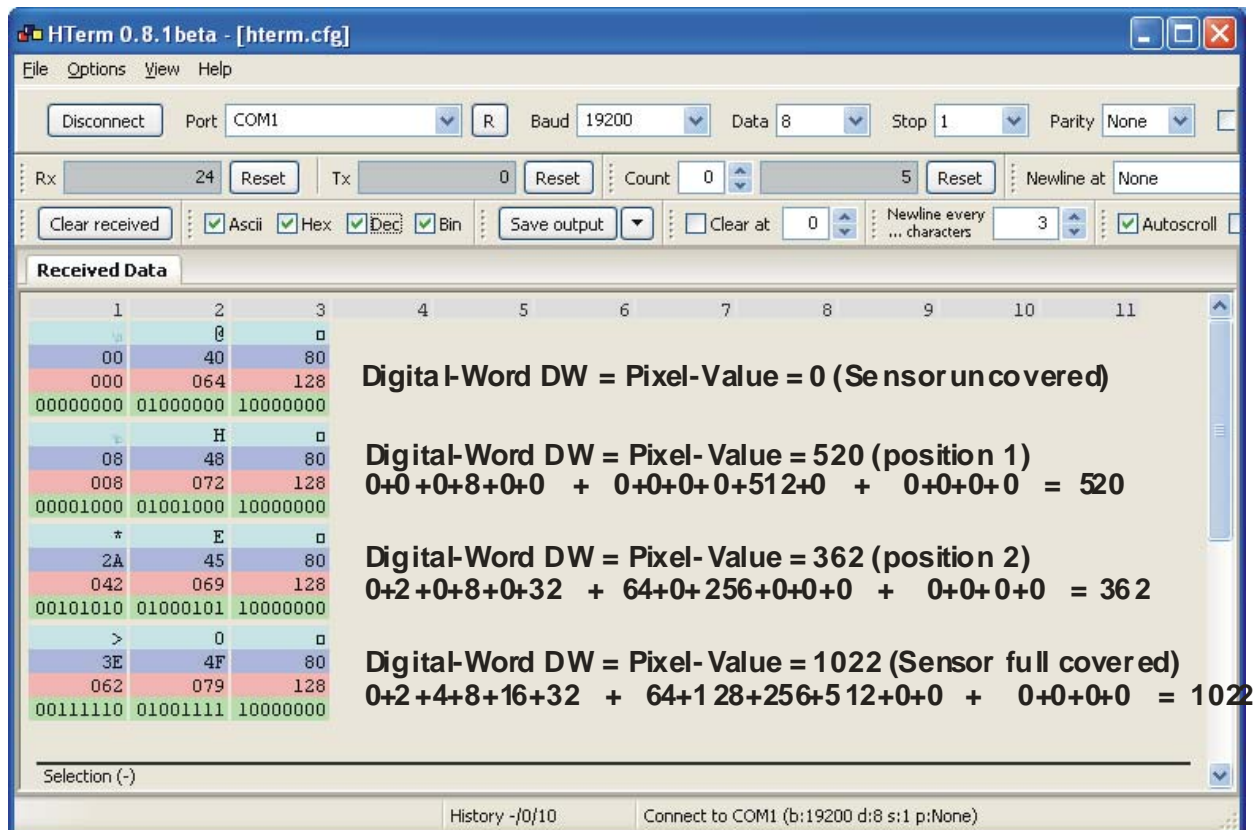


The millimetre value can be determined from the digital value and the pixel pitch. The pixel pitch is sensor-specific.

Example: *L-LAS-RL-10* with 0.5µm pixel pitch:
Measurement value [mm] = DW * 0.005mm

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 0.8.1 beta window 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 calculations for digital word extraction are as follows:

- 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 CCD Calibration

PARA1 PARA2 REC CALIB

CCD-CALIBRATION

L-LAS-RL-20-CL
1024-subpixel; 6.25µm pixel-pitch
reference-distance = 50mm
working-range = +/- 10.0mm

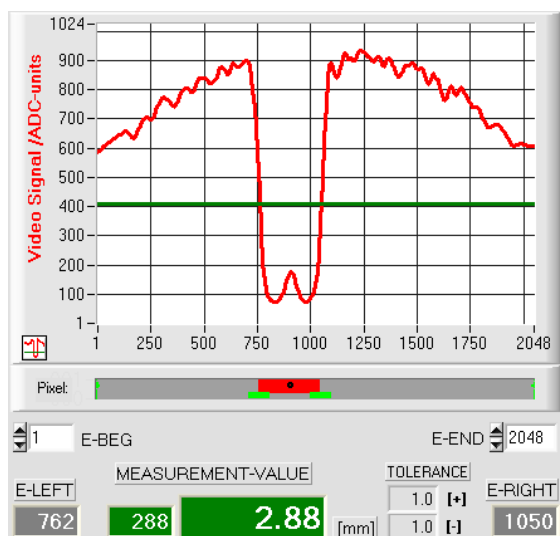
☐ BACKGROUND-COMP. ON
☐ BACKGROUND-COMP. OFF

☒ **ACTIVATE WIDTH-CALIBRATION**

OBJECT-DIAMETER [µm]
1000 0 PIXEL

SLOPE-WIDTH-MEAS [µm/pixel]
10.000 0.000

10.000 SLOPE-VALUE [µm/pixel]



The measurement object has a diameter of 3.0mm, but the measurement value only is 2.88 mm.

PARA1 PARA2 REC CALIB

CCD-CALIBRATION:

A click on the CALIB button opens the CCD-CALIBRATION window. This CCD-CALIBRATION window allows two-point calibration at the sensor.

For the width measurement value (EVAL-MODE=WIDTH), for example, a separate value for the slope (SLOPE µm/pixel) can be preset.

EVAL-MODE WIDTH

The problem with width measurement in reflected-light operation is that with identical reflectance of the measurement object surface the width measurement value largely depends on the set video threshold and the respective set transmitter power.

For fine calibration, width calibration can be activated for the measurement object with known object dimensions (e.g. 3.0mm):

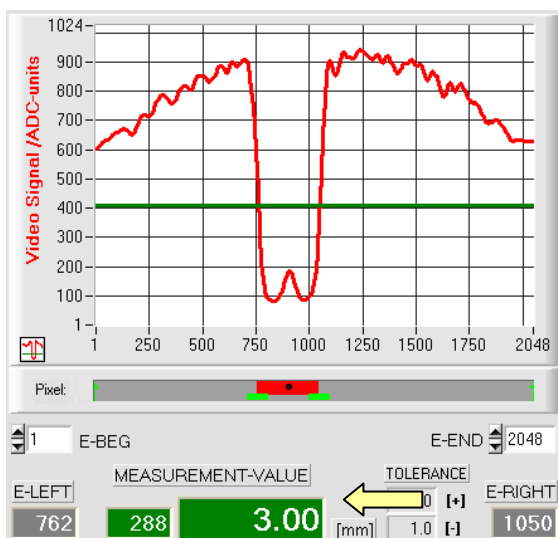
☒ **ACTIVATE WIDTH-CALIBRATION**

OBJECT-DIAMETER [µm]
3000 288 PIXEL

SLOPE-WIDTH-MEAS [µm/pixel]
10.000 10.417

Enter the true width value (e.g.: 3000µm) in the edit field, then click on the Accept button.

After a click on the Accept button, the slope value SLOPE-WIDTH-MEAS (here for example 10.417µm/pixel) is automatically calculated from the known object width and the measured pixel value (288).



Attention !

A click on the SAVE button only saves the new calibration data to the volatile RAM memory! To save them permanently, click on SEND + EEPROM!

After a click on the SAVE button the width of the measurement object then is correctly displayed with the newly determined SLOPE-WIDTH-value (10.417).

SAVE

☐ ACTIVATE WIDTH CALIBRATION

OBJECT-DIAMETER [μm] PIXEL

SLOPE-WIDTH-MEAS [$\mu\text{m}/\text{pixel}$]

EXIT!

A click on the EXIT button cancels fine calibration without saving the calibration values.

Manual input of calibration data:

SLOPE-WIDTH-MEAS [$\mu\text{m}/\text{pixel}$]

☒ RAM ☐ EEPROM ☐ FILE

The calibration data also can be modified manually at the control unit of the sensor.

When the CALIB pop-up window has been opened, the numerical values can at any time be changed manually in the corresponding numerical input fields, 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 SEND button.

SLOPE-WIDTH-MEAS [$\mu\text{m}/\text{pixel}$]

Calibration value SLOPE-WIDTH-MEAS [$\mu\text{m}/\text{pixel}$] for evaluation mode WIDTH.

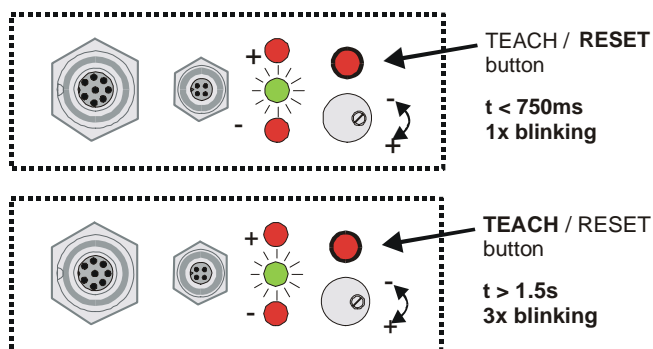
SLOPE-VALUE [$\mu\text{m}/\text{pixel}$]

Calibration value SLOPE-VALUE [$\mu\text{m}/\text{pixel}$] for evaluation modes REDGE, LEDGE, and CENTER

7 Annex

7.1 Function of the TEACH/RESET button

The housing of the *L-LAS-RL* sensor features a pushbutton with two functions:



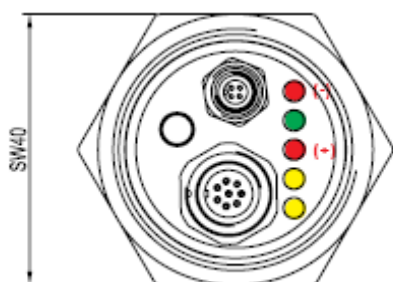
RESET function:

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.



(M34) - Types:

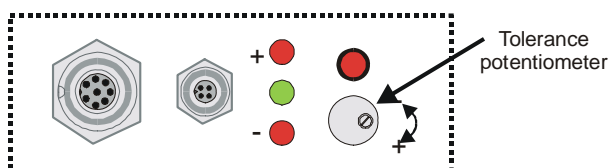
With sensors of type M34-CL the teach/reset function can be activated by pressing the button at the housing.

Reset: LED/yellow blinks 1x

Teach: LED/yellow blinks 3x

7.2 Function of the tolerance potentiometer

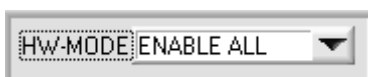
The housing of the *L-LAS-RL* sensor features a potentiometer for setting the tolerance band width [1] .



TOLERANCE potentiometer:

Turning the potentiometer clockwise increases the tolerance band width.

Turning it counter-clockwise decreases the tolerance band width.

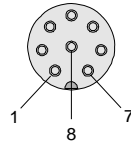
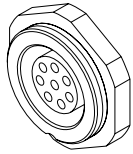


The potentiometer must be activated (switch position ENABLE ALL or ENABLE TOL SET) in order to use it for setting the tolerance band width at the *L-LAS-RL* sensor.

[1] not available with type M34-RL-20

7.3 Function of digital inputs IN0 and IN1

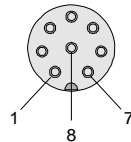
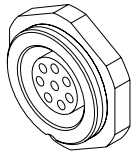
The *L-LAS-TB sensor* has two digital inputs IN0 and IN1 [1] that can be contacted through the 8-pole female connector (type Binder 712).



STANDARD TYPE

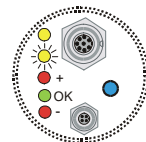
Pin:	Color:	Assignment:
1	white	0V (GND)
2	brown	+24VDC +/- 10% (U_b)
3	green	IN0 (EXT TRIGGER)
4	yellow	IN1 (TEACH/RESET)
5	gray	OUT0 (-)
6	pink	OUT1 (+)
7	blue	OUT2 (OK)
8	red	ANALOG (0...+10V)

[1] IN1 not available with type M34-RL-20:



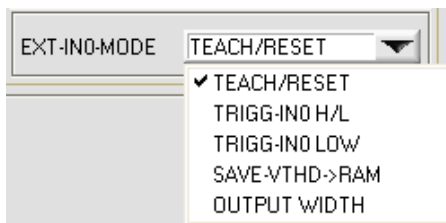
M-34 HOUSING TYPE

Pin:	Color:	Assignment:
1	white	0V (GND)
2	brown	+24VDC +/- 10% (U_b)
3	green	IN0 (EXT TRIGGER)
4	yellow	OUT0 (-)
5	gray	OUT1 (+)
6	pink	OUT2 (OK)
7	blue	I-OUT (4/20mA)
8	red	ANALOG (0...+10V)



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:

TEACH/RESET (only for type M34-RL-20):

Reset of maximum values by a pulse of duration $t < 750\text{ms}$.
Teach function at the sensor by a pulse of duration $t > 1.5\text{s}$.

TRIGG-IN0 H/L (for type RL-20) or L/H:

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

TRIGG-IN0 LOW (for type RL-20) or HIGH:

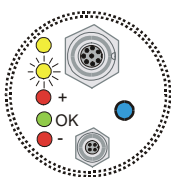
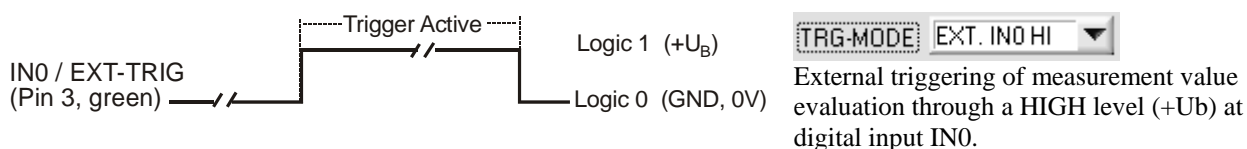
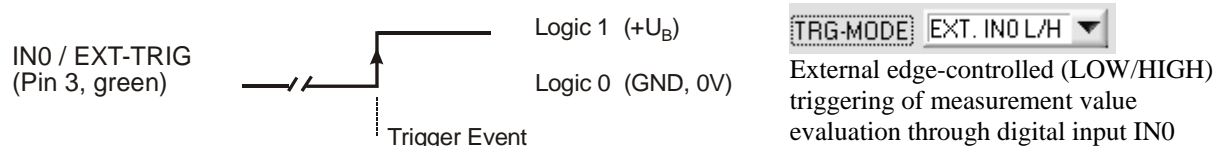
External triggering of measurement value evaluation through a high level ($+U_b$) at digital input IN0/pin3/green.

SAVE-VTHD ->RAM:

Saving of the follow-up video threshold to the volatile RAM memory upon an edge change at digital input IN0/pin3/green.

OUTPUT WIDTH:

Output of width information upon a level change at input IN0.



With sensor type L-LAS-RL-20 (M-34) digital input IN0/pin3/green is

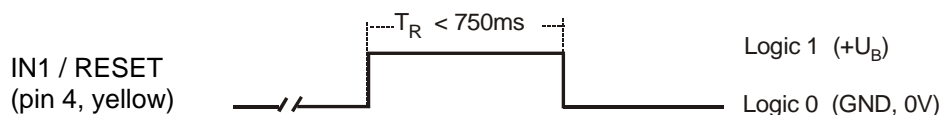
LOW-ACTIVE!

This means that a level change from HIGH/LOW triggers the respective function!

DIGITAL INPUT IN1 (Pin4/yellow) TEACH/RESET:

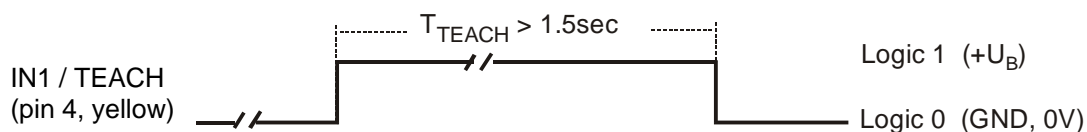
RESET function:

When a HIGH pulse of less than **750 ms** duration is applied, the RESET function is performed at the *L-LAS-RL* 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.

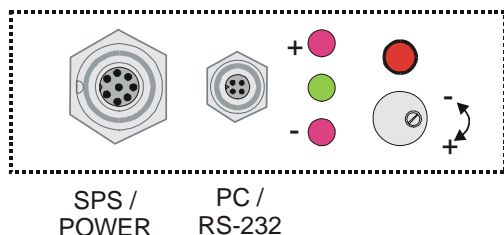


TEACH function:

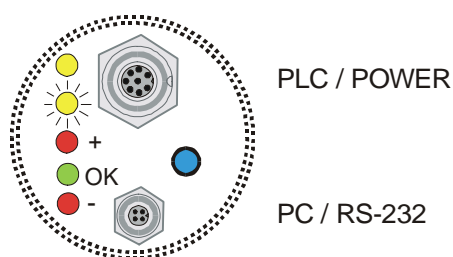
When a HIGH pulse of more than **1.5s** duration is applied, the TEACH function is performed at the *L-LAS-TB* sensor. When a TEACH pulse is detected, the green LED at the housing flashes shortly three times.



7.4 Connector assignment



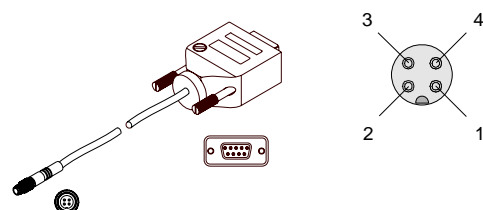
At the housing of the *L-LAS-RL* sensor there is a female connector for power supply connection (8-pol. type Binder 712) and a second female connector for connecting a serial RS232 connecting cable (4-pol. type Binder 707).



L-LAS-RL-20 (M-34) types

RS232 connection to the PC:

4-pole M5 female connector type Binder 707

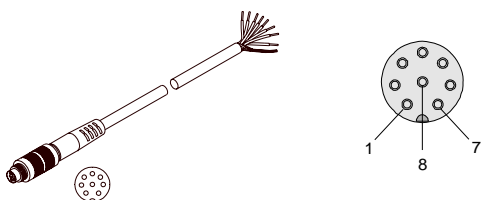


Connecting cable:
cab-las4/PC (length 2m, cable jacket: PUR)

Pin:	Assignment:
1	+Ub
2	0V (GND)
3	RxD
4	TxD

Interface to PLC/voltage supply:

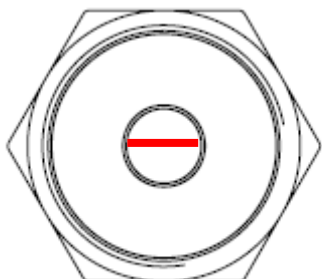
8-pole female connector type Binder 712



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

Pin:	Color:	Assignment: Standard	RL-20 (M34)
1	white	0V (GND)	0V (GND)
1	brown	+24VDC	+24 VDC
3	green	IN0	IN0
4	yellow	IN1	OUT0 (-)
5	grey	OUT0 (-)	OUT1 (+)
6	pink	OUT1 (+)	OUT2 (OK)
7	blue	OUT2 (OK)	I-OUT (4 .. 20mA)
8	red	Analog (0... 10V)	Analog (0 ... 10V)

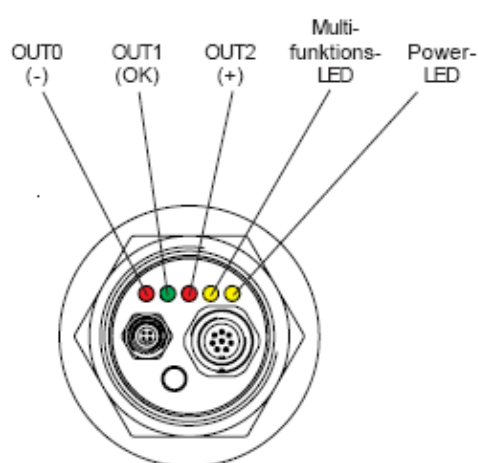
7.5 Alignment of the CCD line / Visualisation LED



The housing of the *L-LAS-RL* M34 sensors features an LED row comprising 5 light-emitting diodes.

The CCD line  is installed in the receiver optics unit in parallel to the visualisation LED row!

Function of the visualisation LED row



(-)	    	Messwert < untere Toleranzgrenze
(ok)	    	Messwert im Toleranzband
(+)	    	Messwert > obere Toleranzgrenze

The switching state that is indicated at the LED display also is applied at the digital outputs OUT0, OUT1 and OUT2.

7.6 RS232 interface protocol

RS232 Interface-Protocol PC \leftrightarrow L-LAS-RL Sensor Firmware Version 3.14

- 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.

The control device (PC or PLC) have to send a frame of 18-words (1 word = 2 byte = 16 bit) to the L-LAS-RL hardware. All words must be transmitted in binary format. The most significant byte must be transmitted first (MSB-first).

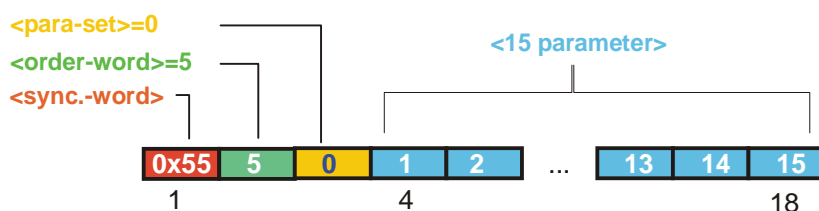
METHOD:

The microcontroller of the L-LAS-RL sensor is permanently reading (polling) the input-buffer of the RS-232 module. If the incoming word = **0x0055** (0x55 hexadecimal = 85 decimal), this is interpreted as the synchronisation-event (**<sync-word>**). After this, the 2.nd word with the order number (**<order-word>**) is read in by the microcontroller.

The order word (**<order-word>**), is followed by a further word, which contents parameter-set number 0 or 1 (**<para-set>**). The para-set-word is followed by 15 further words **<parameter-word>**, which contents the actual parameters.

After reading the complete data-frame (18-words = 36 bytes), the L-LAS-RL sensor-hardware executes the order which is coded at the 2.nd word (**<order-word>**) of the data-frame (c.f. order-table).

DATA FRAME: PC/PLC \rightarrow SENSOR (18-Words=36Bytes, MSB first)





Format of the data-frame: <para-set = 0>		
Word	Meaning	Comment
1	<sync-word>	hex-code 0x55, binary=0000 0000 0101 0101, dec.=85
2	<order-word>	Order word (c.f. table below)
3	<parameter-set> = 0	0 = parameter-set number 0
4	POWER	Laser intensity (0 ... 1000)
5	POWER-MODE	Transmitter-mode: (0 = STATIC), (1=DYNAMIC)
6	POLARITY	Polarity setting for OUT0, OUT1,OUT2 (0=DIRECT, 1=INVERSE)
7	EVAL-MODE	Evaluation mode (0=L-EDGE, 1=R-EDGE, 2=WIDTH, 3=CENTER)
8	E-BEGIN	Evaluation start -pixel (1 .. E_END-1)
9	E-END	Evaluation end-pixel (E_BEG+1 .. SUBPIXEL)
10	TEACH-VALUE	Teach-value (1 ... SUBPIXEL)
11	TOLERANCE-HIGH VALUE	Upper-tolerance TOL-HIGH: (0 ... SUBPIXEL/2)
12	TOLERANCE-LOW-VALUE	Lower-tolerance TOL-LOW: (0 ... SUBPIXEL/2)
13	AVERAGE	Average-setting (1,2,4,8,16,32,64,128 or 256)
14	TRIGG-MODE	Trigger mode (0=CONTINUOUS, 1=EXT. IN0 L/H, 2=EXT.IN0 HIGH, 3=SAVE-VTHD, 4=OUTPUT WIDTH)
15	ANALOG-OUT	Analog-output-mode: (0=DIRECT 0..10V, 1=MAXIMA, 2=MINIMA, 3=MAX-MIN)
16	OPERATION-MODE	CCD-operation-mode (0=LOW-GAIN / 1=HIGH-GAIN)
17	HW-MODE	Enable/disable TOL-potentiometer and button at housing (DISABLE-ALL=0, ENABLE-ALL=1,ENABLE-BTN=2, ENABLE POTI=3)
18	VIDEO-THD-MODE	Video-threshold -mode 0=FIX, 1=AUTO

Format of the data-frame: <para-set = 1>		
Word .	Meaning	Comment
1	<sync-word> = 0x0055	hex-code 0x55, binary=0000 0000 0101 0101, dec.=85
2	<order-word>	Order-word (c.f. table below)
3	<parameter-set> = 1	1 = parameter-set-number 1
4	VIDEO-THD-FIX	Video-threshold (0 ... 100) percent of full ADC-range
5	VIDEO-THD-AUTO	Video-threshold (0 ... 100) percent of full ADC-range
6	RS-232-MODE	Data-recorder-mode: 0 = STATIC, 1=EXT-IN0 L/H, 2=EXT-IN0 L/H (3-BYTE), 4=CONTINUOUS (3-BYTE)
7	RS-232-BAUD	Baudrate: 0=9600, 1=19200, 2=38400, 3=57600 , 4=115200 baud
8	SMOOTH-VIDEO-SIGNAL	Smooth video signal over (1,2,4,6,8,12,16,24,32,48 or 64) pixel
9	ANALOG-ZOOM	Zoom-mode for analog-output (0=DIRECT, 1=ZOOMx1, 2=ZOOMx2, 3=ZOOMx4, 4=ZOOMx8, 5=ZOOMx16, 6=WIN-5V, 7=WIN-10V)
10	EXPOSURE-TIME	2, 3, 4 ... 20 , exposure time [ms]
11	TOLERANCE-MODE	0=USE-TOL-VALUES, 5=AUTO[5%], 10=AUTO[10%], ...60=AUTO[60%]
12	Parameter 9	0 ,not used
13	Parameter 10	0, not used
14	Parameter 11	0, not used
15	SLOPE VALUE L-WORD	Slope value for calibration (x 1024), low-word
16	SLOPE VALUE H-WORD	Slope value for calibration (x1024), high-word
17	SLOPE-WIDTH L-WORD	Slope value for width-calibration (x1024), low-word
18	SLOPE-WIDTH H-WORD	Slope value for width-calibration (x1024), high word

Meaning of the 2.nd word of the data-frame: <order-word> ORDER-TABLE		
value	Meaning / Action	
0	NOP	no operation
1	Send parameter from PC to L-LAS-RAM	18 words, PC \Rightarrow L-LAS-RAM
2	Get parameter from L-LAS-RAM	18 words, L-LAS-RAM \Rightarrow PC
3	Send parameter from PC to EEPROM	18 words, PC \Rightarrow L-LAS-EEPROM
4	Get parameter from EEPROM of L-LAS	18 words, L-LAS-EEPROM \Rightarrow PC
5	Echo check: Get echo of L-LAS	18 words, first word=0x00AA=170dec
6	Activate teach at L-LAS, store in RAM	18 words PC \Rightarrow L-LAS-RAM
7	Get software version info of L-LAS	72-bytes, L-LAS \Rightarrow PC
8	Get measured values out of L-LAS-RAM	18 words, L-LAS-RAM \Rightarrow PC
9	Get video-buffer info from L-LAS	64 words, L-LAS-RAM \Rightarrow PC
11	Reset maximum/minimum values at analog-output	18 words PC \Rightarrow L-LAS-RAM
13	Refresh auto-video-threshold to RAM or EEPROM	18 words PC \Rightarrow L-LAS-RAM
18	Get measured values from L-LAS-RAM (data-recorder)	18 words PC \Rightarrow L-LAS-RAM
190	Change RS232-baud-rate (L-LAS-RAM)	18 words PC \Rightarrow L-LAS-RAM

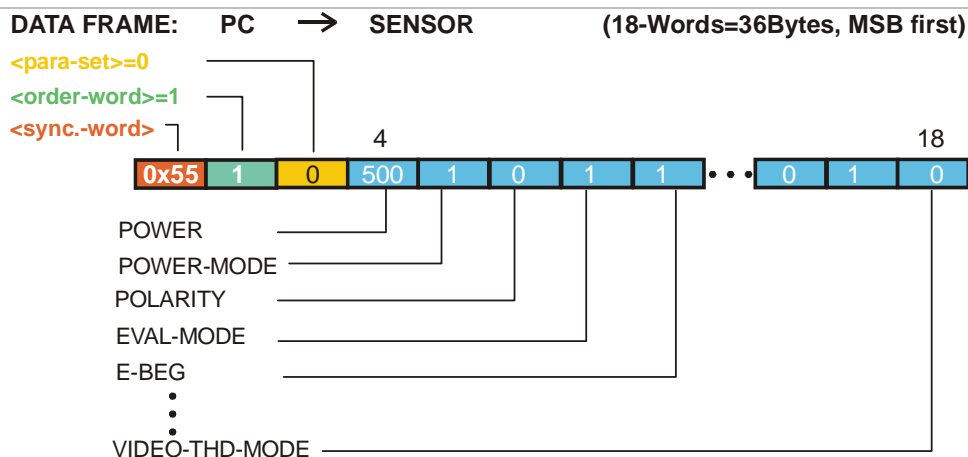
Examples for the data-transfer:

Echo check: <order-word> = 5		
<p><order-word> = 5</p> <p>Echo check: L-LAS sensor sends echo: word=0x00AA=170 to PC</p>		
<p>DATA FRAME: PC \rightarrow SENSOR (18-Words=36Bytes, MSB first)</p> <p><para-set>=0 <order-word>=2 <sync.-word></p> 		
<p>DATA FRAME: SENSOR \rightarrow PC (18-Words=36Bytes, MSB first)</p> <p>ECHO=0xAA=170 <sync.-word></p> 		

SEND parameter-set = 0 to L-LAS-RAM <order-word> = 1

<order-word> = 1 <para-set> = 0

Send the actual parameter (set=0) into the RAM of the L-LAS-sensor

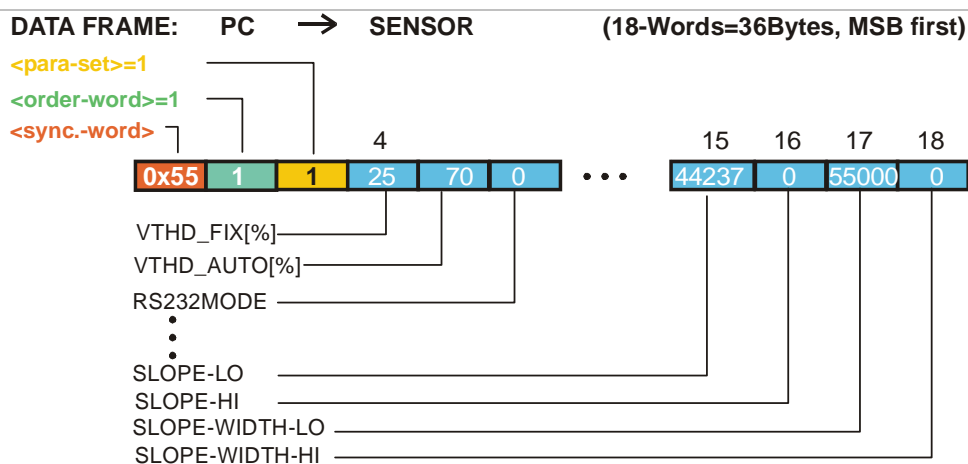


The transmitted data-frame is automatically echoed back by the L-LAS sensor !

SEND parameter-set = 1 to L-LAS-RAM <order-word> = 1

<order-word> = 1 <para-set> = 1

Send the actual parameter (set=0) into the RAM of the L-LAS sensors



SLOPE-VALUE is multiplied with x1024 e.g. 43.2[μm/pixel] x 1024 = 44237

SLOPE-WIDTH is multiplied with x1024

The transmitted data-frame is automatically echoed back by the L-LAS sensor !

GET parameter-set = 0 of L-LAS-RAM <order-word> = 2

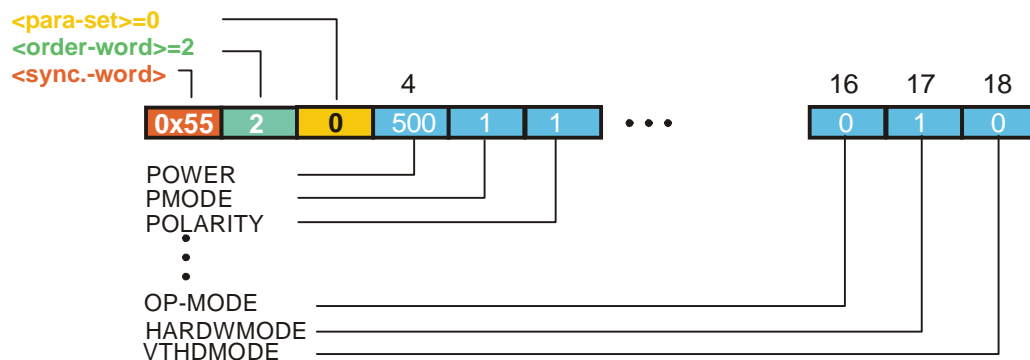
<order-word> = 2 <para-set> = 0

Get the actual RAM-parameters (set=0) of L-LAS-RAM

DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)



DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)



GET parameter-set = 1 of L-LAS-RAM <order-word> = 2

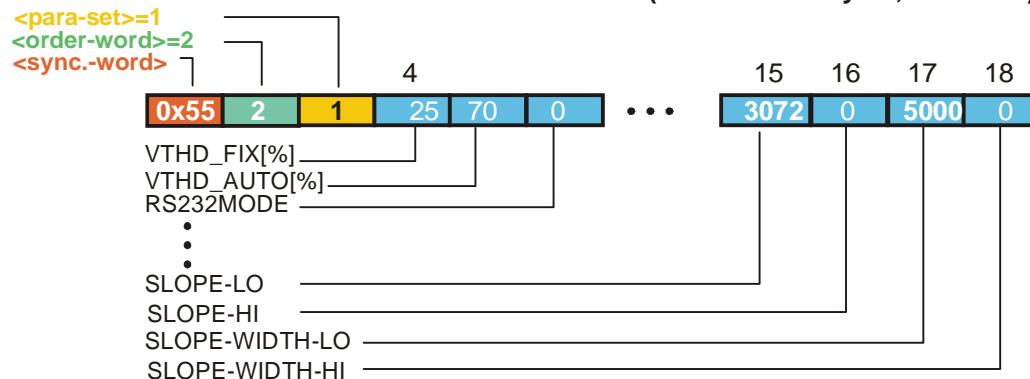
<order-word> = 2 <para-set> = 1

Get the actual RAM-parameters (set=1) of L-LAS-RAM

DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)



DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)



SLOPE-VALUE is multiplied with x1024 e.g. 3.0µm/pixel] x 1024 = 3072

SLOPE-VALUE-WIDTH is multiplied with x1024

TEACH-FUNCTION <order-word> = 6

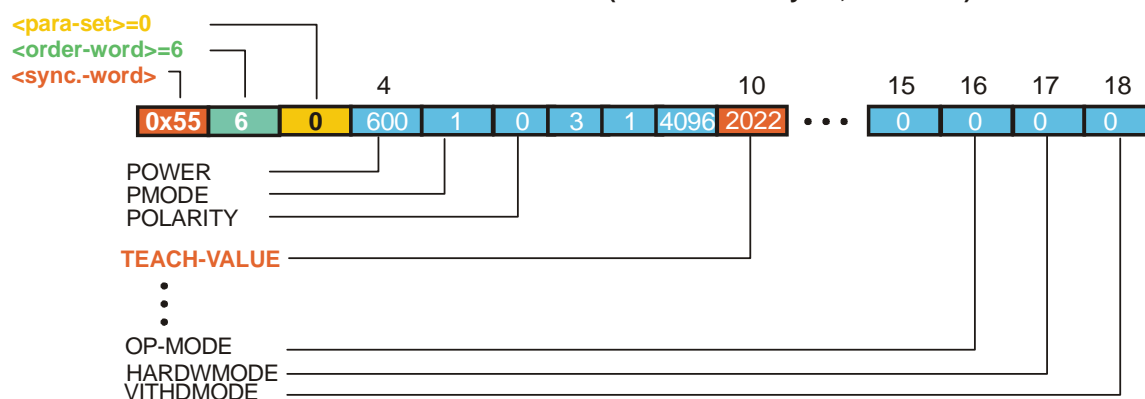
<order-word> = 6 <para-set> = 0

Start teach-procedure at L-LAS-sensor. The 10. word of the echo contents the new teach-value.

DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)



DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)



GET measured-values of L-LAS-RAM <order-word> = 8

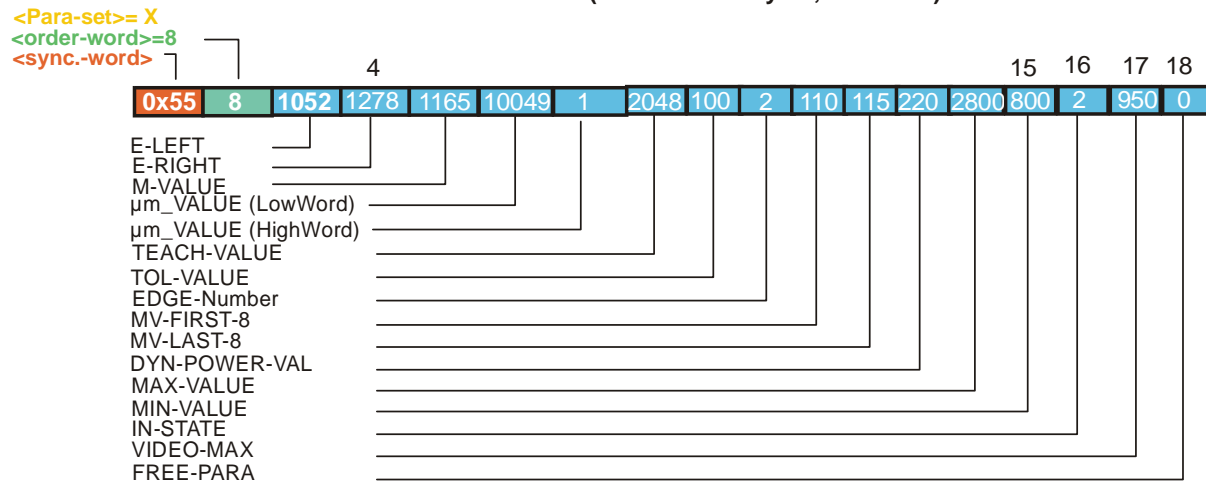
<order-word> = 8 <para-set> = 0

Get the actual measured values of L-LAS-RAM

DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)



DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)



Example µm-Value: 75.584mm = 75584µm = LowWord (10049) + HighWord (1x65535)

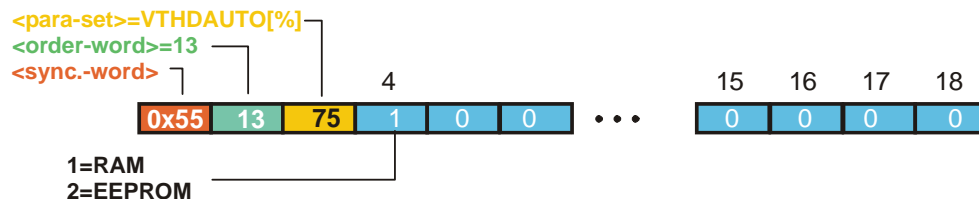
REFRESH-VIDEO-THRESHOLD <order-word> = 13

<order-word> = 13 <para-set> = VTHD-AUTO[%]

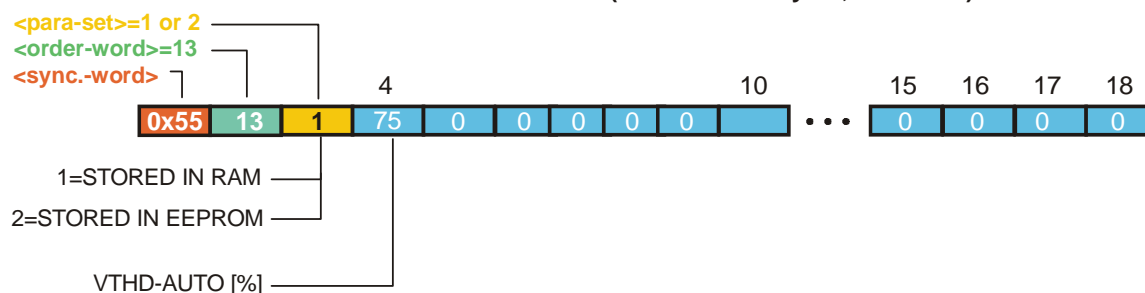
Start the refresh of the auto-video-threshold at L-LAS-sensor. The new video threshold is calculated from the actual intensity profile over the ccd-line. The <para-set> = VIDEO-THD-AUTO [%] is used for calculation.

ATTENTION: Make sure that the laser-beam is not covered before you start this action!

DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)



DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)



GET measured-values / recorder-of L-LAS-RAM <order-word> = 18

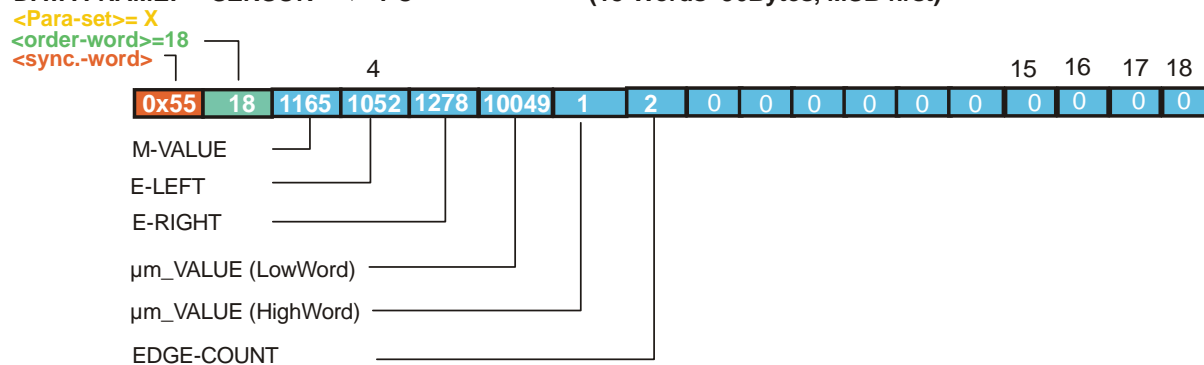
<order-word> = 18 <para-set> = 0

Get the current measurement values of RAM

DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)



DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)



Example µm-Value: 75.584mm = 75584µm = LowWord (10049) + HighWord (1x65535)

Change baudrate: <order-word> = 190

<order-word> = 190

Change rs-232-baudrate at the L-LAS Sensor.

The new baudrate-parameter is transmitted in the 3.rd word <para-set>.

9600 baud = 0, 19200 baud = 1, 38400 baud = 2, 57600 baud = 3, 115200 baud = 4

The transmitted data-frame is automatically echoed back from the L-LAS Sensor by using the old baudrate!!

The new baudrate is stored in the RAM-memory (volatile).

To change the baudrate permanently this must be done by the parameter RS-232-BAUD of the second parameter-set=1 by saving the complete parameter frame <para-set-1> to the EEPROM (c.f. order = 3).

DATA FRAME: PC → SENSOR (18-Words=36Bytes, MSB first)



DATA FRAME: SENSOR → PC (18-Words=36Bytes, MSB first)

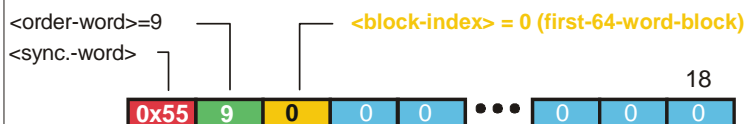


GET Video-data from L-LAS-RAM <order-word> = 9

<order-word> = 9 <para-set> = 0,64,128 or 192

Get the current video-data from the RAM (only 256-pixel of the full video-profile are transmitted)

Step1: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)



DATA FRAME: L-LAS-sensor → PC (64-Words = 128Byte, MSB first)



First block of 64 words are the first 64 pixel of the intensity-profile

Attention: Only every 8th pixel is transmitted

Step2: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)



DATA FRAME: L-LAS-sensor → PC (64-Words = 128Byte, MSB first)



2nd. block of 64 words: pixel 65 to 128

Attention: Only every 8th pixel is transmitted

Step3: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)



DATA FRAME: L-LAS-sensor → PC (64-Words = 128Byte, MSB first)



3rd. block of 64 words: pixel 129 to 192

Attention: Only every 8th pixel is transmitted

Step4: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)



DATA FRAME: L-LAS-sensor → PC (64-Words = 128Byte, MSB first)



3rd. block of 64 words: pixel 193 to 256

Attention: Only every 8th pixel is transmitted

