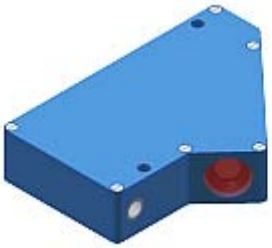
Manual

L-LAS-LT-Scope V3.0x

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

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

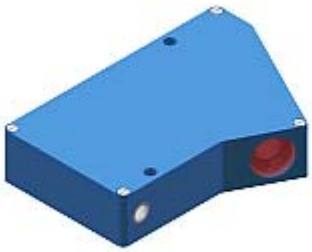
L-LAS-LT-37



L-LAS-LT-55

L-LAS-LT-80

L-LAS-LT-110

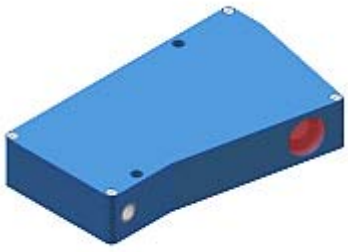


L-LAS-LT-135

L-LAS-LT-160

L-LAS-LT-200

L-LAS-LT-275



L-LAS-LT-450

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0 Contents

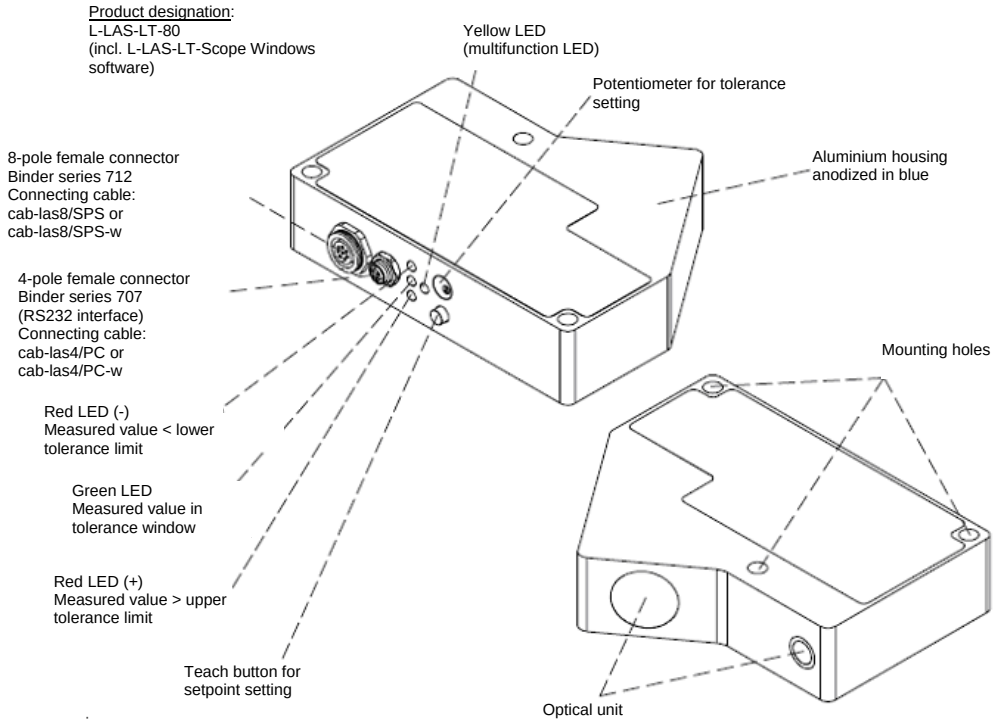
1 Functional principle: *L-LAS-LT* sensor with integrated control unit

1.1 Technical description

In the laser line sensors of the *L-LAS-LT* series the laser beam of a laser diode (λ=670nm, 1mW power, laser class 2) through suitable collimators and apertures is emitted from the optical transmitter unit as a parallel laser beam with homogeneous light distribution. After being reflected from the object surface, the laser light impinges on the CCD line receiver of the optical receiver unit. This CCD 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 and, after performing analog-digital conversion, can be stored in a data field as a digital value.

Depending on the object distance the laser light that is scattered back from the measuring object (triangulation principle) will only illuminate certain receiver elements (pixels) on the line. Compared to the non-illuminated pixels these pixels will output a considerably higher analog voltage (intensity maxima). By way of suitable software algorithms the areas of the illuminated zones can be determined from the previously stored data field. Since the distance of the pixels on the CCD line is known, the position and distance of the measuring object can therefore be determined.

The micro-controller of the *L-LAS-LT* sensor can be parameterized through the serial RS232 interface by means of a Windows PC software. This allows the setting of various evaluation and operating modes. The housing of the control unit features a TEACH/RESET button and a potentiometer for tolerance setting. Switching states are visualized by means of 4 LEDs (1x green, 1x yellow, and 2x red) that are integrated in the housing of the *L-LAS-LT* sensor. The control unit that is integrated in the sensor has three digital outputs (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 ... 10V) with 12-bit digital/analog resolution.



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

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

- 200 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 higher.
- Windows 98, Windows NT4.0, Windows 2000, Windows XP, or Windows Vista operating system
- Free serial RS232 interface or USB port with USB-RS/232 adaptor at the PC

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

1. 

Insert the installation CD-ROM in your CD-ROM drive. In our example we suppose that this is drive "D".

2. 

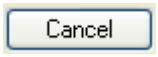
Start the Windows Explorer and in the folder tree of your CD-ROM drive go to the installation folder D:\Install\ .
Then start the installation program by double-clicking on the SETUP.EXE symbol.

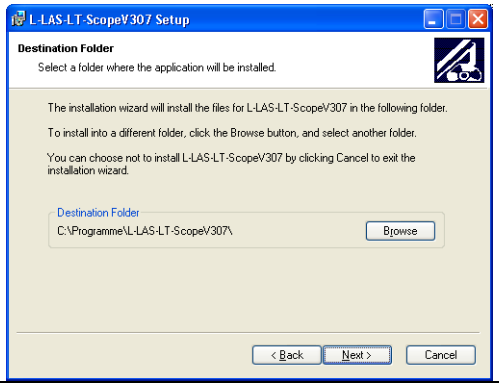
As an alternative, software installation can also be started by clicking on **START-Run...** and then entering "D:\Install\setup.exe", which must be confirmed by pressing the **OK** button.

The installation program then displays a dialog box for *L-LAS-LT-Scope* installation.
This dialog box shows some general information about installation.

Click on Next> to start the installation

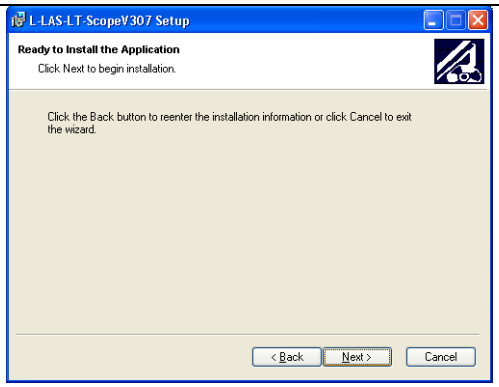
or on Cancel to quit the installation of the L-*LAS-LT-Scope* software.



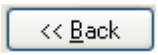
3. 

When you click on the Next> button, a new dialog appears for selecting the folder where the application will be installed (destination folder).

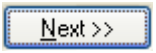
You may accept the suggested folder with Next>, or you may change the installation folder as desired by clicking on the Browse button.

4. 

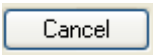
Another *L-LAS-LT-Scope* Setup dialog will be displayed.



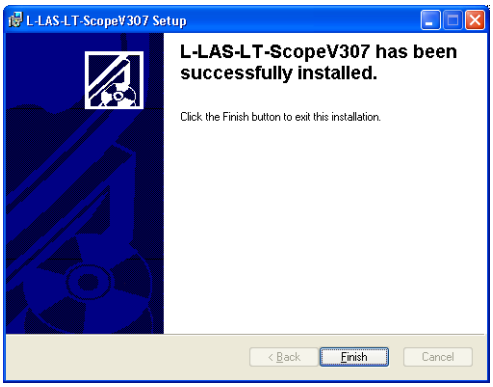
Click on the Back button if you want to change the installation folder again.



Click on Next>> to start the installation,
or

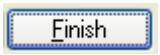


click on Cancel to quit the installation process.

5. 

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

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



Click on the Finish button to finish the installation.

The *L-LAS-LT-Scope* software can now be started by clicking on the respective icon in the newly created program group under:
Start >All Programs > L-LAS-LT-ScopeV3.0x

Deinstallation of the L-LAS-LT-Scope software:

Please use the Windows® deinstallation tool to remove the software.

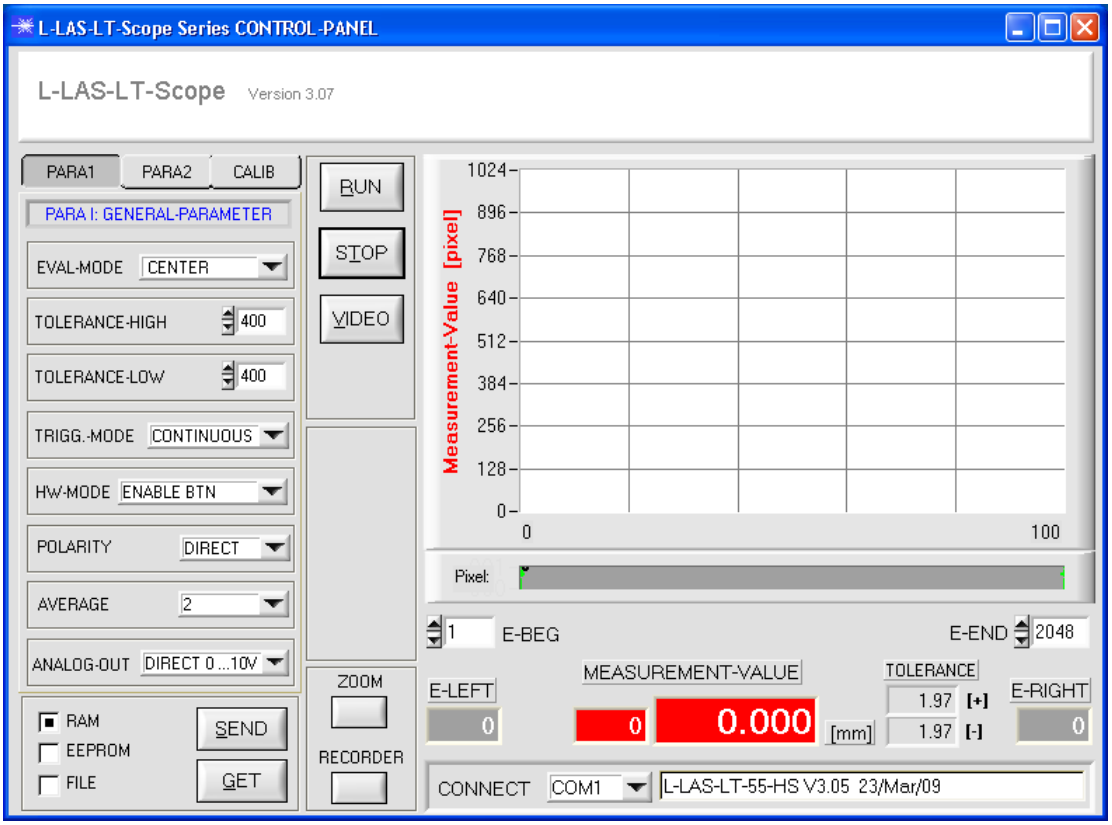
The Windows deinstallation tool can be found under
Start / Settings / Control Panel / Software

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

The *L-LAS-LT-Scope* software is used for parameterizing the electronic control unit of the *L-LAS-LT* line sensors through the serial interface. 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-LT control unit*. The sensor system then continues to operate in "STAND-ALONE" mode without PC.

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

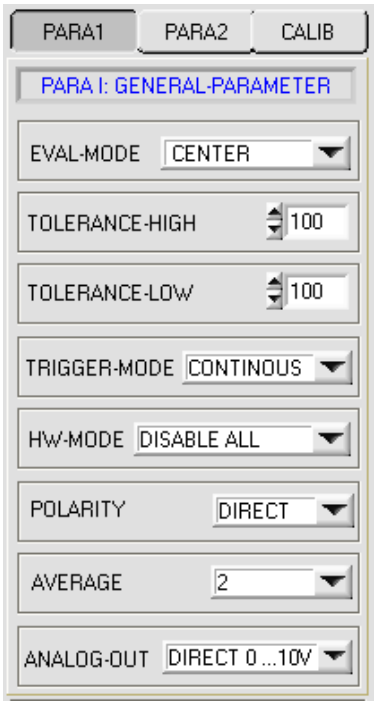


The *L-LAS-LT-Scope* CONTROL PANEL provides a great variety of functions:

- Visualization of measurement data in numeric and graphic output fields.
- Setting of the laser power for the respective 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-LT-Scope* software.

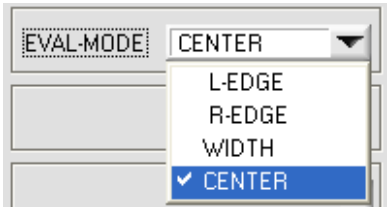
3.1 Control elements of the *L-LAS-LT-Scope* software:



A click on the PARA I button opens the PARAMETER I window on the user interface. This window is used for setting various parameters at the control unit.

Attention !

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



Diffuse reflection, normally there is only one intensity maximum at the CCD line.

In the standard version
EVAL-MODE = CENTER
is mostly used.

EVAL-MODE:

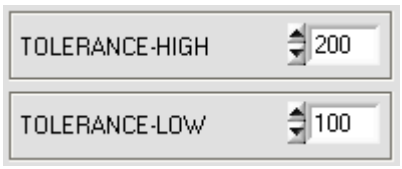
List selection field for setting the evaluation mode at the *L-LAS-LT sensor*.

L-EDGE (LEFT EDGE)
The first intensity maximum on the CCD line is used as measurement value for evaluation. The intersection points between the video threshold (green horizontal line) and the intensity maximum (red curve) are calculated. The measurement value can be calculated from the detected pixel values. In the standard version the first bright/dark transition = left edge is evaluated.

R-EDGE (RIGHT EDGE):
The right edge of the only occurring intensity maximum is used for evaluation.

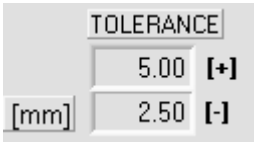
WIDTH:
The width of the only intensity maximum is calculated with the help of the video threshold.

CENTER:
The center of the only intensity maximum is calculated with the help of the video threshold.

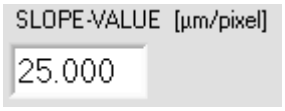


TOLERANCE –HIGH, TOLERANCE-LOW:

In this input field a tolerance default value in pixels can be set for the tolerance limits by entering a numerical value or by clicking on the arrow elements. The tolerance limits are applied around the setpoint value (TEACH-VALUE).
The tolerances currently set at the sensor are shown in [mm] in numerical display fields. If the TOLERANCE potentiometer at the sensor housing is activated, the tolerance value that is set at the potentiometer is displayed here.



Example for the tolerances in combination with the SLOPE-VALUE

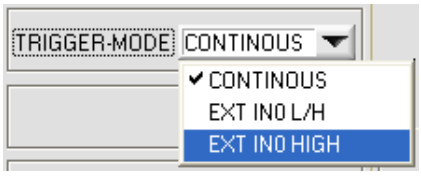


$$TOL[+]\,[mm] = SLOPE * TOLERANCE\_HIGH$$

*Here: TOL [mm] = 25.000*200 Pixel =5.00 mm*

$$TOL[-]\,[mm] = SLOPE * TOLERANCE\_LOW$$

*Here: TOL [mm] = 25.00*100 Pixel =2.50 mm*



TRIGGER-MODE:

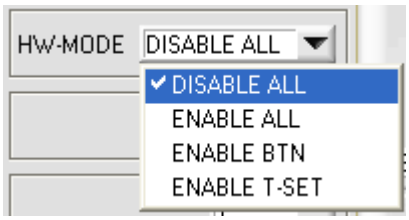
CONTINUOUS:
Continuous evaluation of the current measurement values.

EXT. IN0 L/H:
External edge-controlled (LOW/HIGH) triggering of measurement value evaluation through digital input IN0/pin3/green at the 8-pol. PLC female connector.

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

POLARITY:

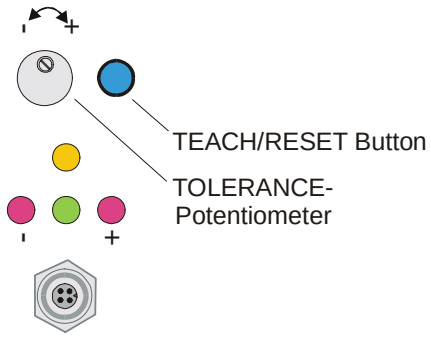
In this function field the output polarity at the *L-LAS-LT sensor* can be set with a mouse-click on the input field or by clicking on the arrow button. The L-LAS-LT sensor has 3 digital outputs (OUT0, OUT1, OUT2) through which error states can be sent to the PLC.
DIRECT:
In case of an error the respective digital output is set to +Ub (+15DC … +30VDC), (red LED on).
INVERSE:
In case of an error the respective digital output is set to the reference potential (GND,0V), (red LED on).



HARDWARE (Hardware mode):

The TOLERANCE potentiometer and/or the TEACH/RESET button at the housing of the *L-LAS-LT 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 T-SET, it is not possible to enter numerical values in the TOLERANCE-VALUE input field on the PC software user interface. The corresponding function fields are dimmed.

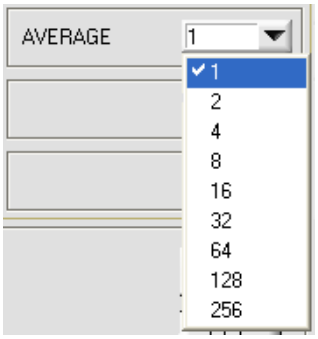


DISABLE ALL
Both the TEACH/RESET button and the TOLERANCE potentiometer at the sensor housing are deactivated.

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 < 0.5s) : RESET.
Button pressed for a longer time (t > 1.5s) : TEACH.

ENABLE BTN:
Only the TEACH/RESET button at the housing is activated.

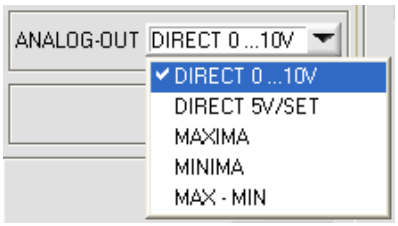
ENABLE T-SET:
Only the TOLERANCE potentiometer at the housing is activated.



AVERAGE:

In this function field the averaging at the *L-LAS-LT 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.



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.

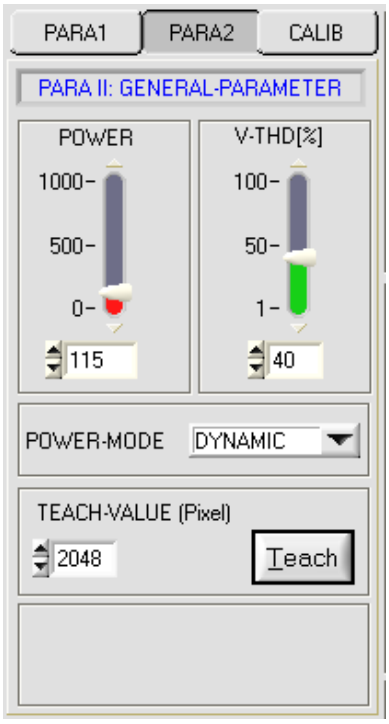
DIRECT 0..10V :
A voltage (0 .. 10V) that is proportional to the current measurement value is provided at the analog output pin8/red/.

DIRECT 5V/SET:
After the teach process a voltage of 5V (5V = teach 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).

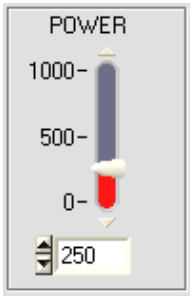
MAX-MIN:
The current difference between maximum and minimum value is provided at the analog output pin8/red/ (drag pointer principle, resetting by input IN1/pin4/yellow pulse of <750ms length, or by pressing the TEACH/RESET button).



A click on the PARA II button opens the PARAMETER II window on the user interface. This window is used for setting additional parameters at the control unit.

Attention!

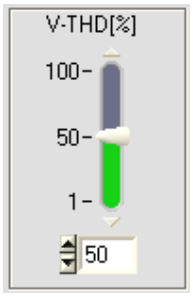
Changes that are made in the function fields described below only become active at the control unit of the *L-LAS-LT sensor* after a click on the SEND button!

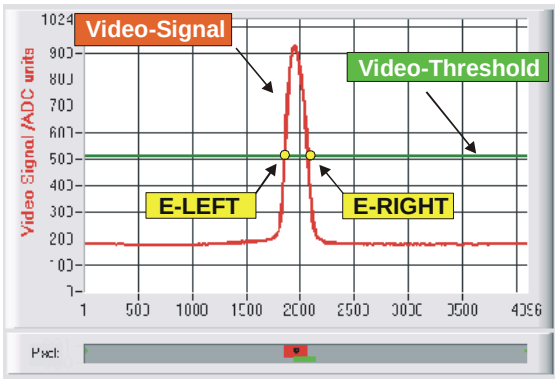


POWER:

(only relevant with POWER-MODE = STATIC)

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

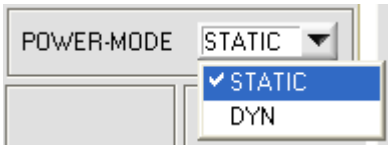




VTHD[%]:

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



POWER-MODE:

This function field is used for setting the laser mode at the *L-LAS-LT sensor*.

STATIC:
The laser power at the master/slave sensor is not automatically controlled.
The values that are set at the respective sliders are used as setting values for the laser power.

DYNAMIC:
When the operating mode is set to dynamic, the laser power at the *L-LAS-LT sensor* is automatically controlled.
The laser power here is controlled in such a way that the maximum values of the "intensity peaks" approx. are at 80-90% of the analog dynamic range.

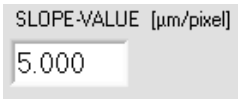
TEACH-VALUE (Pixel):

In this function field a teach value can be preset at the *L-LAS-LT* sensor by entering a numerical value or by using the arrows.

Please note:
A change of the teach value will only be updated at the control unit when the SEND button is pressed.

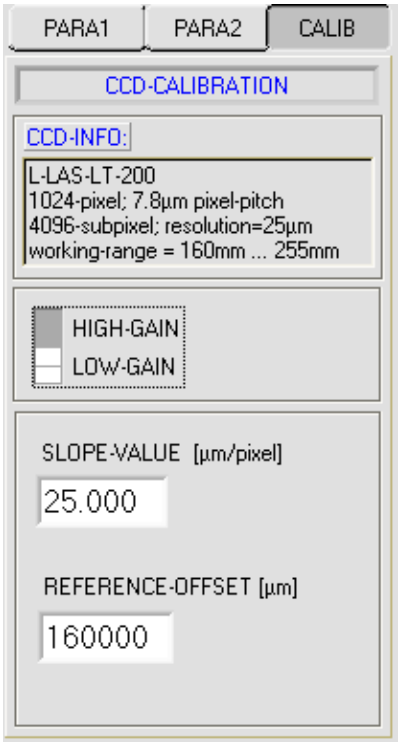
The TEACH-VALUE is set in pixels. As with the tolerance, conversion into µm can be done by way of the SLOPE-VALUE (sensitivity – µm/pixel).

For example, the result for the *L-LAS-LT-80 is:*



$$TEACH\_VALUE\ [mm] = SLOPE * TEACH\ \ [Pixel]$$

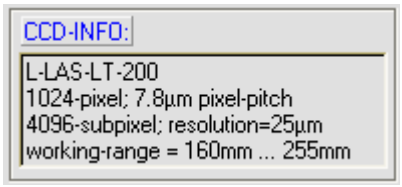
*TEACH_VALUE [mm] = 5.000[um/Pixel] * 1024[Pixel] = 5.120 mm*



A click on the CALIB button opens the CCD-CALIBRATION window on the user interface.

Attention!

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



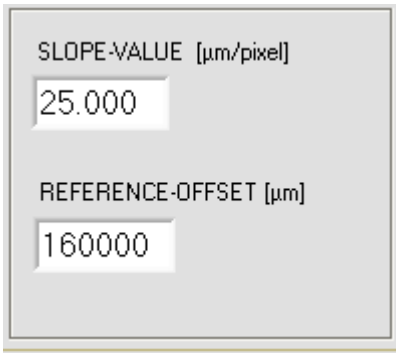
CCD-INFO:

This text field shows some system information about the CCD line that is used at the *L-LAS-LT sensor*.

CCD-GAIN:

Binary switch for setting the gain at the CCD line.

Please note:
This function is not available with all the *L-LAS-LT* sensors.

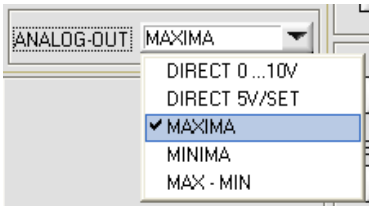


SLOPE-VALUE [µm/pixel]:

Numerical input field for setting the sensitivity of the *L-LAS-LT sensor*. The numerical value that is set here determines how many micrometers of distance correspond with a pixel.

REFERENCE-OFFSET [µm]:

Numerical input field for setting any desired offset value. If, for example, the *L-LAS-LT-200* sensor is used for determining the distance to the measuring object, the offset value is 160000µm = 160mm. The offset value is added to the CCD-line value to derive the measurement value in mm.

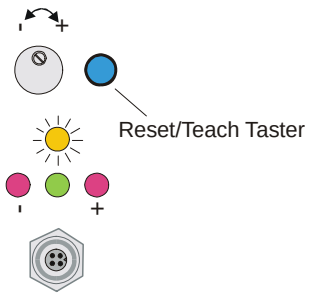


RESET button:

The current drag pointer values of maximum and minimum value determination can be reset with the RESET button.

The current maximum values MAX and minimum values MIN since the last RESET are displayed in the respective numerical output fields.

These numerical output fields are only displayed if the MAXIMA, MINIMA or MAX-MIN drop-down list elements are selected.



TEACH button:

A click on the TEACH button starts a teach process at the *L-LAS-LT sensor*. The position of the intensity maxima at the *L-LAS-LT* sensor is evaluated and, depending on the evaluation mode, the calculated value is written to the volatile RAM memory of the control unit as a teach value.

When the teach process is completed the yellow LED at the housing of the *L-LAS-LT sensor* shortly 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 pulse at digital input IN1/yellow/pin4 of at least 1.5s length.

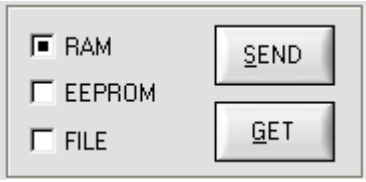
As an alternative the current teach value (setpoint value) also can be set by entering a numerical value in the numeric input field. The teach value that is set by this method will only be activated at the *L-LAS-LT sensor* after a click on the SEND button.

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). The analog information of the pixels lying left of E-BEG is not used for evaluation.

E-END:

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



PARAMETER TRANSFER:

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

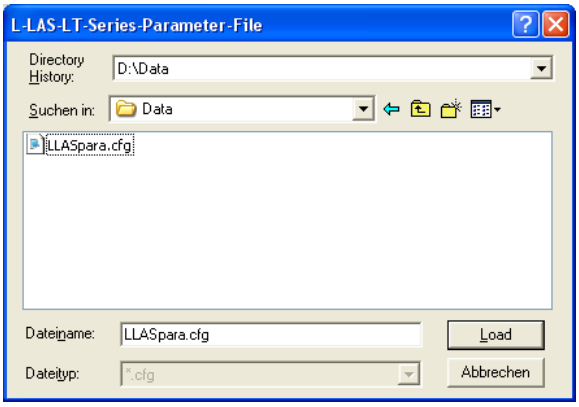
SEND:
When the SEND button is clicked, the parameters currently set on the user interface are transferred to the *L-LAS-LT control unit*.
The target of data transfer is determined by the selected radio-button (RAM, EEPROM, or FILE).

GET:
When the GET button is clicked, the setting parameters are transferred from the *L-LAS-LT 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-LT 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-LT control unit* is turned off.

EEPROM:
The currently set parameters are written to the non-volatile EEPROM memory of the *L-LAS-LT 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-LT control unit*, these must be written to the RAM of the *L-LAS-LT control unit* by selecting the RAM button and then clicking on SEND. The *L-LAS-LT 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.



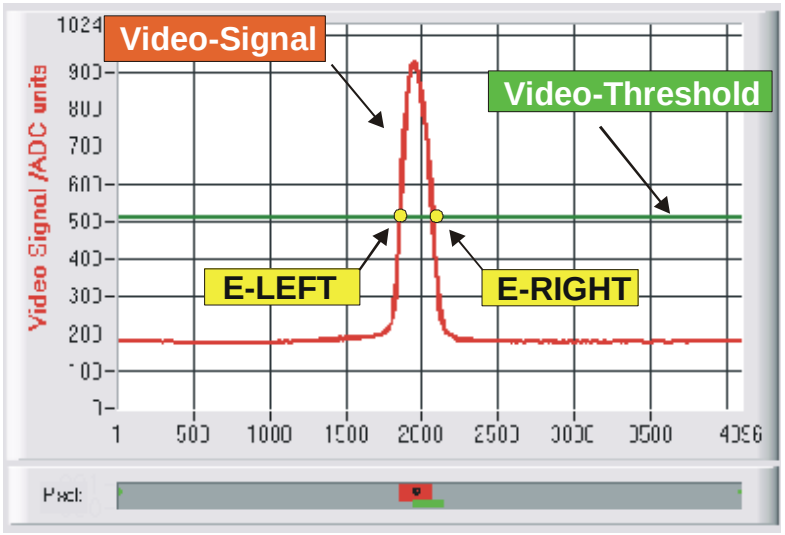
FILE dialog window:

The standard output file for the parameter values has the file name "LLASpara.cfg".

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

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 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 .. 1024. The currently set video threshold (V-THD) is shown as a green horizontal line in the graphic window.

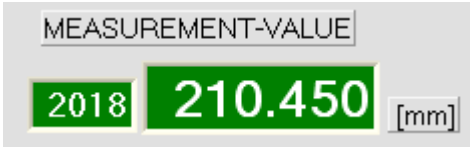
The intensity maximum results from the optical representation of the laser light that is scattered back from the measuring object.

The edge values (pixels) are derived from the intersection points of the intensity profile (red curve) with the video threshold (green line). The x-axis shows the pixels of the CCD line (e.g.: pixel: 1 .. 4096). 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 (gray) and the illuminated areas (red) of the CCD line. Furthermore the currently detected edge position is indicated by way of a black point-shaped 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 CCD 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 CCD line.



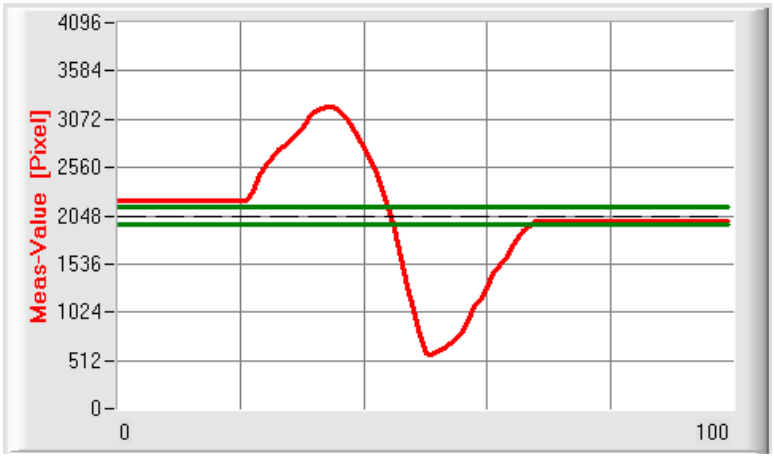
MEASUREMENT-VALUE:
Numeric display field that shows the current measurement value (depending on the set evaluation mode). The left numeric display field shows the current measurement value in pixels, whereas the right display field shows the measurement value converted into millimetres

RUN button:

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

STOP button:

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



After a click on the RUN button the current measurement value is shown in the graphic display window in "scroll mode".

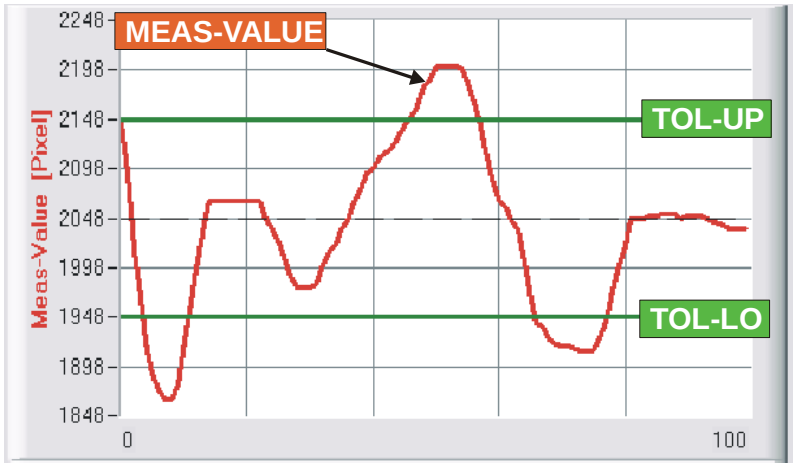
In the form of a red curve the measurement values pass through the graphic display window from right to left.

The y-axis graduation corresponds with the pixels or sub-pixels on the CCD line. The most recent measurement value is shown at the right end of the graphic display at x-value = 100.

The currently set setpoint value (TEACH value) is shown as a broken horizontal line.
In addition, the currently set tolerance window is represented by two horizontal green lines that are applied symmetrically around the setpoint value.

The length of the data frame that is transferred through the serial interface in "RUN mode" 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).



A click on the ZOOM button automatically rescales the y-axis in the graphic display window, which means that the changes of the measurement value can be displayed more clearly.

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

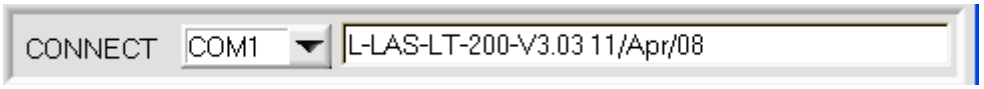
3.3 Serial RS232 data transfer:

RS232 COMMUNICATION:

- Standard RS232 serial interface without hardware-handshake.
- 3-line-connection: GND, TXD, RXD.
- Speed: 19200 baud, 8 data bits, no parity bit, 1 stop bit in binary mode, MSB first.

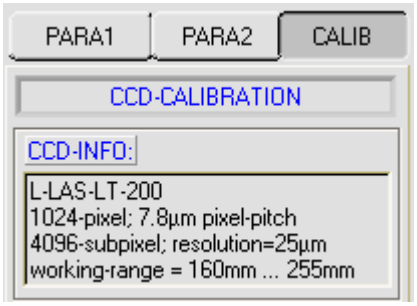
Attention !

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-LT 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-LT control unit* it is therefore necessary to stop the data transfer during the normal monitoring process (click on the STOP button).



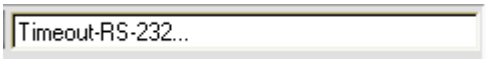
CONNECT:

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



This text field shows some system information about the CCD line that is used at the *L-LAS-LT sensor*.

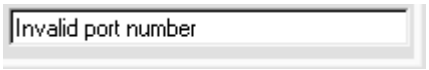
If another sensor type of the *L-LAS-LT-series* is connected via the RS-232 interface, the CONNECT drop-down function field must be actuated again to refresh the hardware information.



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

In this case it should first be checked whether the *L-LAS-LT control unit* 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, interface COM1 to COM9 can be selected by using the CONNECT drop-down list.



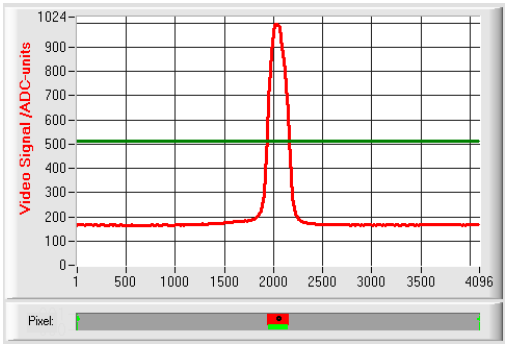
If there is an "Invalid port number" status message, the selected interface (e.g. COM2) is not available at your PC.

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-LT-Scope* as an aid for sensor adjustment:

VIDEO:

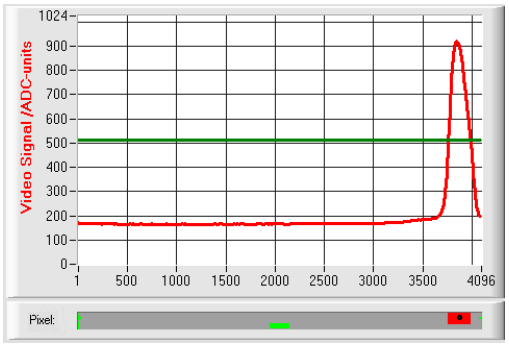
After a click on the VIDEO button, fine adjustment of the sensors relative to the measuring object can be done in the graphic display window. Because of the limited data transfer rate of the RS232 interface the display window can only be updated every second.



Adjustment OK - centered

In the graphic display window the intensity profile is shown as a red curve. The numerical values 1 ... 4096 on the x-axis represent the individual pixels of the CCD line.

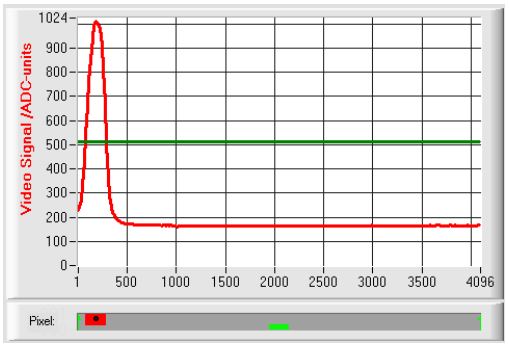
The intensity maximum approx. lies at pixel 2048. The *L-LAS-LT sensor* thus is optimally adjusted at the centre of the measuring range.



Upper measuring range limit reached:

The distance of the *L-LAS-LT sensor* from the measuring object almost is too large. The intensity maximum lies at pixel values close to 4000.

The distance between the *L-LAS-LT sensor* and the measuring object should be reduced.

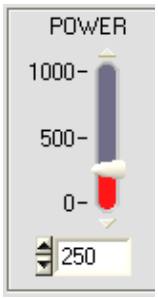


Lower measuring range limit reached

The distance of the *L-LAS-LT sensor* from the measuring object almost is too small. The intensity maximum lies at pixel values close to 1.

The distance between the *L-LAS-LT sensor* and the measuring object should be increased.

3.5 *L-LAS-LT-Scope* as an aid for transmitter power adjustment:



POWER:

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

Attention!

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

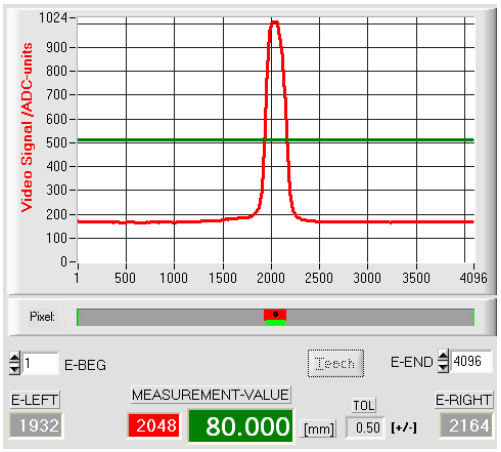
DYNAMIC:

When the power mode is set to DYNAMIC, the laser power at the *L-LAS-LT sensor* is automatically regulated. This means that the laser power is regulated in such a way that the maximum values of the "intensity peaks" approx. lie at 80-90% of the analog dynamic range.

In this power mode the POWER slider is without function!

VIDEO:

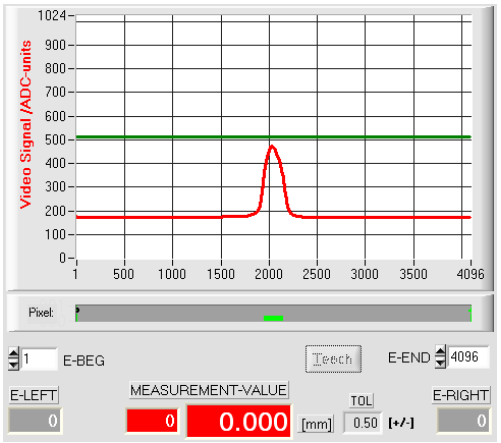
After a click on the VIDEO button, the current intensity profile is transferred from the *L-LAS-LT sensor* to the PC and is shown as a red curve in the graphic display window.



Optimum transmitter power:

In the whole measuring range (pixel 1 ... 4096) the maximum of the intensity characteristic should be clearly above the video threshold (green line).

The measurement values can be calculated from the intersection points of the intensity profile with the video threshold:



Transmitter power too low:

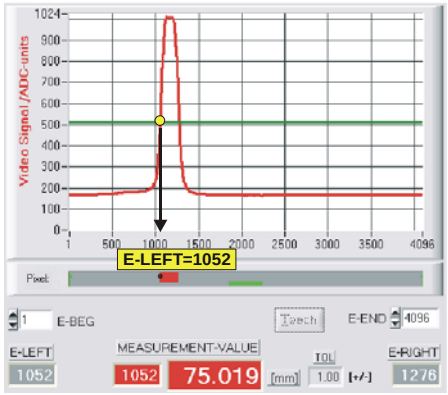
The intensity profile (red curve) at the CCD receiver is too low. The maximum values lie below the video threshold (green horizontal line).

No bright/dark transition (intersection point between red and green curve) can be detected.

The calculated measurement value therefore = 0!

4 Evaluation modes

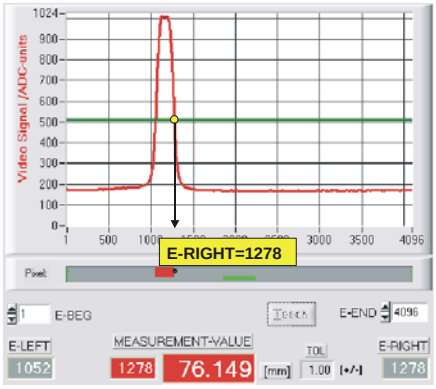
4.1 LEFT-EDGE:



The left intersection point (bright/dark transition) at the intensity maximum is used as the measurement value.

$MVAL[pixel] = E\_LEFT$ here: 1052

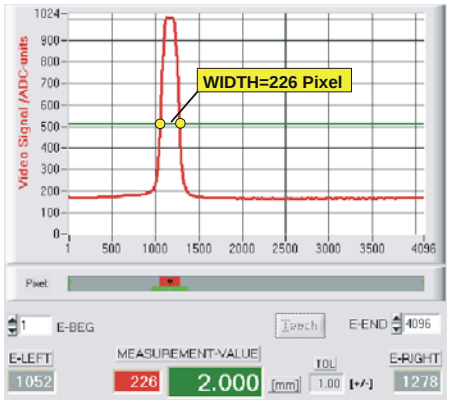
4.2 RIGHT-EDGE



The right intersection point (bright/dark transition) at the intensity maximum is used as the measurement value.

$MVAL[pixel] = E\_RIGHT$ here: 1278

4.3 WIDTH

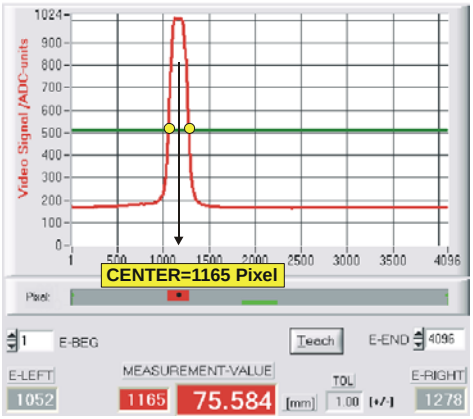


The width of the intensity maximum is calculated from the intersection points of the intensity profile (red curve) with the video threshold (green line).

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

here: MVAL = 226 = 1278-1052

4.4 CENTER



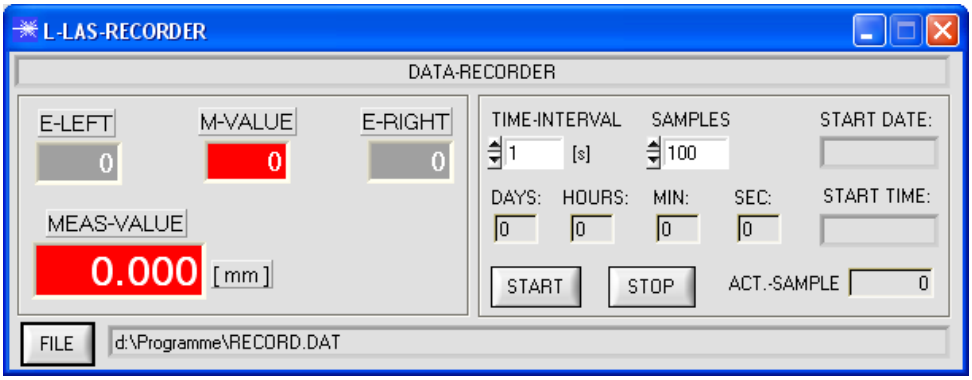
The center position of the intensity maximum is calculated from the intersection points of the intensity profile (red curve) with the video threshold (green line).

$$MVAL[pixel] = (E\_RIGHT + \_LEFT)/2$$

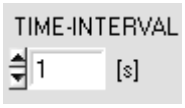
here: MVAL = 1165 = (1278 + 1052)/2

The EVAL-MODE CENTER should be used as the default mode!

5 Data recorder function



A click on the RECORD button opens a new window for setting the data recorder.

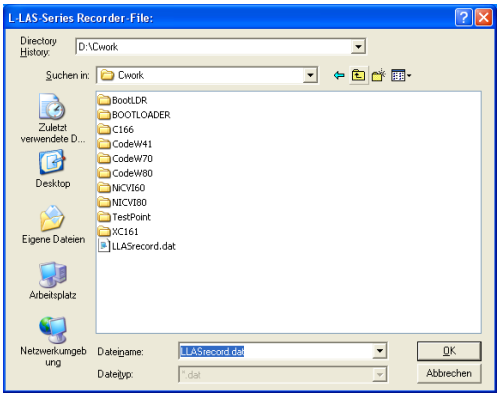


A time interval in seconds can be set in this numeric input field. After this time interval the PC software automatically transfers measurement data from the sensor to the PC and stores these data in an output file on the hard disk.

Numeric input field for setting the maximum number of measurement values that should be stored. The value range is from 10 to 30000.

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

Numeric display elements showing the time in seconds that has passed since the recorder function has been activated.



A click on the File button opens a dialog for entering the file name and the target directory of the output file.

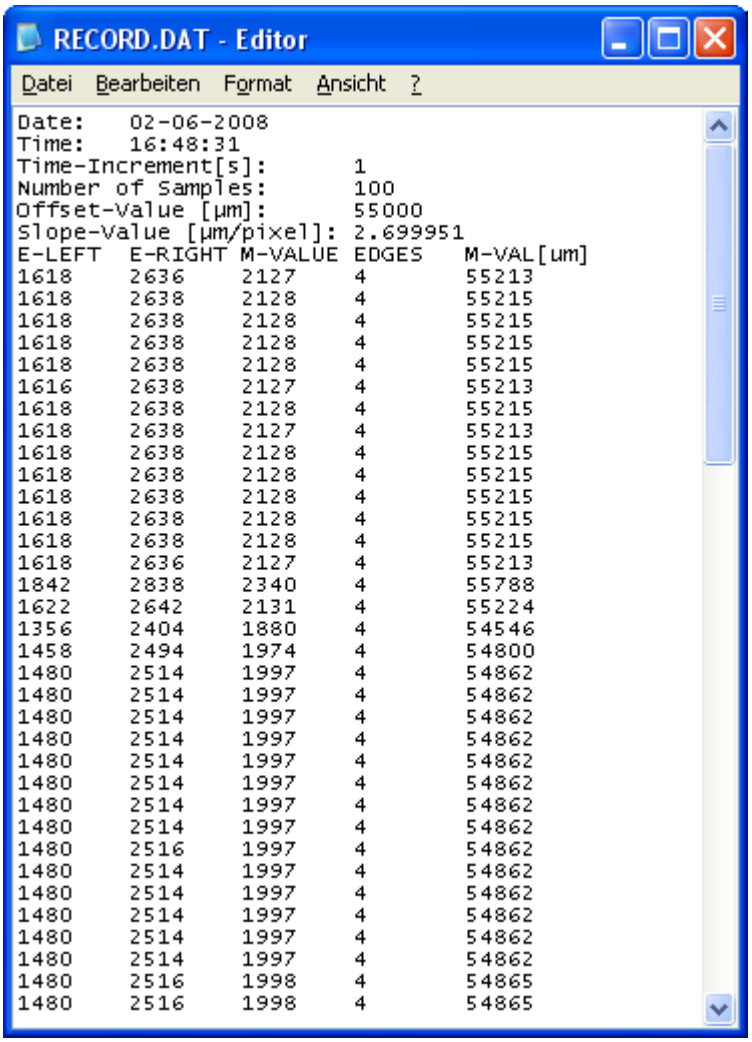
The currently selected target directory and file name of the output file are shown in the text display below.

Automatic recording can be started by pressing the START button. With a click on the STOP button recording can be stopped before the maximum number set in SAMPLES is reached.

Numeric display field shown the current number of read measurement values.

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).



1st column = Measurement value (pixel) E-LEFT

2nd column = Measurement value (pixel) E-RIGHT

3rd column = Measurement value (pixel) M-VALUE

4th column = Number of edges

5th column = Measurement value (micrometers)

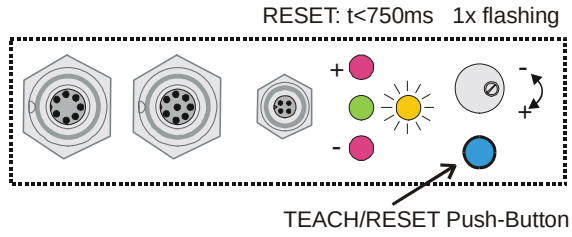
6 Annex

6.1 Laser warning

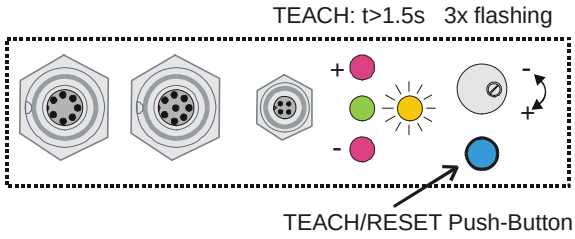
LASER WARNING
Solid-state laser, λ=670 nm, 1mW max. optical power, laser class 2 acc. to EN 60825-1 Therefore no additional protective measures are required for the use of these laser transmitters.    

6.2 Function of the TEACH/RESET button:

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



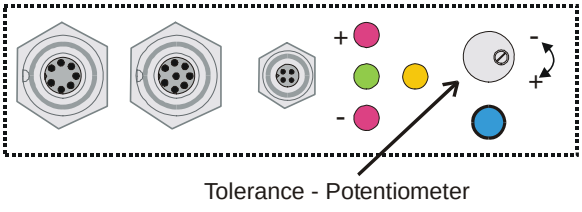
RESET function:
When the button is pressed for a short time (t < 750ms) the current maximum and minimum values (drag pointer values) are reset.
This does not perform a hardware/software RESET!



TEACH function:
When the button is pressed for a longer time (t > 1.5s), the current edge coverings are stored as teach value in the RAM memory. When the teach process has been performed successfully, the green LED flashes three times.

6.3 Function of the tolerance potentiometer:

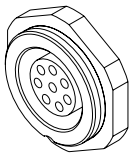
The housing of the *L-LAS-LT sensor* features a potentiometer for setting the tolerance band width.

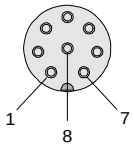


TOLERANCE potentiometer:
Turning the potentiometer clockwise increases the tolerance band width.
Turning it counter-clockwise decreases the tolerance band width. The potentiometer must be activated in order to use it for setting the tolerance band width at the *L-LAS-LT sensor* (switch HW-MODE to position ENABLE ALL or ENABLE TOL SET).

6.4 Function of digital inputs IN0 and IN1

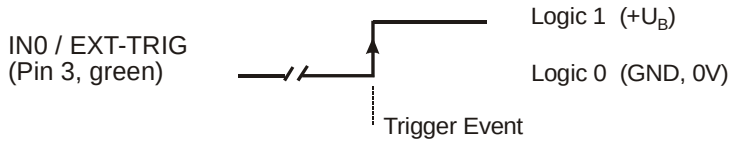
The *L-LAS-LT sensor* has two digital inputs IN0 and IN1 that can be contacted through the 8-pole female connector (type Binder 712).



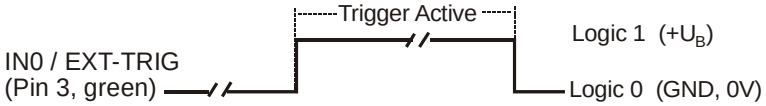


Pin:	Colour:	Assignment:
1	white	0V (GND)
2	brown	+12VDC … +32VDC
3	**green**	**IN0 (EXT TRIGGER)**
4	**yellow**	**IN1 (TEACH/RESET)**
5	gray	OUT0
6	pink	OUT1
7	blue	OUT2
8	red	ANALOG (0 … +10V)

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



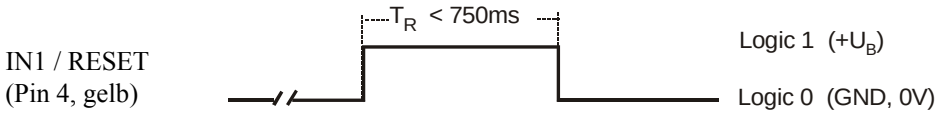
External edge-controlled (LOW/HIGH) triggering of measurement value evaluation through digital input IN0.



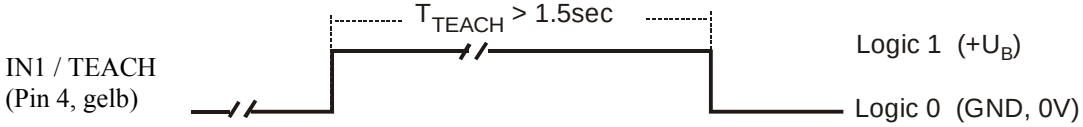
External triggering of measurement value evaluation through a HIGH level (+Ub) at digital input IN0.

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

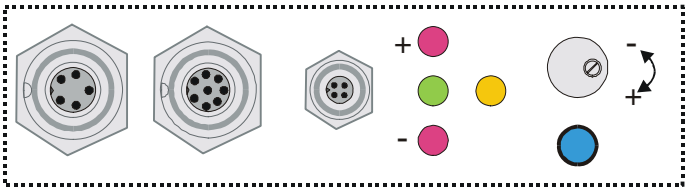
RESET function:
When a HIGH pulse of less than **750 ms** duration is applied, the RESET function is performed at the *L-LAS-LT sensor*. This resets the current maximum and minimum values (drag pointer). A hardware/software RESET is not performed! When a RESET pulse has been detected, the yellow LED 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-LT sensor*. When a TEACH pulse has been detected, the green LED at the housing flashes shortly three times.

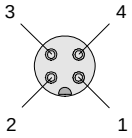


6.5 Connector assignment



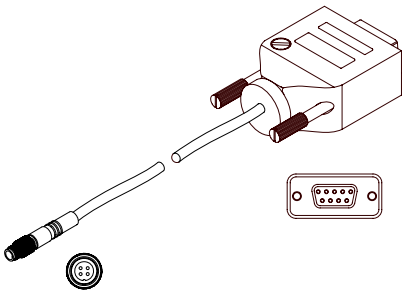
At the housing of the *L-LAS-LT sensor* there is a female connector for power supply connection (8-pole type Binder 712), a 7-pole female connector (type Binder 712) for connection of the SLAVE sensor, and a third female connector for connecting a serial RS232 connecting cable (4-pole type Binder 707).

RS232 connection to PC:
4-pole M5 female connector type Binder 707

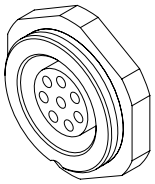


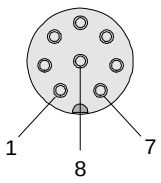
Pin:	Assignment:
1	n.c.
2	0V (GND)
3	TxD
4	RxD

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



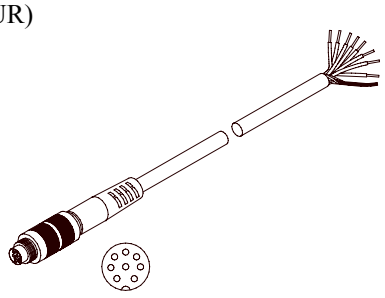
Interface to PLC / power supply:
8-pole female connector type Binder 712





Pin:	Colour:	Assignment:
1	white	0V (GND)
2	brown	+15VDC … +32VDC
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)

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



6.6 RS-232 interface protocol

RS232 interface protocol PC ⇔ *L-LAS-LT sensor*
Firmware version 3.0x

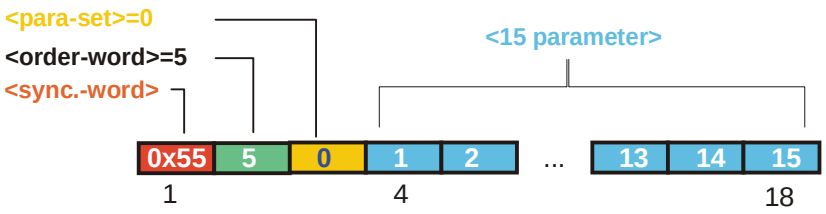
- Standard RS232 serial interface, no hardware handshake
- 3-line connection: GND, TXD, RXD
- Speed: 19200 baud, 8 data-bits, no parity-bit, 1 stop-bit, binary-mode

The control device (PC or PLC) must send a data frame consisting of *18-words (1 word = 2 byte = 16 bit)* to the *L-LAS-LT control unit*. All words in the data frame must be transferred in binary format. The higher-order byte must be transferred first (MSB-first).

METHOD:

The microcontroller in the *L-LAS-LT* sensor permanently reads the input buffer of its RS-232 module (polling). If the arriving word is *0x0055 (0x55 hexadecimal = 85 decimal)*, this is interpreted as a synchronisation event: (**<sync-word>**). The microcontroller then reads the order number (**<order-word>**) that is transferred with the 2nd word. After the order word (**<order-word>)** another word is transferred that informs about the number of the parameter set (**<para-set>**). This is followed by additional 15 words **<parameter-word>** that contain the actual parameters. When the complete data frame (18 words = 36 bytes) has been read in, the *L-LAS-LT* control unit starts to execute the order contained in the 2nd word (**<order-word>**).

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



Format of the data frame: <para-set = 0>		
Word no.	**Meaning**	**Comment**
1	**<sync-word>**	hex-code 0x55, binary=0000 0000 0101 0101, dec.=85
2	**<order-word>**	order word (see table below)
3	**<order-word>**	0 = parameter set zero
4	POWER	Transmitter power (0 … 1000)
5	POWER-MODE	Transmitter power mode: (0 = STATIC), (1=DYNAMIC)
6	POLARITY	Polarity 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	Beginning of the evaluation range, start-pixel (1 .. E_END-1)
9	E-END	End of the evaluation range, end-pixel (E_BEG+1 .. SUBPIXEL)
10	TEACH-VALUE	Teach value in pixels (1 ... SUBPIXEL)
11	TOLERANCE-HIGH-VALUE	Upper tolerance value TOLUP: (0 ... SUBPIXEL/2)

Format of the data frame: <para-set = 0>		
Word no.	**Meaning**	**Comment**
12	TOLERANCE-LOW-VALUE	Lower tolerance value TOLUP: (0 ... SUBPIXEL/2)
13	AVERAGE	Averaging (1,2,4,8,16,32,64,128 or 256)
14	TRIGMODE	Trigger mode (0=CONTINOUS, 1=EXT. IN0 L/H, 2=EXT.IN0 HIGH)
15	ANALOG-OUT	Operating mode of the analog output: (0=DIRECT 0..10V, 1=DIRECT/5V-SET, 2=MAXIMA, 3=MINIMA, 4=MAX-MIN)
16	OP-MODE	Operating mode of the CCD line (0=LOW-GAIN / 1=HIGH-GAIN)
17	HARDWMODE	Operating mode of hardware button and potentiometer (DISABLE-ALL=0, ENABLE-ALL=1,ENABLE-BTN=2, ENABLE POTI=3)
18	VIDEOTHD [%]	Video threshold (0 ... 100) in percent of the ADC range

Format of the data frame: <para-set = 1>		
Word no.	**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	<order-word> = 1	1 = parameter set one
4	Parameter 1	0 , presently not used
5	Parameter 2	0 , presently not used
6	Parameter 3	0 , presently not used
7	Parameter 4	0 , presently not used
8	Parameter 5	0 , presently not used
9	Parameter 6	0 , presently not used
10	Parameter 7	0 , presently not used
11	Parameter 8	0 , presently not used
12	Parameter 9	0 , presently not used
13	Parameter 10	0 , presently not used
14	Parameter 11	0 , presently not used
15	SLOPE VALUE L-WORD	Sensitivity of the sensor (x 1024), lower-order word
16	SLOPE VALUE H-WORD	Sensitivity of the sensor (x1024), higher-order word
17	REF-OFFSET L-WORD	Reference offset in µm, lower-order word
18	REF-OFFSET H-WORD	Reference offset in um, higher-order word

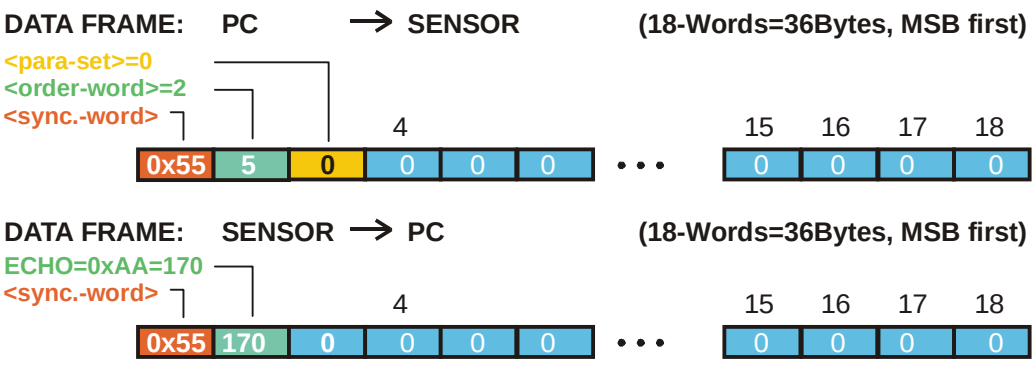
Meaning of the 2nd word in the data frame: <order-word>		
Value	**Meaning / Action**	
0	Nop	no operation
1	Send parameters from PC to L-LAS RAM	18 words, PC ⇒ L-LAS-RAM
2	Get parameters from L-LAS RAM	18 words, L-LAS-RAM ⇒ PC
3	Send parameters from PC to L-LAS EEPROM	18 words, PC ⇒ L-LAS-EEPROM
4	Get parameters from L-LAS EEPROM	18 words, L-LAS-EEPROM ⇒ PC
5	Echo check: Get echo character from L-LAS hardware, Line Ok = 0xAA	18 words, first word=0x00AA (echo=170)
6	Activate teach process, store in RAM	18 words PC ⇒ L-LAS-RAM
7	Get firmware version message from L-LAS	72-bytes, L-LAS ⇒ PC
8	**Get measurement data from L-LAS-RAM**	**18 words, L-LAS-RAM ⇒ PC**
9	Get video buffer information from L-LAS	64 words, L-LAS-RAM ⇒ PC
11	Reset maxima/minima values	18 words PC ⇒ L-LAS-RAM

Examples for data exchange:

Echo check: <order-word>=5

<order-word> = 5

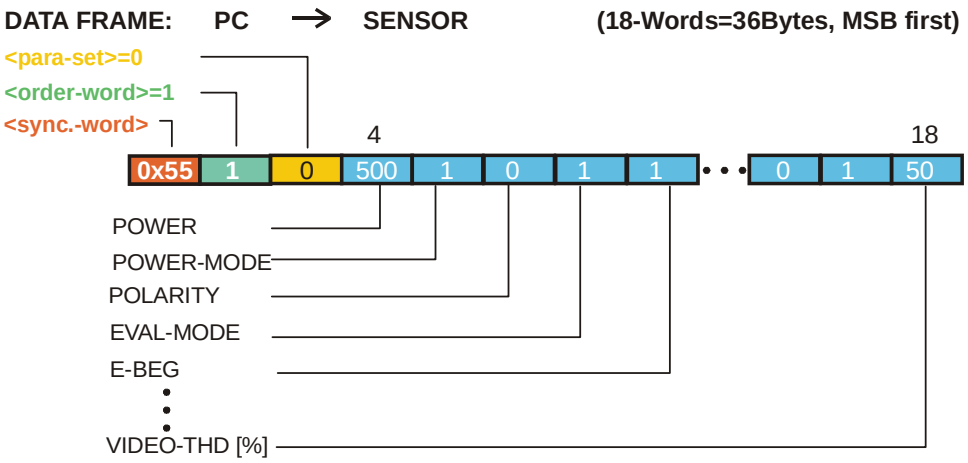
Echo check: The L-LAS-LT sensor sends an echo: word=0xAA=170 to PC



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

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

Send the current parameters (SET=0) to the RAM of the L-LAS-LT sensor

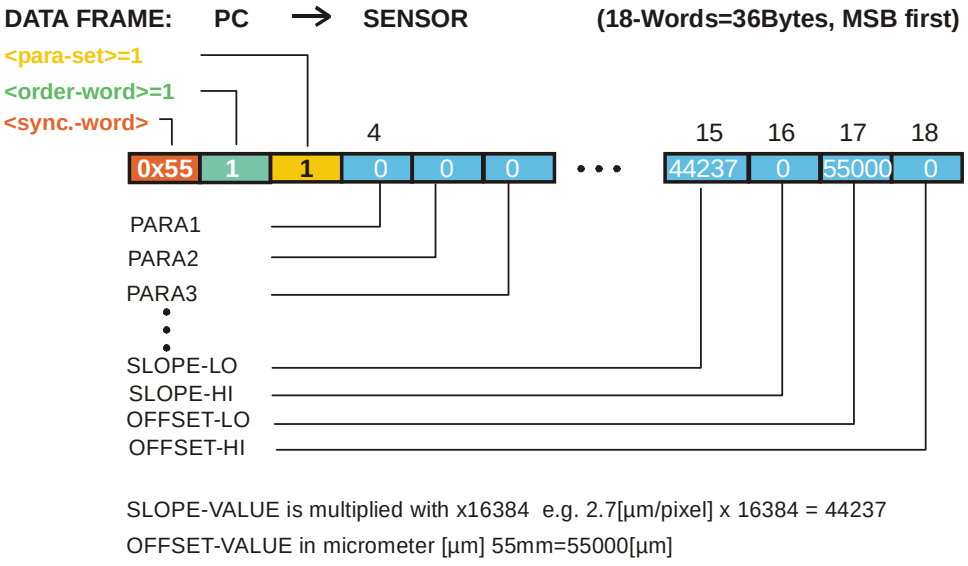


The transferred data frame automatically is sent back as an echo from the L-LAS-LT sensor!!

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

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

Send the current parameters (SET=1) to the RAM of the L-LAS-LT sensor



The transferred data frame automatically is sent back as an echo from the L-LAS-LT sensor!!

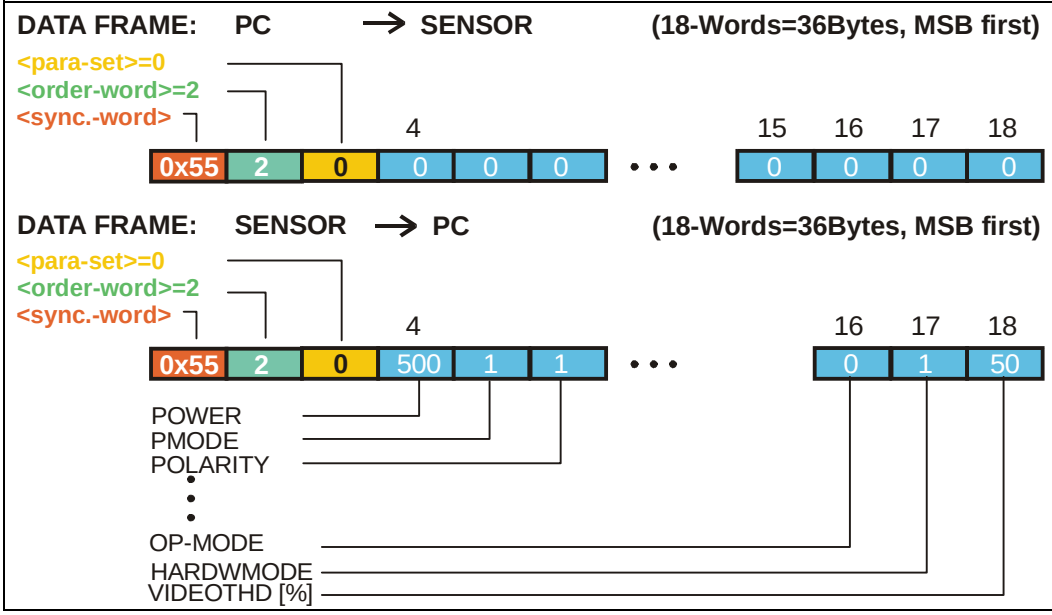
Attention !

For the final take-over of the full parameter set, both parameter sets (set=0 and set=1) must be transferred.

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

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

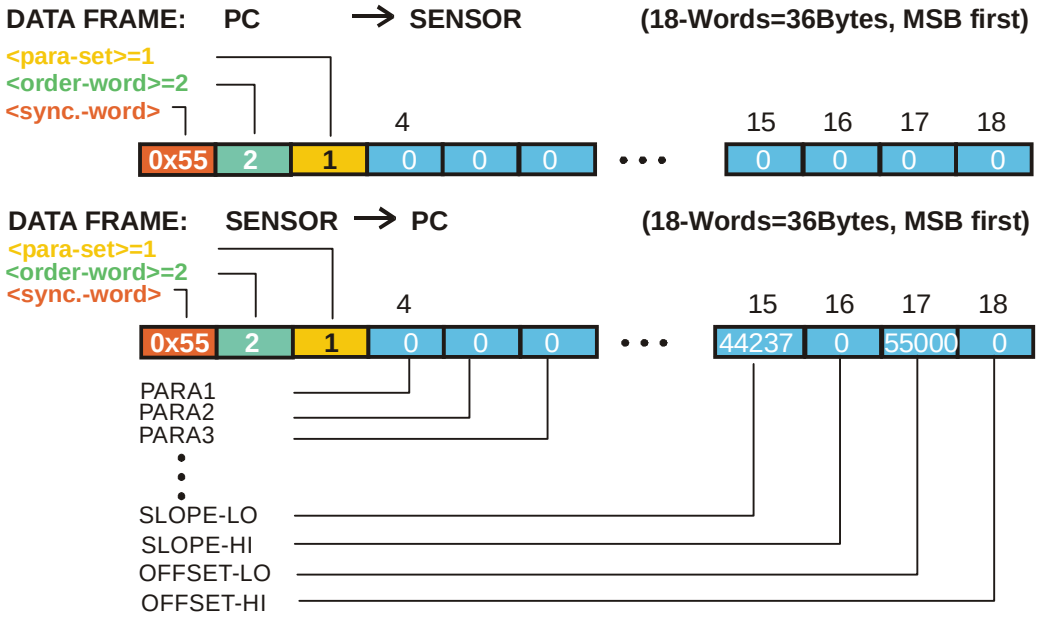
Get the current RAM parameters (SET=0) from the L-LAS RAM



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

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

Get the current RAM parameters (SET=1) from the L-LAS RAM



SLOPE-VALUE is multiplied with x16384 e.g. 2.7[µm/pixel] x 16384 = 44237

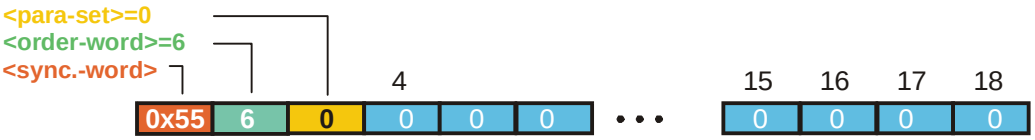
OFFSET-VALUE in micrometer [µm] 55mm=55000[µm]

Start the TEACH FUNCTION at the L-LAS <order-word>=6

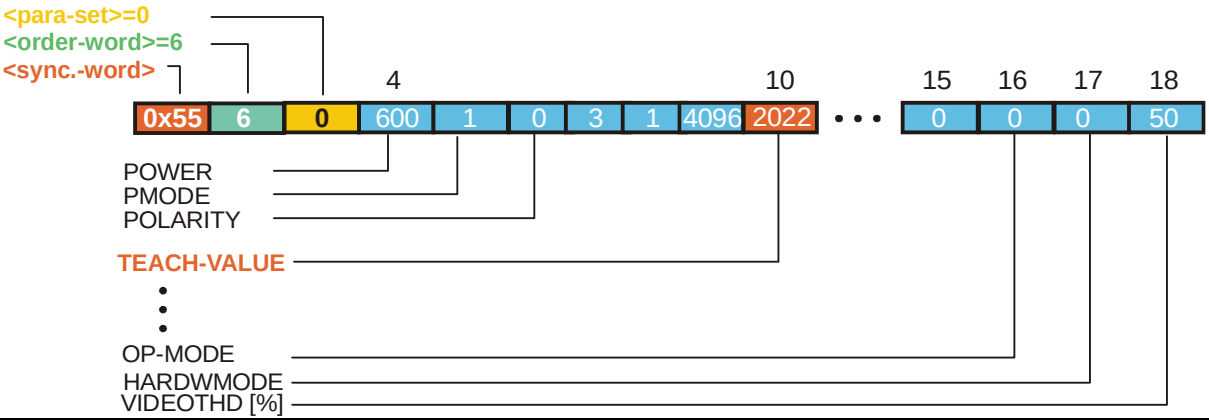
<order-word> = 6 **<para-set> = 0**

Start the teach function at the L-LAS-LT sensor. The 10th word of the echo contains the new teach value.

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



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

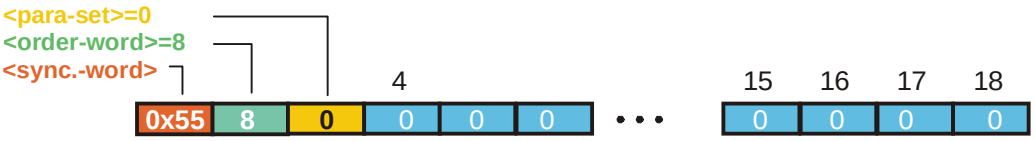


GET measurement values from L-LAS RAM <order-word>=8

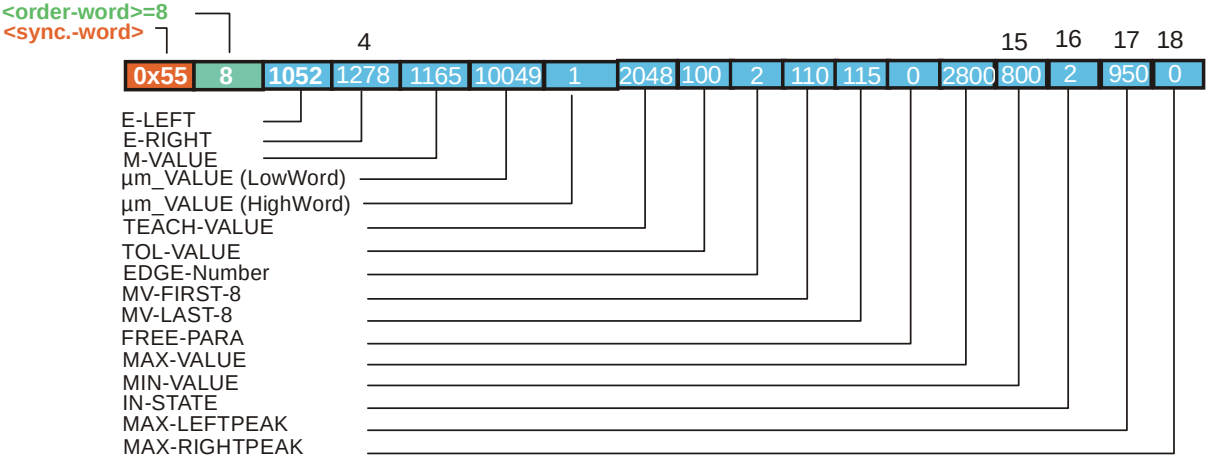
<order-word> = 8 **<para-set> = 0**

Get the current measurement values from the RAM

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



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



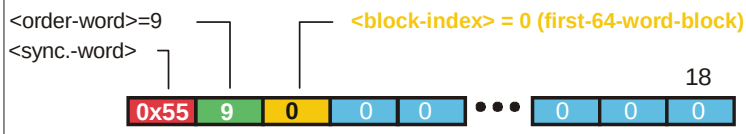
Example µm-Value: 75.584mm = 75584µm = LowWord (10049) + HighWord (1x65535)

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 every 8th pixel is read out)

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