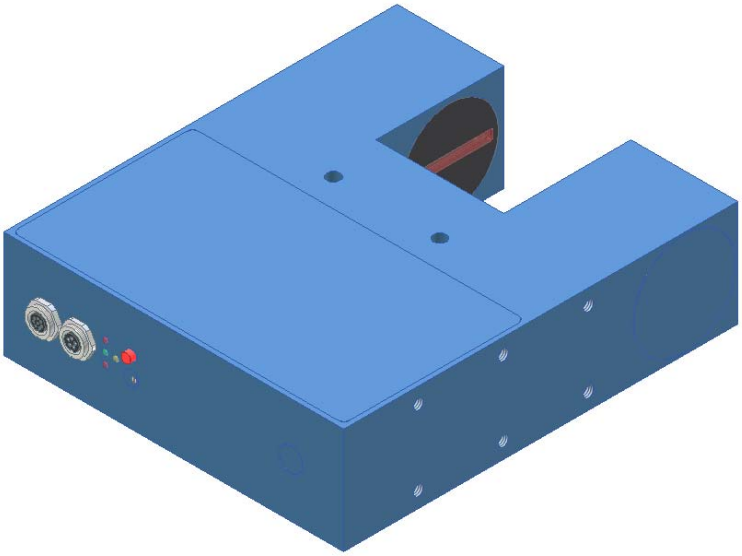
Operating Instructions

Software L-LAS-TB-Scope V1.5

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

for Laser Line Sensor
L-LAS-TB-F-35x1-60/60-XC



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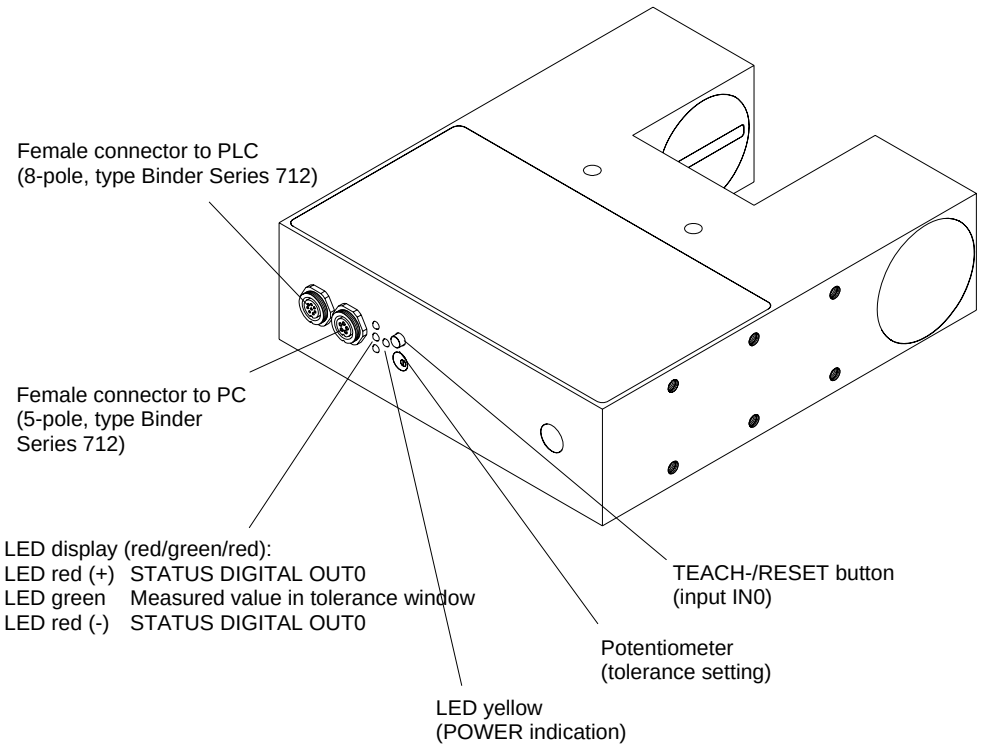
1 Function principle: *L-LAS-TB* electronic control unit

1.1 Technical description

In the laser line sensors of the *L-LAS 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 laser line, i.e. as a parallel laser light with homogeneous light distribution. In the optical receiver unit the laser line impinges on a CCD line receiver. 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.

When there is a non-transparent measuring object in the laser line, the parallel laser light only illuminates those receiver elements (pixels) of the line that lie outside the shadow zone of the measuring object. As a result the pixels within the shadow zone give off a considerably lower analog voltage compared to the illuminated pixels. By way of suitable software algorithms the areas of the shadow zones can be determined from the previously stored data field. Since the distance of the pixels on the CCD line is known, the size and position of the measuring object can therefore be determined. The micro-controller of the *L-LAS-TB* sensor can be parameterised through the serial RS232 interface by means of a Windows PC software. The sensor can be set to operate with different evaluation modes. The housing of the control unit features a TEACH/RESET BUTTON and a potentiometer for tolerance setting. Switching states are visualised by means of 4 LEDs (1x green, 1x yellow, and 2x red) that are integrated in the housing of the L-LAS-sensor. The *L-LAS-TB* control unit has three digital outputs (OUT0, OUT1, OUT2), the output polarity of which can be set with the software. A digital input (IN0) makes it possible to realise an external TEACH/RESET functionality through a PLC. In addition the control unit features a high-speed analog output (0 ... 10V) with 12-bit digital/analog resolution as well as a current output (4 ... 20mA).



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

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

- 100 MHz Pentium-compatible processor or better.
- CD-ROM or DVD-ROM drive
- Approx. 8 MByte of free hard disk space
- SVGA graphics card with at least 800x600 pixel resolution and 256 colours or higher.
- Windows 98, Windows NT, Windows 2000 or Windows XP operating system
- Free serial RS232 interface or USB port with USB-RS/232 adaptor at the PC

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

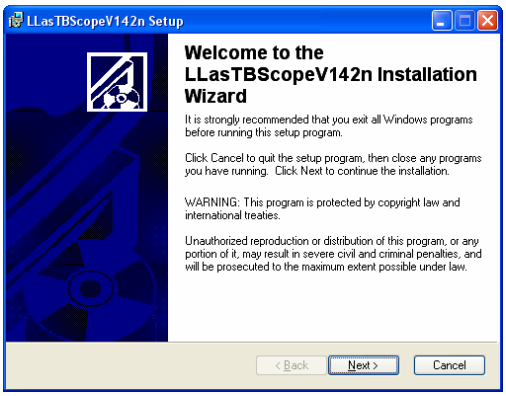
1. 

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 directory tree of your CD-ROM drive go to the installation directory D:\Install\ .
Then start the installation program by double-clicking on the SETUP.EXE symbol.

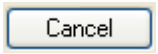
As an alternative, software installation can also be started by clicking on **START-Run...** and then entering „D:\Install\setup.exe“, which must be confirmed by pressing the **OK** button.

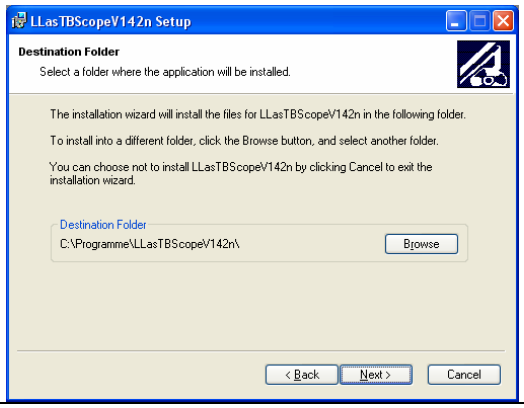


The installation program then displays a dialog-box for L-LAS-TB-Scope installation.
This dialog-box shows some general information about installation.

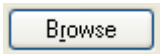
Click on Next> to start the installation,

or on Cancel to cancel the installation.



3. 

When you click on the Next> button, a new dialog field will appear and suggest an installation path.
You may accept the suggested path with Next>, or you may change the installation path by clicking on the Browse button



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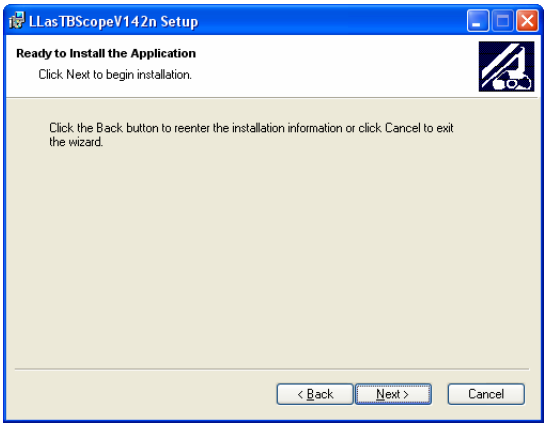
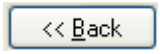
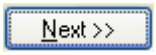


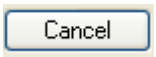
Another L-LAS-TB-Scope Setup dialog field will be displayed.



Click on the Back button to change the installation path again.

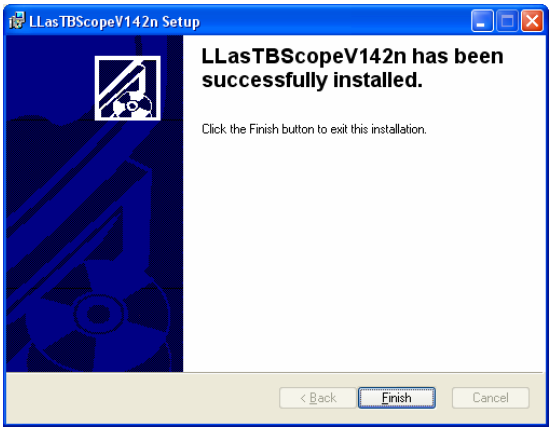


Click on Next>> to start the installation
or



click on Cancel to cancel the installation.

5.



When installation is completed, a dialog box informs you about successful installation.
During the installation process a new program group for the L-LAS-TB-Scope software is created in the Windows Program Manager. This program group contains the symbol for starting the software.

Click on the Finish button to finish the installation.

The L-LAS-TB-Scope software can now be started by double-clicking on the program symbol.

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

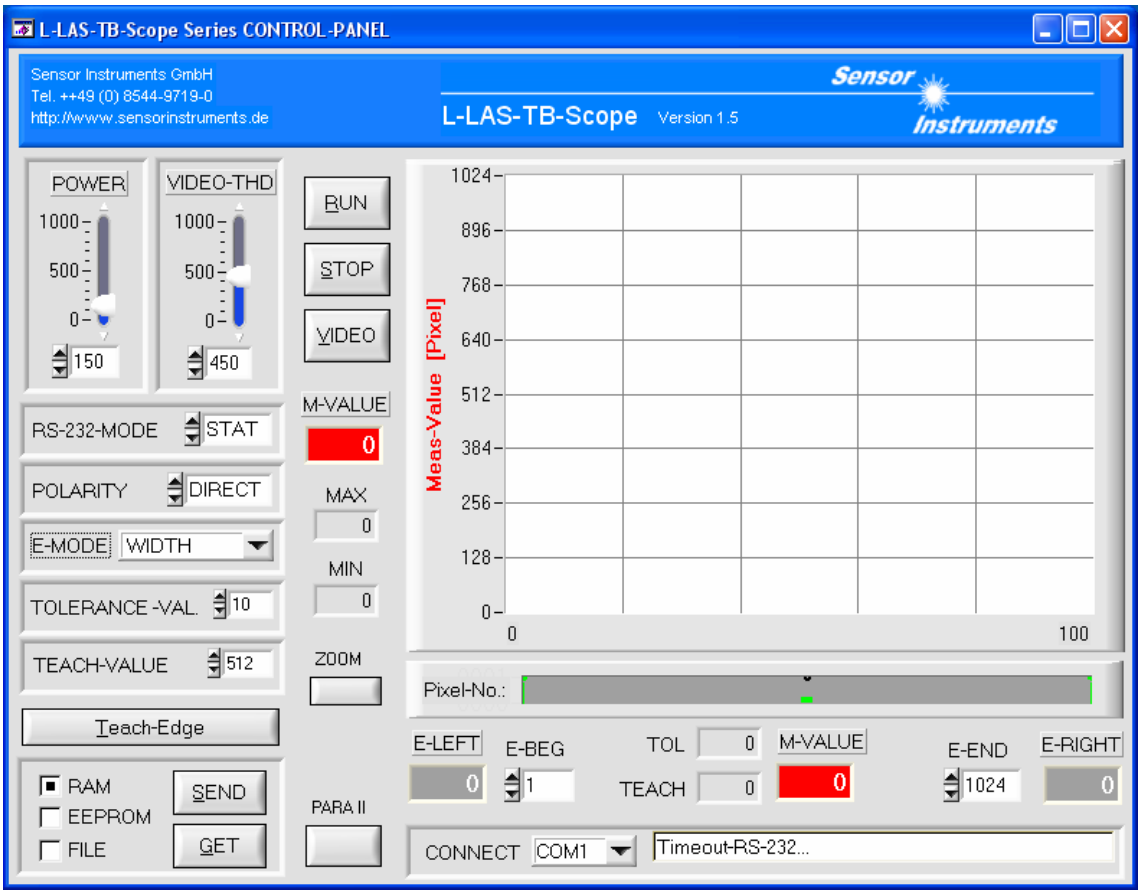
Please use the Windows deinstallation tool to remove the software.
The Windows deinstallation program can be found under Start / Settings / Control Panel / Software.

3 Operation of the *L-LAS-TB-Scope* Software

The L-LAS-TB-Scope software is used for parameterising the L-LAS-TB laser line sensors. The measured values provided by the sensor can be visualised with the PC software, which means that the software 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 must be connected to the PC with the serial interface cable cab-las-5/PC. When parameterisation is finished, the setting values can be permanently saved in an EEPROM memory of the L-LAS-TB control unit. The sensor system then continues to operate in "STAND-ALONE" mode without PC.

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

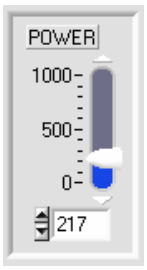


The L-LAS-TB-Scope CONTROL PANEL provides a great variety of functions:

- Visualisation 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 in a configuration file on the hard disk of the PC.

The individual control elements of the *L-LAS-TB-Scope* software will be explained in the following chapter.

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



Attention !

POWER:

In this function field the laser power at the laser transmitter unit can be adjusted by using the slider or by entering a numerical value in the corresponding input field.

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

RS-232-MODE:

This function field is used for setting the operating mode of the RS-232 interface at the *L-LAS-TB Sensor*.

STAT:

The RS-232 interface of the L-LAS sensor returns a separate data frame on demand of PC/PLC (cf. RS232 communication protocol).

CONT:

If the operating mode CONT (continuous) is selected, the microcontroller of the *L-LAS-TB sensor* continuously moves measuring data via the RS-232 interface.

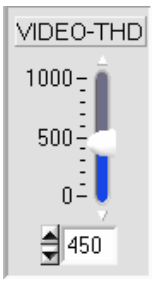
Hint:

This mode can not be activated with the L-LAS-TB-(35)-60/60-XC sensor type !

Attention !

If the RS-232-Mode is set to CONT and you work with the *L-LAS-TB-Scope* software at the same time, there will be data exchange errors.

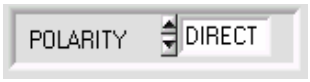
Remedy: Deactivate automatic measurement data transfer by selecting STAT and activating this selection with the SEND button!



VIDEO-THD (Video Threshold):

In this function field a threshold can be set by entering a numerical value; with the help of this threshold the measurement values are derived from the intensity characteristic (video signal) of the CCD line. For this purpose the intersections 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 is assigned to a pixel on the CCD line. The measurement value can be calculated from this information and from the distances of the pixels on the CCD line. The intersections between intensity profile and video threshold that are determined this way will be referred to as edges hereinafter.

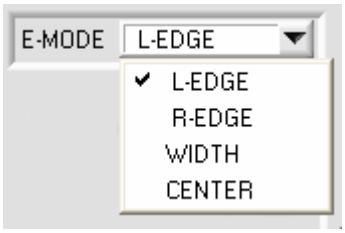


POLARITY:

In this function field the output polarity at the L-LAS-TB sensor can be set with a mouse-click on the edit box or by clicking on the respective arrow button. The L-LAS-TB sensor has 3 digital outputs (OUT0, OUT1, OUT2) through which error states can be sent to the PLC.

DIRECT: In case of error OUT0 or OUT1 = +24VDC (high-active), red LED on.

INVERSE: In case of error OUT0 or OUT1 = 0V (low-active), red LED off.



E-MODE:

This drop-down function field is used for setting the active evaluation mode at the L-LAS-TB sensor. The edges that are determined from the video signal (intensity profile) of the CCD line will be evaluated differently depending on the evaluation mode that is currently set.

L-EDGE:
The 1st edge (left edge) of the sensor's intensity profile is used as measurement value.

R-EDGE:
The 2nd edge (right edge) of the sensor's intensity profile 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.

E-BEG:

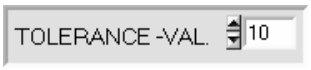
Numeric input field for entering the beginning of evaluation. The CCD line is evaluated starting from the pixel that is set here (Evaluation-Begin). (Default value = 1)

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.

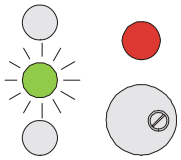
TEACH-VALUE:

In this input field a default value for the setpoint value (teach value) at the *L-LAS-TB sensor* can be set by entering a numerical value or by clicking on the arrows.



TOLERANCE-VALUE:

In this input field a default 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).



Teach-Edge:

With a click on the Teach-Edge 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-TB sensor*.

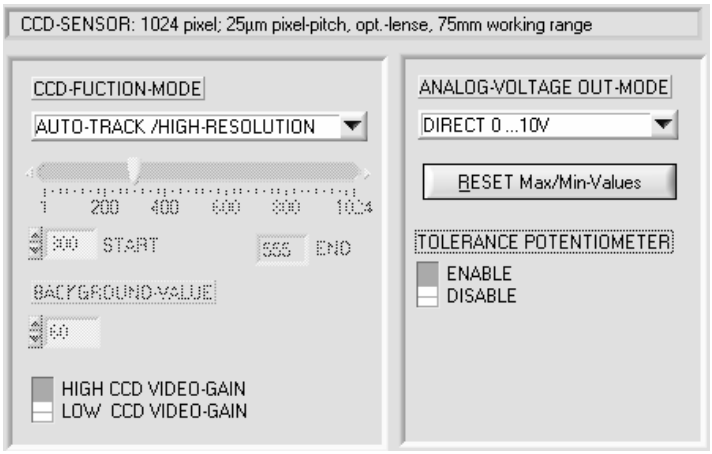
When the teach process is completed, the green LED at the housing of the *L-LAS-TB sensor* blinks 3 times.

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.

CCD-Settings:

A click on this button opens a new function window:



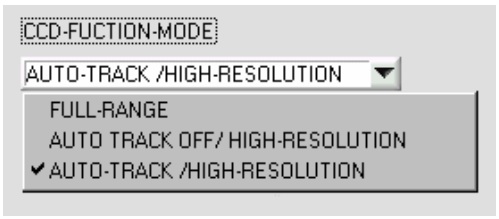
CCD-Settings window:

This function window allows additional settings for the *L-LAS-TB sensor*.

The window can be closed by clicking on the CCD-Settings button again.

PLEASE NOTE:
Changes that are made in this function window only are activated at the *L-LAS-TB sensor* after a click on the SEND button.

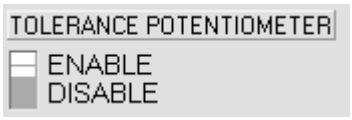
In this function window the resolution and the working range of the CCD line can be set. The video gain of the CCD line also can be set here. A scaling factor (SCALING-FACTOR) allows the conversion of the measurement values into micrometers.



CCD-FUNCTION-MODE:

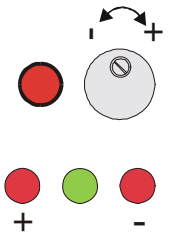
In this list selection field the operating mode that is active at the CCD line can be preset.

Please note:
This function field has no effect with sensor type L-LAS-TB-F-35x1-60/60-XC, because the micro-controller has sufficient memory to process the complete line (1024 pixel data).
The sensor permanently operates in Full Range mode with highest resolution (HIGH RESOLUTION / 1024 PIXEL).



TOLERANCE POTENTIOMETER:

With a click on this software changeover switch the tolerance potentiometer at the housing of the *L-LAS-TB sensor* can be activated (ENABLE) or deactivated (DISABLE).
The tolerance potentiometer allows the setting of a tolerance window around the setpoint value. When this switch is set to ENABLE, it is not possible to enter numerical values in the TOLERANCE-VALUE input field of the PC software.



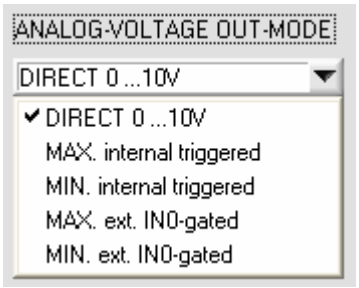
Tolerance potentiometer

ENABLE:
Tolerance potentiometer at the housing is active.
Clockwise rotation increases the tolerance band width.

DISABLE:
Tolerance potentiometer at the housing is deactivated.

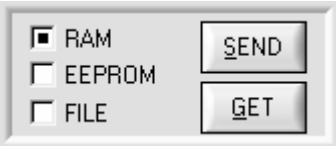
VIDEO-GAIN:

This software switch sets the video gain at the CCD receiver. HIGH CCD VIDEO-GAIN should be set if the transmitter/receiver distance is too large and the laser intensity arriving at the CCD receiver is not sufficient.



ANALOG-VOLTAGE OUT-MODE:

A click on this function element opens a drop-down list for selecting the output mode of the analog voltage at the *L-LAS-TB sensor* (pin8/red 8-pol. PLC/POWER connector).



PARAMETER TRANSFER:

This group of function buttons is used for transferring parameters between the PC and the L-LAS-TB control unit through the serial RS-232 interface.

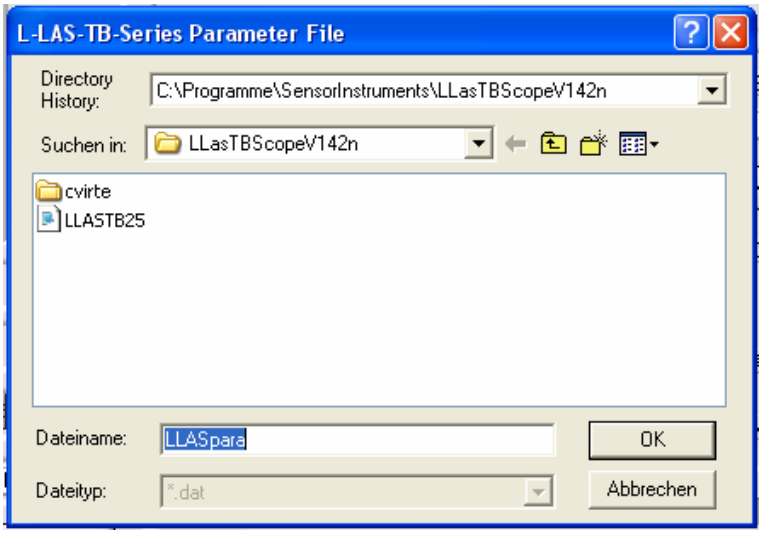
SEND:
When the SEND button is clicked, the parameters currently set on the user interface are transferred to the L-LAS-TB control unit. The target of data transfer is determined by the selected radio-button (RAM, EEPROM, or FILE).

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

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

EEPROM:
The currently set parameters are written to the non-volatile EEPROM memory of the L-LAS-TB control unit, or they are read from the EEPROM and transferred to the PC. Parameters that are saved in the EEPROM will not be lost when the power supply is turned off.
If parameters are read from the EEPROM of the L-LAS-TB control unit, these must be written to the RAM of the L-LAS-TB by selecting the RAM button and then clicking on SEND. The L-LAS-TB control unit then continues to operate with the set RAM parameters.

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



FILE dialog window:

The standard output file for the parameter values has the file name „LLASpara.dat“.

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

3.2 Numerical and graphical display elements:

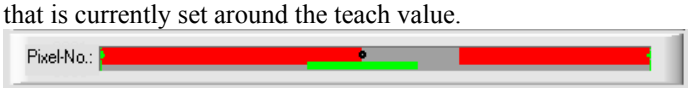
VIDEO button:
After a click on the VIDEO button, the intensity profile measured at the CCD receiver is transferred to the PC.

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 x-axis shows the pixels of the CCD line (1 ... 1024).

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.



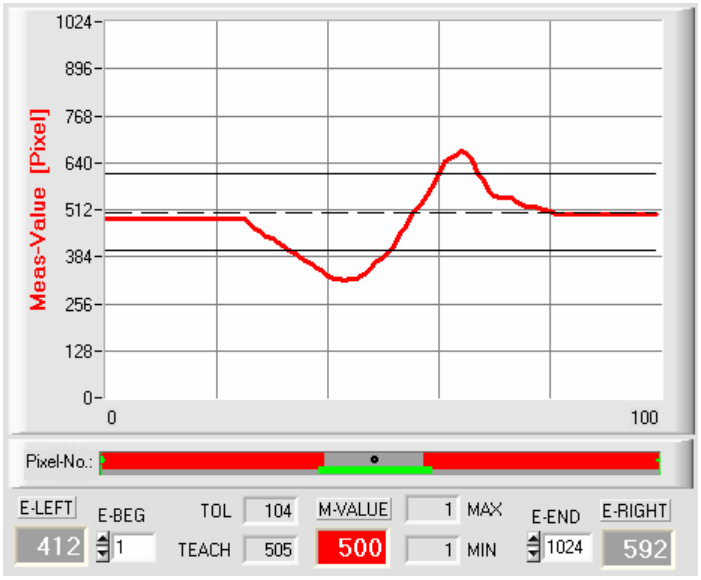
E-LEFT:
Numeric display field that shows the current left edge position.

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).

RUN button:

After a click on the RUN button, the currently measured data will be transferred from the L-LAS-TB 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 current setpoint value (TEACH value) is shown as a broken horizontal line.

In addition, the current tolerance window is represented by two horizontal black 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).

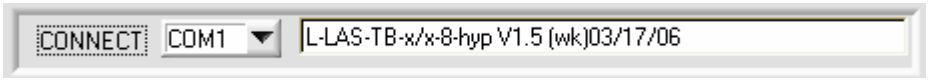
3.3 Serial RS232 data transfer:

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-TB control unit. Due to the limited data transfer rate of the serial RS232 interface (19200 bit/s) only slow changes of the analog values at the L-LAS-TB sensor can be observed in the graphic display at the PC. In order to guarantee the maximum switching frequency of the L-LAS-TB control unit it is therefore necessary to terminate the data exchange during the normal monitoring process in production (press the STOP button).



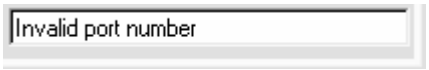
CONNECT:

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

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

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



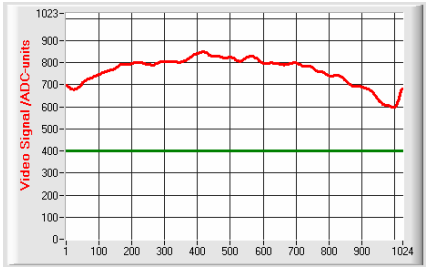
If there is an “Invalid port number” status message, the selected interface, e.g. COM2, is not available at your PC.

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

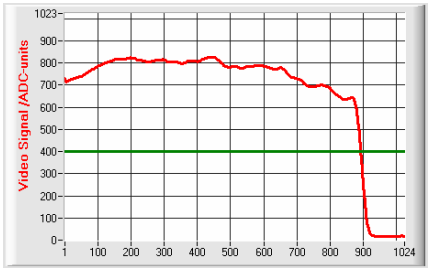
3.4 *L-LAS-TB-Scope* as an aid for sensor adjustment :

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

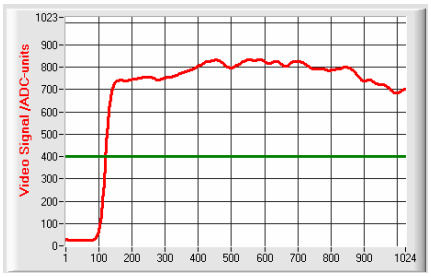
STOP:
A mouse-click on the STOP button stops the data transfer between the L-LAS-TB and the PC.



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.

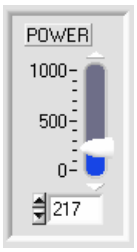


Wrong adjustment - right:
The transmitter beam no longer sufficiently illuminates the pixels at the right end of the CCD line. The alignment of the laser transmitter unit or the CCD receiver unit must be readjusted in such a way that the pixels at the right end are illuminated again.



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-TB-Scope* as an aid for transmitter power adjustment:



POWER:

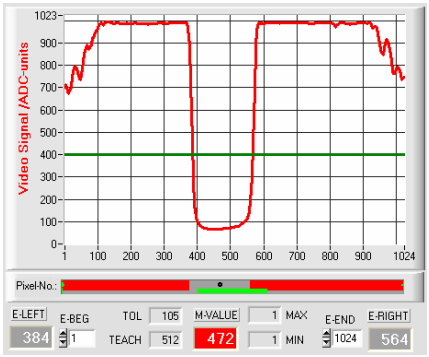
In this function field the intensity of the laser transmitter can be set by using the slider or by entering a value in the edit box.

Attention !

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

VIDEO:

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

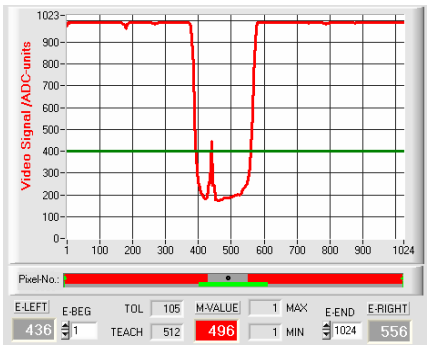


Optimal adjustment:

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

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

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



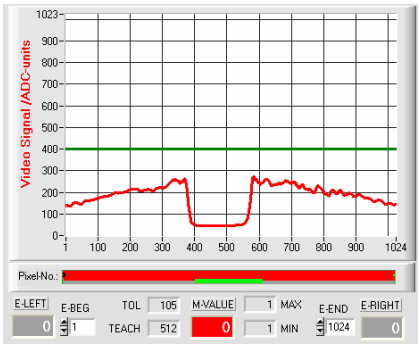
Transmitter power too high:

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

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

Remedy:

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



Transmitter power too low:

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

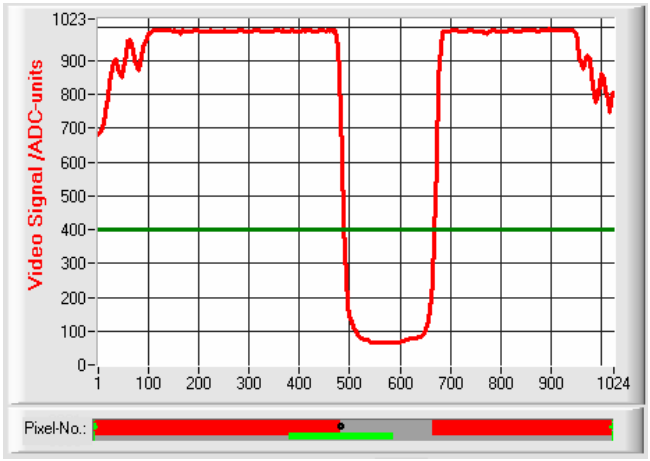
Remedy:

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

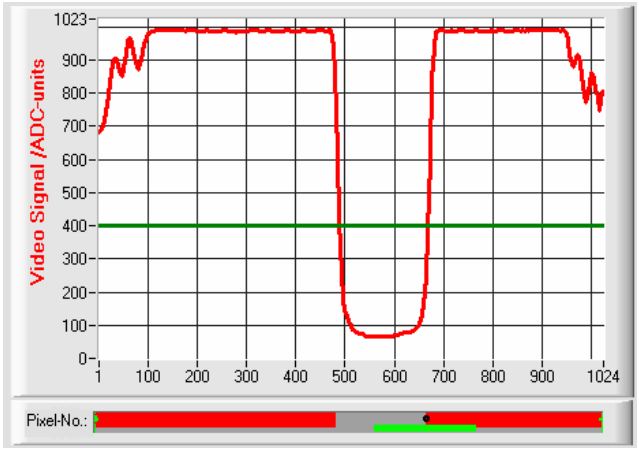
The one pixel of the CCD line at which this bright/dark transition takes place can be determined from the intersection between the video threshold (green horizontal line) and the intensity characteristic (red curve).

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 field.

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).

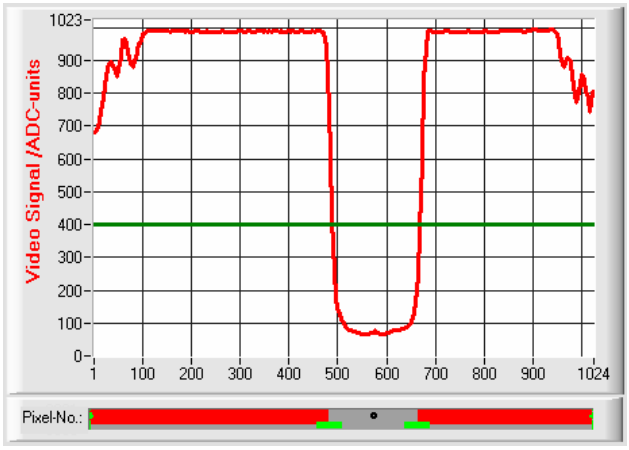
In the example picture on the left, the second bright/dark transition is detected at pixel no. 668.

The black dot-shaped curser 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 field.

4.3 WIDTH

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

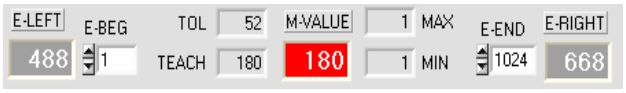


The two pixels where the bright/dark transition occurs can be determined from the two intersections between the video threshold (green horizontal line) and the intensity characteristic (red curve).

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.

By forming the difference, the result is

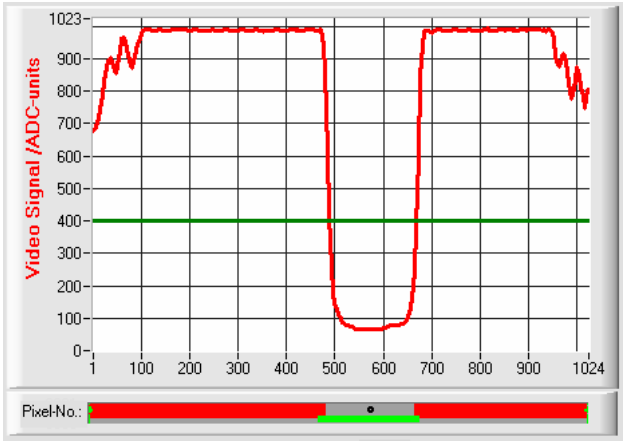
$$WIDTH = E\_RIGHT - E\_LEFT$$



The current measurement value M-VALUE = WIDTH (here 180) is shown in the red numeric display field.

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.

By forming the mean value, the result is

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

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

5 Annex

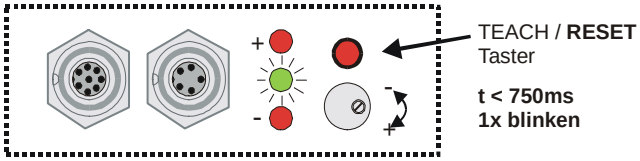
5.1 Laser warning

LASER WARNING

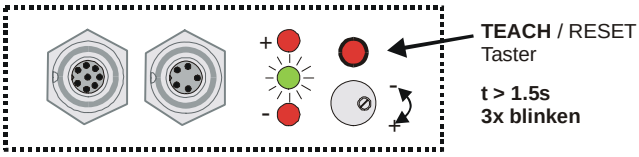
Solid-state laser, λ=670 nm, 1mW max. optical power,
laser class 2 acc. to EN 60825-1
Therefore no additional protective measures are required for the use of these laser transmitters.

5.2 Function of the TEACH/RESET button

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



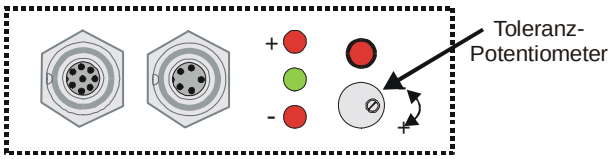
RESET function:
When this button is pressed for a short time (t < 750ms), the current maximum and minimum values are reset.
A hardware/software RESET is not performed!



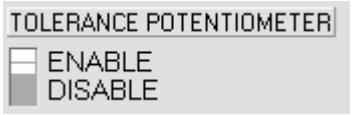
TEACH function:
When this button is pressed for a longer time (t > 1.5s), the current edge coverings are stored as teach value in the RAM memory. When the teach process has been performed successfully, the green LED blinks three times.

5.3 Function of the tolerance potentiometer:

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



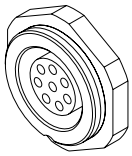
TOLERANCE potentiometer:
Turning the potentiometer clockwise increases the tolerance band width.
Turning it counter-clockwise decreases the tolerance band width.

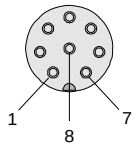


The potentiometer must be activated (switch position ENABLE) in order to use it for setting the tolerance band width at the *L-LAS-TB sensor*.

5.4 Function of the digital input IN0

The L-LAS sensor has a digital input IN0 that can be contacted through the 8-pole socket (type Binder 712).

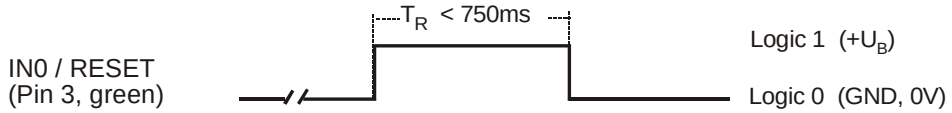




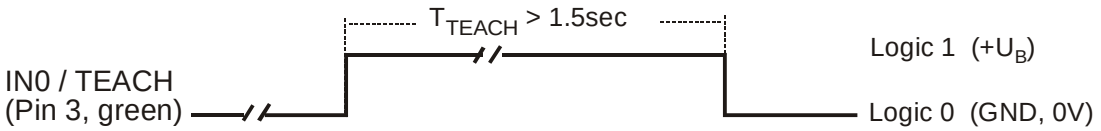
Pin:	Color:	Assignment:
1	white	0V (GND)
2	brown	+12VDC … +32VDC
3	green	IN0 (TEACH/RESET)
4	yellow	OUT2 (DIRT 50%)
5	grey	OUT0 (TOLERANCE ERROR)
6	black	OUT1 (DIRT 25%)
7	blue	I_{OUT} (4 … 20mA)
8	red	ANALOG (0 … 10V)

DIGITAL INPUT IN0 (pin3/green):

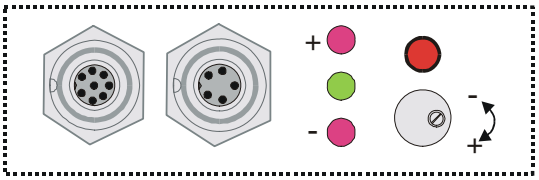
RESET function:
When a HIGH-pulse of less than **750 ms** duration is applied, the RESET function is performed at the *L-LAS-TB*-sensor. This resets the current maximum and minimum values. It does not perform a hardware/software RESET! When a RESET-pulse has been detected, the green LED blinks shortly two times.



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 has been detected, the green LED at the housing blinks shortly three times.



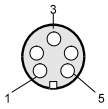
5.5 Connector assignment



SPS / POWER PC / RS-232

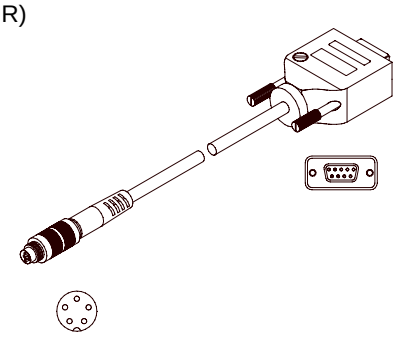
At the housing of the *L-LAS-TB* sensor there is a female connector for power supply connection (8-pol. type Binder 712) and a second female connector for connecting a serial RS232 connecting cable (5-pol. type Binder 712).

RS232 connection to PC:
5-pole female connector type Binder 712

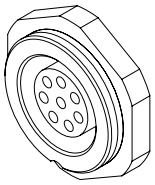


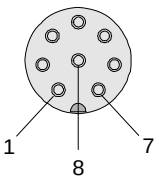
Pin:	Assignment:
1	0V (GND)
2	TxD
3	RxD
4	not connected
5	not connected

Connecting cable:
cab-las5/PC (length 2m, outer jacket: PUR)



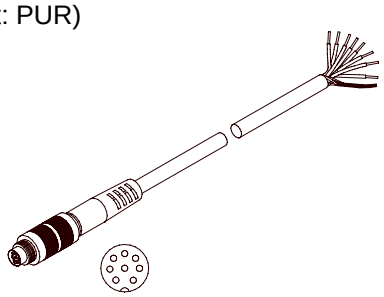
Interface to PLC/voltage supply:
8-pole female connector type Binder 712



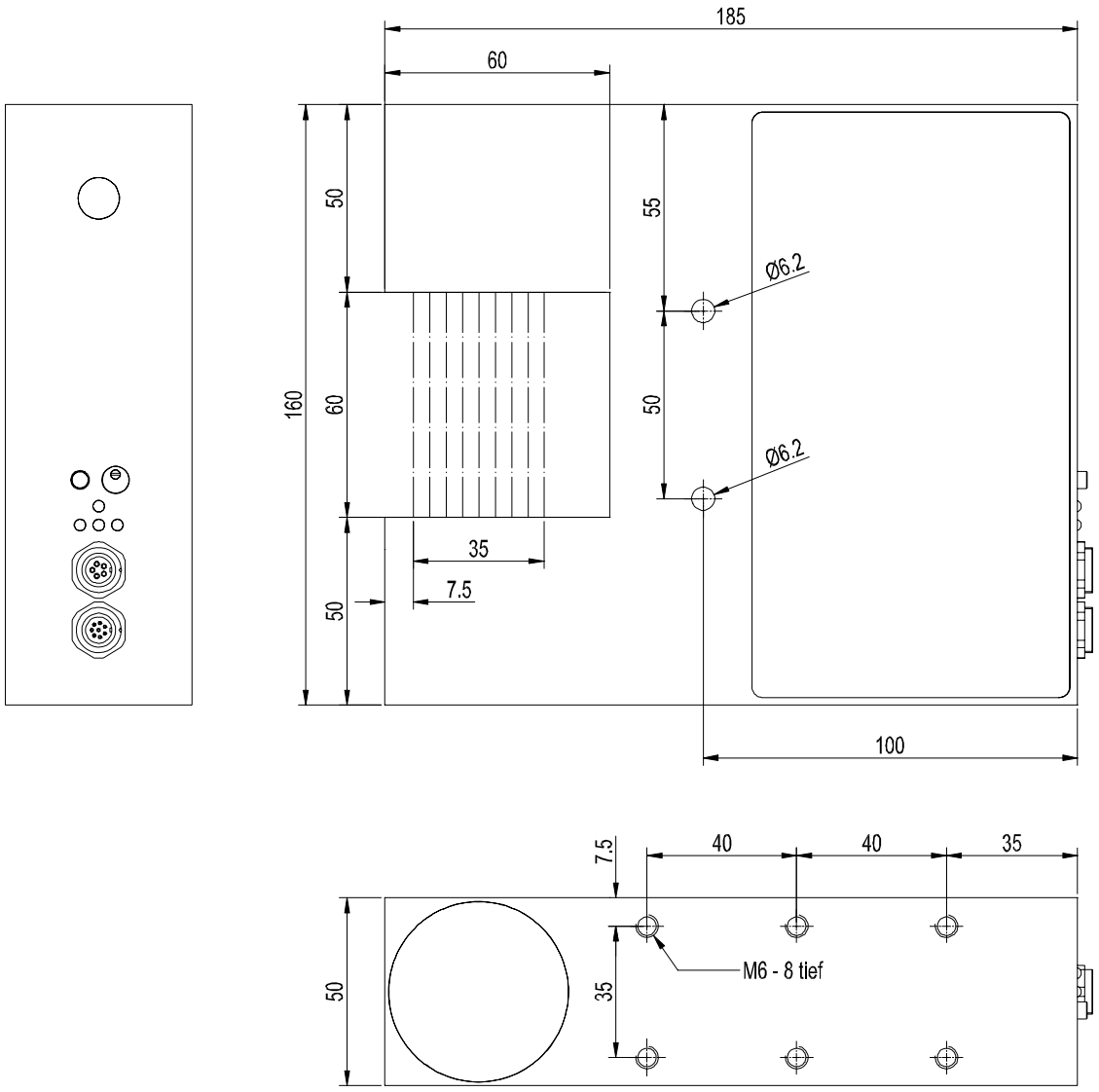


Pin:	Color:	Assignment:
1	white	0V (GND)
2	brown	+12VDC … +32VDC
3	green	IN0 (TEACH/RESET)
4	yellow	OUT2 (DIRT 50%)
5	grey	OUT0 (TOLERANCE ERROR)
6	black	OUT1 (DIRT 25%)
7	blue	I_{OUT} (4 … 20mA)
8	red	ANALOG (0 … 10V)

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



5.6 Housing dimensions:



All dimensions in mm

5.7 RS-232 interface protocol

RS232 Interface Protocol PC ⇔ *L-LAS-TB control unit*

- 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 with a length of *18-words (1 word = 2 byte = 16 bit)* to the L-LAS-TB control unit. All words must be transferred in binary format. The higher-order byte of each word must be transferred first (MSB-first).

METHOD:
The microcontroller of the L-LAS-TB control unit permanently reads the input buffer of the RS-232 module (polling). If the arriving word is *0x0055 (0x55 hexadecimal = 85 decimal)*, this is interpreted as a synchronisation event: **<sync-word>**. When the 1st word <sync-word> has been read in, the 2nd word is read in. The 2nd word contains the order number: **<order-word>** .

After the order number **<order-word>**, the L-LAS-TB reads in 16-parameters = **<parameter-word>**. When the complete data frame (18-words = 36 bytes) has been read in, the L-LAS-TB control unit executes the order transferred in the 2nd word **<order-word>**.

Format of the parameter-frame:

Word No.	Meaning	Comment
1	**<sync-word>** = 0x0055	hex-code 0x55, binary=00000000 01010101, dec.=85
2	**<order-word>**	Order word (c.f. table below)
3	parameter POWER	Laser intensity (0 ... 1000)
4	parameter RS232MODE	RS232-mode STAT=0 / CONT=1 (hyperterminal output active!)
5	parameter VIDEOTHD	Threshold for edge detection of video signal (0 …1023)
6	parameter FREE	Parameter not used
7	parameter POLARITY	Polarity setting for OUT0, OUT1, (0=DIRECT, 1=INVERSE)
8	parameter E-MODE	Eval-mode (0=L-EDGE, 1=R-EDGE, 2=WIDTH, 3=CENTER)
9	parameter E-BEGIN	Evaluation start-pixel (1 .. E_END-1)
10	parameter E-END	Evaluation end-pixel (E_BEG+1 .. 1023)
11	parameter TEACH-VAL	Teach-value TEACH (1 ...1024)
12	parameter TOL	Tolerance-value TOL: (0 ... 512)
13	parameter CCD-GAIN	CCD-receiver-gain (LOW=0 / HIGH=1)
14	parameter E-POTI	Enable/disable TOL-potentiometer (DISABLE=0 / ENABLE=1)
15	parameter FREE	Parameter not used
16	parameter FREE	Parameter not used
17	parameter ANAMODE	Mode of analog-output: (0=DIRECT, 1=MAX-intern-triggered, 2=MIN-intern-triggered, 3=MAX-extern-triggered, 4=MIN-extern-triggered)
18	parameter FREE	Parameter not used (default=0)

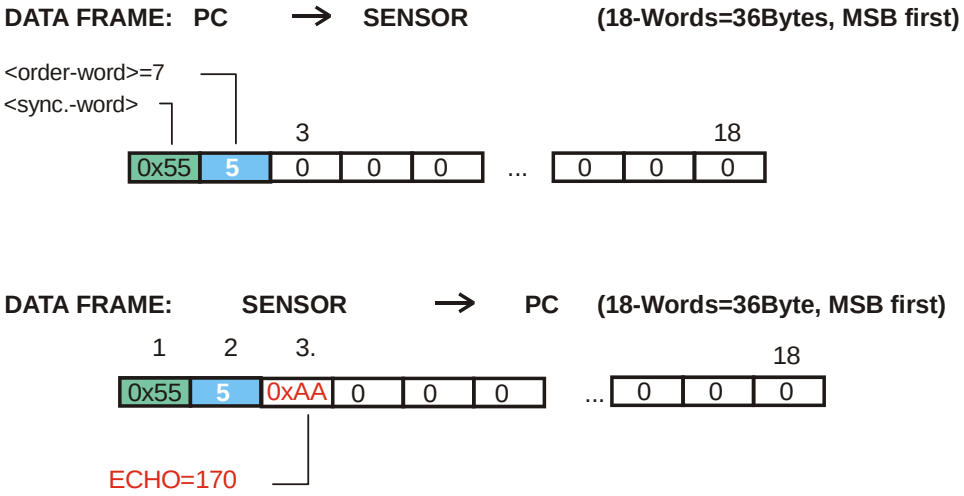
Meaning of the 2nd word of the data-frame: <order-word>		
Value	**Meaning / Action**	
0	Nop	no operation
1	Send parameter from PC into RAM of L-LAS	volatile: 18 words PC ⇒ L-LAS-RAM
2	Get L-LAS-RAM-parameter	18 words, L-LAS-RAM ⇒ PC
3	Send parameter from PC into EEPROM of L-LAS	18 words, PC ⇒ L-LAS-EEPROM
4	Get EEPROM parameters of L-LAS	18 words, L-LAS-EEPROM ⇒ PC
5	Echo check: Get echo of L-LAS, line ok = 0xAA	18 words, 3rd. word=0x00AA (Echo=170)
6	Activate Teach at L-LAS, store in RAM	18 words PC ⇒ L-LAS-RAM
7	Get software version info from L-LAS	36 words, L-LAS ⇒ PC (version-string)
8	Get measured values out of L-LAS-RAM	18 words, L-LAS-RAM ⇒ PC
9	Get data-buffer-block out of L-LAS-RAM,	64 words, L-LAS-RAM ⇒ PC
11	Reset maxima/minima-values (analog-output-mode)	18 words PC ⇒ L-LAS-RAM

EXAMPLES:

Echo check <order-word>=5

<order-word> = 5

Echo check: send echo in 3rd. word to PC

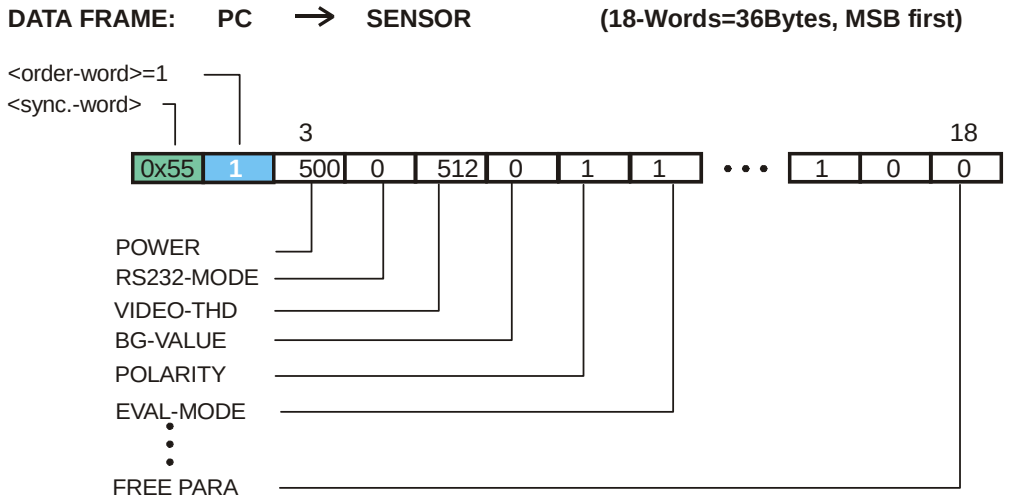


SEND parameter to L-LAS-RAM <order-word>=1

<order-word> = 1

Send actual parameters and store the frame into L-LAS-RAM

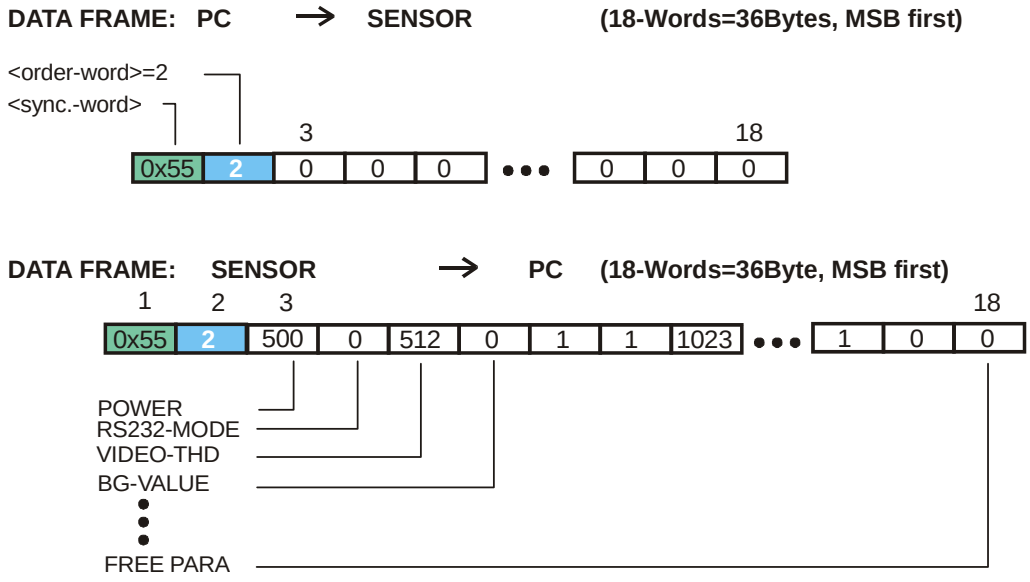
No data frame is send back to the PC with the order = 1 !!!



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

<order-word> = 2

GET L-LAS RAM parameter

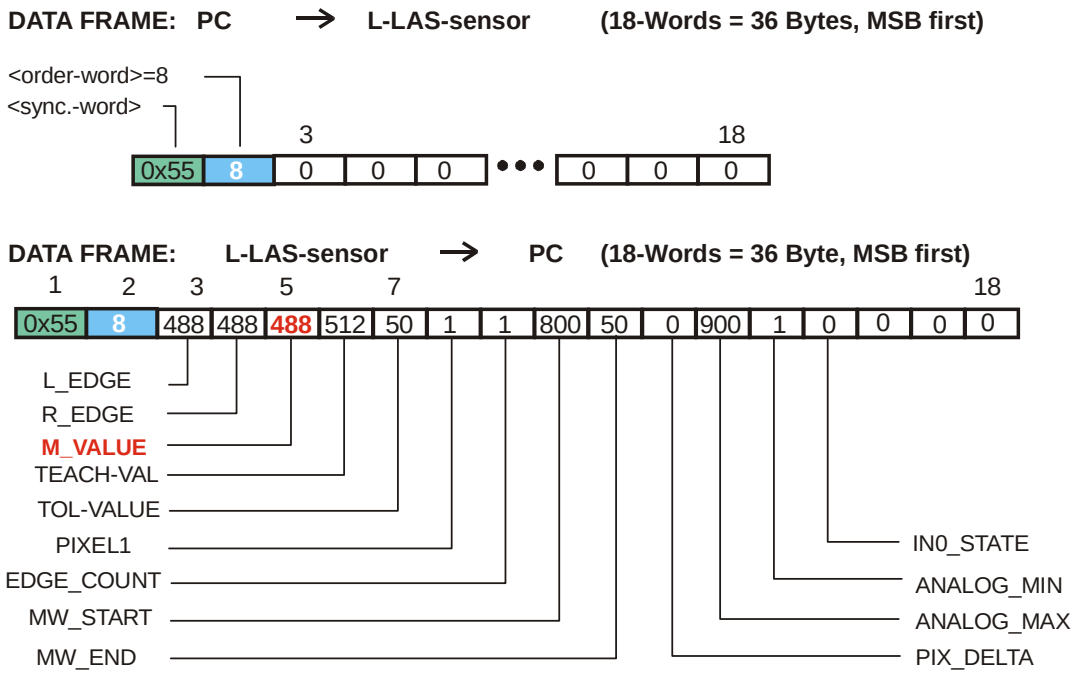


GET measured-values of L-LAS-sensor <order-word>=8

<order-word> = 8

The µController sends the actual measured values to the PC.

The 5. word of the data-frame represents the actual measured value: **M_VALUE**.



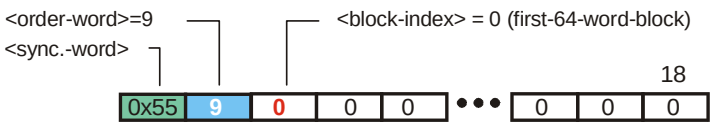
L_EDGE	:= left edge of ccd-intensity profile
R_EDGE	:= right edge
M_VALUE	:= measured value (= left edge because EVALMODE=0)
TEACH-VAL	:= teach value
TOL-VALUE	:= tolerance value
PIXEL1	:= first pixel which was detected in CCDMODE=2 "Auto-tracking"
EDGE_COUNT	:= number of detected edges
MW_START	:= mean value of the first 8 pixels of the evaluation range of the CCD-line
MW_END	:= mean value of the last 8 pixels of the evaluation range of the CCD-line
PIX_DELTA	:= difference of (pixdelta=right-edge- left-edge) position in low resolution-mode
ANALOG_MAX	:= currently stored maximum-analog-value (analog-output)
ANALOG_MIN	:= currently stored minimum-analog-value (analog-output)
IN0_STATE	:= state of digital-input IN0 (0: low, 1: high)

GET L-LAS-sensor DATA-BUFFER <order-word>=9

<order-word> = 9

Due to limited RAM memory at the L-LAS-sensor, the data buffers have to be sent to the PC in blocks of 64-words one after the other. The data buffer contains the 256-pixel of the intensity-profile which is measured at the CCD-receiver.

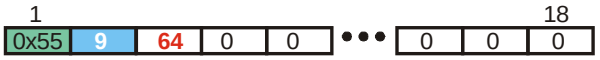
Step1: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)



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

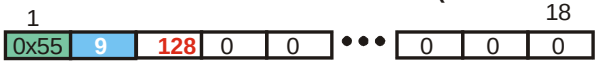
Step2: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)



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

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

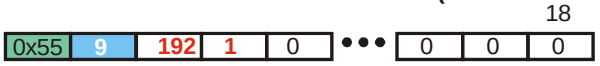
Step3: DATA FRAME: PC → L-LAS-sensor (18-Words=36Bytes, MSB first)



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

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

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