Laser Measuring Module LAM60 OEM

Operating Manual

Dear User,

Please read this operating manual carefully before starting to operate the LAM60 OEM laser measuring module / laser distance meter. This is the only way to make sure that you will be able to make full use of the capabilities of your new laser distance meter, and to prevent any damage caused by operating errors.

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Revision status

Date	Release	Revision	Remarks/ Modifications
04.03.2016	001	001	Preproduction – preliminary edition
28.07.2016	001	002	Figure 2 corrected
01.11.2016	002	000	2.2.+9. laser certification/ Company name changing
14.12.2017	003	000	Mass Production

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Table of contents

1 Overview

1.1 Symbols and references

Enumeration

Note / important note

☞

→   Reference (to a text passage or illustration)

1.2 Warning signs

The sign **Caution** warns against dangers to health which may occur if this advice is not observed

The sign **Attention** warns against possible damage to the device

The sign **Information** points to important information.

This sign indicates that special environmental protection guidelines must be observed when disposing of the device.

1.3   General information

The laser distance meters of the LAM60 series have been designed for application in industrial facilities.
Within the measuring range of 15 cm to 200 m the sensors work with a high accuracy of up to $\pm$ 1 mm and at a variably adjustable measuring frequency of maximally 100 Hz.
Due to the excellent optical measuring performance of the LAM60 OEM, the sensors can be used both indoors and outdoors, even in case of a high percentage of constant light.
When great distances of more than 50 m need to be measured, the sensor can be used in combination with a reflector.

2   Safety advice

2.1   Basic safety advice

Please read the safety and operating advice carefully, and observe the advice when operating the LAM60 OEM laser distance measurement device.	
Danger, laser radiation The LAM60 OEM must not be taken apart unauthorized, otherwise laser radiation can be emitted that can cause injuries to the eyes. Please observe all information and guidelines for operating the laser.	⚠
Danger, electric shock The LAM60 OEM may only be opened for repair purposes by the manufacturer. If the device is opened arbitrarily without authorization, all warranty claims will expire.	⚠
The operating and storage conditions (see chapter 9) have to be observed. The non-observance of this advice and the adverse use of the device can lead to injuries of the user or to damage of the device.	⚠
Connectors may not be plugged or unplugged when voltage is applied. All installation work may only be carried out when no voltage is applied.	⚠
The device may only be operated as intended and in faultless condition.	⚠
Safety installations must not be rendered ineffective.	
Safety and warning signs must not be removed.	
The device is not shatter-proof. Do not let the device fall onto the ground, and avoid any agitation.	⚠
The device may not be used in explosive environments; otherwise there is the danger of damage to the LAM60 OEM and the surrounding equipment, and of injuries of the user.	⚠
ESD (electrostatic discharge) sensitive device. Electrostatic charges readily accumulate on the human body and test equipment and can discharge without detection. Although the circuits features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality. Improper handling leads to the loss of warranty.	⚠

2.2   Laser class

⚠	Based on the standard EN 60825-1:2014 the LAM60 OEM is in correspondence with laser class 2.
	When looking into the laser beam accidentally and for a short moment, the eye will be protected by the eyelid closing reflex. The eyelid closing reflex can be affected by pharmaceuticals, alcohol and other substances.

2.3   Transport and storage

The LAM60 OEM laser distance meter is delivered in standard packaging. All kinds of transport are permitted. It is recommended to store the unit inside the transport packaging until it is used. Please observe the storage conditions.

2.4   Cleaning and maintenance

The LAM60 OEM does not require any maintenance. To ensure trouble-free measurements, the optical surfaces through which the laser beam exits and enters must be free of deposits. Dust can be removed using an air brush. In case of dirt that is hard to remove, please contact the manufacturer.

The device must not be cleaned using solvents or mechanical tools.
Mechanical or electrical modifications of the device are not permitted.

2.5   Service

In case that repair work is necessary, please send the device to the address below:

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info@sensorpartners.com
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3   Intended use

3.1   Operating and storage conditions

Operating temperature	- 10 °C … + 40 °C
Storage temperature	- 40 °C … + 70 °C
Humidity	15% … 60%, non-condensing

The LAM60 OEM has to be used in a closed housing only.

3.2   Improper use and possible error sources

- The unit may be used only as prescribed.

- Please do not remove any labels and type plates.

- Repair work must not be performed by the user. In case of questions or doubt, the manufacturer is to be consulted. For contact data see section 2.5.

- In order to obtain correct measuring values the following advice is to be observed:

    1. Measurements against the sun or onto surfaces with low reflectivity in very bright environments can result in faulty measurements.

    2. Measurements through glass, optical filters, Plexiglas or other translucent materials are possible to a limited extent but can result in measurement errors.

3.3 Warning signs

	Laser label 655 nm einfügen
LASER RADIATION DO NOT STARE INTO BEAM CLASS 2 LASER PRODUCT EN60825-1:2014 P<1mW λ=630nm to 670nm t<3ns	The LAM60 OEM works with a class 2 laser. When looking into the laser beam accidentally and for a short moment, the eye will be protected by the eyelid closing reflex. The eyelid closing reflex can be affected by pharmaceuticals, alcohol and drugs. This device may be used without any additional safety precautions when the following advice is observed: • Do not look directly into the laser beam. • Do not look at the laser beam using optical instruments. • Do not point the laser beam at other people.

4 Device description

4.1 Scope of delivery

Designation	Part no.
LAM60 OEM module	request

PLease use following reflection foils for long range measurements:

Designation	Part no.	Remarks
Reflective tape Oralite 5200, 300x300	request	300 mm x 300 mm measurements from as low as 50 m
Reflective tape Oralite 5200, 1000x1000	request	1 m x 1 m measurements from as low as 50 m
Reflecting tape Oralite special, 300x300	request	300 mm x 300 mm measurements from as low as 0.15 m

4.2 Mechanical installation

The LAM60 OEM can be screwed on using 4 pieces fastening screws M2.5 (length to be chosen depending on the counter piece).

Connector Samtec,
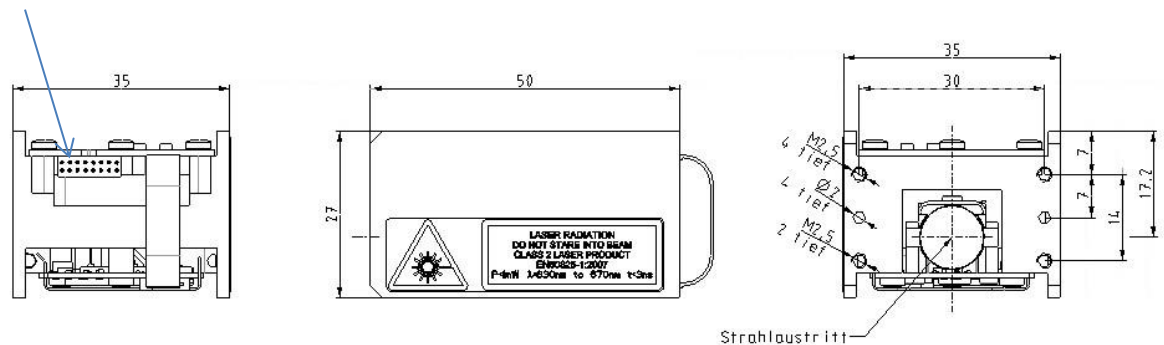
Figure 1   LAM60 Measuring Module OEM, dimensions

Legend:

Tief – deep

Strahlaustritt – laser emission point

The zero point for measurement is identical with the housing front face.

!	When the LAM60 OEM in a standard housing is used outdoors under extreme environmental conditions, an additional weather protector (e.g. cover plate in a small distance to the LAM60) is recommended. Otherwise, moisture may enter the device due to rapid temperature changes.

4.3 Device cable connector pin assignment

PIN	Signal	Description
1	5P	Power 5 $\pm$ 0.5 V DC
2	TXD	RS232 TxD: level 3,3V CMOS
3	GND	Ground
4	RXD	RS232 RxD: level 3,3V CMOS
5	GND	Ground
6	Q1	Switching output Q1: level 3,3V CMOS
7	GND	Ground
8	Q2	Switching output Q2: level 3,3V CMOS
9	GND	Ground
10	Q3	Switching output Q3: level 3,3V CMOS
11	GND	Ground
12	TRIG	Triggerinput and output: level 3,3V CMOS
13	GND	Ground
14	QA	Analog output (3 … 21mA): load impedance $\leq$ 500Ω
15	NBOOT	Boot input (low active)
16	HEIZ_EN	Controller output for heater (high active) ;level 3,3V CMOS
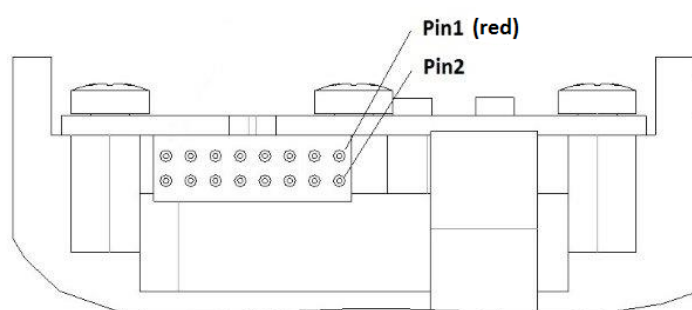
Figure 2   Connector, pin configuration

Related connector, female inclusive flat cable: FFSD-08-D-06.00-01-N (Samtec)

☞   Inverse polarity protection is provided.

☞   Overvoltage protection is provided up to a maximum of 5.5 V DC.

[!]   Open, unused cable wires must be insulated.

4.4   Laser beam image

The laser beam of the LAM60 OEM has a divergence of 0.13 mrad x 0.17 mrad (width x height). The diameter of the laser spot on the exit lens measures 4 mm.
The table below shows the size of the laser spot in dependence on the distance. The laser spot has an elliptical shape.

Distance	Laser spot width	Laser spot height
1 m	5 mm	5 mm
5 m	3 mm	3 mm
10 m	4 mm	5 mm
50 m	6 mm	7 mm
100 m	26 mm	34 mm
200 m	52 mm	68 mm

The above-mentioned laser spot holds approx. 50 % of the entire laser energy. An aura with less energy forms around that spot.

5 Installation and commissioning

5.1 Commissioning

- Remove the packaging of the LAM60 OEM.
- Check the delivery for completeness.
- Examine the device and the accessories for damage.

The delivery is without connecting cable.

If the LAM60 OEM should be operated as a stand alone unit a service cable must be prepared which supplies the LAM60 OEM with voltage and connects the unit to PC (e.g.USB).

Related connector, female inclusive flat cable: FFSD-08-D-06.00-01-N (Samtec)

Where the LAM60 OEM is taken into operation for the first time, we recommend carrying through the configuration steps at a laboratory or office.
The device can be configured using a communication program.
For example, the program HyperTerminal (included in Win32 operating systems) or any other communication program can be used.

In order to parameterize the device using a communication program, the LAM60 OEM must be connected to supply voltage and a PC (see chapter 4.3).

5.2   Mechanical installation conditions

Fastening of LAM60 OEM through the front side with four M2.5 screws.
Please adjust the length of the screws to the local conditions.
The screws are not a part of the delivery.

6   Parameter setup and measuring operation

6.1   General information

The LAM60 OEM is parameterized using the serial interface. Precondition for programming via serial interface is a connection provided by a terminal program (e.g. HyperTerminal --> see chap-ter 7).

The set parameters are stored in an EEPROM.
The last entered data will be available upon restarting.

- **Retrieval of parameters**
  Input PARAMETER <ENTER>   <ENTER> = CR = (0x0D)
- **Setting of parameters**
  Input PARAMETER VARIABLE <ENTER>
  The variables are described with the individual parameters.
  Several variables are separated by spaces (0x20).
- **Starting a measurement** (operating modes)   Input COMMAND <ENTER>
- **Stopping a measurement** <ESC>   <ESC> = (0x1B)
- **Distances** are always entered in 0.1 mm (100 μm).
  The scale factor SF has no influence on the input parameters.
  Example: Input
  3.20 m = 32000

The output values shown in the manual are examples. They may vary depending on the settings and environmental conditions.

Whenever an incorrect or incomplete command is entered, the following responses are shown:
?   The input does not contain any parameter or command.
                                     e.g.:   HELLO<ENTER>

Parameter with current value   Entry of a parameter with incorrect figure/ parameterization
                                     e.g.:
                                     Input: SAxxx<ENTER>
                                     Output: SA 10   (where SA = 10 prior to input)

6.2 Measurement involving moving targets

Where measurements involve a moving object or the LAM60 OEM is moved during measuring, this will have an impact on the accuracy of the measured value.
This must be observed particularly when calculating average values (parameter SA).

Measurement jumps and/or considerable changes in the reflectivity of the target surface can prolong the measurement period.
In case of a fixed output frequency (parameter MF), this may result in no measured value being generated within the predefined time. A warning or error message will be displayed instead.

6.3 Identification

6.3.1 ID recognition

When entering the command ID, the LAM60 OEM will respond by displaying the manufacturer's data in the following order: Device type, serial number, manufacturer's part number, firmware version, time stamp.

Query:	ID

Response (example):   Lumos 175008 012890-001-22 V5.17.0328 17-08-14.10:09

6.3.2 ID? – Online help

By entering the command ID?, the user will obtain an overview of all available operations and parameters described in the following sections.

Query:	ID?

Response:

Command List: Command must start with correct beginning, e.g.: "DM2" = "DM 2".

      (%u) declares the option of adding a positive integer to change the parameter.

      (%d) declares the option of adding an integer to change the parameter.

      (%f) declares the option of adding a floating-point number to change the parameter.

      (%s) declares the option of adding a string (e.g. "cm" in case of MUN) to change the parameter.

      (%b) declares the option of adding a boolean value (0 = false, or 1 = true) to change the parameter.

Identifications

ID?   - Prints this help.

ID   - Prints the firmware ID.

Status/Parameters

TP   - Prints the temperature of the device.

PA   - Prints all parameters.

PR   - Resets the parameters to firmware defaults.

SA   (%u)   - Prints/Changes average. Co-domain: [1, 50].

MF   (%f)   - Prints/Changes measurement frequency. Co-domain: [0.0, 100.0], (0 == auto).

MW   (%u %u)   - Prints/Changes the expected ranged for measurements in 'mm / 10'.

MUN (%s)   - Prints/Changes the unit of the measurements. Co-domain: {mm, cm, dm, m, in/8, in/16, in, ft, yd}.

OF   (%d)   - Prints/Changes the offset in 'mm / 10'. Co-domain: [-5000000, 5000000].

SD   (%u %b %b %b)   - Prints/Changes the output format.

Q1   (%d %u %d %b)   - Prints/Changes the parameterization of switching output Q1.

Q2   (%d %u %d %b)   - Prints/Changes the parameterization of switching output Q2.

Q3   (%d %u %d %b)   - Prints/Changes the parameterization of switching output Q3.

QA   (%u %u)   - Prints/Changes the parameterization of the analog output QA.

TRI (%u %u)   - Prints/Changes the parameterization of the input trigger TRI.

TRO (%u %u)   - Prints/Changes the parameterization of the output trigger TRO.

BR   (%u)   - Prints/Changes the baudrate of the serial port. Co-domain:

                  {1200,2400,4800,9600,14400,19200,28800,38400,56000,57600,115200,128000,230400,256000}.

SB   (%f)   - Prints/Changes the stopbits of the serial port. Co-domain: {0.5, 1.0, 1.5, 2.0}.

AS   (%u)   - Prints/Changes the autostart commands. Co-domain: {1 .. 12}.

TE   (%u)   - Prints/Changes the terminator. Co-domain: {1 .. 10}.

SE   (%u)   - Prints/Changes the behaviour on errors. Co-domain: {0 .. 2}.

SP   (%u)   - Prints/Changes the character that separates the values (e.g. distance and temperature). Co-domain:{1 .. 5}

SF   (%f)   - Prints/Changes the scaling factor. To use [MUN] set "SF 0". Co-domain: [(+/-)0.001, (+/-)10.000].

HE   (%d %d)   - Prints/Changes the heating thresholds.

MCT (%b)   - Prints/Changes the tracking mode, started from the menu. Co-domain: {0 == standard, 1 == continous}.

Operation Mode

DR   - Restarts the device (does not reset parameters).

LF   - Deactivates laser diode.

DM   - Starts single (precise) measurement.

DT   - Activates/Deactivates tracking mode.

CT   - Activates/Deactivates contineous tracking mode.

SDT   - Deactivates tracking modes.

LN   - Activates laser diode.

SH   - Stops heating till next restart.

6.4 Status

6.4.1 AS – Autostart

The autostart function defines the behavior of the LAM60 OEM after a cold boot.
After the connection to the supply voltage and the internal start-up routine the LAM60 OEM will automatically execute the command and send the data to the available outputs.
A figure from the table below must be entered.
The output shows the command.

Query:	AS
Set:	ASx
Range of parameter x:	1 … 6, 13 … 18 (see table below)
Standard:	5

Output: Autostart commands [AS]: DT

Depending on the measurement mode used, it takes max. 6 sec from applying the supply voltage to the point where the first measured value is put out.

Parameter x see table below

Value x	Command	Meaning
1	ID	Output of device identification
2	ID?	Output of command list
3	TP	Output of internal device temperature
4	DM	Start of individual measurement
5	DT	Start of continuous measurement
6	CT	Start of quick continuous measurement
Following parameters are usable if pin 16/ HEIZ_EN (controller output of external heater) is connected		
Value x	Command	Meaning
13	SH	Heating is deactivated
14	SH ID	Heating is deactivated + output of device identification
15	SH TP	Heating is deactivated + output of internal device temperature
16	SH DM	Heating is deactivated + start of individual measurement
17	SH DT	Heating is deactivated + start of continuous measurement
18	SH CT	Heating is deactivated + start of uninterrupted continuous measurement

6.4.2 BR – Baud rate

BR enables the adjustment of the serial baud rate x.
As soon as a new baud rate is set, the device will start communicating with the new baud rate.
BR will not be modified upon a parameter reset via PR.

Query:	BR
Set:	BRx
Range of parameter x:	1200,2400,4800,9600,14400,19200,28800,38400,56000, 57600,115200,128000,230400,256000
Standard:	115200 baud/ 8 data bits /1 stop bit / no parity

!	Prior to setting a high baud rate of > 115200 baud, make sure that the subsequent system is capable of processing that baud rate.
!	Any check of the set baud rate is impossible after wrong input of the baud rate (differ-ence between LAM60 OEM and communication program).

Output: Baud rate of serial port [BR]: 115200

6.4.3 HE – Heating adjustment

The parameter HE defines the switching thresholds for switching an external heating element on and off.
The command is enabled only where the device is actually equipped with a heating element.

Query:	HE
Set:	HEx y
Range of parameter x: Switching on heating	-40 … 40 (integer)
Range of parameter y: Switching off heating	-40 … 40 (integer)
Standard:	HE4 10

For switching the heating on or off, the internal measured temperature is compared to the set parameters.
Internal temperature < x (HeatON)   → Heating is switched on.
Internal temperature > y (HeatOFF)   → Heating is switched off.
Please observe the following when setting the parametrization: x (HeatON) <= y (HeatOFF).

6.4.4 MCT – Output/ modification of the operating mode when starting a measurement using the display

When starting a continuous measurement using an external display, you need to define if the LAM60 OEM should measure based on the operating mode DT or CT.
The operating mode is selected via the command MCT.
When starting a measurement using the display, the predefined operating mode will be applied as a rule.
When a measurement is started using a communication program or PLC, the command DT or CT will determine the type of measurement.

Query:	MCT
Set:	MCTx
Range of parameter x:	0 (DT), 1 (CT)
Standard:	0

6.4.5 MF – Measuring frequency

MF parameterizes the number x of the measured value outputs per second.
When a value x outside of the measurement range is entered, the lowest or highest permissible MF value will automatically be set.

Entered value < x → MF 0.0
Entered value > x → MF 100.0

MF 0 =   Automatic measurement. The output frequency ranges between 0.3 Hz and 10 Hz in most cases. The maximum measuring time will be 6 sec.
Essential factors concerning the measurement period are, among others, the reflectivity of the target surface and the environmental conditions (e.g. light, fog, rain).

Query:	MF
Set:	MFx
Range of parameter x:	0.0 …100.0 (Hz), resolution: 0.1
Standard:	0

Output: Measurement frequency [MF]: 0.0

!	The measuring period will be longer when an average value SA ≠ 1 is set!

6.4.6 MUN – Unit of the measured value

MUNx enables the definition of a unit for the output value. It is shown together with the measured value.
In order to use MUN, SF 0 must be set.

Query:	MUN
Set:	MUNx
Range of parameter x:	mm, cm, dm, m, in/8, in/16, in, ft, yd
Standard:	mm

Output: Unit for the distances [MUN]: mm

6.4.7 MW – Measurement window

Parameterizes the scope of a measurement window by start x and end y.
Only measured values within the measurement window will be put out.

For example, the measurement window can be used to:

- Eliminate interfering objects before or behind a measurement range
- Define a measurement range

If there is no target object within the defined measurement window, an error message will be generated cyclically:

- e1207   A target before or behind the measurement window is recognized
- e1203   Target with unsuitable reflectivity

Query:	MW
Set:	MWx y
Range of parameter x:	Resolution: 0.1 mm
Range of parameter y:	Resolution: 0.1 mm
Standard:	-5000000 5000000

Output:
Minimum distance from target [MW]: -5000000   (→-500 m)
Maximum distance from target [MW]: 5000000   (→ 500 m)

The LAM60 OEM does not check the set measurement window for plausibility. The user is responsible for correct parameterization!

6.4.8 OF – Offset

OF parameterizes an user-specific offset x that is added to the measured value.
It is entered in 0.1 mm.

Query:	OF
Set:	OFx
Range of parameter x:	-5000000 ….5000000
Standard:	0

Output: Offset in 'mm / 10' [OF]: 0

The LAM60 OEM does not check the set offset for plausibility. The user is responsible for correct parameterization!

The offset can be set by a measurement: command SO (see chapter 6.4.16)

6.4.9   PA – Parameter setting

Output of a parameter list with the current settings

Query:	PA

Output:

Baudrate of serial port [BR]:	115200
Stopbits of serial port [SB]:	1
Average [SA]:	1
Measurement frequency [MF]:	0.0
Minimum distance from target [MW]:	-5000000
Maximum distance from target [MW]:	5000000
Offset in 'mm / 10' [OF]:	0
Parametrization of switching output Q1 [Q1]:	0, 1000000, 2500, 0
Parametrization of switching output Q2 [Q2]:	0, 1000000, 2500, 0
Parametrization of switching output Q3 [Q3]:	0, 1000000, 2500, 0
Parametrization of the analog switching output QA [QA]:	0, 1000000
Unit for the distances [MUN]:	mm
Trigger (input) [TRI]:	0, 0
Trigger (output) [TRO]:	0, 0
Autostart commands [AS]:	DT
Output format [SD]:	0 0 0 0
Terminator [TE]:	0x0D0A
Scale factor [SF]:	0.000
Error mode [SE]:	0
Separator [SP]:	0x2C
Heating on threshold [HE]:	4
Heating off threshold [HE]:	10
Standard tracking mode from menu [MCT]:	0

6.4.10 PR – Parameter setting

Resetting of all parameters to factory settings (default values)
The following parameters are not reset by entering PR:
BR   Baud rate
RS   Serial port
SB   Stop bits
Setting parameters for serial interface

Input:	PR

Output:

Parameters set to firmware defaults.

Baudrate of serial port [BR]:	115200
Stopbits of serial port [SB]:	1
Average [SA]:	1
Measurement frequency [MF]:	0.0
Minimum distance from target [MW]:	-5000000
Maximum distance from target [MW]:	5000000
Offset in 'mm / 10' [OF]:	0
Parametrization of switching output Q1 [Q1]:	0, 1000000, 2500, 0
Parametrization of switching output Q2 [Q2]:	0, 1000000, 2500, 0
Parametrization of switching output Q3 [Q3]:	0, 1000000, 2500, 0
Parametrization of the analog switching output QA [QA]:	0, 1000000
Unit for the distances [MUN]:	mm
Trigger (input) [TRI]:	0, 0
Trigger (output) [TRO]:	0, 0
Autostart commands [AS]:	DT
Output format [SD]:	0 0 0 0
Terminator [TE]:	0x0D0A
Scale factor [SF]:	0.000
Error mode [SE]:	0
Separator [SP]:	0x2C
Heating on threshold [HE]:	4
Heating off threshold [HE]:	10
Standard tracking mode from menu [MCT]:	0

6.4.11 SA – Average value

SA parameterizes the number x of the individual measured values to be averaged for measured value output. SA directly correlates with the measuring frequency MF.
SA and MF determine the output frequency for the measured values.

Query:	SA
Set:	SAx
Range of parameter x:	1 … 50; resolution: 1
Standard:	1

Output: Average [SA]: 1

The spread of the measured values can be reduced by determining average values.

$$\sigma_{SA} = \frac{\sigma_1}{\sqrt{SA}}$$

σ_{SA} Spread after average determination including several distance measurements
σ_1 Spread of individual measured values ($\pm$ 1 mm)
SA   Average value

Example values of measurements involving a target with 80% reflectivity and a maximum distance of 30 m.

Measuring frequency MF (Hz)	Average value SA	Output frequency (Hz)	Spread in mm
20	1	20	$\pm$ 1.0
20	10	2	$\pm$ 0.3

6.4.12 SB – Stop bit of the serial output

SB sets the parameter of the stop bit for serial data transmission.

Query:	SB
Set:	SBx
Range of parameter x:	0.5 / 1.0/ 1.5/ 2.0
Standard:	1.0

Output: Stop bits of serial port [SB]: 1

6.4.13 SD – Data format of the serial interface output

SD parameterizes the output format and the possible output values.
The following outputs are possible:

- Distance
- Signal quality
- Temperature
- Switching outputs (active/ inactive)

Query:	SD
Set:	SDw x y z
Range of parameter w:	0…5
Range of parameter x, y, z:	0 or 1
Standard:	0 0 0 0

Output: [SD]: 0 0 0 0

Separator in correspondence with parameter TE

Parameters for data format SD

Parameter w	Output format	Separators between the values	Unit of measure (SF 0 + MUN x)	Example (SF 0 + MUN mm)
0	decimal	1 separator	unit	**d002 925.4 mm** = 2925.4 mm
1	decimal	none	none	**d002925.4** = 2925.4 mm
2	hexadecimal (floating point format IEEE-754)	none	none	**h4536E9EC** = 2926.6 mm
3	hexadecimal	none	none	**h000B6E** = 2926 mm
4	binary	none	none	**0x80 0x01 0x64 0x46** = 2925.4 mm
5	SSI and switching outputs only	none	none	SSI: Distance value in 0.1 mm Switching output: 0 or 1

Parameter setup and measuring operation

Parameter	Value	Signal quality	Temperature	Switching outputs
x	0	off		
x	1	on		
y	0		off	
y	1		on	
z	0			off
z	1			on

Data format SD - Binary format:

Distance:

        4 Byte, MSB = Bit 31

        MSB of Byte 3 always 1

        MSB of Byte 2, 1 and 0 always 0

        Measurement data of each Byte = Bit 6 … Bit 0

        Coding: Two´s complement

Signal:

        2 Byte

        MSB = Bit 15

        MSB of Byte 1 and 0 always 0

        Measurement data of each Byte = Bit 6 … Bit 0

        no sign bit

        maximum value: 16383 (14 Bit data)

Temperature:

        2 Byte

        MSB = Bit 15

        Sign bit = Bit 14

        MSB of Byte 1 and 0 always 0

        Measurement data of each Byte = Bit 6 … Bit 0

Binary format of switching outputs Q1, Q2, Q3

1 Byte

MSB = Bit 7 always 0

Q1 = Bit 2

Q2 = Bit 1

Q3 = Bit 0

1 = switching output on (active)

0 = switching output off

Bit	7	6	5	4	3	2	1	0
	0	0	0	0	0	**1**	**0**	**1**
	MSB					Q1	Q2	Q3
	= 0					on	off	on

For parameterizing of switching outputs see chapter 6.6

6.4.14 SE – Error Mode

Parameterizes the behavior x of switching outputs Q1, Q2, Q3, of the analog output QA and an external SSI Interface in case of faulty measurements as well was the condition upon execution of an individual distance measurement

Query:	SE
Set:	SEx
Range of parameter x:	0, 1 or 2
Standard:	1

x	Q1, Q2, Q3		QA	SSI	
	z = 0	z = 1		24 bit	25 bit
0	Last value	Last value	Last value	Last value	MSB High
1	High	Low	3 mA	000000	MSB High
2	Low	High	21 mA	999999	MSB High

Output in CMOS level:
  low = 0   U < 0,8 V
  high = 1   U > 2,0 V

The LAM60 OEM does not check the set error mode for plausibility!

6.4.15 SF – Scale factor

SFx defines a factor by which the output value is multiplied.

Query:	SF
Set:	SFx
Range of parameter x:	-10.000 …. 10.000
Standard:	0

Output: Scale factor [SF]: 0.000

!	At SF ≠ 0 the parameter MUN is ineffective. At SF = 0 the unit defined by MUN becomes effective.

Example of the data output: Scale factor [SF]: 0.000

SF	0	1	2	10
Distance 1,23 m	001230.0 mm	001230.0	002460.0	00012300

6.4.16 SO – Set Offset

With the parameter SO a single distance measurement is carried out and set a – OF (negative offset)
SO can only be executed in this way, it is not a parameter in the strict sense. SO is used for the zero-adjustment of applications, systems, processes.
Input: SO
Output (for example):   Offset in 'mm / 10' [SO]: -21091

6.4.17 SP – Separator for parameters

Output values are separated by the character SP.

Query:	SP
Set:	SPx
Range of parameter x:	1 … 5
Standard:	1

Output: Separator [SP]: 0x2C

Value x	Symbol	ASCII
1	Comma	0x2C
2	Semicolon	0x3B
3	Space	0x20
4	Slash	0x2F
5	Tabulator	0x09

6.4.18 TE – Terminator

TE is used to set the terminator for the output of measured values in the ASCII format (also see command SD).

Query:	TE
Set:	TEnn
Range of parameter nn:	1 … 10
Standard:	1

Example:
    Input: TE 1
    Output: Terminator [TE]: 0x0D0A

Value selection:

nn	ASCII	Meaning
1	0x0D0A	CR LF
2	0x0D	CR
3	0x0A	LF
4	0x02	STX
5	0x03	ETX
6	0x09	Htab (Tabulator)
7	0x20	Space
8	0x2C	Single Quote
9	0x3A	Colon
10	0x3B	Semicolon

When an invalid character is entered, it will not be set. The current separator will be kept instead.

6.4.19 TP - Internal temperature

Output of the internal device temperature in °C
The internal temperature is about 10 kelvins higher than the ambient temperature.

When the internal temperature of the laser unit is 75°C the laser will be switched off. Warning w1906 will be generated in a cycle of 10 sec.

After the cooling of LAM60 OEM and reaching of an internal temperature of +70°C the interrupted measurement starts automatically (depends on the setup with DT or CT).

The LAM60 OEM will not be switched off automatically when the temperature is below the internal temperature of -10°C.

Query:	TP

Response (example): 26°C

!	Please see the notes in chapter 3.1.

6.4.20 Additional commands

Command	Description
LF	Switches off the laser diode
LN	Switches on the laser diode
SDT or ESC-Taste	Deactivates the continuous measurement mode
SH	Switches off the heating until restart (available only in devices that are equipped with a heating element)
TP	Output of device temperature
DR	Executes a restart (does not reset the parameters; no PR!)

6.5 Operating modes

6.5.1 DM – Individual distance measurement

The LAM60 OEM will perform exactly one measurement and then wait for new instructions. The duration of the measurement depends on the number of preset measuring values SA and the preset measuring frequency MF.

Input: DM

Typical parameter settings
MF0, SA1, DM
Execute single measurement, allowing for a sufficient period of time as needed to determine the distance to a static (during the measurement) target object.

MFx, SA1, DM
Execute single measurement, allowing for a period of time of maximally 1 / x seconds to reliably determine the distance to a static (during the measurement) target object.

6.5.2 DT – Continuous distance measurement (distance tracking)

The LAM60 OEM performs a continuous measurement.
The measurement can be interrupted by a command:
ESC (Escape)   = 0x1B
SDT   = 0x53 0x44 0x54
The output frequency of the measured values depends on the selected parameters MF and SA.

The DT mode works with high measuring stability in the collection of the measured values, even in case of beam interruptions and discontinuous motion sequences of the target.

Input: DT

!	Full measurement (new adjustment of frequencies to define the unambiguous range) will be forced after beam interruptions.

Example response (setting SD1 1 1 0, MUNm):
          d002.0305,02736,00029

Output format	=	dezimal (d)
Distance	=	2,0305 m
Signal quality	=	2736
Temperature	=	29 °C

Remarks:

In case of poor target reflectivity, it cannot be guaranteed at 100 % that the respective measurement will be completed within the available time.
If the time between 2 measurement outputs is too short a warning will be generated
(--> w1910).
The output frequency will remain constant.

The frequency of warnings and error messages will increase if MF > 20 Hz. In addition an output of wrong distance values could be happen with bare probability. For optimal results the recommendation is to set MF to 20 Hz or lower in mode DT.

There are the following alternatives:
1. A variable output frequency can be selected for surfaces with low reflectivity. The LAM60 OEM will keep measuring until a representative distance value can be determined. Normally, the measuring period ranges between 0.01 and 3 seconds (no average determina-tion). The maximum measuring time is 6 sec.

2. Where a measured value output is not needed, a lower frequency can be set via the parameter MF. While this parameter influences the output frequency, it has no impact on the internal measuring frequency.
    The output frequency can also be reduced by using the average determination function.
    For example, if an average determination covering 5 measured values (SA 5) includes a warn-ing, only 4 measured values will be used for average determination. Where there is only one measured value, there will be one output. The output of warnings is avoided.

The table below shows exemplary the ranges and accuracies in relation to the target surface for outdoor applications. The conditions for the measurements were environmental temperature of +25°C and ambient light around the target of 1.2 kLux.
The measuring range in an application depends on a large number of factors, e.g. target reflectivity, stray light, output frequency and other enviromental conditions.
Before integration of LAM60 OEM in a whole system special tests are necessary, to get optimal application results.

Operation Mode DT				
Target	Measu-ring fre-quency	Measuring range*	Accuracy	Repealibility (Standard devi-ation)
white, matt, reflectivity approx. 80 %	variabel	15 cm … 100 m	± 2,5 mm	± 1,0 mm
	20 Hz	15 cm … 40 m	± 2,1 mm	± 0,7 mm
black, matt, reflectivity approx. 6%	variabel	20 cm … 40 m	± 2,7 mm	± 1,0 mm
	20 Hz	20 cm … 16 m	± 2,7 mm	± 2,5 mm
Reflective tape Oralite special	variabel	15 cm … 100 m	± 2,1 mm	± 1,0 mm
	20 Hz	15 cm … 100 m	± 2,1 mm	± 1,0 mm
Reflective tape Oralite 5200	variabel	50 m … 200 m	± 2,1 mm	± 0,8 mm
	20 Hz	50 m … 200 m	± 2,1 mm	± 0,6 mm

* in consideration of parameterization in accordance with chapter 6.4.8 and 6.4.16

Measurements on targets with low reflectivity may cause error messages.
If the output frequency is over 20 Hz the fault rate will increase significantly.

w1910	Generating a measured value within the predefined period of time was impos-sible (laser searches for suitable parameterization after distance jump/surface change). MF too high.
e1201/e1203	No laser reflex received (unsuitable / poorly reflecting surface). Reduce the value of the measuring frequency MF.
e1206	Target surface too bright or ambient light too intensive.
e1207	Distance is outside of the measurement window MW.

6.5.3 CT – Continuous tracking

The LAM60 OEM performs an uninterrupted continuous measurement, adjusting the laser pa-rameters (unambiguous ranges) in relation to the target only every 6 seconds or when an obvi-ous distance measurement error has occurred.
The accuracy for frequencies > 20 Hz is higher in the mode CT as in the operation mode DT.

The measurement can be interrupted by a command:
ESC(Escape)   = 0x1B
SDT   = 0x53 0x44 0x54

Areas of application:

- Scanning of static targets.
- Quick measurements on hot surfaces.
- Tracking of continuously quickly moving targets (e.g. crab [crane], vehicle)

!	Distance jumps or laser beam interruptions can result in faulty measurements! The warning w1912 is issued.

The tables below show the ranges and accuracies in relation to the target surface for outdoor applications. The conditions for the measurements were environmental temperature of +25°C and ambient light around the target of 1.2 kLux.
The measuring range depends on target reflectivity, stray light, output frequency and enviromental conditions.

Operation Mode CT				
Target	Measuring frequency	Measuring range*	Accuracy	Repealibility (Standard deviation)
white, matt, reflectivity approx. 80 %	variabel	15 cm … 100 m	± 2,5 mm	± 1,0 mm
	20 Hz	15 cm … 40 m	± 2,1 mm	± 1,0mm
	50 Hz	15 cm … 35 m	± 2,3 mm	± 1,2 mm
	100 Hz	15 cm … 30 m	± 3,9 mm	± 3,9 mm
black, matt, reflectivity approx. 6%	variabel	15 cm … 85 m	± 2,7 mm	± 1,3 mm
	20 Hz	20 cm … 20 m	± 2,8 mm	± 1,8 mm
Reflective tape Oralite special	variabel	15 cm … 100 m	± 2,1 mm	± 0,7 mm
	20 Hz	20 cm … 100 m	± 2,1 mm	± 0,7 mm
	50 Hz	20 cm … 100 m	± 2,1 mm	± 0,7 mm
	100 Hz	20 cm … 100 m	± 2,1 mm	± 1,7 mm
Reflective tape Oralite 5200	variabel	50 m … 200 m	± 2,1 mm	± 0,7 mm
	20 Hz	50 m … 200 m	± 2,1 mm	± 0,7 mm
	50 Hz	50 m … 200 m	± 2,1 mm	± 0,7 mm
	100 Hz	50 m … 200 m	± 2,1 mm	± 1,7 mm

* in consideration of parameterization in accordance with chapter 6.4.8 and 6.4.16

6.6 Q1/Q2/Q3 – Switching output

The switching outputs Q1, Q2 and Q3 show distance information as logic switching information. They signalize when values are above or below a preset switching range subject to hysteresis. Hence, they are perfectly suitable for the direct further processing of monitoring variables such as filling level or object detection. Parameterization is done via the serial interface.

A load resistance of > 150 ohms must be switched against GND_{power} at the switching output. It is essential that the load current of 0.2 A is not exceeded.
The switching outputs work with CMOS level:

    low = 0   U < 0,8 V
    high = 1   U > 2,0 V

☞	Typical resistance: 1 kohm against GND_{power} (**not** against GND_{signal})!

Q1/Q2/Q3 parameterizes the behavior of the switching outputs.
Parameterization covers the beginning w of the measurement range, i.e. the point where the output will switch, the length x of the measurement range, the hysteresis y and the logic behavior z.

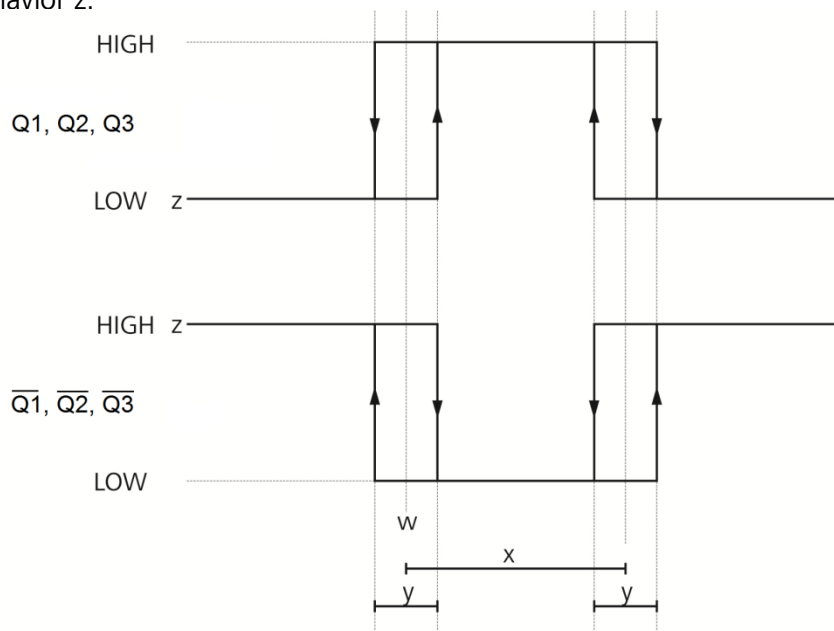Figure 3   Switching behavior and parameters of the switching outputs

Parameter	Description	Spezification
w	Switching threshold (in 0.1 mm); activate switching status z from this distance	32 bits integer
x	Switching range (in 0.1 mm); a range of x µm from w	32 bits integer
y	Switching hysteresis (in 0.1 mm); length of the tolerance range	32 bits integer $y \geq 0$
z	Switching status	$z = 0$ or 1

Query:	Q1 or Q2 or Q3
Set:	Q1w x y z or Q2w x y z or Q3w x y z
Standard:	0 100000 2500 1 (corresponds to: 0 m 10 m 25 cm 1)

The LAM60 OEM does not check the settings of Q1, Q2 and/or Q3 for plausibility.

6.7 QA – Analog output

The analog output enables the normed, analog transmission of distance data across large distances using a two-wire line. The current of 4...20 mA impressed in the line is proportional to the measured distance within an adjustable distance interval. Parameterization is done via the serial interface.

The current to be put out when faulty measurements occur is parameterized using the command SEx.

Properties of the analog output:

- 4 mA ... 20 mA
- Indication in case of an error: 3 mA or 21 mA or last measured value (selectable via the parameter SE)
- Resolution: 12 bit D/A converter

Where current/ voltage is to be converted, a load resistance of 100 ohms $\leq$ R $\leq$ 500 ohms/ 0.5 W is to be switched between current output QA and GND.
Capacitive load $\leq$ 10 nF
Operating voltage $\geq$ 12

The lower and upper distance value (limit) has to be defined for the analog output.
        Lower limit   x =   4 mA
        Upper limit   y = 20 mA

Query:	QA
Set:	QAx y
Range of parameter x:	-5000000 … 5000000
Range of parameter y:	-5000000 … 5000000
Standard:	0 100000 (0 … 10 m)

The measurement window MW also applies to the analog output.
The LAM60 OEM does not check the QA settings for plausibility. The user is responsible for correct parameterization!

Example 1:
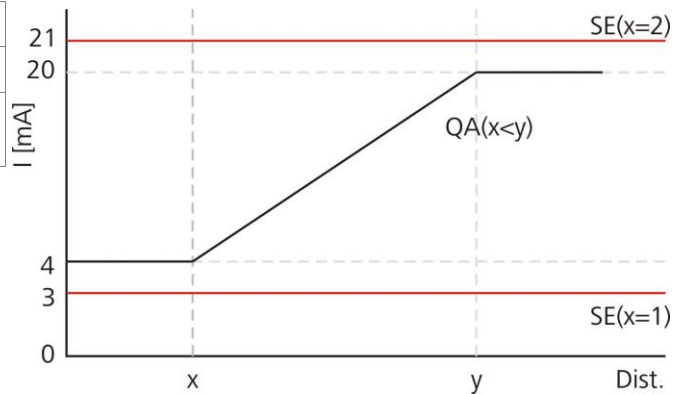A measuring range from 1 m up to 15 m shall be specified.
1 m should be the lowest current. → x = 1 m = 4 mA / y = 15 m = 20 mA

Value	Description	Specification
x	Lower limit	x ≠ y
y	Upper limit	y ≠ x

Input of parameter QA in 0.1 mm.
Input: QA10000 150000
Output: Parametrization of the analog switching output QA [QA]: 10000, 150000

The value of the output current (in mA) is calculated as follows:

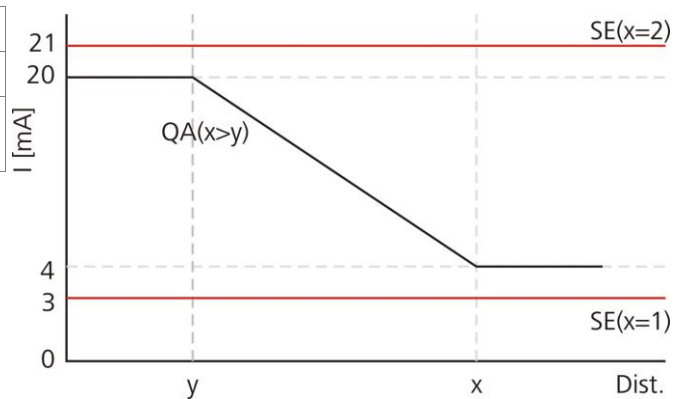| x < y	$QA[mA] = 4mA + 16\dfrac{Dist - x}{y - x}mA$

Dist = measuring distance

Example 2:

A measuring range from 1 m up to 15 m shall be specified.
15 m should be the lowest current. → x = 15 m = 4 mA /   y = 1 m = 20 mA

Value	Description	Specification
x	Lower limit	x ≠ y
y	Upper limit	y ≠ x

Input of parameter QA in 0.1 mm → QA150000 10000
The value of the output current (in mA) is calculated as follows:

x > y	$QA[mA] = 20mA - 16\dfrac{Dist - y}{x - y}mA$

Dist = measuring distance

Entries of identical limits will be ignored and not accepted.

6.8   TRI + TRO Trigger

6.8.1   Trigger function

The LAM60 OEM Trigger could be used as input or output.

1. Trigger input / external trigger function:
   External trigger signal will be sent → start of measurement DM in accordance with
   parame-ter TRI.
   Maximum trigger frequency: 1 Hz

2. Trigger output / e.g. connection between 2 LAM60 OEM:
   The output trigger signal of the 1. LAM60 OEM (parameterized with TRO) starts a single
   measurement DM of the second LAM60 OEM (parameterized with TRO).

The frequency of the trigger output signal is determined by the output frequency. When
using the trigger function the output frequency has to be 1 Hz in maximum.

$$SA = 1 \rightarrow set\ MF \leq 1\ Hz$$
$$SA > 1 \rightarrow set\ MF \leq SA \times 1\ Hz$$

Differences between trigger input and trigger output
Important is the parameter y of TRI and TRO.

TRI y > 0 / TRO y = 0   Trigger input
                              The measurement starts after an external trigger impulse.

TRI y = 0 / TRO y >0   Trigger output
                              LAM60 OEM sends a trigger impulse to the second device.

The parametrization of the trigger connection is carried out via a serial interface.

⚠	For the trigger function may only be activated TRI or TRO. A concurrent use of TRI and TRO is not possible → output of warning information w1907

6.8.2 TRI – Trigger input

The parametrization of trigger input will be set with command TRI.

x   edge   parameterized the edge of trigger signal

               0   rising edge (from LOW to HIGH)

               1   falling edge (from HIGH to LOW)

               2   every edge

y   delay   parameterized the time (delay) up to the measurement in milliseconds msec

Query:	TRI
Set:	TRI x y
Value range parameter x:	0, 1, 2

Value range parameter y:	0 to max 60 000 msec (equal to 1 minute)
	       active: from 1 msec upward
	       disabled: 0 msec

Standard:	0 0

Output: Trigger (input) [TRI]: 0, 0

Maximum frequency of external trigger signal: 1 Hz

If the trigger frequency is too high, no measurement value can be determined. The output is E1203.

The trigger frequency must be reduced.

☞	Parameter MF should be set ≠ 0 (for MF = 0 the measurement time is variable).

Voltage levels for trigger signals IN (load resistance 30 kOhm):

Low-Pegel   < 1.3 V

High-Pegel   > 1.3 V

Hysterese   0.1 V

6.8.3   TRO – Trigger output

The parametrization of trigger output will be set with command TRO.

x   edge   parameterized the edge of trigger signal

                 0   rising edge (from LOW to HIGH)

                 1   falling edge (from HIGH to LOW)

                 2   every edge

y   delay   parameterized the time (delay) up to the measurement in milliseconds msec

Query:	TRO
Set:	TRO x y
Value range parameter x:	0, 1, 2

Value range parameter y:	0 to max 60 000 msec (equal to 1 minute)
	     active: from 1 msec upward
	     disabled: 0 msec

Standard:	0 0

Output: Trigger (output) [TRO]: 0, 0

Voltage levels for trigger signals OUT (load resistance 30 kOhm):

Low-Pegel   0 V

High-Pegel $\geq$ 2.9 V

Hysterese   0.1 V

7 Serial interface and communication software

7.1 Transmission protocol

- Interface settings: Asynchronous, 8 data bits, no parity, 1 stop bit
- Transmission protocol format / syntax: 7 bit ASCII
- Proprietary transmission protocol
- Commands are case-insensitive (NO differentiation between lower and upper case).
- Decimal separator in the output of figures is the dot "." (0x2E).
- The terminator of a command (sending command) is the enter key (0x0D, 0x0A) or Carriage Return (0x0D) or Line Feed (0x0A)
- Where parameters have several values, they are separated by a space (0x20).
- The response to commands with parameters is the respective command including the parameters.
- The response to commands without parameters is the respective command including the current parameters.
- The response to commands with parameters outside of the valid value range is the respective command including the current parameters.
  The response to unknown commands and faulty parameter formats is a "?" (ox3F).

Serial interface and communication software

7.2 Installation of the communication program

HyperTerminal is a terminal program generally included in Win32 operating systems. It can be used as a communication program to parameterize the LAM60 OEM.

Start HyperTerminal via the following menu path:
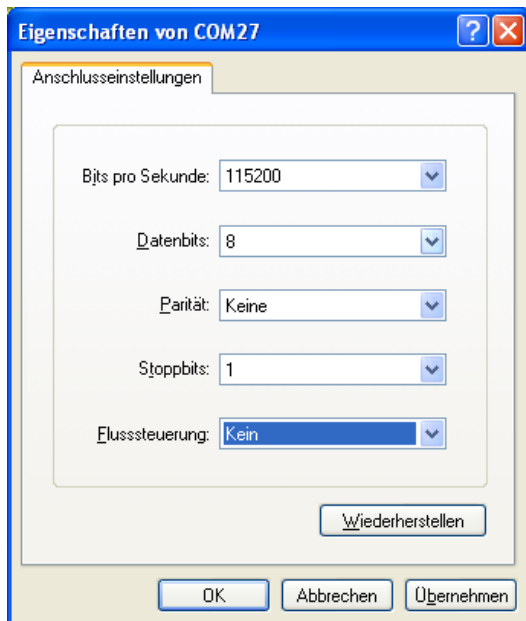|Start | Programs | Accessories | Communication | HyperTerminal|
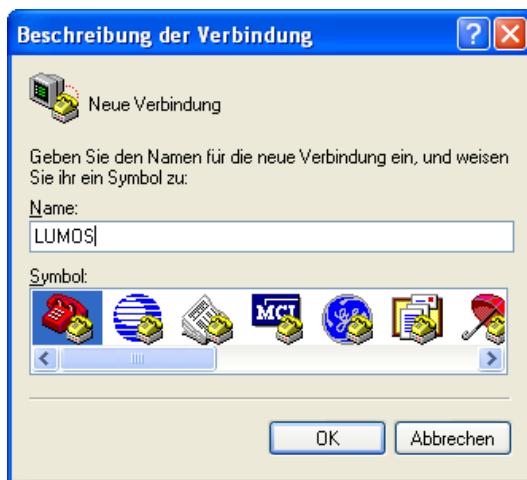
Enter the name of the new connection in the dialog box.
You can select any name. Confirm with [OK].

Select the serial COM interface in the second dialog box.

Upon confirming with [OK] a third dialog box will appear where the parameter settings for the current HyperTerminal session can be selected.

At this point, baud rate (bits per second) and flow control must be initialized correctly. As soon as the settings in the third dialog box are confirmed with [OK], the terminal window will open.
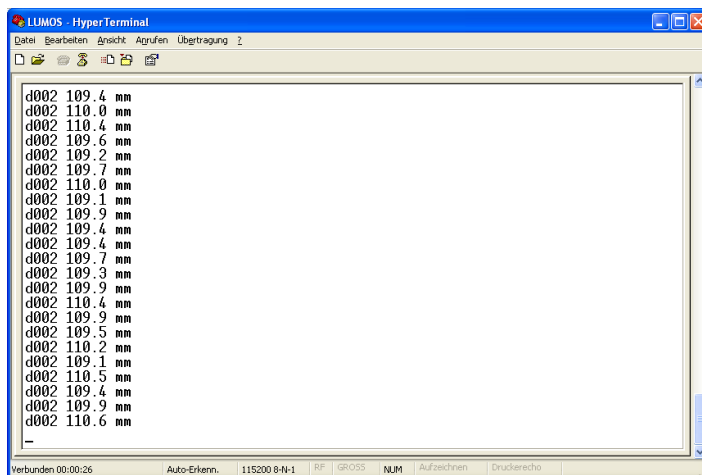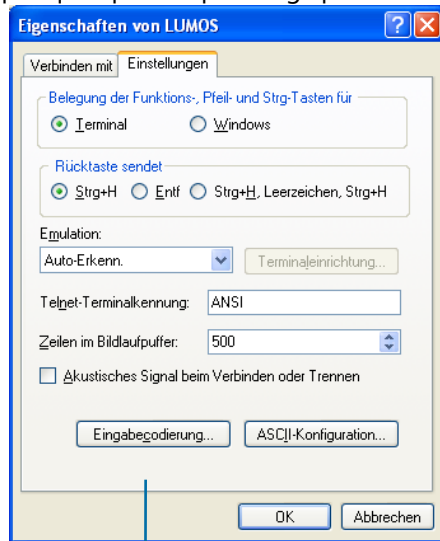

The status indication in the left bottom corner reads "Connected" when the pre-conditions for communication have been set correctly. As soon as the LAM60 OEM is ready for operation
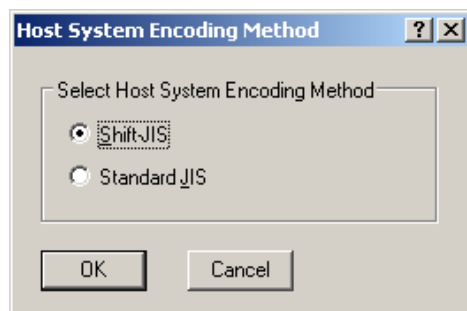(power supply, connection with PC), the commands can be entered - e.g.: ID.

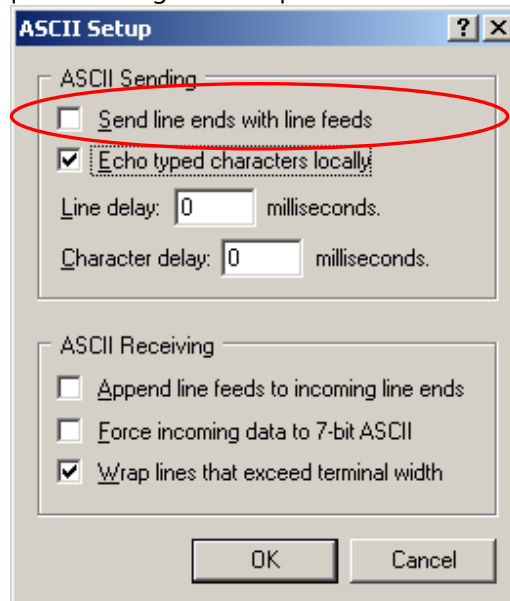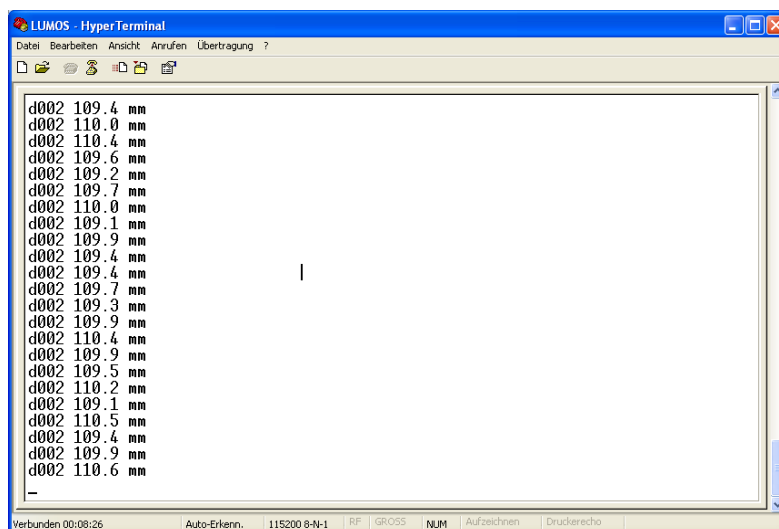| ☞	A command just entered will be displayed only when the "Local echo" function has been activated. The function can be parameterized via the menu "File".

|File | Properties | Settings |

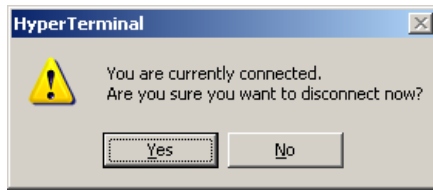|Inpu translation …

|ASCII-configuration...|

Please note: Do not tick the check box "Sent lines end with line feed".
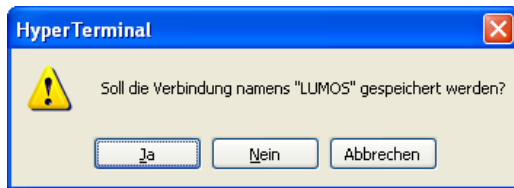

End the session with |File | Quit|.

A small window will appear where you are asked if the connection should really be terminated. This question must be responded to by pressing the [Yes] button.

If the current HyperTerminal session has not been saved yet, a small window will appear where you are asked if the session should be saved. Confirm with "Yes".
HyperTerminal will not have to be configured again upon restart.

8 Error processing

In case of errors or when a measured value cannot be determined or put out, a warning or an error message will be displayed.

Error	Meaning	Action
e1001	Error operation system/ firmware	Restart system
e1002	Error operation system/ firmware	
e1003	Error operation system/ firmware	
e1101	Error in communication with PC	check connection to external system/ contact service for repair
e1102	Error in communication with PC	
e1103	Laser module error	contact service/ send LAM60 OEM to supplier
e1104	Laser module error	
e1105	Laser module error	
e1106	Hardware error (internal data transfer)	
e1107	Hardware error (internal data transfer)	
e1108	Hardware error (controller)	
e1109	Hardware error (controller)	
e1201	Measurement impossible / no target	adjust device/ check target
e1202	Error measuring module (calibration)	contact service/ send LAM60 OEM to supplier
e1203	Target with unsuitable reflectivity	check target and distance
e1204	Measurement interrupted (measuring module)	Restart system
e1205	Measurement still running (measuring module)	Restart system
e1206	Target too bright / too much back light	check/ limit ambient light
e1207	Target outside of the measurement window (MW)	no action or change MW setup
e1208	Incorrect measurement parameterization	check setup
e1209	Hardware error (measuring module)	contact service/ send LAM60 OEM to supplier
e1210	Current of laser is over the limit (laser stops work)	Restart of measurement (e.g. DT)
e1211	Stop of measurement (internal error)	Restart of measurement (e.g. DT)
Warnings	**Meaning**	**Action**
w1901	Restart being executed	no action
w1902	Input voltage outside of the specification (too low)	check power supply (10 … 30 VDC)
w1903	Input voltage outside of the specification (too high)	
w1904	Temperature outside of the specification (too low)	check ambient temperature
w1905	Heating active, min. temperature not reached	no action/ wait until LAM60 OEM is ready
w1906	Temperature outside of the specification (too high)	check ambient temperature
w1907	Trigger input and trigger output active at the same time	Activate TRI or TRO, not both for the same system
w1910	Measurement not completed within predefined period of time	use variable measuring time (MF0)/ check target
w1911	Measuring frequency too high	change MF
w1912	Distance jump	Make sure a continuous movement of target

9 Technical Data

Measurement properties	
Measurement principle	Pulse reflection mixing method
Measured parameter	Distances
Measuring range [1]	
Total	0.15 m … 200 m
Onto Oralite 5200 target board	50 m … 200 m
Onto Oralite special target board	0.15 m … 100 m
Onto natural surfaces, 80% remission	0.15 m … 100 m
Onto natural surfaces, 6% remission	0.15 m … 85 m
Accuracy, absolute [1]	$\leq \pm$ 3.9 mm
Repeatability	$\pm$ 0.6 mm
Resolution of measured values	0.1 mm
Measuring period, minimum	10 ms

Laser	
Laser classification	Laser class 2, EN 60825-1:2014
Wavelength	655 nm (red)
Divergence	< 0.2 mrad
Laser spot in 10 m	4 mm x 5 mm

Electric connection conditions	
Supply voltage	5 + 0,5 V DC
Power consumption	< 2,5 W

Interface/ connections	
Connections on device	16-pin connector (male), FH12-10S-0.5SH(55)
Serial interfaces	RS232, CMOS level 3,3 V
Switching output	3x, Pegel 0 V … 3,3 V DC
Analog output	4 mA … 20 mA Error handling at 3 mA / 21 mA Total output error at 20 mA: + 0.15 % at a temperature of +25°C
Trigger, input + output	1x IN/ OUT, 0 V … 3.3 V DC

Technical Data

Environmental and application conditions	
Operating temperature of LAM60 OEM	-10 °C … + 60 °C
Storage temperature	-40 °C … + 70 °C
Humidity	15 % … 60 %, non-condensing
Dimensions	50 mm x 35 mm x 27 mm (LxWxH)
Weight	approx. 70 g

[1] dependent on target reflectivity, stray light, measurement frequency and environmental conditions in addition to distance and operation mode (see chapter 6.5)