Sensor Partners
LAM71 Laser Distance Sensor
Manual

Dear User,

Please read this operating manual carefully before starting to operate the LAM71 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.

Sensor Partners
Sensor Partners BV – Head Office
James Wattlaan 15
5151 DP Drunen
The Netherlands

Telephone: +31 416 378239
E-mail: info@sensorpartners.com
Internet: www.sensorpartners.com

Revision status:

Date	Release	Revision	Remarks/ Modifications
2018 March	001	000	Feasibility study version
2018 November	001	001	functional model

Table of contents

1 General information

1.1 Warning signs, symbols and references

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

The sign **Laser** warns against emitting visible or invisible laser radiation.

The sign **Electric shock** warns against the danger of an electric shock.

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.

☞ Note / important note

1.2 Intended use

The laser distance meter LAM71 is a custom built functional model. It is destined for professionals to be used solely at research and development facilities. The customer and system integrator is responsible for compliance with the relevant guidelines, laws and standards, in particular compliance with the safety requirements.

1.3 Integration of device in a system

The combination or integration of the device, LAM71, with or into a system not provided and authorized by Sensor Partners for the respective device may result in errors of the data transmission, including but not limited to failures in the total measurement range, accuracy, repeatability, connectivity or transfer speed of data. Sensor Partners assumes no liability for any damages, losses, expenses, costs, injuries, claims or demands arising out of or in connection with the combination or integration of the device, LAM71, with or into a system not provided and authorized by Sensor Partners for the respective device.

2 Safety advice

2.1 Laser class

	Based on the standard EN 60825-1:2014 the LAM71 is in correspondence with laser class 1. The laser radiation of class 1 lasers is not dangerous to the human eye, thus, any injury can be excluded.

2.2 Basic safety advice

Please read the safety and operating advice carefully, and observe the advice when operating the LAM71 laser distance measurement device.

	The LAM71 is equipped with a laser diode emitting in the infrared spectrum, which is not visible to the human eye.
	Ensure there is no voltage applied when establishing a connection to the device and while integrating the device into the customer system. There is a potential risk of an electric shock to the operator or of damage to the device.
	Do not operate the device if there is any damage visible. Contact customer service for further assistance.
	The device may not be used in explosive environments; otherwise there is the danger of damage to the LAM71 and the surrounding equipment, and of injuries of the user.
	Observe the operating conditions for the LAM71. Adverse use can cause damage to the device and will void the warranty.
	Please consider the assembly advices when integrating the device in the system. By applying the wrong voltage level and/or polarity to the LAM71 a permanent damage may be caused.
	Avoid touching the optics and do not use the device if the optics are soiled or clouded.
	Store the device in the delivered packaging.
	Do not perform any modification to the device as this may cause potential harm to the operator and the device. Any modification on the device will void the warranty.

2.3 Transport and storage

The laser distance meter LAM71 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 LAM71 does not require any maintenance. Keep the optical glass surfaces (laser and receiver lenses) free of deposits to ensure trouble-free measurements. Dust can be removed using an air brush. In case of dirt which is hard to remove, please contact the manufacturer. Do not be clean the device by using solvents or mechanical tools. Electrical, mechanical or optical modifications of the device are not permitted!

2.5 Service

In case that repair work is necessary, please contact our After Sales and send the device to the address below:

Sensor Partners
Sensor Partners BV – After Sales
James Wattlaan 15
5151 DP Drunen
The Netherlands

If you have any questions, please contact us via telephone or e-mail:

Telephone: +31 416 378239
E-mail: info@sensorpartners.com

3 Intended use/ Conditions

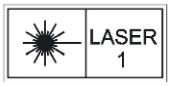
3.1 Operating and storage conditions

Operating temperature	- 40 °C … + 60 °C
Storage temperature	- 40 °C … + 70 °C
Humidity	15% … 90%, non-condensing

3.2 Improper use and possible error sources

- The unit may be used only as described.
- 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 can result in measurement errors.

3.3 Warning signs and type plates

	Laser label The LAM71 works with a class 1 laser.
	Type plate The type plate shown is an example. Serial number (SN) may differ from this image.

4 Device description

4.1 General information

The laser distance meter LAM71 is designed as a compact range finder dedicated for easy integration. Interface solutions like RS232, RS422, analog output and switching outputs are integrated.

LAM71 is designed for an operating temperature (ambient temperature) of as low as -40°C up to +60°C. The heating element ensures the operating temperature of the components and free optics (no condensation) of the LAM71.

Connecting cables are available, for order numbers please see chapter 4.2.
Devices with a cable length of up to 10 m are demonstrably EMC-safe.

4.2 Scope of delivery

Designation	Part no.	Remarks
LAM71.101	225-0116	RS232 or RS42 (see connecting schema)
Accessories		
Interface cable 3 m	18J25019	
Interface cable 5 m	18J25020	
Interface cable 10 m	18J25021	
Light tube	18J25022	

☞	Device cables with angled plug-in connector are available upon request.

4.3 Laser beam image

Divergence of laser

Transmitter: 2 mrad x 0.4 mrad
Receiver: 5.8 mrad

The table below shows the size of the laser spot on the target in dependence on the distance.

Installation of LAM71
Lenses of LAM71 are vertical about each other.

Distance	Laser spot width	Laser spot height	Footprint laser spot (not true to scale)
0.2 m	14 mm	9 mm	
1 m	14 mm	10 mm	
5 m	15 mm	19 mm	
10 m	17 mm	30 mm	
20 m	19 mm	51 mm	
70 m	32 mm	157 mm	
150 m	52 mm	327 mm	
270 m	87 mm	625 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 start of operation

5.1 Preparatory work prior to installation

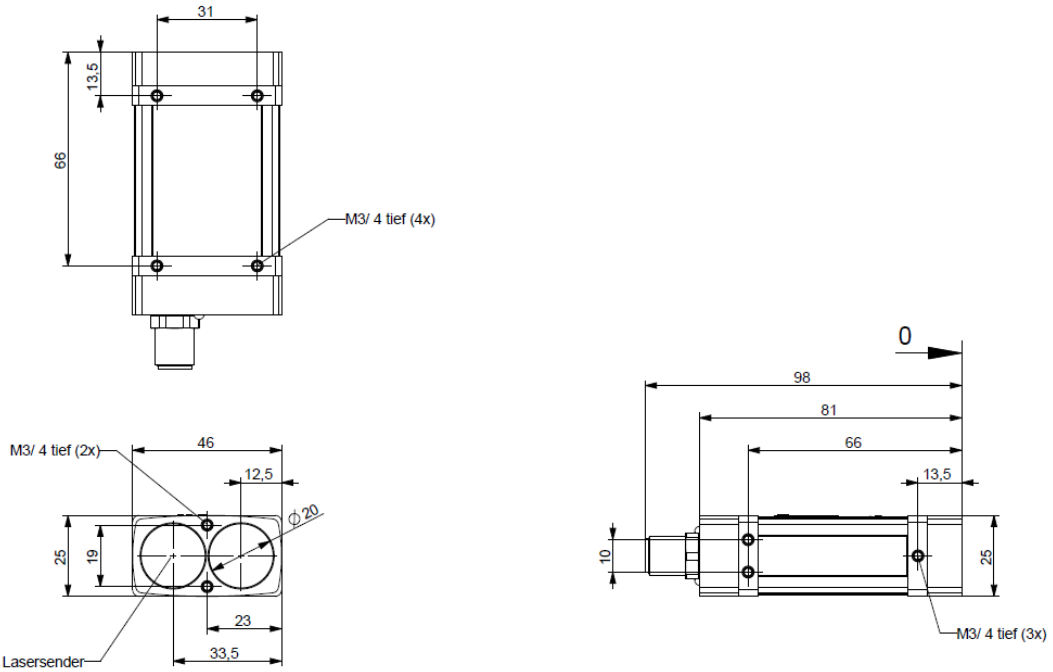
- Remove the packaging of the LAM71 and accessories.
- Check the delivery for completeness.
- Examine the device and the accessories for damage.

5.2 Mechanical installation

The LAM71 can be screwed on 3 positions:
- front with 2 screws M3
- bottom side with 4 screws M3
- one small side with 3 screws M3

Length to be chosen depending on the counter piece.

Recommendation: Use screws with washer and ring washer
Screws are not included in the scope of delivery.
Exact positions are shown in the picture below.
The zero point for measurement is identical with the housing front face.



0 = zero point for measurement
tief = thread depth
Lasersender = laser transmitter

Figure 1 LAM71 dimensions

5.3 Connector pin assignment

Pin	Colour	Signal	Description
1	Brown	Q1	Switching output Q1
2	Blue	VDC-	GND of supply voltage
3	White	RS422 / RS232	Setting pin RS422 or RS232
4	Green	TX+ TXD	RS422 transmission data + RS232 transmission data
5	Pink	RX-	RS422 receiving data -
6	Yellow	TX-	RS422 transmission data -
7	Black	Q2	Switching output Q2
8	Grey	RX+ RXD	RS422 receiving data + RS232 receiving data
9	Red	VDC+	Supply voltage 10 … 30 V DC
10	Violet	TRIGIO	Trigger signal IN / OUT
11	Grey/ pink	QA	Analog output
12	Red/ blue	GND	Ground measurement (for QA, RS232, RS422, Trigger)

☞ Inverse polarity protection is provided.

☞ Overvoltage protection is provided up to a maximum of 42 V DC.

	The shield of the cable should be connected to the connector housing. Open, unused cable wires must be insulated.

LAM71 connector: M12-A male panel mount connector 09 3491 970 12
Producer: Binder

Interface cable see chapter 4.2

5.4 Serial interface RS232 / RS422

Before using the serial interface RS232 or RS422 the user has to check the connection of PIN 3 (white).

	RS232 PIN 3 not connected RS422 PIN 3 connected with PIN 12 (GND)

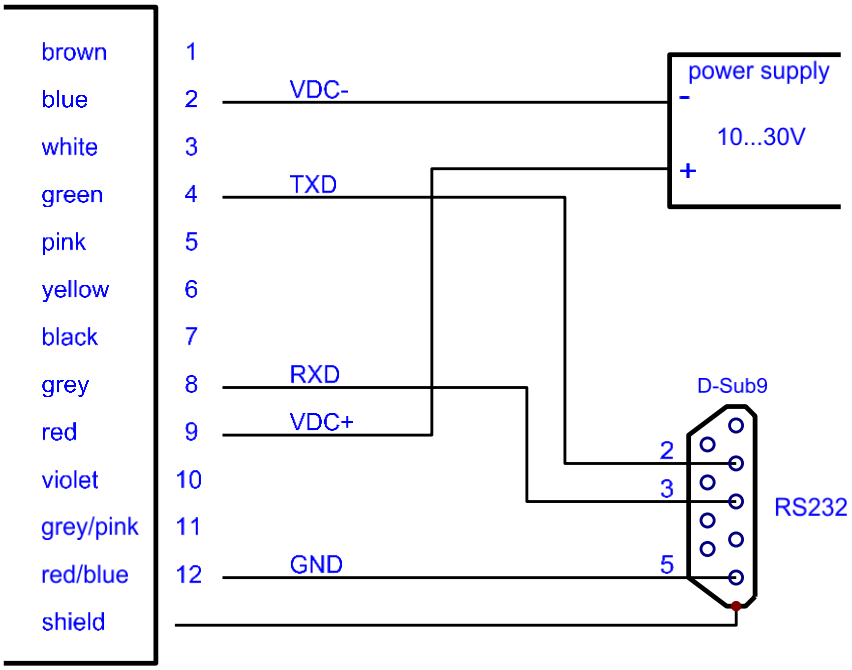


Figure 2 Wiring of serial interface RS232

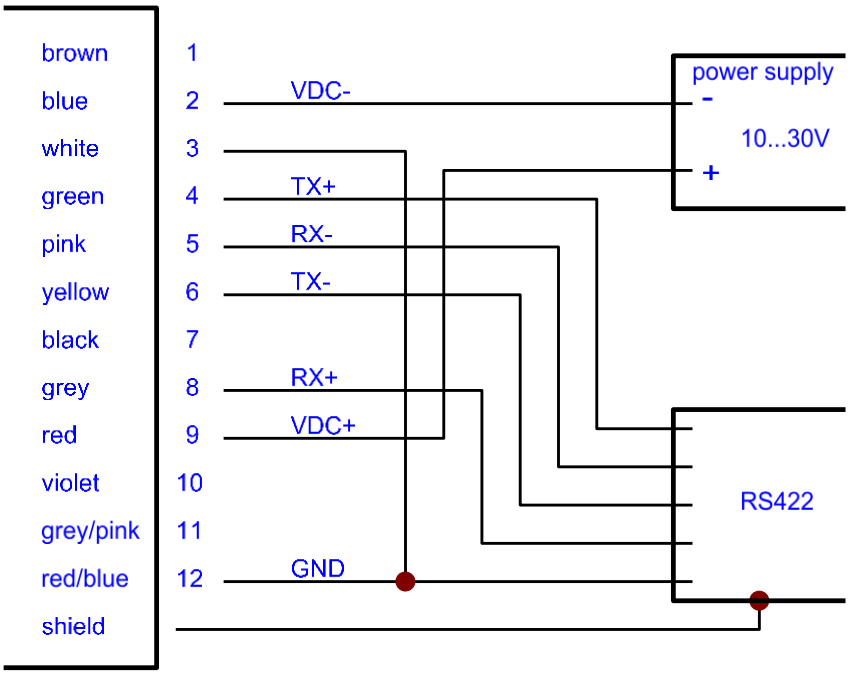


Figure 3 Wiring of serial interface RS422

6 Parameter setup and measuring operation

6.1 General information

The LAM71 is parameterized using the serial interface. Precondition for programming via UART is a connection provided by a terminal program (e.g. HyperTerminal, Tera Term). 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> <ENTER> = CR = (0x0D)

Stopping a measurement

<ESC> <ESC> = (0x1B)

Distances are always entered in meter (m).

Examples: 631 cm → Input: 6.310

5.123 m → Input: 5.123

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)

The LAM71 has a measurement control LED.
The LED is flashing green during measuring without a failure.
The LED is flashing red if a failure is happened.

6.2 Measurement involving moving targets

Where measurements involve a moving object or the LAM71 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).

6.3 Identification

6.3.1 ID recognition

When entering the command ID, the LAM71 will respond by displaying the manufacturer's data in the following order: ID, serial number, firmware version.

Query: ID Response: ID SN 180004 V3.38R 630

6.3.2 ID? – Online help

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

Query:	ID?

Response:

Operation Mode

DM[Enter].....single distance
DT[Enter].....continuous distance

Status

TP[Enter].....internal temperature [°C]
HW[Enter].....hardware status
PA[Enter].....display parameter

Setup Parameter

PR[Enter].....reset parameter
DR[Enter].....reset device
AS[Enter]/ASs[Enter].....display/set autostart command
MF[Enter]/MFx[Enter].....display/set measure frequency
GN[Enter]/GNx[Enter].....display/set receiver gain
SA[Enter]/SAx[Enter].....display/set average value
MW[Enter]/MWx y z[Enter]....display/set measure window
OF[Enter]/OFx[Enter].....display/set distance offset
SO[Enter].....set current distance to offset
SE[Enter]/SEx[Enter].....display/set error mode
Q1[Enter]/Q1w x y z[Enter]..display/set digital out Q1
Q2[Enter]/Q2w x y z[Enter]..display/set digital out Q2
QA[Enter]/QAx y[Enter].....display/set analog out QA
BR[Enter]/BRx[Enter].....display/set serial baud rate
SD[Enter]/SDx y[Enter].....display/set serial output format
UB[Enter]/UBx[Enter].....display/set unit for binary output
TE[Enter]/TEx[Enter].....display/set serial terminator
ST[Enter]/STx[Enter].....display/set first or last target for outout
TC[Enter]/TCx[Enter].....display/set DT recalibration timing x in sec (0 off)
TI[Enter]/TIx y[Enter].....display/setup input trigger
TO[Enter]/TOx[Enter].....display/setup output trigger

6.4 Operation modes

6.4.1 DM – single distance measurement

LAM71 performs one measurement and then waits for new commands.
The duration of the measurement depends on the number of preset measuring values SA and the preset measuring frequency MF.

Input: DM

6.4.2 DT – Continuous distance measurement (distance tracking)

The LAM71 performs a continuous measurement.
The measurement can be interrupted by command:
ESC (Escape) = 0x1B
The measurement output frequency is determined by the number of preset measuring values SA, the preset measuring frequency MF and the data format of serial output SD.
Parameter baud rate is important for the data transfer.

Input: DT

Example response (SD 0 3 setting):
D 0002.935 21.1 57.2

Output format	=	decimal (D)
Distance	=	2.935 m
Signal quality	=	21.1
Temperature	=	57.2 °C

The output frequency of DT depends baud rate BR.
If the baud rate is to low not all measured values can be output / displayed.

6.5 Status

6.5.1 TP - Internal temperature

Output of the internal temperature of the device in °C

	The internal temperature of the device is not the same as the operating temperature stated under Technical Data (see chapter 9)! The internal Temperature will be approximately 25 Kelvin higher as the ambient temperature.

Query:	TP

Example: TP 048.4

	The user of the LAM71 must make sure that the stated ambient temperature (operating temperature) is adhered to. In case of deviations below or above the temperature range no measurement is possible. The LAM71 will send an error message.

6.5.2 HW – hardware status

A device-specific list of parameters and measurements is shown.
All parameters are internal information regarding the hardware status, changes are not possible.

Query:	HW

Example:
Temp (Board) 45.0°C
Laser voltage 25485mV
Measure Result 0

Explanation of the hardware status items:

Error code	Fault indication
Temp (Board)	Temperature of the controller, internal
Laser-Voltage	Supply voltage Laser Diode Driver
Measure Result	Classification of measurement conditions, information to source of error message 0 – measurement o.k. 1 – out of measurement window 2 – invalid pulse width 3 – small pulse width 4 – distance out of range 5 – noise pulses detected 6 – no pulses

6.5.3 PA – Display Parameter setting

Output of a parameter list with the current settings

Query:	PA

Response:

measure frequency[MF].....500(max 40000)Hz
average value[SA].....2
measure window[MW].....-290.000 290.000 0
trigger in[TI].....internal trigger
trigger out[TO].....rising edge
distance offset[OF].....0.000
error mode[SE].....1
digital out[Q1].....0.000 1.000 0.050 1
digital out[Q2].....0.000 1.000 0.050 1
analog out[QA].....0.000 1.000
receiver gain[GN].....0
serial baud rate[BR].....115200
serial output format[SD].....dec (0), value+amplitude (1)
unit for binary output[UB].....1000.000
serial output terminator[TE].....0Dh0Ah (0)
autostart command[AS].....DT
select target[ST].....0/first
recalibration timing[TC].....1 sec/enabled

6.5.4 PR – Parameter reset

All parameters are reset to the factory settings except baud rate (BR) and target selection (ST)

Query:	PR

Response:

reset parameter
measure frequency[MF].....10000(max 40000)Hz
average value[SA].....1000
measure window[MW].....-290.000 290.000 0
trigger in[TI].....internal trigger
trigger out[TO].....rising edge
distance offset[OF].....0.000
error mode[SE].....1
digital out[Q1].....0.000 1.000 0.050 1
digital out[Q2].....0.000 1.000 0.050 1
analog out[QA].....0.000 1.000
receiver gain[GN].....0
serial baud rate[BR].....115200
serial output format[SD].....dec (0), value (0)
unit for binary output[UB].....1000.000
serial output terminator[TE].....0Dh0Ah (0)
autostart command[AS].....DT
select target[ST].....0/first
recalibration timing[TC].....1 sec/enabled

6.6 Setup parameters

Transfer of the settings to the LAM71: Command + terminator 0x0D (ENTER). In case of commands with one parameter, that parameter is entered directly or separated by a space (0x20). In case of commands with several parameters, those are separated from each other by a space (0x20).

6.6.1 AS – Autostart function

The autostart function determines what the LAM71 does after a cold start.
Upon connection to the supply voltage and after the internal switch-on routine, the LAM71 carries out the command automatically and sends the data to the available outputs.

Query:	AS
Set:	ASx
Value range parameter x:	BR, DM, DT, HW, ID, ID?, MF, MW, OF, PA, PR, Q1, Q2, QA, SA, SE, SD, TE, TP
Standard:	DT

The period of time between switching on the supply voltage and the output of the first measured value is max. 750 ms (if SA=1).

6.6.2 BR – Baud rate

BR enables the adjustment of the serial baud rate x.
As soon as a new baud rate has been set, the device will immediately start to communicate based on that new baud rate.

Query:	BR
Set:	BRx
Value range parameter x:	9600, 19200, 115200, 230400, 460800, 921600, 1843200, 2000000
Standard:	115200 bauds/ 8 data bits /1 stop bit / no parity

	Setting a very high baud rate implies a risk. Some computers are unable to support a baud rate of 460 800, for example. If the baud rate is set via the command BR460800, communication will no longer be possible without an interface converter, i.e. it will be impossible to reset the baud rate to a lower value without any auxiliary means!

Example:

Input: BR 9600
Output: BR 9600

6.6.3 DR – LAM71 restart (device reset)

DR executes a cold start of the LAM71 and practically simulates a voltage interruption.
This command is useful when the autostart command has been changed.

Input: DR
Response: reset device
wait...<0>
➔ Continue with execution of command in parameter AS

6.6.4 GN – Setup GAIN

GN parameterizes the amplification of the receiver channel.

Query:	GN
Set:	GNx
Value range parameter x:	-1 = automatic GAIN 0, 1, 2 or 3 = selected GAIN with fixed amplification
Standard:	0

Example:

Input: GN -1
Output: GN -1

GN -1 automatic control of amplification depending on the received light
GN 0 optimal amplification value for most applications
GN 1,2 or 3 higher amplification value as GN 0

Advantage of GN > 0: measurements on targets with low reflectivity are possible
Disadvantage of GN > 0: more interference pulses will cause a lower accuracy of the output values

6.6.5 MF – Measurement frequency

MF parameterises the number x of single pulses to be transmitted per second.

Query:	MF
Set:	MFx
Value range parameter x:	1 … 40000, resolution: 1
Standard:	10000

Example:

Input: MF 1000
Output: MF 1000 Hz

MF1000, for example, means that 1000 single laser pulses are transmitted per second.

The realizable output frequency depends on the following parameters:

- interface solution (e.g. serial interface RS232 or RS422; analog output)
- length of the interface cable
- transfer speed (baud rate)
- average (parameter SA)
- data format of output value (binary, decimal --> parameter SD)
- number of output values (distance/ signal strength/ temperature --> parameter SD)

	The default value of SA is 1000. This means that 1000 measurements are necessary for 1 output value. This procedure extends the measurement time! Example: With parameter MF 1 and SA 1000 every 1 second will be started a measurement; but the output time for 1 value is about 17 min.

	The baud rate BR will be responsible for the limitation of the output frequency. Please check the dependence of measuring frequency/ output frequency with baud rate and data format of serial interface output (SD) in the tables below. If measuring frequency will be higher as the values in the table some measured values will be lost. Please double check with a new setting of measuring frequency MF the BR setting.

Binary output

Output values	Distance	Distance + signal quality	Distance + temperature	Distance + signal quality + temperature
Length of output data (Byte)	2	3	3	4
Output data format	SD 2 0	SD 2 1	SD 2 2	SD 2 3
Baud rate	Maximum output frequency = MF max (Hz)			
9600	470	300	300	220
19200	900	600	600	450
115200	5750	3800	3800	2880
230400	11600	7700	7700	5800
460800	23200	15500	15500	11600
921600	40000	30300	30300	23000
2000000	40000	40000	40000	34000

Decimal output

Output values	Distance	Distance + signal quality	Distance + temperature	Distance + signal quality + temperature
Length of output data (Byte)	11	16	17	22
Output data format	SD 0 0	SD 0 1	SD 0 2	SD 0 3
Baud rate	Maximum output frequency = MF max (Hz)			
9600	80	50	48	40
19200	160	100	90	75
115200	1000	700	660	480
230400	2000	1400	1300	980
460800	4100	2750	2500	1850
921600	7300	4750	4350	3300
2000000	12200	7850	6480	5000

6.6.6 MW – Measurement window

This is for parameterising the range of a measurement window, starting with x and terminating with y. Parameter z set the output value before and after the range of measurement window (MW).
Only those measured values are put out which are within the range of the measurement window.
For example, the measurement window can be used to:

- Blank out interfering objects before and behind a measurement range
- Determine a defined measurement range

An object detected before or behind the measurement window will generate the output of an invalid measured value.

Query:	MW
Set:	MWx y z
Value range parameter x:	float32; resolution: 0.001 (= 1 mm)
Value range parameter y:	float32; resolution: 0.001 (= 1 mm)
Value range parameter z:	0 or 1
Standard:	-71.000 71.000 0

Output: MW -71.000 71.000 0

LAM71 does not perform a plausibility check of the preset measurement window. It is the responsibility of the user to set the correct parameters.

Output values:

	Measuring window		
	distance < x	**x < distance < y**	**distance > y**
z = 0	DE02	Measuring value	DE02
z = 1	No output/ blanking pulse	Measuring value	No output/ blanking pulse

6.6.7 OF – Offset

OF parameterises a user-specific offset x which is added to the measured value.

Query:	OF
Set:	OFx
Value range parameter x:	float32; resolution: 0.001 (-250.000m … +250.000m; resolution 1mm = 0.001m)
Standard:	0.000

Output: OF 0.000

LAM71 does not perform a plausibility check of the preset offset. It is the responsibility of the user to set the correct parameters.

6.6.8 QA – Analogue output

The analogue output enables standardised analogue distance data transfer over long distances by means of 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. Parameterisation is done via the serial interface.

The current to be put out in case of faulty measurements is parameterised via the command SEx.

Analogue output properties:

- 4 mA ... 20 mA
- Indication in case of error: 3 mA or 21 mA (selectable via parameter SE) or last measured value
- Resolution: 16 bit digital-to-analogue converter

If current/voltage is to be converted, there must be a load resistor of < 500 Ohms/0.5 W (12 V of internal voltage --> max. measuring current of 0.024 A) between current output QA and GND.

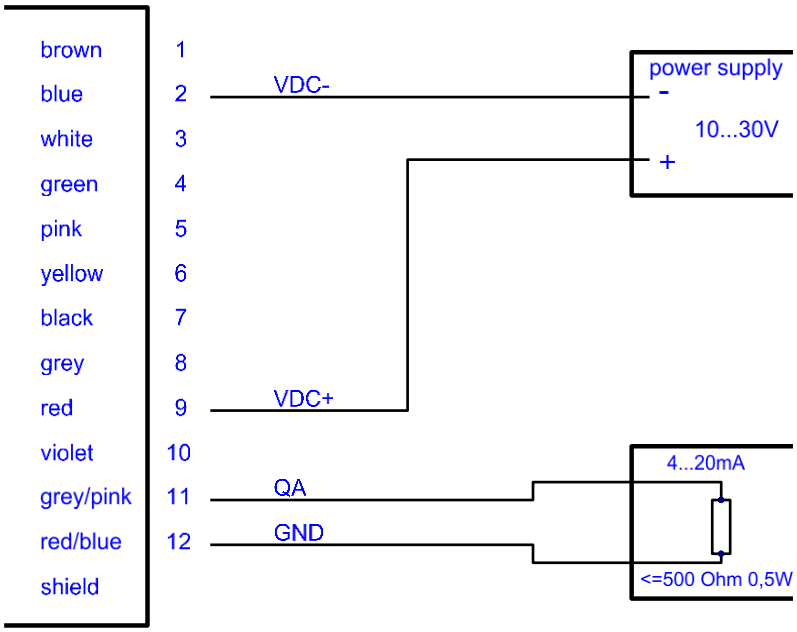


Fig. 5 Wiring of analogue output QA

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

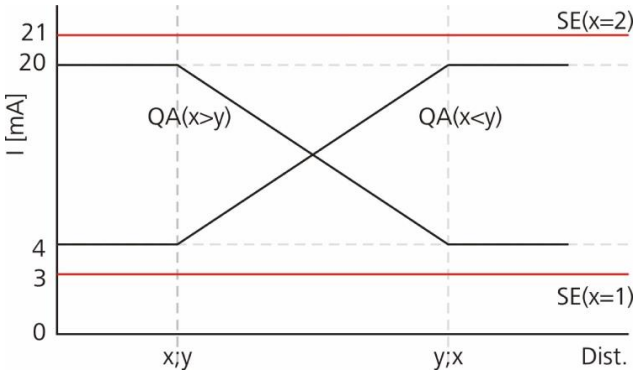


Fig. 6 Analogue output

The lower limit value can be lower or higher than the upper limit value; the current range will invert accordingly.

Entries of identical limit values will be ignored and not be transferred.

Query:	QA
Set:	QAx y
Value range parameter x:	float32; resolution: 0.001
Value range parameter y:	float32; resolution: 0.001
Standard:	0.000 1.000

The LAM71 does not perform a plausibility check of the QA settings. It is the responsibility of the user to set the correct parameters.

☞	The measurement window MW (see 6.6.6) applies to the analogue output as well.

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

x < y	• $QA[mA] = 4mA + 16mA * \frac{Dist - x}{y - x}$
x > y	• $QA[mA] = 20mA - 16mA * \frac{Dist - y}{x - y}$

Dist = measuring distance

!	Please do not use the analog output for fast processes with high distance changes). The typical settling time for a jump between 4 mA and 20 mA will be 40 µs .

6.6.9 Q1/ Q2 – Switching output

Switching outputs Q1 and Q2 show the distance information as logical switching information. They signalise whether the preset hysteresis switching range is exceeded or fallen short of.
Thus, they are ideally suitable for direct further processing of monitored values such as fill level or object detection. Parameterisation is done via the serial interface.

A load resistor of > 150 Ohms/ 6 W (max. operating voltage of 30 V; max. load current of 0.2 A) must be switched against VDC- (GND of supply voltage) at the switching output. It is important that the load current of 0.2 A is not exceeded.

☞	Typical resistance: 1 kOhm against VDC- (**not** against GND)!

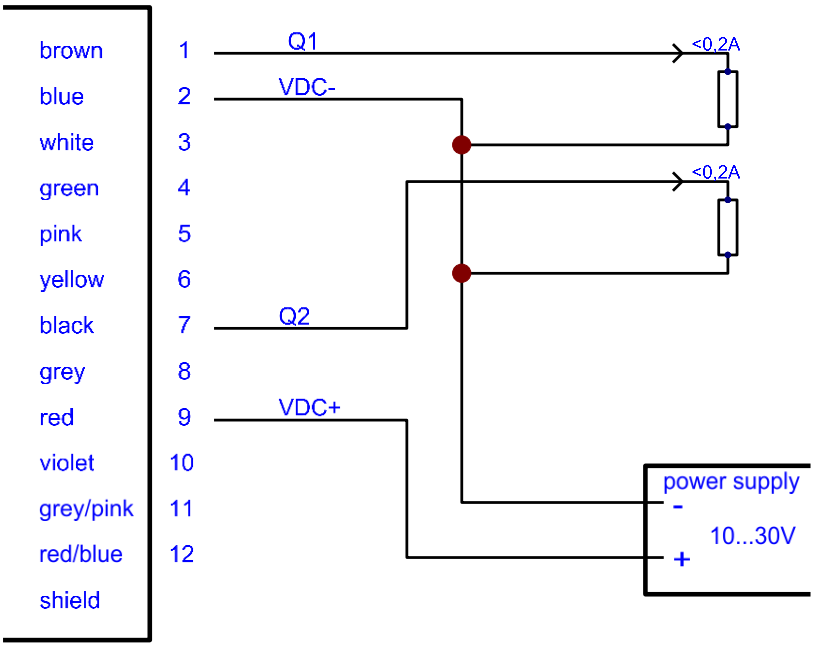


Figure 4 Wiring of switching outputs Q1 and Q2

Q1/Q2 parameterises the behaviour of the switching outputs.
The parameters include the beginning w of the measuring range when the output switches, the length x of the measuring range, the hysteresis y as well as the logic behaviour z.

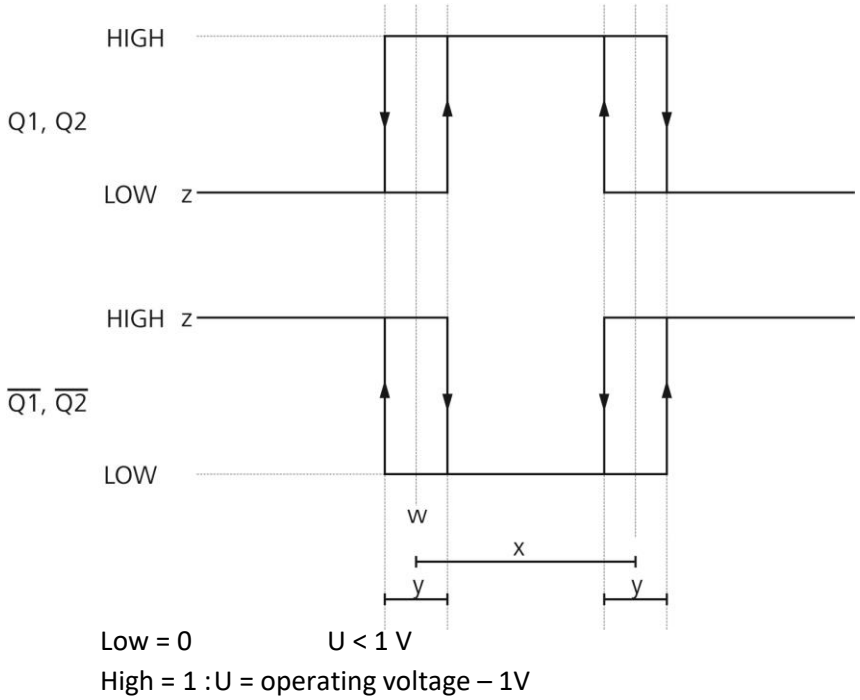


Figure 5 Switching behaviour of Q1 or Q2 respectively

Variable	Description	Specification
w	Switching threshold	- 9999,999 ... + 9999,999
x	Switching range	x > 0 ; x > y
y	Switching hysteresis	y ≥ 0
z	Switching state	z = 0 or 1

Query:	Q1 or Q2
Set:	Q1w x y z or Q2w x y z
Standard:	0.000 1.000 0.050 1

The LDS30 does not perform a plausibility check of Q1 or Q2 settings respectively.

6.6.10 SA – Mean value average

SA parameterises the number x of the single measured values to be averaged for one measurement. SA directly correlates with the measurement frequency MF.
SA and MF determine the output frequency of the measured values.

Query:	SA
Set:	SAx
Value range parameter x:	32 bit integer; resolution: 1
Standard:	1000

The dispersion of the measured values can be reduced by calculating the mean value.

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

σ_{SA} Dispersion after mean value determination from several distance measurements

σ_1 Dispersion of single measured value (± 60 mm)

SA Mean value

Example:
For table below applies:
Measuring frequency 15 kHz and output frequency 15 kHz will be achieved with following parameters:
Baud rate 921.600 / binary output

Measurement frequency MF (Hz)	Mean value SA	Output frequency (Hz)	Dispersion (mm)
15000	1	15000	± 60
15000	10	1500	± 19
15000	100	150	± 6
15000	1000	15	± 2

For SA will be used all valid measured distance values. If distance is out of the measurement window MW the measured value will ignored for the SA calculation.

6.6.11 SO – Set offset

SO carries out a single distance measurement and sets it as - OF (offset). SO can only be executed and is not really a parameter.
SO can be used for zero adjustment of distances in systems or processes.

☞	Please note the interaction of parameter MW, OF, SO.

6.6.12 SD – Data format of serial interface output

SD parameterises the output format n and the output values m.

Query:	SD
Set:	SDn m
Value range parameter n:	0, 1, 2
Value range parameter m:	0, 1, 2, 3
Standard:	0 0

Example:

Input: SD 0 3
Output: SD 0 3

n	Output format		m	Output values
0	Decimal		0	Distance
1	not available		1	Distance + signal quality (not available for binary)
2	Binary		2	Distance + temperature (not available for binary)
			3	Distance + signal quality + temperature (not available for binary)

	Output format 1 (hexadecimal) is not available! For binary output distance value is available only (not temperature and/ or signal quality).
	In conjunction with the baud rate, the output format determines the maximally possible output speed of measured values. If a higher measurement frequency is set, the results of some measurements will not be put out.

Binary format:

Distance:

2 bytes, MSB = bit 7
MSB of byte 1 is always 1.
MSB of byte 0 is always 0.
Data in each byte = bit 6 … bit 0

Coding: Two's complement
Conversion of binary value into decimal value: *1/100

Signal:

1 byte
MSB = bit 7
MSB of byte 0 is always 0.
Data = bit 6 … bit 0

Temperature:

1 byte
MSB = bit 7
MSB of byte 1 and 0 is always 0.
Data in each byte = bit 6 … bit 0
Conversion of binary value into decimal value: -40

	Distance (2 bytes)																Signal (1 byte)								Temperature (1 byte)							
	Byte 1								Byte 0								Byte 0								Byte 0							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Data	**1**	x	x	x	x	x	x	x	**0**	x	x	x	x	x	x	x	**0**	x	x	x	x	x	x	x	**0**	x	x	x	x	x	x	x

Distance	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**: 100 = 3.38 m**

Signal	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	*** 2 = 22**

Temperature	**0**	**1**	**0**	**1**	**1**	**1**	**0**	**1**	**- 40 = 53°C**

The binary distance range will determined by parameter UB.
If the distance value is below or above the distance range, the binary output is 0!

6.6.13 SE – Error mode

Parameterises the behaviour x of switching outputs Q1 and Q2 and of analogue output QA in case of faulty measurements as well as the state after carrying out a single distance measurement.

Query:	SE
Set:	SEx
Value range parameter x:	0. 1 or 2
Standard:	1

x	Q1, Q2 (z=0)	Q1, Q2 (z=1)	QA
0	Last value	Last value	Last value
1	High	Low	3 mA
2	Low	High	21 mA

Low: U < 1 V
High: U = operating voltage – 1 V

The LAM71 does not perform a plausibility check of the preset error mode.

6.6.14 ST – Select Target

ST defines the target which should be detected. LAM71 is able to detect 4 different target in maximum. Selection will be done between the first or the last detected target.

first target – target next to the LAM71
last target – last detected target

Output will be the distance of the defined target.

Query:	ST
Set:	STx
Value range parameter x:	0 (first target) or 1 (last target)
Standard:	0

Output: ST 0

	Parameter MW (measurement window) and SA (mean value, average) will influence the output. If the selected target will be outside of the range of measurement window the output will be not a distance values → please see setting of MW parameter z.

6.6.15 TC – Time Calibration

Parameterises the time between 2 customized calibrations.
The calibration is necessary to stabilize the distance accuracy and to avoid a lower accuracy because of temperature changes in the environmental of the electronic parts.

Query:	TC
Set:	TCx
Value range parameter x:	0 (no calibration),1… 3660 (seconds) (= 1 sec up to 1 h interval)
Standard:	1

Up to a Measuring frequency of approx. 35 kHz the calibration will be done without any influences of the output frequency.
Between 35 k Hz and 40 kHz it could be possible that the data output will interrupt for one (1) distance output every x seconds (x= parameter of TC).

6.6.16 TE – Terminator

Sets the terminator for the output of measured values in ASCII format (see also command SD).

Query:	TE
Set:	TEnn
Value range parameter nn:	0 … 9
Standard:	0

Example:

Input: TE 1
Output: TE 1

Possible values:

nn	ASCII	Meaning
0	0x0D 0x0A	CR LF
1	0x0D	CR
2	0x0A	LF
3	0x02	STX
4	0x03	ETX
5	0x09	HTab
6	0x20	Space
7	0x2C	Single quote
8	0x3A	Colon
9	0x3B	Semicolon

When an invalid character is entered, it will not be set. The previous terminator will be maintained.

6.6.17 TI + TO Trigger

Trigger function

The LAM71 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 parameter TI.
2. Trigger output / e.g. connection between 2 LAM71:
   The output trigger signal of the 1. LAM71 (parameterized with TO) starts a single measurement DM of the second LAM71 (parameterized with TO).
3. Continuous distance tracking controlled by trigger

Differences between trigger input and trigger output

Important is the parameter y of TI and TO.

TI y > 0 / TO y = 0	Trigger input The measurement starts after an external trigger impulse.
TI y = 0 / TO y >0	Trigger output LAM71 sends a trigger impulse to the second device.

The parametrization of the trigger connection is carried out via the serial interface or the internal display.

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

Voltage levels for the trigger signals

Low level	0 – 1.5 V
High level	3 – 30 V
Threshold	2.25 V
Hysteresis	0.1 V

TI – Trigger input

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

x edge parameterized the edge of trigger signal and
start and stop for “Autotrigger function”
0 rising edge (from LOW to HIGH)
1 falling edge (from HIGH to LOW)
2 every edge
3 start or stop of Autotrigger with rising edge
4 start or stop of Autotrigger with falling edge

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

Query:	TI
Set:	TI x y
Value range parameter x:	0, 1, 2, 3, 4
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) [TI]: 0, 0

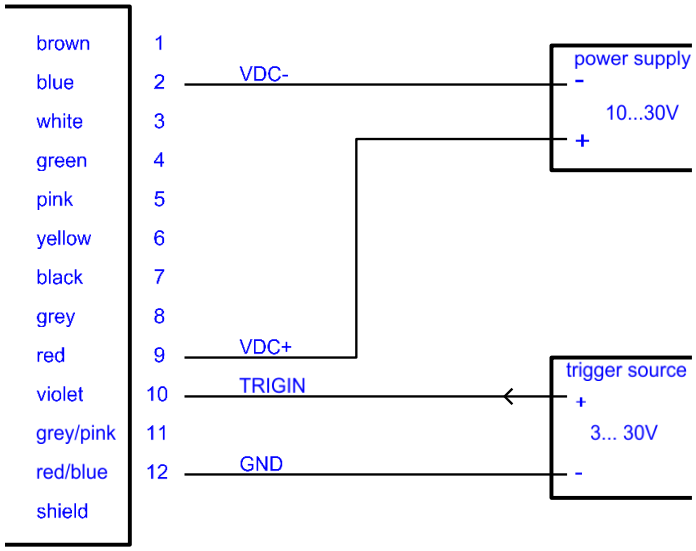


Figure 6 Wiring of trigger input

Maximum frequency of external trigger signal for Trigger IN (TI): 30 k Hz

If the trigger frequency is too high, no measurement value can be determined. The output is E02. The trigger frequency must be reduced.

TO – Trigger output

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

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

Query:	TO
Set:	TO x
Value range parameter x:	0, 1, 2
Standard:	0

Output: Trigger (output) [TO]: 0

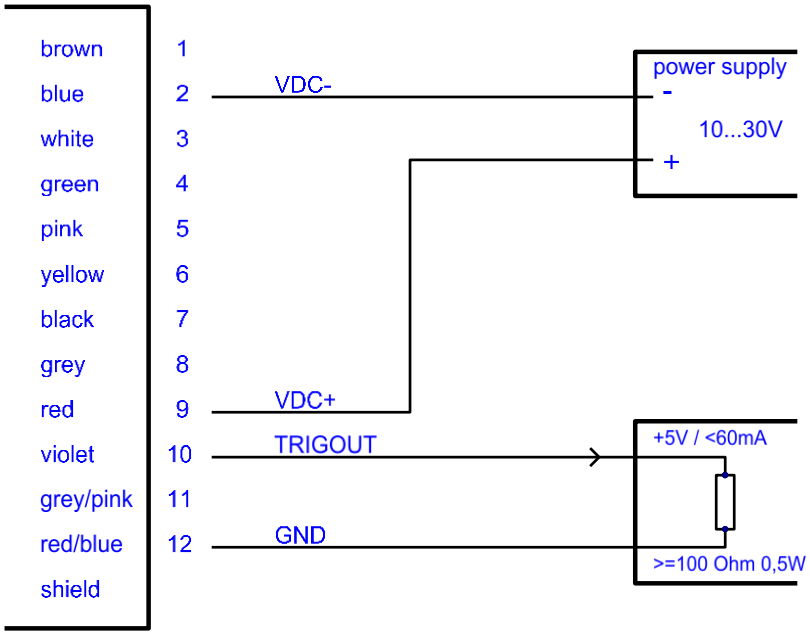


Figure 7 Wiring of trigger output

Maximum frequency of Trigger OUT (TO) = MF (Measurement frequency)

AUTOTRIGGER function_ Continuous distance tracking controlled by trigger

The parametrization of AUTOTRIGGER function will be set with command TI.
The first trigger signal starts the command which is defined in AUTOSTART (command AS) the second trigger signal will stop the process.

x edge parameterized the edge of start or stop of Autotrigger signal
- 3 start or stop of Autotrigger with rising edge
- 4 start or stop of Autotrigger with falling edge

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

Query:	TI
Set:	TI x y
Value range parameter x:	3, 4
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

Example:
AS DT
TI 3 10
First trigger signal starts a continuous measurement (DT) with the rising edge. The delay between the triggersignal and start of measurement is 10 msec.
Next trigger signal stops a continuous measurement (DT) with the rising edge. The delay between the triggersignal and stop of measurement is 10 msec.

6.6.18 UB – Unit for binary output

UB parameterized the resolution (in bit) for distance values in binary format (in mm).

Query:	UB
Set:	UBx
Value range parameter x:	float32; resolution: 0.001
Standard:	1000.000

Example:

Input: UB 2.5
Output: UB 2.500

This parameter influences all measurement outputs in binary format independent of the measuring frequency.
The binary output format will be set with parameter SD.

Example:

UB 0.001 → resolution 1 µm
UB 1.000 → resolution 1 m
UB 1000.000 → resolution 1 mm (standard)

The measuring range will be depicted with 14 signed bits.

Distance value (binary) = Distance (mm) / UB

Distance range (binary) : -8192 ≤ Distance ≤ 8191

If the distance value is below or above the distance range, the binary output is 0!

7 Serial interface and communication software

Transmittion 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 ENTER (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 “?” (0x3F).

8 Error processing

In case of one or more detected errors, the error code with the highest index will be outputted (most serious defect/ error).

Example:
no distance value identified, no other error: DE02
no distance value identified, in addition temperature out of range: DE06

Non-critical errors will be reset automatically, a critical error requires a device reset (see table) – command DR or power off/ on. Hardware errors generate error code DE04.

Error code	Description	Reset
DE02	no distance identified	Automatically, with the next measuring value
DE04	Device error (hardware)	Not automatic, device reset necessary
DE06	Temperature out of range	Automatically, if measured temperature is in the specified range
DE10	Internal laser voltage lower than the defined minimum voltage ($ULaser_{MIN}$)	Not automatic, device reset necessary

In binary format all errors will be sent as “0” (00).
The described error codes will be outputted, if an error is detected during

- LAM71 measurement (DM, DT)
- a measuring mode (DM, DT) will be started.

Output of error message (like output of measuring values):

- once for measuring mode DM
- in the specified output frequency for measuring mode DT

The measuring mode DT could be stopped with <ESC> in the case of error and error message output too. The communication with LAM71, e.g. parameterizing, reset or start of new measurement, will be not influence by the error message. If DT is started and the error did not reset automatically, the error message will be outputted again.

	The temperature (check with command TP) may be higher than the ambient temperature. Approx. 30 min after power ON the measured temperature could be 25 Kelvin higher than ambient temperature.

9 Technical Data

Following table shows the specified target values. For all devices which will be delivered before the series approval the specified parameters are not proven and no guarantee is given.

Measurement properties	
Measurement principle	Time of flight (TOF)
Measured parameter	Distances
Measuring range [1]	
Total range	0.2 m to 270 m
Typical range on target board [1, 2]	0.2 m … 270 m
Typical range on natural surface, 80% reflectivity [1]	0.2 m … 125 m
Typical range on natural surface, 10% reflectivity [1]	0.2 m … 70 m
Accuracy, absolute [1 3]	± 60 mm (1 σ)
Repeatability [4]	± 25 mm (1 σ)
Resolution of measured values	1 mm
Measurement frequency, maximum	40 kHz
Laser	
Laser classification	Laser class 1, EN 60825-1:2014
Wavelength	905 nm (invisible)
Divergence, transmitter	2 mrad x 0.4 mrad
Electric connection conditions	
Supply voltage	10 V DC … 30 V DC
Power consumption	≤ 3 W
Interface/ connections	
Connections on device	12 pole jack M12 (Binder 713 series) 09-3491-970-12
Environmental and application conditions	
Operating temperature	-40 °C … +60 °C
Storage temperature	-40 °C … +70 °C
Humidity	15 % … 90 %, non-condensing
Housing protection class	IP 67
Dimensions	98 mm x 46 mm x 25 mm (L x W x H) inclusive connector
Weight	approx. 137 g

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

[2] Measuring range for special targets, e.g. Scotchlite Cube

[3] Accuracy can be ± 100 mm for close-up ranges up to 1 m.

[4] Repeatability ± 50 mm at measurement distance 70 m.

Sensor Partners
Sensor Partners BV – Head office
James Wattlaan 15
5151 DP Drunen
The Netherlands

Phone: +31 416 378239
Email: info@sensorpartners.com
Internet: www.sensorpartners.com