LASER DISPLACEMENT SENSOR

Series LAM

Key-Features:

- *Excellent for highly dynamic measurements*
- *Measurement ranges: 0.5 to 200 mm*
- *Resolution up to 0.2 µm*
- *Linearity up to ±1 µm*
- *Measuring frequency up to 100 kHz*
- *Sampling rate up to 400 kHz*
- *Analog output 4...20 mA, -10...10 V*
- *Ethernet Interface*
- *Operating temperature 0 to 50 °C*
- *External evaluation electronics inclusive*

Content:

Introduction	*....2*
Technical Data - LAM-S Series	*....4*
Technical Data - LAM-S Series	*....5*
Technical Drawing	*....6*
Electrical Connection	*....7*
Order Code	*....9*

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WayCon
Positionsmesstechnik

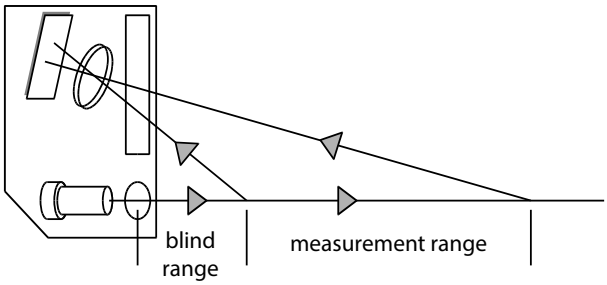
INTRODUCTION

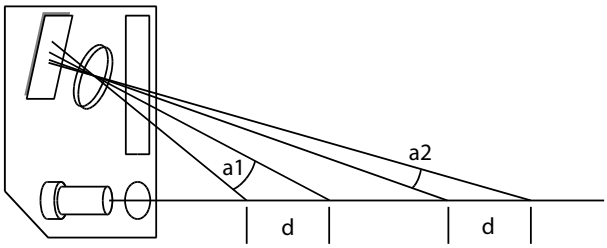
The optical position measuring system LAM is used in non-contact measurement applications. LAM distance sensors are available in various models so as to offer the suitable sensor type for any application.

Due to the high measuring frequency of up to 100 kHz this series is particularly suited for highly dynamic measurements. This high resolution of up to 0.05 µm guarantees reliable use in sophisticated measurements in quality control.

MEASUREMENT PRINCIPLE

The LAM laser sensors are used for non-contact position or presence measuring of objects. They utilise the triangulation method for measuring. The laser beam hits the object as a small spot and the sensor's receiver defines the position of this spot. The relation of the angles is used to calculate the distance. The possible resolution and the accuracy change with the distance d: If d is near the sensor, it causes a large change to the angle a1. If d is farther away, the change to the angle is much smaller a2 (see drawing).
The middle of the measuring range is the reference distance. A light spot is focused on the object measured. The technology uses light impulses for very low dependence on constant ambient light. The projected light spot is mapped onto a position sensor through use of a lens. Diffuse reflection of the light of the laser spot is important for the measurement. Depending on the reflectance of the area measured a fine self-actuated regulating circuit automatically adjusts the light intensity of the laser source.
If the intensity of the reflected light is too low (min. 10% surface reflection), this will trigger the error message F1: "too little light". With highly reflective surfaces reflecting the transmitting light directly into the reception optics will trigger the error message F2: "too much light/reflection". Both errors are indicated by logic signals and LED displays. Analogue voltage describing the light intensity is delivered as additional information on the lighting conditions.





The output voltage "Distance" on pin 1 is emitted linear to the distance of the object. In addition to signal output ±10 V the output signals 4...20 mA and an Ethernet interface are available (optional 0...10 V, 0...5 V, ±5 V). Two comparators can be used to adjust the limits for the object distance measured. Thus, the ranges too close, OK or too far are defined. The respective range can be identified by the LED display.

FEATURES

Self test
Permanent monitoring of the reflected light tests if an object is within the measuring ranges and the intensity of the reflected light is adequate.

Response time and frequency response
The rise time of the analog output is particularly fast in laser sensors. For the LAM-S this is 50 µs and 5 µs for the LAM-F for rising to > 90% of the end value.
The cut-off frequency of the low pass filter can be adjusted with dip-switches (under the cover in the lid of the electronics unit).
The internal sampling rate of the sensor is not impacted by the dip-switch-settings. The filter frequencies specified on pages 9 and 10 correspond to the -3 dB bandwidth of the low pass filter. Higher frequencies and noise are reduced more and more, thus increasing the measuring accuracy. Example: Set to 2.5 kHz a recorded oscillation of a frequency of 2 kHz is transmitted without considerable reduction. A frequency of 10 kHz, however, would be severely reduced.

INSTALLATION NOTES

Sensor head installation
To achieve absolutely accurate distance measurements, the light measuring beam must be aligned square to the measuring surface. Any tipping will geometrically cause a greater measured displacement.
When installing the laser measuring head be sure the laser light beam can neither directly nor indirectly (e. g. through reflection) hit the human eye. The laser warning decal must be applied to the sensor where it is clearly visible.
To adjust, use the MIN, OK and MAX LEDs.
At delivery the MIN and MAX values are set to the limits of the measuring range. Whilst the OK LED is lit the object is within the measuring range and reflecting adequate light.

SURFACE-DEPENDENT MEASUREMENT ERROR

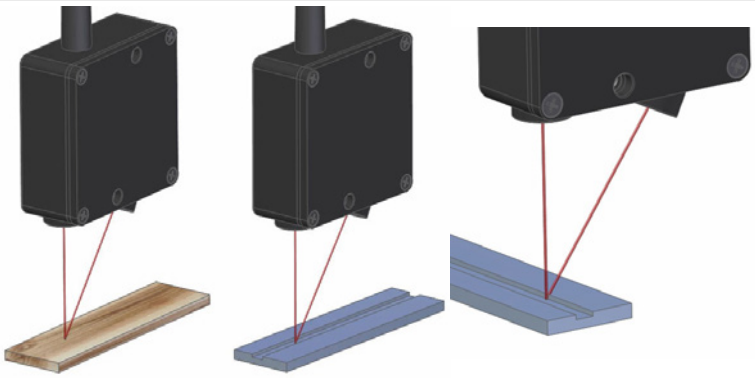
Surface-related measurement errors impacted by material and colour
Any materials, e.g. metal, plastic, ceramics, rubber and paper, can be measuring objects. Use only needs to be reviewed on an individual basis with highly reflective surfaces or liquids.

Surface reflectance
The sensor requires a minimum of 10% surface reflection to function properly. Only diffuse reflection can be used for measurement.

Lateral flare
When projecting the light spot slight flare also occurs, which is reflected laterally by the measuring point, and then reaches the receiver. Highly reflective parts within the flare area close to the measuring point reflecting the flare directly to the receiver can result in measurement errors. Homogeneously scattering objects with the same level of reflectance do not cause this error. If the reflecting range is outside of the measuring point the errors can in worst case be 2%.

Beam entering the measured material
With slightly transparent plastics or cloudy liquids the measuring beam penetrates the medium to a certain level before the diffusely reflected light is reflected. Here the true measuring plane must be expanded by the penetration depth. In individual cases this can only be determined experimentally.

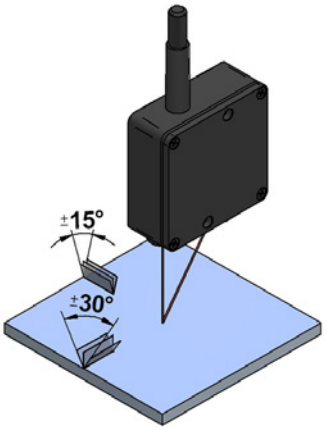
Striped objects
If the measuring objects have light/dark stripes, e.g. wood, the sensor must be mounted with the optical axis parallel to the direction of the stripe (see illustration right). The LAM lasers with its small measuring points are ideally suited for this.



Light / dark change within the measuring point
If a distance is measured at a point where the material transitions from a diffusely reflecting to a reflective material, hence has a strong change in the reflection factor, measurement errors can result. Based on the surface, here the maximum of the light intensity is not at the centre of the measuring point. However, if the line of the transition is in the direction of the optical axis, the error is minimal.

Change of the surface reflection factor during measurement
The LAM sensor features an automatic light intensity adjustment to adjust to well or low reflecting objects. If the surface reflection changes during the measurement it automatically readjusts accordingly.

Angle dependency of measurements
If the sensor is not square to the object surface the measurement has low angle dependency. On matt surfaces with high diffuse reflection the angle dependency is low, with reflective surfaces it is higher.
The object's angles of rotation around the x-axis can be reached up to ±30° without considerable measurement error, around the y-axis up to ±15°. The measurement error shows to be a change between the output voltage / distance relation. If the angle is constant it can be eliminated through readjustment.



TECHNICAL DATA - LAM-S SERIES

Key-Features LAM-S Series
- especially suited for fast measurement
- low noise
- measurement frequency up to 10 kHz
- sampling rate of 54 kHz
- Ethernet interface

LAM-S-...		...-0,5	...- 2	...- 4	...-10	...-20	...-50	...-100	...-200
Measurement range	[mm]	23.75...24.25	23...25	22...26	40...50	55...75	115...165	170...270	240...440
Linearity [1]	[µm]	±1	±4	±8	±20	±40	±100	±200	±400
Resolution [1] at CF 10 kHz	[µm]	0.3	1.3	2.6	6.5	13	32.5	65	200
Resolution [1] at CF 20 Hz	[µm]	0.02	0.1	0.2	0.5	1	2.5	6	20
Temperature drift	[%/°K]	0.02							
Light source		red pulsed laser diode , power: 1 mW (optional: 5 mW)							
Laser class		class 2							
Beam diameter	[mm]	0.1	0.2	0.3	0.6	0.9	1.5		2
Wavelength	[nm]	650...670							
Cut-off frequency CF		20 Hz ... 10 kHz (-3 db, adjustable via DIP switches)							
Sampling rate	[kHz]	54 (at the output of the electronics)							
Analog output		±10 V, 4...20 mA (optional: ±5 V, 0...10 V, 0...5 V, 0...20 mA)							
Digital output		Ethernet TCP / IP							
Light intensity output		0...10 VDC (Signal quality <3 = risk of underexposure, ~5 = excellent, >8 = risk of overexposure)							
Power supply		24 VDC / 250 mA (10...30 VDC)							
Isolation voltage		200 VDC (0 V against housing)							
Protection class		sensor IP64, electronics IP40							
Operating temperature	[°C]	0...+50							
Storage temperature	[°C]	-20...+70							
Humidity		up to 90 % relative humidity, not condensing							
Ambient illuminance max.	[lx]	20 000							
Vibration resistance		5 g up to 1 kHz (optional: 20 g up to 1 kHz)							
Housing		Aluminium							
Weight sensor	[g]	250					480		
Weight electronics	[g]	300							

[1] referring to measurement of matt, white surfaces

RESOLUTION AS FUNCTION OF FILTERSETTINGS

Example: Sensor LAM-S-10, measurement range 10 mm (Measurement was recorded with an analog oscilloscope)

Measurement on a white target			Measurement on a black target		
Frequency	**Noise [1]**	**Resolution**	**Frequency**	**Noise [1]**	**Resolution**
10 000 Hz	13 mV	6.5 µm	10 000 Hz	200 mV	100 µm
7 000 Hz	12 mV	6 µm	7 000 Hz	180 mV	90 µm
4 000 Hz	8 mV	4 µm	4 000 Hz	150 mV	75 µm
1 000 Hz	6 mV	3 µm	1 000 Hz	100 mV	50 µm
250 Hz	3 mV	1.5 µm	250 Hz	60 mV	30 µm
100 Hz	2 mV	1 µm	100 Hz	40 mV	20 µm
25 Hz	1.5 mV	0.7 µm	25 Hz	20 mV	10 µm
20 Hz	1 mV	0.5 µm	20 Hz	15 mV	7.5 µm

[1] measured at analog output ±10 V = 10 mm

TECHNICAL DATA - LAM-F SERIES

Key-Features LAM-F Series
- especially suited for highly dynamic measurements
- measurement frequency up to 100 kHz
- sampling rate of 400 kHz
- Ethernet interface

LAM-F-...		...-0,5	...-2	...-4	...-10	...-20	...-50	...-100	...-200
Measurement range	[mm]	23.75...24.25	23...25	22...26	40...50	55...75	115...165	170...270	240...440
Linearity [1]	[µm]	±1.5	±6	±12	±30	±60	±150	±300	±600
Resolution [1] at CF 100 kHz	[µm]	0.8	3.5	7	17.5	70	100	200	500
Resolution [1] at CF 230 Hz	[µm]	0.05	0.2	0.4	1	2	7.5	15	50
Temperature drift	[%/°K]	0.02							
Light source		red pulsed laser diode , power: 1 mW (optional: 5 mW)							
Laser class		class 2							
Beam diameter	[mm]	0.1	0.2	0.3	0.6	0.9	1.5		2
Wavelength	[nm]	650...670							
Cut-off frequency CF		230 Hz ... 100 kHz (-3 db, adjustable via DIP switches)							
Sampling rate	[kHz]	400 (at the output of the electronics)							
Analog output		±10 V, 4...20 mA (optional: ±5 V, 0...10 V, 0...5 V, 0...20 mA)							
Digital output		Ethernet TCP / IP							
Light intensity output		0...10 VDC (Signal quality <3 = risk of underexposure, ~5 = excellent, >8 = risk of overexposure)							
Power supply		24 VDC / 250 mA (10...30 VDC)							
Isolation voltage		200 VDC (0 V against housing)							
Protection class		sensor IP64, electronics IP40							
Operating temperature	[°C]	0...+50							
Storage temperature	[°C]	-20...+70							
Humidity		up to 90 % relative humidity, not condensing							
Ambient illuminance max.	[lx]	20 000							
Vibration resistance		5 g up to 1 kHz (optional: 20 g up to 1 kHz)							
Housing		Aluminium							
Weight sensor	[g]	250					480		
Weight electronics	[g]	300							

[1] referring to measurement of matt, white surfaces

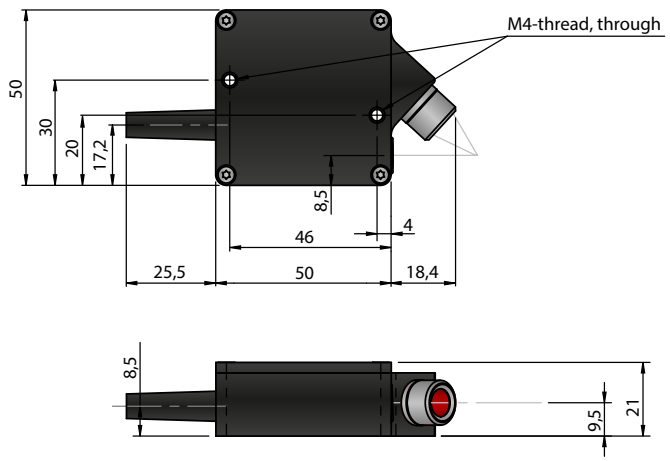
RESOLUTION AS FUNCTION OF FILTERSETTINGS

Measured on a white target, recorded with an analog oscilloscope

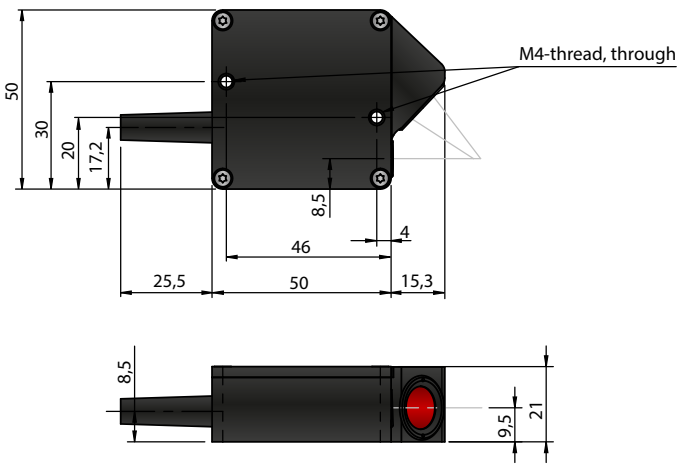
Example: LAM-F-0,5			Example: LAM-F-4		
Frequency	**Noise**	**Resolution**	**Frequency**	**Noise**	**Resolution**
100 kHz	30 mV	0.75 µm	100 kHz	32 mV	6.4 µm
70 kHz	27 mV	0.68 µm	70 kHz	30 mV	6 µm
40 kHz	22 mV	0.55 µm	40 kHz	22 mV	4.4 µm
10 kHz	12 mV	0.3 µm	10 kHz	12 mV	2.4 µm
2,5 kHz	8 mV	0.2 µm	2.5 kHz	8 mV	1.6 µm
1 kHz	5 mV	0.13 µm	1 kHz	5 mV	1 µm
0.25 kHz	4 mV	0.1 µm	0.25 kHz	3 mV	0.5 µm
0.23 kHz	4 mV	0.1 µm	0.23 kHz	2 mV	0.4 µm

TECHNICAL DRAWING

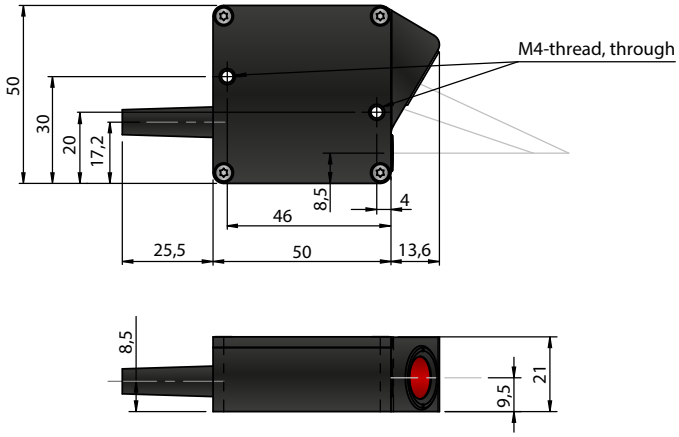
LAM-...-0,5



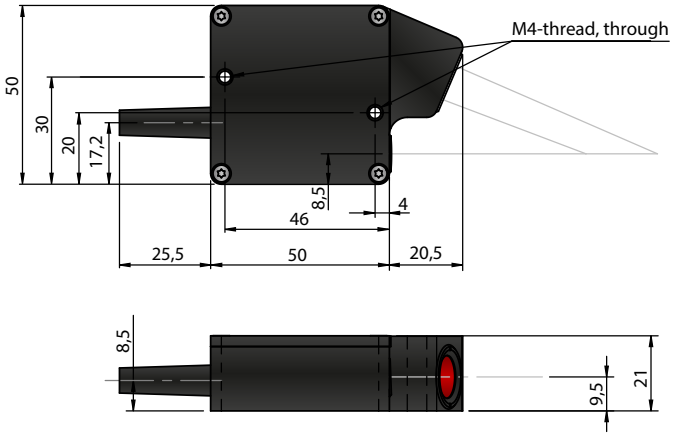
LAM-...-2, LAM-...-4



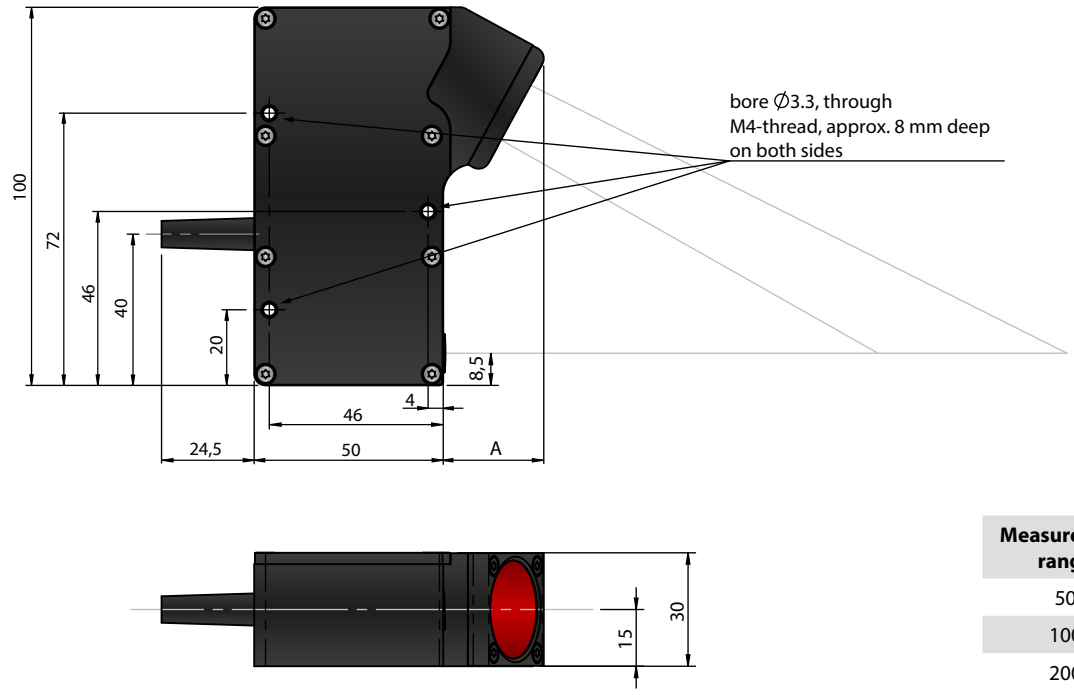
LAM-...-10



LAM-...-20



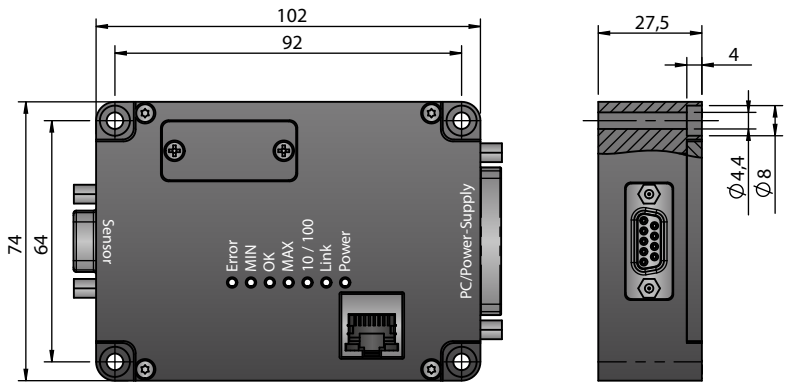
LAM-...-50, LAM-...-100, LAM-...-200



Measurement range	A
50	26.6
100	25.8
200	27.5

TECHNICAL DRAWING

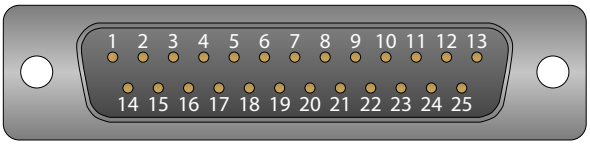
Electronics



ELECTRICAL CONNECTION

Assignment SUB-D-connector, 25 pins

Pin	Function
1	analog output voltage
2	error output 0...24 V
5	digital output OK 0...24 V
6	analog output current [1]
8	GND_{supply}
14	GND_{analog}
16	digital output MAX 0...24 V
17	analog input ±10 V
18	GND
19	digital output MIN 0...24 V
20	light intensity output 0...10 V
21	+V
Housing	EMC



[1] To use the analog output 4...20 mA (or 0...20 mA if LAM-20A is selected), a series resistor of 400 Ω (0.5 W; 0.1 % intensity) must be connected in series between pin 6 and pin 14.

Assignment Ethernet cable, RJ45, crossed

Pin	Function	Plug A
1	transmitted data +	GN / WH
2	transmitted data -	GN
3	received data +	RD / WH
4	n. c.	BU
5	n. c.	BU / WH
6	received data -	RD
7	n. c.	BN / WH
8	n. c.	BN

Pin	Function	Plug B
1	received data +	RD / WH
2	received data -	RD
3	transmitted data +	GN / WH
4	n. c.	BU
5	n. c.	BU / WH
6	transmitted data -	GN
7	n. c.	BN / WH
8	n. c.	BN

Note: direct connection between sensor and network card requires a cross Ethernet cable. If an Ethernet-switch is interconnected, Ethernet cables assigned 1:1 can be used. If the Ethernet-switch automatically recognises the line polarity due to its "Autosense + AutoMDI"-function it doesn't matter if the cables used are assigned 1:1 or crossed.

STATUS LEDS

LED	Function	Colour	Light pattern
Power	Power on	green	lights up
Link	Ethernet link in function	yellow	lights up
10 / 100	Ethernet link activity	yellow	rapidly flashing
MAX [1]	Upper threshold value reached	orange	lights up
OK [1]	Object within measurement range	green	lights up
MIN [1]	Lower threshold value reached	yellow	lights up
Error	FPGA self test OK Object out of measurement range	red red	off lights up

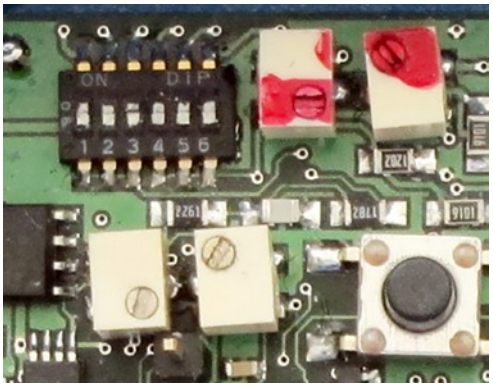
[1] OK refers to the measuring range of the sensor. As long as the green LED is lightning, the object is within the measurement range. Outside the range the LED is off.
MAX/MIN can be adjusted by the user and they must be within the measurement range (Default: MIN at the lower end and MAX at the upper end, both within the measurement range).

DIP SWITCH SETTINGS

The Dip-switch (under the cover inside the lid for the electronics unit) is used to adjust the frequency of the low pass filter. Switch 1 is on the left, switch 6 on the right.
The internal sampling rate of the sensor is not impacted by the Dip-Switch-settings. The filter frequencies specified correspond with the -3 db bandwidth of the low pass filter. Higher frequencies and noise are reduced more and more.

Never change the potentiometers!

Example: Set to 2.5 kHz a recorded oscillation of a frequency of 2 kHz is transmitted without considerable reduction. A frequency of 10 kHz, however, would be severely reduced.



Dip Switch Settings LAM-S

Frequency	S1	S2	S3	S4	S5	S6
10 kHz [1)]	O	O	O	O	O	O
7 kHz	X	O	O	O	O	O
4 kHz	O	X	O	O	O	O
1 kHz	O	X	X	O	O	O
250 Hz	O	O	O	X	O	O
100 Hz	O	O	O	O	X	O
25 Hz	O	O	X	X	O	X
20 Hz	X	X	X	X	X	X

Dip Switch Settings LAM-F

Frequency	S1	S2	S3	S4	S5	S6
100 kHz [1)]	O	O	O	O	O	O
70 kHz	X	O	O	O	O	O
40 kHz	X	X	O	O	O	O
10 kHz	O	X	X	O	O	O
2,5 kHz	O	O	O	X	O	O
1 kHz	O	O	O	O	X	O
0,25 kHz	O	O	O	O	X	X
0,23 kHz	X	X	X	X	X	X

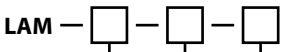
X = switch closed
O = switch open

[1)] default setting

SCOPE OF DELIVERY

- Sensor with 2 m cable
- External electronics
- SUB-D-connector, 25 pins, solderable
- Test log

ORDER CODE



Measuring frequency max.	
10 kHz	S
100 kHz	F

Measurement range [mm]	
0,5 / 2 / 4 / 10 / 20 / 50 / 100 / 200	z. B. 100

All models with analog outputs ±10 V and 4...20 mA, Ethernet and 2 m cable

	Version
-	Standard
O	Sensor with additional options

	Options
LAM-10V	analog output 0...10 V
LAM-5V5V	analog output ±5 V
LAM-5V	analog output 0...5 V
LAM-20A	analog output 0...20 mA
LAM-HD	increased vibration resistance, 20 g
LAM-3R	increased laser power 5 mW
LAM-IF	interference filter

ACCESSORIES

Digital displays for sensors with analog output, 2 channel	
WAY-AX-S	touch screen, supply: 18...30 VDC
WAY-AX-S-AC	touch screen, supply: 115...230 VAC

For more information and options please refer to the WAY-AX data sheet.

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