

## FEATURES

- Static and dynamic measurements of displacement (measures also DC)
- Wide measurement ranges - high accuracy
- Visible red type class 1 & 2 laser
- Default sensor files with a type depending calibration are included in dB-Lab
- Precise specimen calibration is easily possible by the user
- Good cost-performance ratio
- Ideal for loudspeaker measurements - direct mechanical parameter identification

Klippel Analyzer hardware equipped with a Laser displacement sensor allows the measurement of electrical and mechanical states. Transducer measurements are thereby simplified and shortened considerably.

The Laser displacement sensors based on optical triangulation measures not only AC components but also a DC-part of the displacement accurately. A variety of laser sensors are provided to get optimal performance in the particular application.

The combination with a Driver Stand allows the easy mounting and adjustment of the sensor head and allows also the calibration the sensor by the user. Management for multiple laser sensor heads is provided by dB-Lab and allows choosing a specific laser according to measurement demands. (e.g. small signal, large signal measurements, woofers or tweeters)

## CAUTION! Laser Radiation!

Avoid direct or indirect (e.g. reflection) exposure of human eyes to beam.

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## 1 Components

### Klippel Analyzer

The Klippel Analyzer hardware provides a special laser sensor input and a built in power supply (for all 24 V<sub>DC</sub> supplied sensors). Each laser sensor can be calibrated via the frame software dB-Lab (@ Klippel Analyzer 3) or using the Laser Displacement Meter (@ Distortion Analyzer 2). Default Calibration data are included with the dB-Lab for all Klippel-supplied sensor heads. Individual calibration data can be stored and selected using the dB-Lab.



KA3 Laser-Card with 2 Laser sensor inputs at IN 1 & IN2 with LEMO connector

### Laser Sensor Heads

A variety of different laser heads is provided to fulfill the particular application requirements. The following criteria should be considered for the selection of the sensor head:

- Measurement range: DUT displacement range must be covered by the laser sensor.
- In some application also the reference distance resulting in stand-off height from the DUT has to be considered.
- Bandwidth:
  - Fundamental displacement could be measured as long as  $f_{\text{sample}}$  of the laser sensor is at least twice the resonance frequency  $f_s$  of the DUT.
  - For all other measurements a full bandwidth ( $\geq 20$  kHz) laser sensor is required.
- Sensitivity:
  - Fundamental displacement could be measured with cost-effective laser sensors.
  - Sensitive small signal measurements, distortion analysis, and others require a maximum of sensitivity and linearity which could only be achieved by the high-resolution types.



LK-H052 laser sensor

**Laser Controller**

Almost all laser sensor heads require a separate and dedicated laser controller.

The laser sensor heads LK-H022, 52, 82 & 152 of the LK-G5000 series are operated by the laser controller LK-G5001P. It can directly be powered by the Klippel Analyzer 3 or with an external power supply if used with DA2 or PA. With version 2 of the Klippel connection panel two sensor can be operated at one laser controller in parallel.

The laser head IL-030 is operated by the controller IL-1000. It can be powered by the Klippel Analyzer, for QC LST measurements at the PA it needs an external power supply.

All heads of the discontinued ANR series are operated with the controller ANR5132. This controller is powered by the KA3 or DA2.

Only the sensors of the HL-G-series come with an integrated laser controller within the sensor.



LK-G5001P laser controller with Klippel Connection Panel rev.2.0

**Calibration Target**

(Item No. 2201-004)

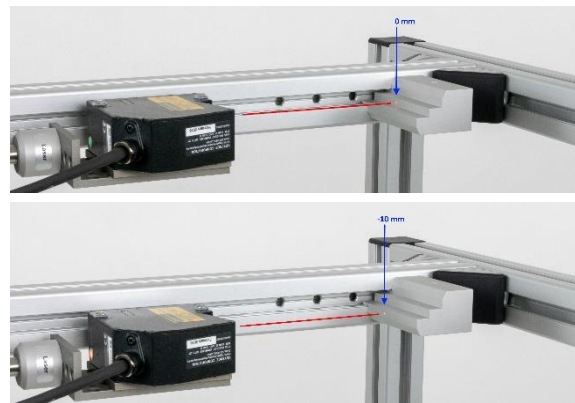
Laser displacement sensors with +/- 12.5 mm working range and more may be calibrated using the Laser Calibration Target having diffuse reflecting surfaces of required preciseness at its 10 mm stairs.

It is part of the Pro Driver Stand and SPM bench.

May be used for calibrating:

- LK-H082, LK-H152
- HL-G108, HL-G112, IL-030
- discontinued ANR 1282, ANR 1215

See the “Laser Handling” chapter in the hardware manual for details.



**Translation stage (incl. Micrometer)**

(Item No. 2300-001)

Laser displacement sensors providing high resolution in a working range of less than +/-12.5 mm may be calibrated and adjusted by accurate positioning with the Translation Stage. Equipped with a high-resolution micrometer (with 1µm vernier) the calibration process can be performed easily.

- See type-dependent calibration suggestion in the following table.
- See the “Laser Handling” chapter in the hardware manual for details.



2 Laser Sensor Heads		2.1 High Resolution Types			
Sensor type	LK-H022	LK-H052	LK-H082	LK-H152	
Manufacturer & series	Keyence LK-G5000				
Reference Distance (mm)	20 ±0.15	50 ±0.5	80 ±0.9	150 ±2.0	
Measurement Range (mm)	±3	±10	±18	±40	
	@ >= 20 µs sample rate (up to 2.55 µs with reduced measurement range)				
Linearity Error absolute (µm):	±1.2	±4.0	±7.2	±16.0	
	relative: ±0.02 % of full scale (measurement range)				
Repeatability (µm)	0.02	0.025	0.1	0.25	
Max. Signal Frequency (kHz)	25 (Default Laser Controller Setup with 20µs sampling usable at KA3 & DA2)				
	44 (-3 dB) (Default Laser Controller Setup with 20µs sampling usable at KA3 & DA2)				
	44 (Advanced Laser Controller Setup with 10µs sampling usable at DA2)				
	50 (Advanced Laser Controller Setup with 10µs sampling usable at KA3)				
	66 (-3dB) (Advanced Laser Controller Setup with 10µs sampling usable at KA3 only)				
Laser Class	Class 2 / IEC60825-1				
	(closing the eyelids will protect the eyes, avoid the laser beam)				
Light source	visible laser diode (650 nm)				
Max. Output (mW)	0.95				
Beam Spot Diameter (µm) @ Reference Distance	25	50	70	120	
Max. Ambient Light Level	Max. 10,000 lx				
Indication	LED: inside / outside Measurement, Reference Distance				
Weight (with cable in g)	230	260	280	300	
Length of the cable	0.5 m mounted at the Laser Sensor Head				
	Could be extended with 0.7 / 2 / 5 / 10 / 20 / 30 m extension cables 5 m included in the "All Purpose" Sets, 0.7 m included with the SCN				
Supported Calibration Procedures	using dB-Lab included type depending sensor file				
	with Translation Stage (recommended method)				
	with SCN Vibrometer				
	with Calibration Spacer (@ Pro Stand, SPM Bench)				
Item number					
• all-purpose set	2103-100	2103-200	2103-300	2103-421	
• for SCN only set	2103-110	2103-210	-	-	
• sensor only set	2103-120	2103-220	2103-320	2103-420	

<b>2.2 Cost-effective Types</b>				
<b>Sensor type</b>	<b>IL-030 (RnD setup)</b>	<b>IL-065 (LST setup)</b>	<b>HL-G108</b>	<b>HL-G112</b>
Manufacturer & series	Keyence IL series		Panasonic HL-G series	
Reference Distance (mm)	32.5 ±0.5	80 ±15.0	85 ±1.0	120 ±3.0
Measurement Range (mm)	±12.5	±20	±20	±60
absolute (µm):	±25	±40	±40	±120
Linearity Error relative:	±0.1 % of full scale (measurement range)			
Repeatability (µm)	2		2.5	8
Max. Signal Frequency (kHz)	1.5		2.5	
Laser Class	Class 1		Class 2 / IEC60825-1	
	(closing the eyelids will protect the eyes, avoid the laser beam)			
Light source	visible laser diode (655 nm)			
Max. Output (mW)	0.22		1	
Beam Spot Diameter (mm) @ Reference Distance	0.2 x 0.75		0.75 x 1.25	1.0 x 1.5
Max. Ambient Light Level	max. 5,000 lx		max. 3,000 lx	
Indication	LED: ON, inside meas. range, reference distance		LED & included display: ON, inside meas. range, reference distance, measurement value	
Weight (without cable in g)	60		70	
Cable length @ sensor	0.2 m		0.5 m	
Cable length (Sensor-to-Controller)	2 m		-	
Cable length (Controller-to-KA3)	2 m		5 m	
Supported Calibration Procedures	using dB-Lab included type depending sensor file (recommended method)			
	with Calibration Spacer			
	included @ Pro Driver Stand	included @ SPM or LST bench	included @ Pro Driver Stand	
	with Translation Stage			
	with SCN Vibrometer			
Item number				
• @ KA3 set	2102-041	2102-044	2103-071	2103-060
• @ PA set	-	2102-042	-	-

<b>2.3 Discontinued</b>				
<b>Manufacturer / Type</b>	<b>Measurement Range (mm)</b>	<b>Reference Distance (mm)</b>	<b>Max. Signal Frequency (kHz)</b>	<b>Supply Voltage (V<sub>DC</sub>)</b>
Keyence IL-030 (LST setup)	±10	32.5 ±8.0	1,5	24 KA3 powered, ext. powered @ PA
	replaced by IL-065, due to its better suitable measurement range for LST application, SNR is not the dominant property at LST application			
Keyence LK-G32	±5	30 ±0.25	10	24 ext. powered
	-1.8 / +5		25 44 (-3 dB)	
	replaced by LK-H052, due to its better resolution and bandwidth			
Keyence LK-G37	±5	30 ±0.25	10	24 ext. powered
	-1.8 / +5		25 44 (-3 dB)	
	Replaced by LK-G32, as round laser spot has advantages for loudspeaker measurements compared to the slotted laser spot type.			
Keyence LK-G82	±15	80 ±0.75	10	24 ext. powered
	-9 / +15		25 44 (-3 dB)	
	replaced by LK-H082, due to its increased resolution and bandwidth			
Panasonic ANR 1250	±10	50	1 (-3 dB)	12 – 24 KA3/DA2 powered
	discontinued by the manufacturer, replaced by LK-G5000 series			
Panasonic ANR 1282	±20	80	1 (-3 dB)	12 – 24 KA3/DA2 powered
	discontinued by the manufacturer, replaced by LK-G5000 series			
Panasonic ANR 1215	±50	130	1 (-3 dB)	12 – 24 KA3/DA2 powered
	discontinued by the manufacturer, replaced by LK-G5000 series			
Micro Epsilon LD 1605-0,5 LD 1607-0,5	±0,25	24	10 (-3 dB)	24 ext. powered
	replaced by LK-G32, due to its increased measurement range, reference distance, linearity, bandwidth and usability			
Micro Epsilon LD 1605-4	±2	24	10 (-3 dB)	24 ext. powered
	replaced by LK-G32, due to its increased measurement range, reference distance, linearity, bandwidth and usability			

2.4 Legend		
Terms & Criteria	Example	Definition & Explanation
Reference Distance (mm)	50 <sup>±0.5</sup>	50 = center point distance or distance between the middle of the measurement range and the sensor enclosure
		<sup>±0.5</sup> = OK range or span the sensor indicates adjustment at reference distance with a green LED
Measurement Range (mm)	±10.0	Relative positive and negative measurement range based on reference distance. In this example the absolute measurement range will be 40 to 60 mm from the edge of the sensor enclosure.
Linearity Error	±4	<p>absolute (µm):</p> <p>Calculated theoretical value based on the relative value given below. Could be used to compare sensor capabilities. The following rule of thumb could be used to define a minimum measurement signal span <math>X_{PP}</math> to realize sufficient linearity.</p> <p><math>X_{PP} \geq 10 * \text{abs. linearity error}</math></p> <p>In other words: In this case, linearity could also be called independence from reference distance! With signal spans smaller as the recommended value repeated measurements at changed reference distance could give varied results.</p> <p>Hint: Repeating a measurement at a slightly changed reference distance and comparing the results is a good verification.</p>
		<p>relative:</p> <p>±0.02 % of full scale</p> <p>Determined under special conditions specified by the manufacturer. Using the best possible optical properties and a high number of averaging.</p>
Repeatability (µm)	0.025	
Max. Signal Frequency (kHz)	25	Default values are based on $f_{SAMPLE}/2$ of the sensor or measurement device input channel.
	44 (-3 dB)	Values marked with (-3 dB) are limited by the internal signal processing of the laser sensor and controller or the low-pass characteristic of the used measurement device input channel.

<b>3 Laser Controller</b>		<b>3.1 High Resolution Types</b>	
<b>Controller type</b>	<b>LK-G5001P</b>	<b>LK-G3001P</b>	
Manufacturer & series	Keyence LK-G5000	Keyence LK-G3000 (discontinued)	
Analog voltage output (V)	±10		
Output impedance (Ω)	100		
Input channels	2		
Output channels	2 (with Connection Panel rev.2.0)	1	
	1 (with Connection Panel rev.1.x)		
Sample Rate (μs)	2.55	-	-
	<b>5 Klippel advanced setting</b>	-	-
	<b>10 Klippel advanced setting</b>	-	-
	<b>20 Klippel default setting</b>	<b>20 Klippel advanced setting</b>	<b>20 Klippel default setting</b>
	50	<b>50 Klippel default setting</b>	
	100	100	
	200	200	
	500	500	
	1000	1000	
	Advanced settings causing reduced displacement measurement range!		
Temperature Drift	0.02 % of F.S. / °C	0.01 % of F.S. / °C	
Operating Ambient Temperature	0 to 50 °C (+32 to +122°F)		
Operating Ambient Humidity	35 % to 85 % RH (no condensation)		
Indication	LED: ON, operation		
Signal & supply connector	2x 4-pin M8 male socket (with Connection Panel rev.2.0)		
Signal & supply cable	5 m M8 female to LEMO male (with Connection Panel rev.2.0)		
Signal connector & cable	7-pin LEMO male connector with fixed mounted 2 m cable (with Connection Panel rev.1.x)	7-pin LEMO male connector with fixed mounted 2 m cable	
Power supply connector	3-pin M8 female socket (with Connection Panel rev.1.x)	3-pin M9 male socket	
Power supply	24 V <sub>DC</sub> ± 10 %, max. 500 mA		
Power supply source	KA3 (for Connection Panel rev.2.0)	external 24 V <sub>DC</sub> power supply with 3-pin M9 female connector	
	external 24 V <sub>DC</sub> power supply with 3-pin M8 male connector (for Connection Panel rev.1.x)		
Item number (incl. in Sensor & Controller sets)	2103-500		



<b>3.2 Cost-effective Types</b>			
<b>Controller type</b>	<b>IL-1000</b>	<b>HL-G1xx included in sensor</b>	<b>ANR 5132 discontinued</b>
Manufacturer & series	Keyence IL series	Panasonic HL-G series	Panasonic LM10 series
Analog voltage output (V)	±5	0 - 10V	±5
Output impedance (Ω)	100		50
Input channels	1		
Output channels	1		
Sample Rate (ms)	-	<b>0.2</b>	-
	<b>0.33</b>	0.5	<b>0.4</b>
	1	1	-
	2	2	-
	5	-	4 40
	<b>selected by Controller setting</b>		<b>selected by switch</b>
Temperature Drift	0.05 % of F.S. / °C	0.08 % of F.S. / °C	0.03 % of F.S. / °C
Operating Ambient Temperature	0 to 50 °C (+32 to +122°F)		
Operating Ambient Humidity	35 % to 85 % RH (no condensation)		
Indication	LED: ON, MIN, OK, MAX, OUT Display: measurement value		LED: ON, operation
Signal & supply connector & cable	7-pin LEMO male connector with fixed mounted 2 m cable		
Power supply	10 - 30 V <sub>DC</sub> ± 10 %, max. 2.3 W @ 30 V	24 V <sub>DC</sub> ± 10 %, max. 100 mA	12 - 24 V <sub>DC</sub> ± 10 %, max. 250 mA @ 12 V
Power supply source	KA3 DA2 PA with adapter & PSU	KA3	KA3 DA2
Item number	incl. in Sensor & Controller sets		

4 Application Guide		4.1 By Transducer Type																	
Legend		✓ = best performance a = applicable (with limited performance or measurement range)																	
Laser type		LK-H 022	LK-H 052	LK-H 082	LK-H 152	IL-030 (RnD setup)	IL-065 (LST setup)	HL-G108	HL-G112		IL-030 (LST setup)	LK-G32	LK-G37	LK-G82	ANR 1250	ANR1282	ANR 1215	LD160x-0,5	LD1605-4
Application	Software Modules																		
<b>Long throw Woofer</b>																			
Small signal analysis	LPM, TSX	a	✓	✓	✓							✓	✓	✓	✓	✓			
Large signal analysis	LSI Woofer, DIS, TRF, ...		a	✓	✓	a		✓	✓					✓	a	✓	✓		
<b>Woofer</b>																			
Small signal analysis	LPM, TSX	✓	✓	✓	✓							✓	✓	✓	✓	✓			
Large signal analysis	LSI Woofer, DIS, TRF, ...		✓	✓	✓	✓		✓	✓			a	a	✓	✓	✓	✓		
<b>Midrange, Broadband, small Woofer, Exciter</b>																			
Small signal analysis	LPM, TSX	✓	✓	✓	✓							✓	✓	✓	a	a			
Large signal analysis	LSI Woofer, DIS, TRF, ...	a	✓	✓	✓	✓		✓	a			✓	✓	✓	✓	✓	a		a
<b>Horn Compression Driver</b>																			
Small signal analysis	LPM, TSX	✓	✓	a	a							✓	✓	a					
Large signal analysis	LSI Woofer, DIS, TRF, ...	✓	✓	✓	a							✓	✓	✓				a	a
<b>Tweeter, Micro-Speakers, Headphone</b>																			
Small signal analysis	LPM, TSX	✓	✓	a	a							✓	✓	a					
Large signal analysis	LSI Woofer, DIS, TRF, ...	✓	✓	✓	a							✓	✓	✓				a	a

4.2 By Application																				
Legend		✓ = best performance a = applicable (with limited performance or measurement range)																		
Laser type		LK-H 022	LK-H 052	LK-H 082	LK-H 152	IL-030 (RnD setup)	IL-065 (LST setup)	HL-G108	HL-G112		IL-030 (LST setup)	LK-G32	LK-G37	LK-G82	ANR 1250	ANR1282	ANR 1215	LD160x-0,5	LD1605-4	
Application	Software Modules																			
<b>SCN – Scanning Vibrometer – Multi Scanning Workbench</b>																				
Cone Vibration Measurement	SCN, TRF	a	✓	a																
<b>Soft Parts RnD Measurements</b>																				
Suspension Part Measurement	SPM Lite	✓	✓	✓	a	✓		a				✓	✓	✓	a	a				a
	SPM Pro		a	✓	✓									✓		✓				
Microspeaker Suspension Part Measurement	MSPM Lite	✓	✓	a								✓	✓	a						
	MSPM Pro	✓	✓	a	a							✓	✓	a						
Material Parameter Measurement (E- Modulus)	MPM		✓	✓	a	✓		a				a	a	✓	✓	a				
<b>Soft Parts QC Measurements</b>																				
Linear Suspension Test	LST Lite	a	a	a	a		✓				✓	a	a	a						
	LST Pro	a	a	a	a		✓				✓	a	a	a						

Find explanations for symbols at:  
<http://www.klippel.de/know-how/literature.html>

Last updated: September 25, 2023

