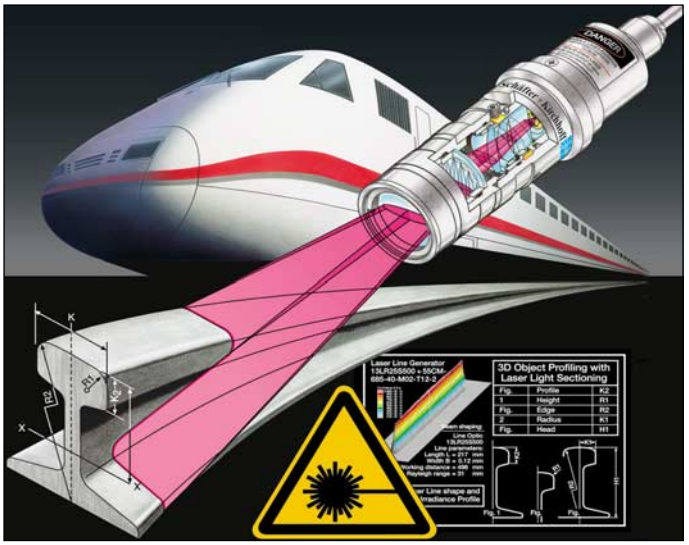
Laser Micro Line Generator 13LR...
Laser Macro Line Generator 13LRM...

A key component for the 3D laser measurement technique



Characteristics:
Laser line with homogeneous intensity distribution and constant line width
Beam and intensity profile see figure **1**

Integrated electronics for laser power control

External modulation TTL up to 250 kHz – analog up to 100 kHz

Fig. 1

Application:
Laser Microline Generator for measurement of 3D-Profile and gage exactness.

The 13LR... laser line generator was specially developed for the 3D profile measurement using the laser light-sectioning method. Its specific characteristics are the homogeneous intensity distribution, and the constant line width throughout the whole measuring area. This ideal beam and intensity profile increases the accuracy and resolution of the measurements and reduces the calculation time for the image analysis.
The laser micro line generator or laser macro line generator is chosen to accomodate to the measurement application. The laser micro line generator generates laser lines from 0.025 mm width with high power density and a small depth of focus. With the laser macro line generator the laser line is wider by a factor of 2-3, the depth of focus larger by a factor of 10. The power density is constant throughout the whole depth of focus (fig. 2).

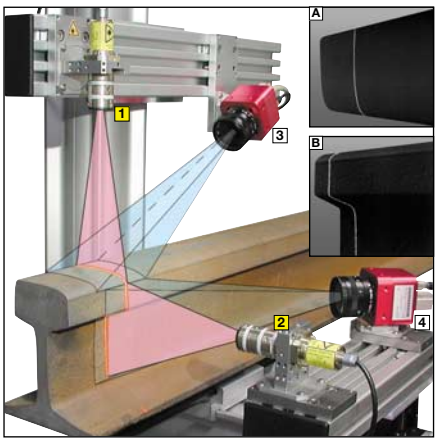


Fig 2: *3D profile measurements of a rail track with the laser light sectioning method*
1 *Laser Microline Generator 13LR... (for objects with small elevation profile variations)*
2 *Laser Macroline Generator 13LRM... (for objects with large elevation profile variations)*
3 *and* 4 *CCD/CMOS area camera*
A *Line contour of the contact surface (cam.* 3*)*
B *Line contour of the side-face (camera* 4*)*

Laser light sectioning - Measurement technique
Disturbing influence by laser speckle
Depth of focus of camera and lens
Laser Light Sectioning in Scheimpflug-Configuration
see **www.SuKHamburg.de/dl/lightsect-e.pdf**

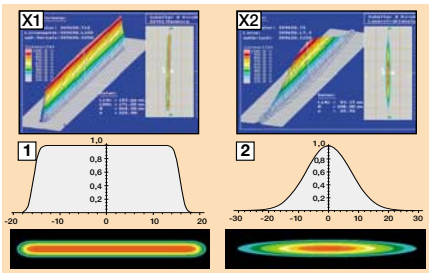
Characteristics and parameters of performance

The beam shaping optics determine the parameters fan angle and line length as well as the optimal working distance and the focussing range of the laser line generator.
The laser diode used determines the wavelength, the emitted power, and therefore also the laser protection class.

Main characteristics:

- Fan angle 12°, 25°, and 40°
- Homogeneous intensity distribution in line direction, Gaussian perpendicular to laser line
- Constant line width along the laser line
- Line width down to 0.04 mm (1/e2)
- Line length from 26 mm up to 2840 m
- Focusable, adjustment of the focus position by internal lens focussing (within the focussing range specified in the tables on next page)
- Metal housing, Ø 25/28 mm
- Spectral range: 635 - 980 nm, optional 405 nm and 1064-1550 nm
- Laser power: up to 100 mW in the visible range (660 nm) up to 105 mW in the IR range (830 nm)
- Integrated electronics for laser power control
- Laser output power adjustable with potentiometer <1 - 100%
- External modulation TTL up to 250 kHz, analog up to 100 kHz
- Power supply: +5V

Fig. 3 Beam and intensity profile



Laser line generator 13LR **classical laser line**
X1 and X2 beam analysis
1 and 2 intensity distribution in line direction
3 and 4 beam profile

Depth of Focus of a Laser Line

The laser line is focussed to a fixed working distance. With actual working distances diverging from the setting the laser line widens and the power density of the radiation decreases. The region around the nominal working distance, where linewidth does not increase by more than a factor of 1.41, is according to agreement characterized as the depth of focus of a laser line.
There are two types of laser line generators (see Fig. 4). Laser micro line generators create thin laser lines with Gaussian intensity profile orthogonal to the laser line. The depth of focus of a laser line at wavelength λ and of width B (at 13.5%-level) is given by the so called Rayleigh Range 2 z_R:

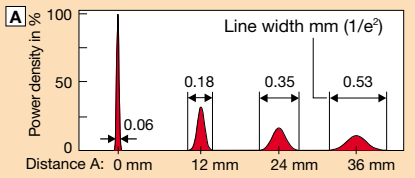
$$2\,z_R = \frac{\pi}{2}\,\frac{B^2}{\lambda}$$

Laser macro line generators create laser lines with increased depth of focus.
At the same working distance macro laser lines are wider than micro laser lines (factor 2-5). At the same working distance, their depth of focus is enlarged by a factor of 7 to 35.

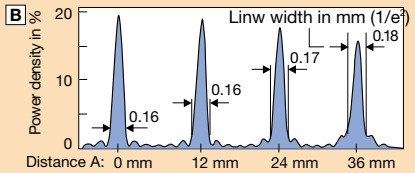
Line Width

Within the two design types, macro resp. micro line generator, the line width is proportional to the working distance. Due to the theoretical relation between line width and the depth of focus, the minimum line width of the laser line is limited by the depth of focus required.

Fig. 4 *Intensity profile and line width*



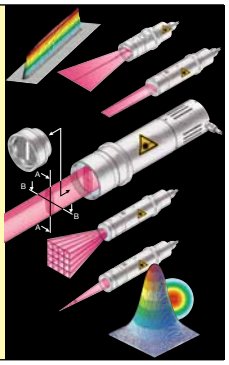
Micro Line: Intensity profile and line width
e.g. Micro Line Generator
13 LR 25 S 250 + 55CM-660-26-M01-T12-C-6
high power density and narrow laser line in the focus. Line broadening and highly reduced power density with variation of the working distance.



Macro Line: Intensity profile and line width
e. g. Macro Line Generator
13 LRM 25 S 250 -1,5 + 55CM-660-23-M01-T12-C-6
Power density and line width remain nearly constant under changing working distances. The possible working range can be a factor of 35 larger compared to the micro line generator A)

Laser line and micro focus generators for optical metrology
For this purpose **Schäfter + Kirchhoff** offers a product range well accomodated to the requirements of the measuring tasks e.g.,
- semi-telecentric laser lines with high edge intensity and const. line width
- Micro focus generators for laser spots≥0.001 mm
- Collimator 90CM... for laser diffraction, and edge detection systems

Info see: data sheets www.SuKHamburg.de



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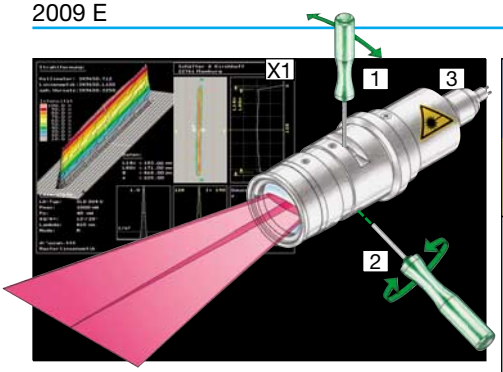


Laser micro line generator 13LR.../13LRM...
1 Focussing the laser line to the working distance
2 Locking/unlocking of the focus position, 3 Potentiometer for laser output power, X1 Line shape

The line lengths and line widths listed in table 1 and table 3 are valid for the nominal working distance of the line optics. Deviating working distances can be reached by refocussing, considering the given focussing range. The line length and line width approximately change proportional with the working distance.

Laser Micro Line Generator 13LR...

Laser fan with homogeneous intensity distribution and constant line width

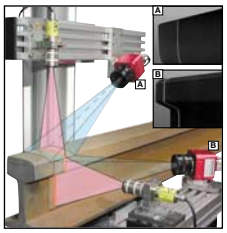
Laser Macro Line Generator 13LRM...

Laser line with extended depth of focus

- Fan angle 12°, 25°, and 40°
- Intensity profile homogeneous in direction of line, perpendicular Gaussian (type 13LRM... approx. Gaussian)
- Constant line width along the entire line length (s. Fig. X1)
- Line width starting at 0.04 mm (1/e²)
- Line length from 26 mm to 2840 m
- Integrated focussing mechanism
- Metal housing ∅ 25/28 mm
- Laser output power up to 100 mW
- Laser wavelength 635 to 980 nm optional 408 nm or 1064 – 1550 nm
- Integrated power control
- Output power adjustable <1 - 100 %
- External modulation TTL up to 250 kHz and analog up to 100 kHz
- Supply voltage 5V DC

Laser micro line generators 13LR... and laser macro line generators 13LRM... are characterized by a homogeneous intensity distribution and a constant line width along the entire line length. In addition, type 13LRM... has an extended depth of focus. The laser line generators have an integrated electronics and can be modulated externally. The beam shaping optics defines the beam parameter fan angle and line length, the optimum working distance, and the focussing range, see table 1 and table 3 respectively. The used laser module defines the wavelength and the output power and so the laser safety class, see table 2 and table 4 respectively.

Application



3D profile measurement with the laser light section method

Line width factor F

Properties of the laser diode beam source, like beam diameter and wavelength, affect width and Rayleigh range/ depth of focus of the laser line:
line width: multiply by F
Rayleigh range/ depth of focus: multiply by $1/F^2$

Laser Micro Line Generator 13LR... Order Code 13 LR 25 S500 + 55CM - 660 - 26 - M01-T12 - C - 6

Table 1 — Beam Parameters / Line Optics 13LR

Line Optics 13LR...	Line Length L [mm]	Line Width B [mm]	Working Distance A [mm]	Rayleigh Range $2z_R$ [mm]	Focusing Range [mm]	Convergence β [Deg]	Dim. X [mm]	Order Code
Table 1.1	26	0.043	120	3.0	100 - 205	1.4	12	13LR12M125
Fan angle α = 12°	52	0.072	248	12.2	205 - 415	0.7	8	13LR12S250
	103	0.144	496	48.8	415 - 815	0.3	8	13LR12S500
	201	0.288	977	195	815 - 1300	0.2	8	13LR12S1000
	409	0.580	2000	788	1300 - ∞	0.1	8	13LR12S000
Table 1.2	55	0.043	119	3.0	100 - 205	1.4	12	13LR25M125
Fan angle α = 25°	109	0.072	249	12.2	205 - 415	0.7	8	13LR25S250
	217	0.144	496	48.8	415 - 815	0.3	8	13LR25S500
	425	0.288	977	195	815 - 1300	0.2	8	13LR25S1000
	1300	0.868	3000	1767	1300 - ∞	0.06	8	13LR25S000
Table 1.3	90	0.065	120	3.0	100 - 205	1.4	15	13LR40M125
Fan angle α = 40°	180	0.108	245	12	205 - 410	0.7	10.5	13LR40S250
	357	0.216	492	49	410 - 815	0.3	10.5	13LR40S500
	698	0.433	973	195	815 - 1290	0.2	10.5	13LR40S1000
	2840	1.735	4000	3136	1290 - ∞	0.04	10.5	13LR40S000

Each line optics can be combined with all laser modules

Table 2

curr. no.	Laser Diode Source	Wavelenght [nm]	P_{out} [mW]	LD Code	Lens	Electronics	Cable	Safety Classification	Edge Intensity [%]	Line Width Factor F
1	55CM	- 635	- 10 -	H10	- T12	- C	- ...	3B	>80	0.95
2	55CM	- 638	- 22 -	N09	- T12	- C	- ...	3B	>80	1.09
3	55CM	- 660	- 26 -	M01	- T12	- C	- 6	3B	>80	0.79
4	55CM	- 660	- 100 -	M25	- T12	- P	- ...	3B	>80	0.79
5	55CM	- 660	- 44 -	M26	- T12	- C	- ...	3B	>80	0.88
6	55CM	- 685	- 26 -	M21	- T12	- C	- ...	3B	>80	0.86
7	55CM	- 780	- 39 -	H06	- T12	- C	- ...	3B	>80	0.98
8	55CM	- 785	- 7 -	Y03	- T12	- C	- ...	3B	>80	0.72
9	55CM	- 785	- 61 -	N08	- T12	- C	- ...	3B	>80	1.17
10	55CM	- 830	- 105 -	N07	- T12	- C	- ...	3B	>80	1.42
11	55CM	- 980	- 9 -	W01	- T12	- C	- ...	3B	>80	1.46

Electr. Cable:
- 1.5 m shielded conn. cable 4xAWG 26CUL 0.14 mm² . . . 1
- as 1, with connector type Lumberg SV50 **6**
- cabel specified by customer. 5

Y03: Laser diodes with low coherence lengths in the lower power range
Further wavelengths/ output powers on request.

Laser Macro Line Generator 13LRM... Order Code 13 LRM 25 S500-1,5 + 55CM - 660 - 23 - M01-T12 - C - 6

Table 3 — Beam Parameters / Line Optics 13LRM

Line Optics 13LRM...	Line Length L [mm]	Line Width B [mm]	Working Distance A [mm]	Depth of Focus [mm]	Focusing Range [mm]	Convergence β [Deg]	Dim. X [mm]	Order Code
Table 3.1	26	0.08	113	21	95 - 195	0.69	18.9	13LRM12M125-1,5
Fan angle α = 12°	52	0.16	236	83	195 - 355	0.34	18.9	13LRM12S250-1,5
	103	0.32	412	332	355 - 780	0.17	18.9	13LRM12S500-1,5
	201	0.65	965	1327	780 - 1330	0.09	18.9	13LRM12S1000-1,5
	409	1.31	2000	3000	1330 - ∞	0.04	18.9	13LRM12S000-1,5
Table 3.2	55	0.08	111	21	95 - 195	0.69	18.9	13LRM25M125-1,5
Fan angle α = 25°	109	0.16	238	83	195 - 355	0.34	18.9	13LRM25S250-1,5
	217	0.32	413	332	355 - 780	0.17	18.9	13LRM25S500-1,5
	425	0.65	966	1327	780 - 1330	0.09	18.9	13LRM25S1000-1,5
	1300	1.96	3000	4500	1330 - ∞	0.03	18.9	13LRM25S000-1,5
Table 3.3	90	0.08	111	21	105 - 195	0.69	23.4	13LRM40M125-1,5
Fan angle α = 40°	180	0.16	240	83	195 - 355	0.34	18.9	13LRM40S250-1,5
	357	0.32	415	332	355 - 785	0.17	18.9	13LRM40S500-1,5
	698	0.65	968	1327	785 - 1340	0.09	18.9	13LRM40S1000-1,5
	2840	2.61	4000	6000	1340 - ∞	0.02	18.9	13LRM40S000-1,5

Each line optics can be combined with all laser modules

Table 4

curr. no.	Laser Diode Source	Wavelenght [nm]	P_{out} [mW]	LD Code	Lens	Electronics	Cable	Safety Classification	Edge Intensity [%]	Line Width Factor F
1	55CM	- 635	- 7 -	H10	- T12	- C	- ...	3B	>80	0.95
2	55CM	-638	- 16 -	N09	- T12	- C	- ...	3B	>80	0.95
3	55CM	- 660	- 23 -	M01	- T12	- C	- 6	3B	>80	0.99
4	55CM	- 660	- 53 -	M25	- T12	- P	- ...	3B	>80	0.99
5	55CM	- 660	- 28 -	M26	- T12	- C	- ...	3B	>80	0.99
6	55CM	- 685	- 16 -	M21	- T12	- C	- ...	3B	>80	0.86
7	55CM	- 780	- 24 -	H06	- T12	- C	- ...	3B	>80	1.16
8	55CM	- 785	- 3 -	Y03	- T12	- C	- ...	3B	>80	1.17
9	55CM	- 785	- 42 -	N08	- T12	- C	- ...	3B	>80	1.17
10	55CM	- 830	- 79 -	N07	- T12	- C	- ...	3B	>80	1.24
11	55CM	- 980	- 6 -	W01	- T12	- C	- ...	3B	>80	1.46

Electr. Cable:
- 1.5 m shielded conn. cable 4xAWG 26CUL 0.14 mm² . . . 1
- as 1, with connector type Lumberg SV50 **6**
- cabel specified by customer. 5

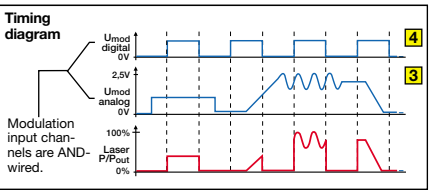
Y03: Laser diodes with low coherence lengths in the lower power range
Further wavelengths/ output powers on request.

Integrated electronics

		P	C
Electronics type			
Supply voltage		+5 V ± 0.2 V	
Current consumption	max.	250 mA	
Max. modulation frequency	analog	10 Hz	100 kHz
	TTL	250 kHz	100 kHz
With potentiometer adjustable outp. power		<5-100%	<1-100%
TTL modulation logic	Laser ON	TTL high	
Analog control voltage	P_{min} to P_{max}	0...2.5 V	

Modulation: The laser has two AND-wired modulation input channels, U_{analog} 3 and U_{TTL} 4.
The laser is OFF in case of an open modulation input. Using the digital modulation input the laser can be modulated. If only one modulation input channel is used the other has to be set to +5 V. (see timing diagram).
The voltage U_{analog} at analog modulation input 3 linearly controles the laser output power between ≤ 1% and 100% of the optical power set with the potentiometer.

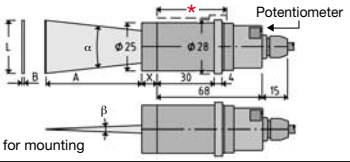
Timing diagram



Dimensions

Laser micro line generator 13LR...
Laser macro line generator 13LRM...

A = working distance
B = line width L = line length
α = fan angle
β = beam convergence

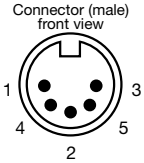


* = Clamping region for mounting

Pin-out

Cable	Conn.	
black	1	GND
red	2	+5V
br	3	U_{mod} analog
or	4	U_{mod} TTL
	5	n.c.
shield	case	⏚

Connector (male) front view



Circular connector Lumberg SV50 (IEC-60130-9) for power supply and external modulation (pin U_{mod}).
Cable shielding and housing are connected. Both are galvanically decoupled from the laser diode and electronics.

Laser-Mlg13LR_09_E