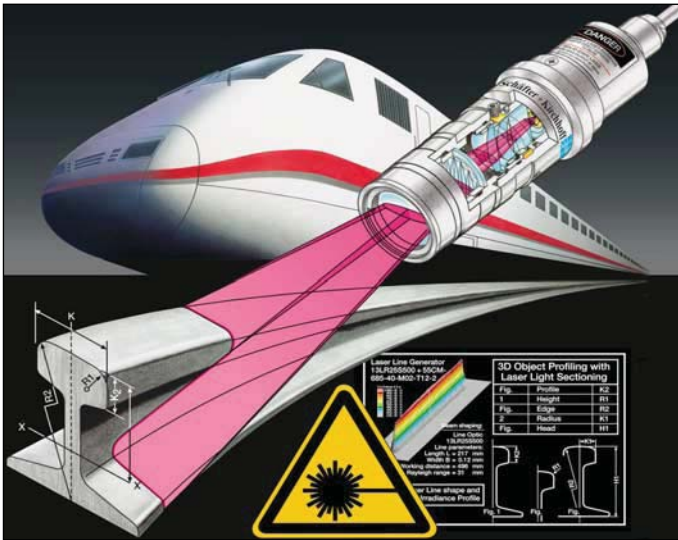


Laser Micro Line Generator 13LR... Laser Macro Line Generator 13LRM... A key component for the 3D laser measurement technique



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.

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 $2 z_R$:

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

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.

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.

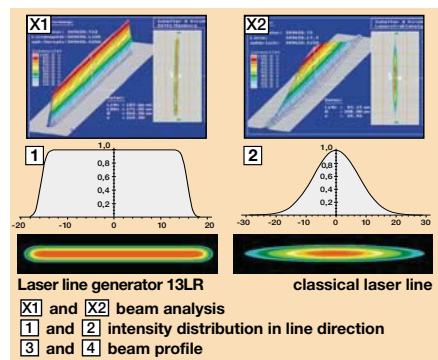
The laser micro line generator or laser macro line generator is chosen to accommodate to the measurement application. The laser micro line generator generates laser lines from 0.025 mm width with high power density and a small depth of focus. With the laser macro line generator the laser line is wider 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).

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 mm
 - 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



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

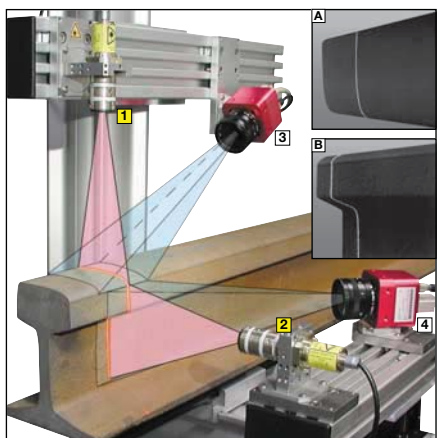
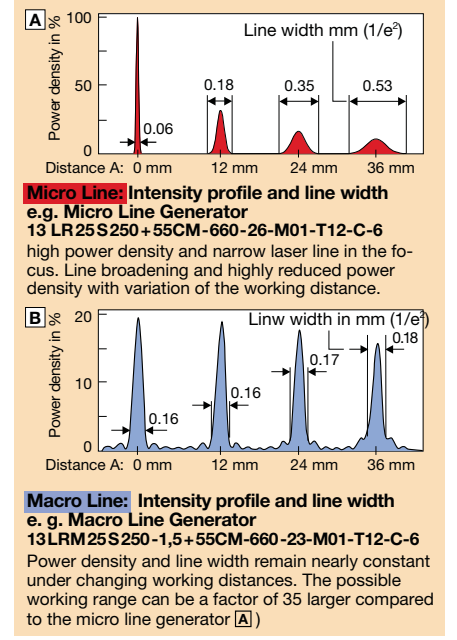


Fig 2: 3D profile measurements of a rail track with the laser light sectioning method
1 Laser Microline Generator 13LR... (for objects with small elevation profile variations)
2 Laser Macroline Generator 13LRM... (for objects with large elevation profile variations)
3 and **4** CCD/CMOS area camera
A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

Laser line and micro focus generators for optical metrology
 For this purpose Schäfter + Kirchhoff offers a product range well accommodated to the requirements of the measuring tasks e.g.,

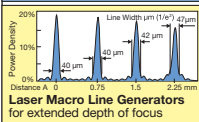
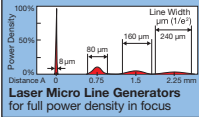
- semi-telescopic laser lines with high edge intensity and const. line width
- Micro focus generators for laser spots ≥ 0.001 mm
- Collimator 90CM... for laser diffraction, and edge detection systems

Info see: data sheets
www.SuKHamburg.de

Laser-Mag13LR_C09_E

Depth of Focus:

Plots of power density vs. working distance

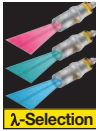
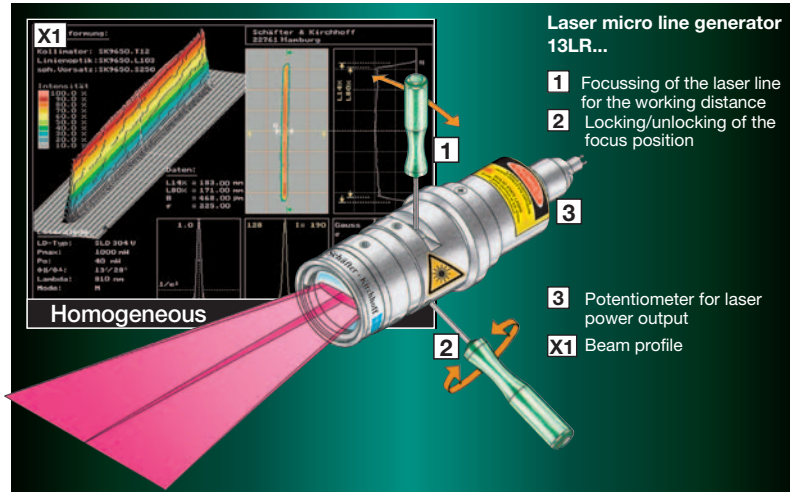


Laser Micro Line Generator 13LR...

Laser fan with homogeneous intensity distribution and constant line width

Laser Macro Line Generator 13LRM...

Laser line for extended depth of focus



- Fan angles 12°, 25° and 40°
- Intensity profile homogeneous in line direction, Gaussian in perpendicular
- Constant line width along the entire line length (see inset X1)
- Line width starting at 40 μm (1/e²)
- Line lengths from 26 mm to 2840 mm
- Integrated focussing mechanism
- Laser power output up to 105 mW
- Laser wavelengths 405 to 850 nm optionally from 1064 to 1550 nm
- Integrated power control, adjustable from <1%–100%
- External modulation: TTL up to 250 kHz and analog up to 100 kHz

The beam-shaping optics define the beam parameters, fan angle and line length, the optimum working distance and the focussing range, see tables 1.1 and 2.1. The chosen laser module defines the wavelength and the power output and, thereby, the laser safety class, see tables 1.2 and 2.2.

The line lengths and line widths in tables 1.1 and 2.1 are valid for the nominal working distance of the line optics. Any working distance changes do require refocussing within the available focussing range, with both line length and line width increasing in direct proportion with greater working distance.

Laser Micro Line Generator 13LR... Order Code		13 LR 25 S500 + 55CM - 660 - 24 - M01-T12 - C - 6							
Beam Parameters				Line Optics					
Table 1.1	Line Length L [mm]	Line Width B [mm]	Working Distance A [mm]	Rayleigh Range Z _R [mm]	Focussing Range [mm]	Convergence β [Deg]	Dim. X [mm]	13LR	Order Code
Table 1a	26	0.038	120	2.4	100 - 205	1.5	12	13LR12M125	
	52	0.063	248	9.5	205 - 415	0.8	8	13LR12S250	
	103	0.126	496	38.0	415 - 815	0.4	8	13LR12S500	
	201	0.253	977	152	815 - 1300	0.2	8	13LR12S1000	
	409	0.508	2000	614	1300 - ∞	0.1	8	13LR12S000	
Table 1b	55	0.038	119	2.4	100 - 205	1.5	12	13LR25M125	
	109	0.063	249	9.5	205 - 415	0.8	8	13LR25S250	
	217	0.126	496	38.0	415 - 815	0.4	8	13LR25S500	
	425	0.253	977	152	815 - 1300	0.2	8	13LR25S1000	
	1300	0.761	3000	1377	1300 - ∞	0.06	8	13LR25S000	
Table 1c	90	0.057	120	2.4	100 - 205	1.5	15	13LR40M125	
	180	0.095	245	9	205 - 410	0.8	10.5	13LR40S250	
	357	0.190	492	38	410 - 815	0.4	10.5	13LR40S500	
	698	0.379	973	152	815 - 1290	0.2	10.5	13LR40S1000	
	2840	1.520	4000	2444	1290 - ∞	0.05	10.5	13LR40S000	

All combinations of line optics and laser module are possible

Table 1.2										Safety Classification	Edge Intensity [%]	Line Width Factor F
curr. no.	Laser Diode Source	Wave-length [nm]	P _{out} [mW]	LD Code	Lens	Elec-tronics	Cable					
1	55CM	- 405	- 66	X05	- A15	- C	- x	3B	>80	0.49		
2	55CM	- 515	- 17	X09	- A15	- P	- x	3B	>80	0.56		
3	55CM	- 635	- 10	H10	- T12	- C	- x	3B	>80	1.08		
4	55CM	- 639	- 21	H18	- T12	- C	- x	3B	>80	1.09		
5	55CM	- 640	- 31	H22	- T12	- C	- x	3B	>80	0.97		
6	55CM	- 660	- 24	M01	- T12	- C	- x	3B	>80	1.00		
7	55CM	- 660	- 39	M26	- T12	- C	- x	3B	>80	1.06		
8	55CM	- 660	- 98	M25	- T12	- P	- x	3B	>80	0.88		
9	55CM	- 685	- 35	H13	- T12	- C	- x	3B	>80	1.10		
10	55CM	- 785	- 56	AR3	- T12	- C	- x	3B	>80	1.19		
11	55CM	- 830	- 35	H19	- T12	- C	- x	3B	>80	1.26		
12	55CM	- 830	- 105	N23	- T12	- C	- x	3B	>80	1.41		
13	55CM	- 850	- 69	EY05	- T12	- C	- x	3B	>80	1.16		

• 1.5 m shielded connection cable
 4xAWG 26CUL 0.14 mm² 1
 • as for 1, with Lumberg SV50 connector 6
 • customer-specified cable length 5

Laser Macro Line Generator 13LRM... Order Code		13 LRM 25 S500-1.5 + 55CM - 660 - 15 - M01-T12 - C - 6							
Beam Parameters				Line Optics					
Table 2.1	Line Length L [mm]	Line Width B [mm]	Working Distance A [mm]	Depth of Focus [mm]	Focussing Range [mm]	Convergence β [Deg]	Dim. X [mm]	13LRM	Order Code
Table 2a	26	0.08	113	20	95 - 195	0.69	18.9	13LRM12M125-1.5	
	52	0.16	236	82	195 - 400	0.34	18.9	13LRM12S250-1.5	
	103	0.32	484	327	400 - 805	0.17	18.9	13LRM12S500-1.5	
	201	0.64	965	1307	805 - 1290	0.09	18.9	13LRM12S1000-1.5	
	409	1.28	2000	3000	1290 - ∞	0.04	18.9	13LRM12S000-1.5	
Table 2b	55	0.08	111	20	95 - 195	0.69	18.9	13LRM25M125-1.5	
	109	0.16	238	82	195 - 405	0.34	18.9	13LRM25S250-1.5	
	217	0.32	485	327	405 - 805	0.17	18.9	13LRM25S500-1.5	
	425	0.64	966	1307	805 - 1290	0.09	18.9	13LRM25S1000-1.5	
	1300	1.92	3000	4500	1290 - ∞	0.03	18.9	13LRM25S000-1.5	
Table 2c	90	0.08	111	20	105 - 195	0.69	23.4	13LRM40M125-1.5	
	180	0.16	240	82	195 - 405	0.34	18.9	13LRM40S250-1.5	
	357	0.32	487	327	405 - 805	0.17	18.9	13LRM40S500-1.5	
	698	0.64	968	1307	805 - 1290	0.09	18.9	13LRM40S1000-1.5	
	2840	2.56	4000	6000	1290 - ∞	0.02	18.9	13LRM40S000-1.5	

All combinations of line optics and laser module are possible

Table 2.2										Safety Classification	Edge Intensity [%]	Line Width Factor F
curr. no.	Laser Diode Source	Wave-length [nm]	P _{out} [mW]	LD Code	Lens	Elec-tronics	Cable					
1	55CM	- 405	- 42	X05	- A15	- C	- x	3B	>80	0.61		
2	55CM	- 515	- 10	X09	- A15	- P	- x	3B	>80	0.78		
3	55CM	- 635	- 7	H10	- T12	- C	- x	3B	>80	0.96		
4	55CM	- 639	- 14	H18	- T12	- C	- x	3B	>80	0.97		
5	55CM	- 640	- 20	H22	- T12	- C	- x	3B	>80	0.97		
6	55CM	- 660	- 15	M01	- T12	- C	- x	3B	>80	1.00		
7	55CM	- 660	- 26	M26	- T12	- C	- x	3B	>80	1.00		
8	55CM	- 660	- 56	M25	- T12	- P	- x	3B	>80	1.00		
9	55CM	- 685	- 23	H13	- T12	- C	- x	3B	>80	1.04		
10	55CM	- 785	- 36	AR3	- T12	- C	- x	3B	>80	1.19		
11	55CM	- 830	- 22	H19	- T12	- C	- x	3B	>80	1.26		
12	55CM	- 830	- 72	N23	- T12	- C	- x	3B	>80	1.26		
13	55CM	- 850	- 40	EY05	- T12	- C	- x	3B	>80	1.29		

• 1.5 m shielded connection cable
 4xAWG 26CUL 0.14 mm² 1
 • as for 1, with Lumberg SV50 connector 6
 • customer-specified cable length 5

Line width factor F

Properties of the laser diode, such as divergence angle and wavelength, affect the width and Rayleigh range/depth of focus of the laser line.

For line width: multiply by F

for Rayleigh range/

depth of focus: multiply by F² · 660 nm / λ [nm]