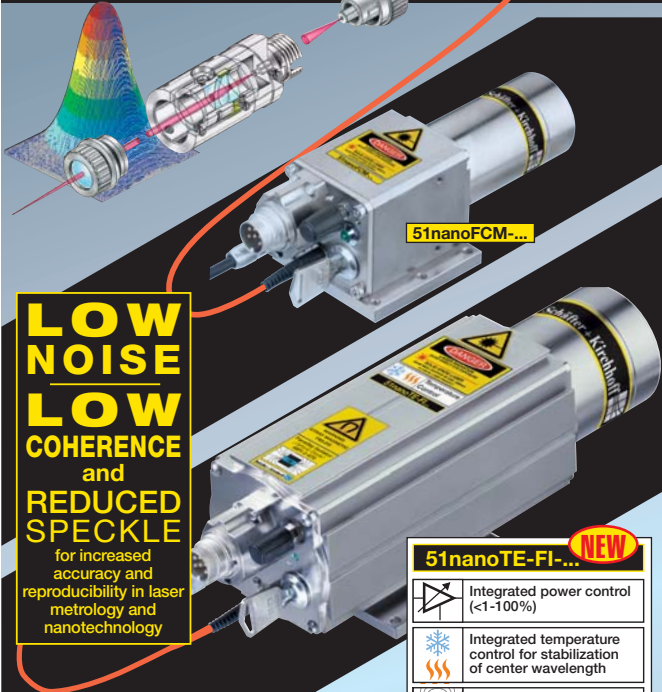


## Laser Diode Beam Sources

with singlemode and polarization-maintaining fiber cables

- 51nanoFCM-...
- 51nanoTE-...
- 51nanoFI-...
- 51nanoTE-FI-...



**LOW NOISE**  
**LOW COHERENCE**  
**and**  
**REDUCED SPECKLE**  
for increased accuracy and reproducibility in laser metrology and nanotechnology

- 51nanoTE-FI-... NEW**
- Integrated power control (<1-100%)
  - Integrated temperature control for stabilization of center wavelength
  - Integrated Faraday Isolator (optical diode)

### Characteristics of laser diode beam source of type 51nano-...

**Noise**

RF modulation results in constant mean laser power with noise < 0.1% RMS (<1MHz)

**Laser Spectrum**

Broadened spectrum (~1.5 nm FWHM) with reduced coherence length (~0.3 mm) as a result of RF modulation. No mode hopping occurs.

**Laser Speckles**

Low speckle contrast from reduced coherence length: uniform illumination of 4-quadrant diodes for AFM with improved edge detection

**Temperature control: 51nanoTE / 51nanoTE-FI**

Diodes show a drift by 2.3-3nm (GaAs) for a temperature range of 20-30°C. This can also be observed for the center wavelength of the laser diode beam sources of type 51nano (in white; T low, in red; T higher). The integrated temperature control for the 51nanoTE and 51nanoTE-FI stabilizes the center wavelength.

### Disadvantages of conventional laser diode sources

**Noise**

Power noise resulting from laser diode which generates an external cavity with the fiber coupling.

**Laser Spectrum**

Mode hopping: temporal shifts between modes. The coherence length changes over time. It can be > 1 m.

**Laser Speckles**

The laser spot produced by a standard laser diode beam has a speckle pattern, increasing the statistical uncertainty in position determinations.

### Laser Diode Beam Sources of Type 51nano

Features	51nanoFCM-...	51nanoFI-...	51nanoTE-...	51nanoTE-FI-...
Reduced coherence	x	x	x	x
Reduced noise	x	x	x	x
Low speckle contrast	x	x	x	x
Faraday Isolator		x		x
Temperature control			x	x
Wavelength range [nm]	405-1550	405-1550	405-1550	405-1550
Vacuum feed-through	x	x	x	x
PC-Interface		x	x	x
Page	60	61	62	63

### Characteristics of Laser Diode Beam Sources 51nano-...

- Coherence length 300  $\mu\text{m}$
- Spectral range 405 to 1550 nm
- Output power adjustable using potentiometer or external voltage control input
- Modulation inputs for analog and TTL control (100 kHz)
- Operation mode: constant power
- Singlemode fiber cable, polarization-maintaining or standard
- FC-APC connector (8°-polish), optional DIN AVIO, ST or E2000
- Beam profile with rotational symmetry and Gaussian intensity distribution
- Noise <0.1% RMS (<1MHz)
- Laser output power up to 30 mW

Laser diode beam sources of type 51nanoFCM-..., 51nanoFI-..., 51nanoTE-... and 51nanoTE-FI-... have reduced power noise, reduced coherence length and low speckle contrast. These characteristics make these laser diode beam sources highly suitable for atomic force microscopy (AFM), particle measurements and for LID measurements (laser-induced deflections).

### Applications: Back-Reflection Particle Measurement

**Optical scheme of particle measurement**

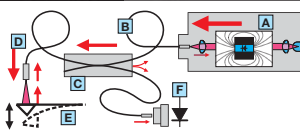
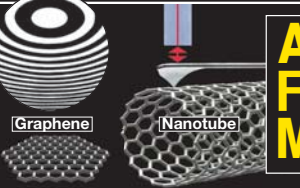
**A** Laser beam source 51nanoFI-...  
**B** Singlemode fiber  
**C** Fiber-optical beam splitter (p. 22)  
**D** Fiber collimator with micro-focus (p.27ff)  
**E** Particle flow  
**F** Detector

The radiation of the laser source 51nanoFI-... is guided via a singlemode fiber and a fiber-optic beam splitter onto the particle flow. Particles passing through the focussed beam cause the light to scatter and some is back-reflected into the emitting fiber. This back-coupled light is redirected into a detector. Precise measurements require low speckle contrast and a constant laser power. By using RF-modulation, the coherence length is reduced, the spectrum broadened and the power averaged, resulting in a detected signal with much less noise.

**Standard Laser Diode:**  
noisy signal

**Signal with 51nanoFI-...:**  
much less noise

### Fabry Perot Interferometry



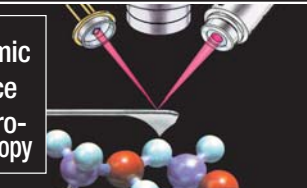
- Scheme of a fiber-optic interferometer**
- A** Laser beam source 51nanoFI-...
  - B** Singlemode fiber
  - C** Fiber-optical beam splitter (p. 22)
  - D** FC-PC fiber connector
  - E** Cantilever
  - F** Detector

**Standard Laser Diode:**  
Interferences disturb the signal

**Signal with 51nanoFI-...:**  
No disturbing interferences

With singlemode fibers, it is possible to create a compact interferometer. The light emanating from the fiber is partially back-reflected at the fiber end-facet (approx. 4%) and is reflected by a moving mirror or cantilever. These two waves interfere, depending on the distance between fiber end-face and mirror. The back-coupled light is guided through a fiber-optic beam splitter, where

### Laser Deflection Measurement



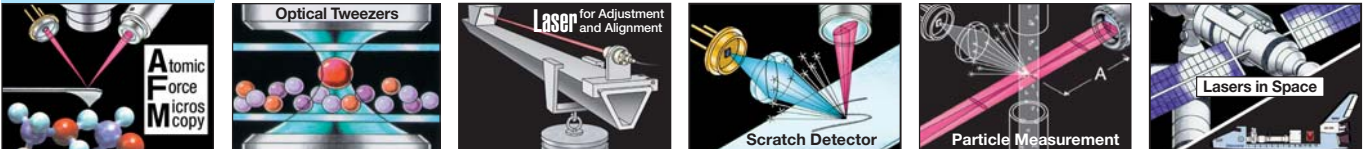
The deflection of the cantilever is measured sensitively using a laser spot reflected from the top surface of the cantilever onto a quadrant diode. The 51nanoFCM-... used as laser source avoids disturbing interferences from back-scattered light of the sample.

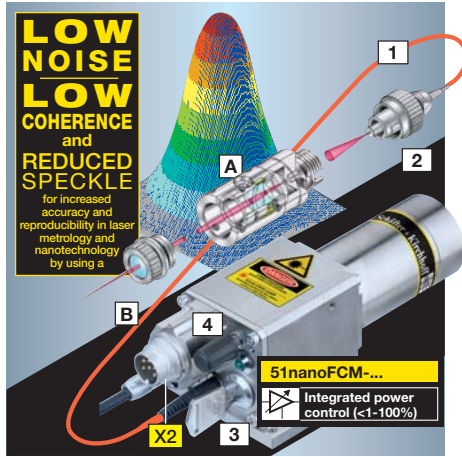
**Standard Laser Diode:**  
Interferences disturb the signal

**Signal with 51nanoFCM-...:**  
No disturbing interferences

one portion is redirected onto a detector for the interference measurement and the other is blocked by the Faraday Isolator. The reduced coherence length of the 51nanoFI-... offers an additional advantage because the disturbing interference is suppressed and only interference between the surfaces of interest contribute to the signal.

### Further Applications





## Laser Diode Beam Source 51nanoFCM-...

with singlemode or polarization-maintaining singlemode fiber cable  
 • low noise • reduced coherence length • low speckle contrast

Laser diode beam sources of type 51nanoFCM-... have reduced power noise, reduced coherence length and low speckle contrast as a result of the internal RF modulation. The laser diode beam source 51nanoFCM-... can be used for atomic force microscopy (AFM) and as a pilot laser during alignment applications.

- Spectral range 405 nm to 1550 nm
- Laser output power up to 30 mW
- Noise <0.1 % RMS (<1 MHz)
- Output power adjustable with potentiometer or external voltage control input
- Modulation inputs for analog and TTL control (up to 100 kHz)
- Operation mode: constant power
- Coherence length 300 µm
- Beam profile is rotationally symmetric with Gaussian intensity distribution
- Singlemode fiber cable or polarization-maintaining singlemode fiber cable (polarization aligned to connector key index)
- FC-APC connector (8°-polish), optional DIN AVIO, ST or E-2000
- Fiber cable with strain relief and protective sleeving (Ø 3 mm)

Laser safety measures conforming to IEC 825 / EN 60825-1:

- Key switch 3 • LED-indicator for laser operation
- Interlock connection X2 • Potentiometer for reduction of power output

Option: laser diode beam source 51nanoFCM-N-...

OEM version without key switch and interlock, on request: does not meet requirements of EN 60825-1.

Laser Diode Beam Source 51nanoFCM-... (Tab. 1)

- 1 Singlemode fiber with 2 FC-APC connector
  - 3 Key switch: ON/OFF - LED ON
  - 4 Potentiometer (for reduction of laser power output)
  - X2 Connector, external modulation and interlock
- Attachments:**
- A Fiber collimator, focussable, 60FC-...
  - B Micro-focus optics 5M-... and 13M-...

### Applications

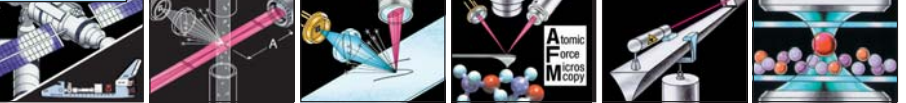


Table 1 Laser Diode Beam Source 51nanoFCM-...

Cur. No.	Type	Version	Wavelength (nm)	P <sub>out</sub> (mW)*	Laser diode code	LD operation mode	Supply power (V)	Electric connection	Fiber type	Fiber connector option	Fiber length (cm)	Case type	MFD ** (µm)	Power adjustment %
1	51nanoL	S	405	5	M29	P	12	..	..	..	..	L	2.9	<1 - 100
2	51nanoL	S	514	5	X09	P	12	..	..	..	..	L	3.6	<1 - 100
3	51nanoFCM	S	637	2.5	H10	P	5/12	..	..	..	..	M	4.5	<1 - 100
4	51nanoFCM	S	640	12	H22	P	5/12	..	..	..	..	M	4.5	<1 - 100
5	51nanoFCM	S	660	6	M01	P	5/12	..	..	..	..	M	4.7	<1 - 100
6	51nanoFCM	S	660	25	B15	P	5/12	..	..	..	..	M	4.7	<1 - 100
7	51nanoFCM	S	685	10	H13	P	5/12	..	..	..	..	M	4.8	<1 - 100
8	51nanoFCM	S	780	10	H06	P	5/12	..	..	..	..	M	5.6	<1 - 100
9	51nanoFCM	S	830	8	H19	P	5/12	..	..	..	..	M	5.9	<1 - 100
10	51nanoFCM	S	1060	10	Q05	P	5/12	..	..	..	..	M	7.5	<1 - 100
11	51nanoFCM	S	1080	20	EY10	P	5/12	..	..	..	..	M	7.6	<1 - 100
12	51nanoFCM	S	1310	2.5	M14	P	5/12	..	..	..	..	M	9.2	<1 - 100
13	51nanoFCM	S	1550	3	M28	P	5/12	..	..	..	..	M	10.9	<1 - 100

**Order Code**

51nanoFCM - S - 660 - 6 - M01 - P - 5 - 2 - 28 - 0 - 150

**Laser Diode Beam Source**

**Safety:**  
 with key switch and interlock ..... S  
 without key switch and interlock (OEM) ..... N

**Laser diode operation mode:**  
 Constant power ..... P

**Supply power:**  
 5 V DC (standard) ..... 5  
 12 V DC (option) ..... 12

**Electrical cable:**  
 1.5 m shielded 3 x 0.14 mm<sup>2</sup> ..... 1  
 as for 1, with connector SV30 (5 V) ..... 2  
 as for 1, with connector SV40 (12 V) ..... 4  
 specified by customer ..... 5

**Connector option:**  
 0 = standard  
 C = core-alignment (singlemode only)

**Fiber type:**  
 18 = singlemode fiber cable, FC-APC connector (8°-polish)  
 28 = PM singlemode fiber cable, FC-APC connector (8°-polish)

**optional:** Fiber connector DIN-Avio, ST, and E-2000. Available with vacuum feed-through or prefitted fiber-optic beam splitter, upon request.

\* Typical laser output power. The actual power output may differ by ±10%.  
 \*\* With fiber NA = 0.11

Dimensions	Laser diode beam source 51nanoFCM-...	Laser diode beam source 51nanoL-...

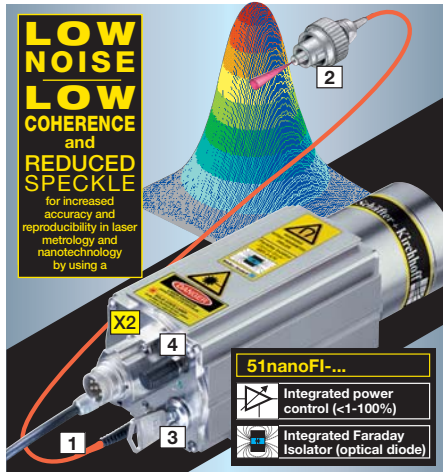
### Beam Parameters and advantages of the Laser Diode Beam Source of type 51nano-...

<p><b>Laser Spectrum</b></p> <p>• reduced coherence</p>	<p><b>Noise</b></p> <p>• low noise</p>	<p><b>Laser Speckles improved</b></p> <p>• low speckle contrast</p>	<p><b>Low Interference</b></p> <p>• low interference</p>
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### Disadvantages of standard laser diode sources with conventional fiber coupling

<p><b>Laser Spectrum</b></p>	<p><b>Noise</b></p>	<p><b>Laser Speckles worsened</b></p>	<p><b>High Interference</b></p>
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51nanoFCM\_ED\_Indk • Page 60



**LOW NOISE**  
**LOW COHERENCE**  
**and**  
**REDUCED SPECKLE**  
for increased accuracy and reproducibility in laser metrology and nanotechnology by using a

- 51nanoFI...**
- Integrated power control (<1-100%)
- Integrated Faraday Isolator (optical diode)

- Laser Diode Beam Source 51nanoFI...** (Tab. 2)
- 1** Singlemode patch fiber with **2** FC connector
  - 3** Key switch: ON/OFF - LED ON
  - 4** Potentiometer (for reduction of laser power output)
  - X2** Connector, external modulation and interlock

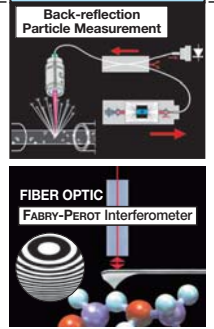
## Laser Diode Beam Source 51nanoFI...

with singlemode or PM fiber cable and Faraday Isolator.  
Stable mode of operation for sensing applications with back-reflection

In addition to the laser diode beam source **51nanoFCM...** features of reduced power noise, reduced coherence length and low speckle contrast, the **51nanoFI...** has an integrated Faraday Isolator to protect the laser source from back-reflection (optical diode). Radiation that couples back into a laser diode results in mode hopping, noise, frequency instability and decreased lifetime.

- Spectral range 405 nm to 1550 nm
- Laser output power up to 27 mW
- Noise <0.1 % RMS (<1 MHz)
- Integrated Faraday Isolator for feedback protection
- Output power adjustable with potentiometer or external voltage control input
- Modulation inputs for analog and TTL control (up to 100 kHz)
- Operation mode: constant power
- Coherence length 300  $\mu$ m
- Beam profile is rotationally symmetric with a Gaussian intensity distribution
- Singlemode fiber cable or polarization-maintaining singlemode fiber cable (polarization aligned with connector index pin)
- FC-APC connector (8°-polish), optional DIN AVIO, ST or E-2000
- Fiber cable with strain relief and protective sleeving ( $\varnothing$  3 mm)

### Applications



### Laser safety according IEC 825 / EN 60825-1 by:

- Key switch **3**
- Interlock connection **X2**
- LED-indicator for laser operation
- Potentiometer for reduction of power output

### Option: laser diode beam source 51nanoFI-N...

OEM version without key switch and interlock, on request: does not meet requirements of EN 60825-1.

**Table 2 Laser Diode Beam Source 51nanoFI...**

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	
Cur. No.	Type	Version	Wavelength (nm)	P <sub>out</sub> (mW)*	Laser diode code	LD operation mode	Supply power (V)	Electr. connection	Fiber type	Fiber connector option	Fiber length (cm)	Case type	MFD ** (μm)	Power adjustment %
1	51nanoFI	S	405	18	M29	P	12	..	..	..	..	A	2.9	<1 - 100
2	51nanoFI	S	514	4.5	X09	P	12	..	..	..	..	B	3.6	<1 - 100
3	51nanoFI	S	637	2.3	H10	P	5/12	..	..	..	..	B	4.5	<1 - 100
4	51nanoFI	S	640	10.8	H22	P	5/12	..	..	..	..	B	4.5	<1 - 100
5	51nanoFI	S	660	5.4	M01	P	5/12	..	..	..	..	B	4.7	<1 - 100
6	51nanoFI	S	660	22.5	B15	P	5/12	..	..	..	..	B	4.7	<1 - 100
7	51nanoFI	S	685	8	H13	P	5/12	..	..	..	..	B	4.8	<1 - 100
8	51nanoFI	S	780	8	H06	P	5/12	..	..	..	..	C	5.6	<1 - 100
9	51nanoFI	S	830	7.2	H19	P	5/12	..	..	..	..	D	5.9	<1 - 100
10	51nanoFI	S	1060	10	Q05	P	5/12	..	..	..	..	D	7.5	<1 - 100
11	51nanoFI	S	1080	20	EY10	P	5/12	..	..	..	..	D	7.6	<1 - 100
12	51nanoFI	S	1310	2	M14	P	5/12	..	..	..	..	D	9.2	<1 - 100
13	51nanoFI	S	1550	3	M28	P	5/12	..	..	..	..	D	10.9	<1 - 100

**51nanoFI** - S - 660 - 6 - M01 - P - 5 - 2 - 28 - 0 - 150 **Order Code**

**Laser Diode Beam Source**

**Safety:**  
with key switch and interlock ..... S  
without key switch and interlock (OEM) ..... N

**Laser diode operation mode:**  
Constant power ..... P

**Supply power:**  
5 V DC (standard) ..... 5  
12 V DC (option) ..... 12

**Electrical cable:**  
1.5 m shielded 3 x 0.14 mm<sup>2</sup> ..... 1  
as for 1, with connector SV30 (5 V) ..... 2  
as for 1, with connector SV40 (12 V) ..... 4  
specified by customer ..... 5

\* Typical laser output power. The actual power output may differ by  $\pm 10\%$ .  
\*\* With fiber NA = 0.11

**Length of fiber cable** in cm (standard = 150)

**Connector option:**  
0 = standard  
C = core-alignment (singlemode only)

**Fiber type:**  
18 = singlemode fiber cable, FC-APC connector (8°-polish)  
28 = PM singlemode fiber cable, FC-APC connector (8°-polish)

**optional:** Fiber connector DIN-Avio, ST, and E-2000. Available with vacuum feed-through or prefitted fiber-optic beam splitter, upon request.

**Dimensions Laser diode beam source 51nanoFI...**

Case Type	L1	L2
A	141	195
B	111	165
C	126	180
D	118	172

**Faraday Isolator 48FI**

The Faraday isolator (see also page 49) is used to protect laser sources from back-reflection (an optical diode). Radiation reflected back into a laser diode leads to mode hopping, noise, frequency instability and decrease of lifetime.

**Spectrum of an undisturbed laser beam source 51nano** (FWHM 22%)

**Back-reflections disturb spectrum (mode hopping)**

## Electronics and Accessories for Laser Beam Sources Type 51nanoFCM... and 51nanoFI...

**Power Supplies**

Power supply for laser diode beam sources, electrically isolated, 1.5 m cable with connector (IEC60130-9) Lumberg series KV (female).

	Linear power supply	Switching power supply
Input	115/230 V AC	100 - 240 V AC
Output with connector	5V DC/0.4A BC0103F 12V DC/0.4A BC0104F 5V DC/2.6A BC0103F 12V DC/1.25A BC0104F	PS051003E PS120516E
Order Code	PSL05B PSL12B	PS051003E PS120516E

Linear power supply, low noise, connector female 5-pin Lumberg KV50

Switching power supply, connector (female 5-pin) KV50 for 5 V (pins compatible with KV30) or 4-pin KV40 for 12 V DC version

**Power cord for Power Supplies**  
1.5 m, IEC320 3-pin line socket  
10 A, 250 V AC with IEC-connector (IEC-60320)

	Europe	USA/Canada	Great Britain
PC150DE	PC150US	PC150UK	
DE	US	UK	

**Electrical Data**

Supply voltage	standard	5V DC ( $\pm$ 0.2V)
	optional	12V DC ( $\pm$ 0.2V)
Laser diode operation mode		constant power
Max. operating current		260 mA
Ambient temperature range		15 - 35 °C
Modulation frequency	analog	DC - 100 kHz
	TTL	0 - 100 kHz
Laser power output potentiometer		< 1-100% *
TTL modulation logic		TTL high
Analog control voltage		0 - 2.5V

\* depending on laser diode: see Table 1-2, col. 13

**Laser Source with Multiple Fiber Outputs**

**Fiber collimators 60FC-F-4-M40-10**

51nanoFCM... with fiber-optic beam splitters to convert a laser input into 2 to 6 fiber-coupled outputs, integrated in a compact housing. Fiber outputs: 60FC-F-4-M40-10 fiber collimator with angular adjustment.

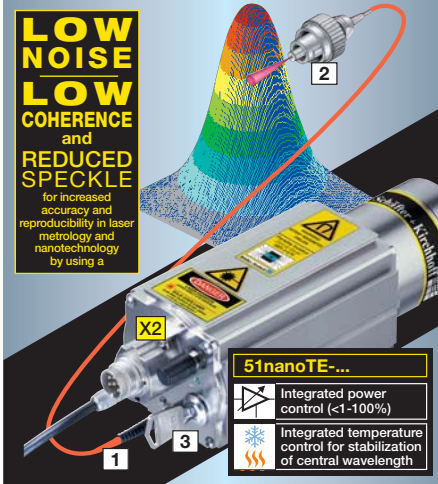
**Order Code 51nanoC4...**

**Connectors**

Lumberg connector (female) according IEC 60130-9

**Order Code BC 01 06 F**

Type KV 60 (6-pin) for connection to interlock chain and for external modulation



## Laser Diode Beam Source 51nanoTE-...

with singlemode or PM fiber cable with Temperature control.  
Stable mode of operation for wavelength/temperature sensitive applications and longer diode life times

In addition to the laser diode beam source 51nanoFCM-... features of reduced power noise, reduced coherence length and low speckle contrast, the 51nanoTE-... has an integrated temperature control that stabilizes the center wavelength. This makes this laser beam source ideally suited for wavelength sensitive applications. The 51nanoTE-FI-... additionally has an integrated Faraday Isolator to protect the laser source from back-reflection.

- Spectral range 405 nm to 1550 nm
- Laser output power up to 30 mW
- Noise <0.1 % RMS (<1 MHz)
- Integrated temperature control ( $\pm 0.01^\circ\text{C}$ ) for wavelength/temperature sensitive applications and longer diode life times
- Output power adjustable with external voltage control input
- Serial PC-Interface (RS232) for external temperature and power control
- Modulation inputs for analog and TTL control (up to 100 kHz)
- Operation mode: constant power
- Coherence length 300  $\mu\text{m}$
- Beam profile is rotationally symmetric with a Gaussian intensity distribution
- Singlemode fiber cable or polarization-maintaining singlemode fiber cable (polarization aligned with connector index pin)
- FC-APC connector (8°-polish), optional DIN AVIO, ST or E-2000
- Fiber cable with strain relief and protective sleeving ( $\varnothing$  3 mm)

### Laser safety according IEC 825 / EN 60825-1 by:

- Key switch [3]
- Interlock connection [X2]
- LED-indicator for laser operation

### Option: laser diode beam source 51nanoTE-N-...

OEM version without key switch and interlock, on request: does not meet requirements of EN 60825-1.

### Laser Diode Beam Source 51nanoTE-... (Tab. 3)

- [1] Singlemode patch fiber with [2] FC connector
- [3] Key switch: ON/OFF - LED ON
- [X2] Connector, external modulation and interlock

Table 3 Laser Diode Beam Source 51nanoTE-...

Cur. No.	Row	1	2	3	4	5	6	7	8	9	10	11	12	13
Type	Version	Wavelength (nm)	$P_{out}$ (mW)	Laser diode code	LD operation mode	Supply power (V)	Electr. connection	Fiber type	Fiber connector option	Fiber length (cm)	Case type	MFD ** ( $\mu\text{m}$ )	Power adjustment %	
1	51nanoTE	S	405	5	M29	P	12	..	..	..	E	2.9	<1 - 100	
2	51nanoTE	S	514	5	X09	P	12	..	..	..	E	3.6	<1 - 100	
3	51nanoTE	S	637	2.5	H10	P	12	..	..	..	E	4.5	<1 - 100	
4	51nanoTE	S	640	12	H22	P	12	..	..	..	E	4.5	<1 - 100	
5	51nanoTE	S	660	6	M01	P	12	..	..	..	E	4.7	<1 - 100	
6	51nanoTE	S	660	25	B15	P	12	..	..	..	E	4.7	<1 - 100	
7	51nanoTE	S	685	10	H13	P	12	..	..	..	E	4.8	<1 - 100	
8	51nanoTE	S	780	10	H06	P	12	..	..	..	E	5.6	<1 - 100	
9	51nanoTE	S	830	8	H19	P	12	..	..	..	E	5.9	<1 - 100	
10	51nanoTE	S	1060	10	Q05	P	12	..	..	..	E	7.5	<1 - 100	
11	51nanoTE	S	1080	20	EY10	P	12	..	..	..	E	7.6	<1 - 100	
12	51nanoTE	S	1310	2.5	M14	P	12	..	..	..	E	9.2	<1 - 100	
13	51nanoTE	S	1550	3	M28	P	12	..	..	..	E	10.9	<1 - 100	

51nanoTE - S - 660 - 6 - M01 - P - 12 - 4 - 28 - 0 - 150 **Order Code**

**Laser Diode Beam Source Safety:**  
with key switch and interlock ..... S  
without key switch and interlock (OEM) ..... N

**Laser diode operation mode:**  
Constant power ..... P

**Supply power:**  
12 V DC (option) ..... 12

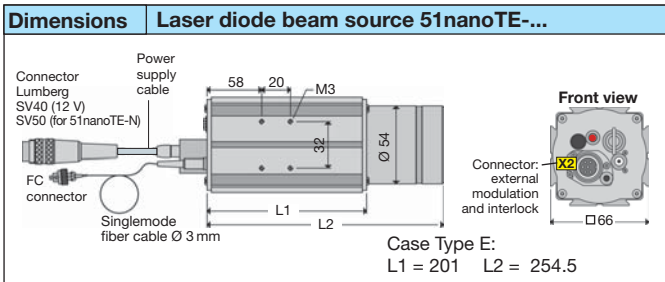
**Electrical cable:**  
1.5 m shielded 3 x 0.14 mm<sup>2</sup> ..... 1  
as for 1, with connector SV40 (12 V) ..... 4  
specified by customer ..... 5

**Connector option:**  
0 = standard  
C = core-alignment (singlemode only)

**Fiber type:**  
18 = singlemode fiber cable, FC-APC connector (8°-polish)  
28 = PM singlemode fiber cable, FC-APC connector (8°-polish)

**optional:** Fiber connector DIN-Avio, ST, and E-2000. Available with vacuum feed-through or prefitted fiber-optic beam splitter, upon request.

\* Typical laser output power. The actual power output may differ by  $\pm 10\%$ .  
\*\* With fiber NA = 0.11



### Integrated Temperature Control

Common Singlemode diodes show a drift by 2.3-3 nm (GaAs) for a temperature range of 20-30°C. This temperature dependence of the center wavelength can also be observed for the laser diode beam sources of type 51nano (in blue: T low, in red: T higher). Although the RF-modulation leads to a broader spectrum with a FWHM of 1.5 nm the central wavelength still varies with temperature. An integrated temperature control stabilizes the center wavelength, making the 51nanoTE-... and 51nanoTE-FI-... ideal for wavelength or temperature sensitive applications. Another positive effect is that the life time of the laser diode increases.

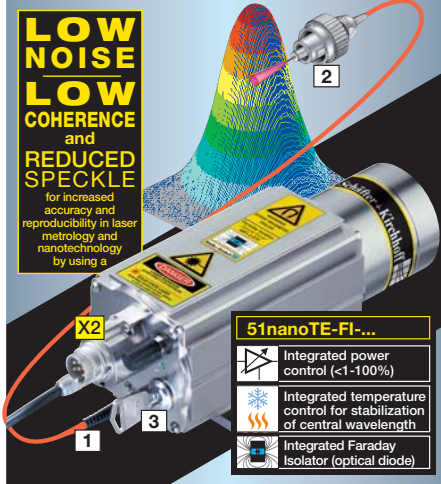
Drift  $\approx$  2 nm for  $\Delta T = 10$  K  
FWHM  $\approx$  1.5 nm

### Beam Parameters and advantages of the Laser Diode Beam Source of type 51nano...

<h4>Laser Spectrum</h4> <p>Broadened spectrum (~1.5 nm FWHM) with reduced coherence length (~0.3 mm) as a result of using RF modulation.</p>	<h4>Noise</h4> <p>The RF modulation results in a constant mean laser power. Power noise &lt; 0.1% RMS (&lt;1MHz).</p>	<h4>Laser Speckles improved</h4> <p>Low speckle contrast due to reduced coherence length: uniform illumination of 4-quadrant diodes for AFM and improved edge detection during position determinations.</p>	<h4>Low Interference</h4> <p>Gaussian intensity distribution of the collimated laser beam at a CCD sensor. No interference patterns, despite the CCD sensor protection window.</p>
• reduced coherence	• low noise	• low speckle contrast	• low interference

### Disadvantages of standard laser diode sources with conventional fiber coupling

<h4>Laser Spectrum</h4> <p>Mode hopping: temporal shifts between modes. The short-term coherence of individual modes is &gt; 1 m, but effective coherence length is reduced.</p>	<h4>Noise</h4> <p>Power noise from a laser source coupled to a fiber. The fiber generates an external cavity with the laser diode, resulting in stochastic power jumps.</p>	<h4>Laser Speckles worsened</h4> <p>The laser spot produced by a standard laser diode beam produces a speckle pattern, increasing the statistical uncertainty in position determinations.</p>	<h4>High Interference</h4> <p>The collimated laser beam recorded directly using a CCD sensor, with its protection window generating a disturbing pattern of interference.</p>
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## Laser Diode Beam Source 51nanoTE-FI-...

with singlemode or PM fiber cable with Faraday Isolator and Temperature control.  
Stable mode of operation for wavelength/temperature sensitive applications and longer diode life times

In addition to the laser diode beam source 51nanoFCM-... features of reduced power noise, reduced coherence length and low speckle contrast, the 51nanoTE-... has an integrated temperature control that stabilizes the central wavelength. This makes this laser beam source ideally suited for wavelength sensitive applications. The 51nanoTE-FI-... additionally has an integrated Faraday Isolator to protect the laser source from back-reflection.

- Spectral range 405 nm to 1550 nm
- Laser output power up to 27 mW
- Noise <0.1 % RMS (<1 MHz)
- Integrated temperature control ( $\pm 0.01^\circ\text{C}$ ) for wavelength/temperature sensitive applications and longer diode life times
- Integrated Faraday Isolator
- Output power adjustable with external voltage control input
- **Serial PC-Interface (RS232)** for external temperature and power control
- Operation mode: constant power
- Modulation inputs for analog and TTL control (up to 100 kHz)
- Coherence length 300  $\mu\text{m}$
- Beam profile is rotationally symmetric with a Gaussian intensity distribution
- Singlemode fiber cable or polarization-maintaining singlemode fiber cable (polarization aligned with connector index pin)
- FC-APC connector (8°-polish), optional DIN AVIO, ST or E-2000
- Fiber cable with strain relief and protective sleeving ( $\varnothing 3 \text{ mm}$ )

- Laser Diode Beam Source 51nanoTE-FI-...** (Tab. 4)
- 1 Singlemode patch fiber with 2 FC connector
  - 3 Key switch: ON/OFF - LED ON
  - X2 Connector, external modulation and interlock

**Laser safety according IEC 825 / EN 60825-1 by:**

- Key switch 3
- Interlock connection X2
- LED-indicator for laser operation

**Option: laser diode beam source 51nanoTE-FI-N-...**  
OEM version without key switch and interlock, on request: does not meet requirements of EN 60825-1.

**Table 4 Laser Diode Beam Source 51nanoTE-FI-...**

Cur. No.	Row	1	2	3	4	5	6	7	8	9	10	11	12	13
Type	Version	Wavelength (nm)	$P_{out}$ (mW)	Laser diode code	LD operation mode	Supply power (V)	Electr. connection	Fiber type	Fiber connector option	Fiber length (cm)	Case type	MFD ** ( $\mu\text{m}$ )	Power adjustment %	
1	51nanoTE-FI	S	405	18	M29	P	12	..	..	..	F	2.9	<1 - 100	
2	51nanoTE-FI	S	514	4.5	X09	P	12	..	..	..	F	3.6	<1 - 100	
3	51nanoTE-FI	S	637	2.3	H10	P	12	..	..	..	F	4.5	<1 - 100	
4	51nanoTE-FI	S	640	10.8	H22	P	12	..	..	..	F	4.5	<1 - 100	
5	51nanoTE-FI	S	660	5.4	M01	P	12	..	..	..	F	4.7	<1 - 100	
6	51nanoTE-FI	S	660	22.5	B15	P	12	..	..	..	F	4.7	<1 - 100	
7	51nanoTE-FI	S	685	8	H13	P	12	..	..	..	F	4.8	<1 - 100	
8	51nanoTE-FI	S	780	8	H06	P	12	..	..	..	F	5.6	<1 - 100	
9	51nanoTE-FI	S	830	7.2	H19	P	12	..	..	..	F	5.9	<1 - 100	
10	51nanoTE-FI	S	1060	10	Q05	P	12	..	..	..	F	7.5	<1 - 100	
11	51nanoTE-FI	S	1080	20	EY10	P	12	..	..	..	F	7.6	<1 - 100	
12	51nanoTE-FI	S	1310	2	M14	P	12	..	..	..	F	9.2	<1 - 100	
13	51nanoTE-FI	S	1550	3	M28	P	12	..	..	..	F	10.9	<1 - 100	

**51nanoTE-FI - S - 660 - 6 - M01 - P - 12 - 4 - 28 - 0 - 150** **Order Code**

**Laser Diode Beam Source**  
Safety: with key switch and interlock ..... S  
without key switch and interlock (OEM) ..... N  
Laser diode operation mode: Constant power ..... P  
Supply power: 12 V DC (option) ..... 12  
Electrical cable: 1.5 m shielded 3 x 0.14 mm<sup>2</sup> ..... 1  
as for 1, with connector SV40 (12 V) ..... 4  
specified by customer ..... 5

**Connector option:**  
0 = standard  
C = core-alignment (singlemode only)

**Fiber type:**  
18 = singlemode fiber cable, FC-APC connector (8°-polish)  
28 = PM singlemode fiber cable, FC-APC connector (8°-polish)

**option:** Fiber connector DIN-Avio, ST, and E-2000. Available with vacuum feed-through or prefitted fiber-optic beam splitter, upon request.

\* Typical laser output power. The actual power output may differ by  $\pm 10\%$ .  
\*\* With fiber NA = 0.11

**Dimensions Laser diode beam source 51nanoTE-FI-...**

Connector Lumberg SV40 (12 V) SV50 (for 51nanoTE-FI-N)  
FC connector  
Power supply cable  
Singlemode fiber cable  $\varnothing 3 \text{ mm}$   
M3  
32  
 $\varnothing 54$   
L1 L2  
Front view  
Connector: external modulation and interlock X2  
Case Type F: L1 = 201 L2 = 254.5

**Faraday Isolator 48FI for 51nanoTE-FI-...**

The Faraday isolator (see also page 49) is used to protect laser sources from back-reflection (an optical diode). Radiation reflected back into a laser diode leads to mode hopping, noise, frequency instability and decrease of lifetime.

Spectrum of an undisturbed laser beam source 51nano  
Back-reflections disturb spectrum (mode hopping)

**Electronics and Accessories for Laser Beam Sources Type 51nanoTE-... and 51nanoTE-FI-...**

**Power Supplies**

Power supply for laser diode beam sources, electrically isolated, 1.5 m cable with connector (IEC60130-9) Lumberg series KV (female).

Input	Switching power supply
100 - 240 V AC	
Output with connector	12 V DC / 1.25 A BC0104F
Europe	PS120516E

Switching power supply, connector (female 4-pin) KV40 for 12 V

**Power cord for Power Supplies**  
1.5 m, IEC320 3-pin line socket, 10 A, 250 V AC with IEC-connector (IEC-60320)

Europe	USA/Canada	Great Britain
PC150DE	PC150US	PC150 UK

**Electrical Data**

Supply voltage	12 V DC ( $\pm 0.2\text{V}$ )
Laser diode operation mode	constant power
Max. operating current	500 mA
Ambient temperature range	15 - 35 °C $\pm 0.5^\circ$
Modulation frequency	analog DC - 100 kHz TTL 0 - 100 kHz
Laser power output potentiometer	< 1-100% *
TTL modulation logic	TTL high
Analog control voltage	0 - 2.5V

\* depending on laser diode: see Table 3-4, col. 13

**Fiber Collimators 60FC-... Micro-focus optic 5M-...**

**Vacuum Feed-throughs V-KF-...**

**Fiber-optic Beam Splitters FBS-...**

As an option, the 51nano can be supplied directly coupled with vacuum feed-through V-... or fiber-optic beam splitter. Information and order codes on pages 22ff. For fiber collimators 60FC-..., see from page 30 or visit [www.SuKHamburg.com](http://www.SuKHamburg.com)

**Connectors**

Lumberg connector (female) according IEC 60130-9  
**Order Code BC 01 08 F**  
Type KV 80 (8-pin) for connection to interlock chain and for external modulation

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