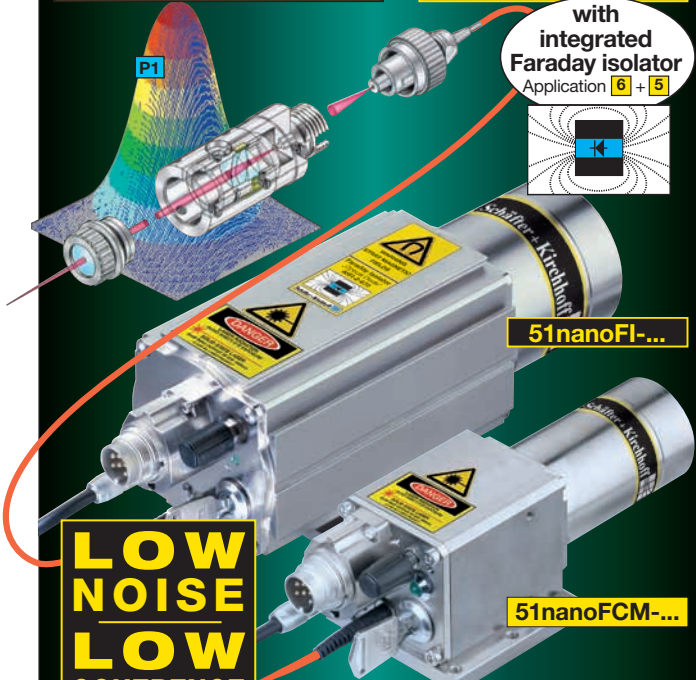


Laser Diode Beam Sources

with singlemode and polarization-maintaining fiber cable

51nanoFCM-... / 51nanoFI-...



with integrated Faraday isolator
Application **6** + **5**

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

- Spectral range 370 nm to 1083 nm
- Coherence length 300 μm
- Noise < 0.1% RMS (<1MHz)
- Laser output power up to 40 mW
- Beam profile rotational symmetry with Gaussian intensity distribution **P1**
- FC-APC connector (8°-polish), optional DIN AVIO or E200

Advantages of laser beam sources 51nanoFCM-... / 51nanoFI-...

<p>Noise</p> <p>RF modulation results in constant mean laser power with noise < 0.1% RMS (<1MHz)</p>	<p>Laser Spectrum</p> <p>Broadened spectrum (~1.5 nm FWHM) with reduced coherence length (~0.3 mm) as a result of RF modulation. No mode hopping occurs.</p>	<p>Laser Speckles</p> <p>Low speckle contrast from reduced coherence length: uniform illumination of 4-quadrant diodes for AFM with improved edge detection</p>
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Disadvantages of conventional laser diode sources

<p>Noise</p> <p>Power noise resulting from laser diode which generates an external cavity with the fiber coupling.</p>	<p>Laser Spectrum</p> <p>Mode hopping: temporal shifts between modes. The coherence length changes over time. It can be > 1 m.</p>	<p>Laser Speckles</p> <p>The laser spot produced by a standard laser diode beam has a speckle pattern, increasing the statistical uncertainty in position determinations</p>
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Accessories

<p>Fiber Collimators 60FC-... Micro focus optic 5M-...</p>	<p>Vacuum Feed-throughs V-KF-...</p>	<p>Fiber-optic Beam Splitters FBS-...</p>
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Applications

<p>1 Atomic Force Microscopy</p>	<p>2 Optical Tweezers</p>	<p>3 Laser for Adjustment and Alignment</p>
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Laser diode beam sources of type **51nanoFCM-...** and **51nanoFI-...** 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).

- Coherence length 300 μm
- Noise <0.1% RMS (<1MHz)
- Spectral range 405 to 1080 nm
- Laser output power up to 30 mW
- 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 E200
- Beam profile with rotational symmetry and Gaussian intensity distribution **P1**

51nanoFCM-... Highly sensitive applications for laser diode sources with low coherence length

AFM (Atomic Force Microscopy) **1** 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.

<p>Oscillogram</p>	<p>Signal with 51nanoFCM-...</p>
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Standard Laser Diode

Back-Reflection Particle Measurement **5**

A Laser beam source **51nanoFI-...**
B Singlemode fiber
C Fiber-optic beam splitter (p. 13)
D Fiber collimator with micro focus (p. 15)
E Particle flow
F Detector

Particle signals

<p>H</p>	<p>G</p>
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Standard Laser Diode

The radiation of the laser source is guided via a single-mode 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 **H**.

51nanoFI-... With a Faraday Isolator to protect the laser diode against disturbing back-reflections (an optical diode)

Application: AFM (Atomic Force Microscopy) **6** Interferometric measurement of cantilever position

A Laser beam source **51nanoFI-...**
B Singlemode fiber
C Fiber-optic beam splitter (p. 13)
D FC-PC fiber
E Cantilever
F Interferometer signal at Detector

Oscillogram

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Standard Laser Diode

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 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.

<p>4 Scratch Detector</p>	<p>5 Back-reflection Particle Measurement</p>	<p>6 FIBER OPTIC FABRY-PEROT Interferometer</p>
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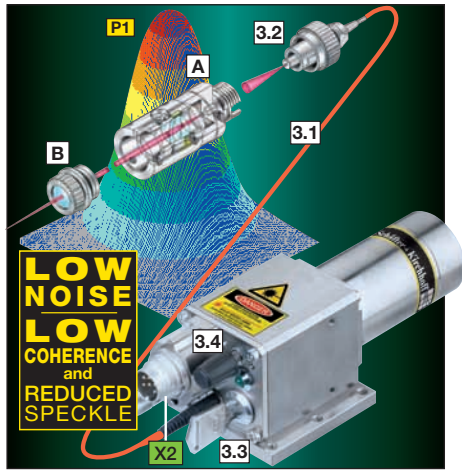


Fig. 1: Laser Diode Beam Source 51nanoFCM-... (Tab. 1)

- 3.1 Singlemode fiber with 3.2 FC-APC connector
- 3.3 Key switch: ON/OFF - LED ON
- 3.4 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-...

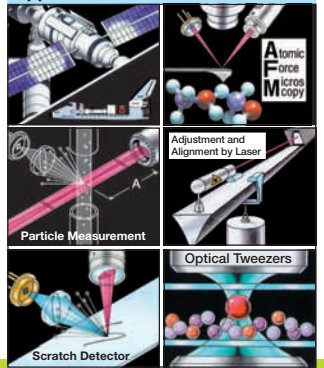
Laser Diode Beam Source 51nanoFCM-...

with singlemode and 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-... is typically 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 P1
- 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)

Applications



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

- Key switch 3.3 • 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 Speckles

Laser speckles are interference arising from, e.g., the diffuse reflection of coherent radiation at rough surfaces. The degree of coherence (coherence length) determines the speckle contrast.

Figure 2: Beam Parameters and advantages of the Laser Diode Beam Source 51nano...

<p>Laser Spectrum</p> <p>Broadened spectrum (~1.5 nm FWHM) with reduced coherence length (~0.3 mm) as a result of using RF modulation.</p>	<p>Noise</p> <p>The RF modulation results in a constant mean laser power. Power noise < 0.1% RMS (<1MHz).</p>	<p>Laser Speckles improved</p> <p>Low speckle contrast due to reduced coherence length: uniform illumination of 4-quadrant diodes for AFM and improved edge detection during position measurements.</p>	<p>Low Interference</p> <p>Gaussian intensity distribution of the collimated laser beam at a CCD sensor. No interference patterns, despite the CCD sensor protection window.</p>
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Figure 3: Disadvantages of standard laser diode sources with conventional fiber coupling

<p>Laser Spectrum</p> <p>Mode hopping: temporal shifts between modes. The short-term coherence of individual modes is > 1 m, but effective coherence length is reduced.</p>	<p>Noise</p> <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>	<p>Laser Speckles worsened</p> <p>The laser spot produced by a standard laser diode beam produces a speckle pattern, increasing the statistical uncertainty in position determinations.</p>	<p>High Interference</p> <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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Electrical Data

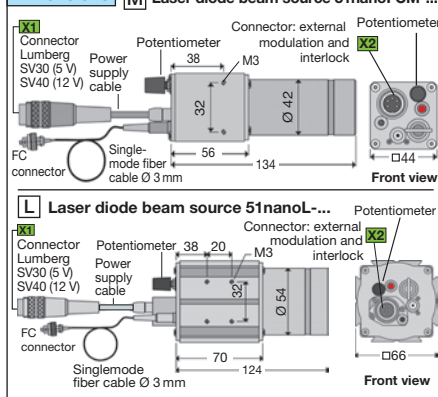
Supply voltage	standard	5V DC (± 0.2V)
	optional	12V DC (± 0.2V)
Laser diode operation mode	constant power	
Max. operating current	260 mA	
Ambient temperature range	15 - 35 °C	
Modulation frequency	analog	DC - 100 kHz
	TTL	0 - 100 kHz
Laser power output potentiometer	< 20-100% *	
TTL modulation logic	TTL high	
Analog control voltage	0 - 2.5V	

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

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

Cur. No.	Row	1	2	3	4	5	6	7	8	9	10	11	12	13
Type	Version	Wave-length (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 1/e ² (µm)**	Power adjustment %	
1	51nanoL	S	405	20	M29	P	12	..	..	..	L	2.9	<1 - 100
2	51nanoL	S	514	5	X09	P	12	..	..	..	L	4.4	<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	30	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	1080	20	EY10	P	5/12	..	..	..	M	7.6	<1 - 100
11	51nanoFCM	S	1310	1	M06	P	5/12	..	..	..	M	9.2	<1 - 100
12	51nanoFCM	S	1550	1	M15	P	5/12	..	..	..	M	10.9	<1 - 100
13	51nanoFCM													

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



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 mm² 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
 28 = PM singlemode fiber cable, FC-APC
 optional: Connector DIN-Avio, ST, E-2000.

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

Power Supplies for 51nanoFCM-...

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	5 V DC/0.4 A BC0103F	5 V DC/1 A BC0103F
		12 V DC/0.5 A BC0104F
Europe	PSL05B	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

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-4-M40-10 fiber collimator with angular adjustment.

Order Code 51nanoC4-...

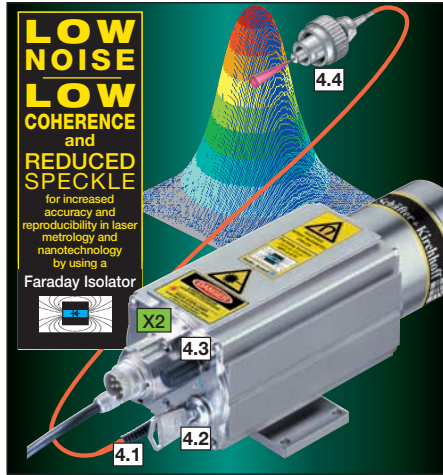


Fig. 4: Laser Diode Beam Source 51nanoFI... (Tab. 2)
4.1 Singlemode patch fiber with **4.4** FC connector
4.2 Key switch: ON/OFF - LED ON
4.3 Potentiometer (for reduction of laser power output)
X2 Connector, external modulation and interlock

Laser Diode Beam Source 51nanoFI...

with singlemode and 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 laser sources 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
- 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
- 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 (Ø 3 mm)
- Noise <0.1 % RMS (<1 MHz)
- Coherence length 300 µm

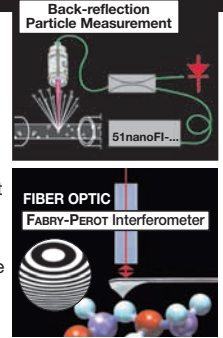
Laser safety according IEC 825 / EN 60825-1 by:

- Key switch **4.2**
- Interlock connection **X2**
- LED-indicator for laser operation
- Potentiometer for reduction of power output

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

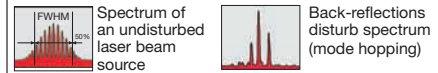
OEM version without key switch and interlock, on request: does not meet requirements of EN 60825-1.

Applications



Faraday Isolator 48FI

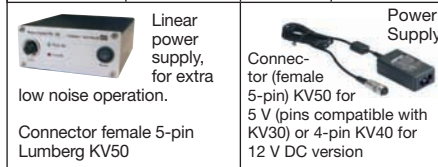
The Faraday isolator is used to protect laser sources from back-reflection (an optical diode). Radiation reflected back into a laser diode leads to mode hopping, noise, frequency instability and decrease of lifetime.



Power Supplies for 51nano...

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	5 V DC/0.4 A BC0103F	5 V DC/1 A BC0103F
		12 V DC /0.5 A BC0104F
Europe	PSL05B	PS051003E
		PS120516E



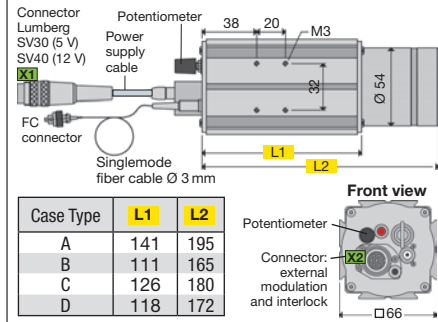
Power cord for Power Supplies
 1.5 m, IEC320 3-pin line socket, 10 A, 250 V AC with IEC-connector (IEC-60320)

Country	Europe	USA/Canada	Great Britain
Order Code	PC150DE	PC150US	PC150 UK

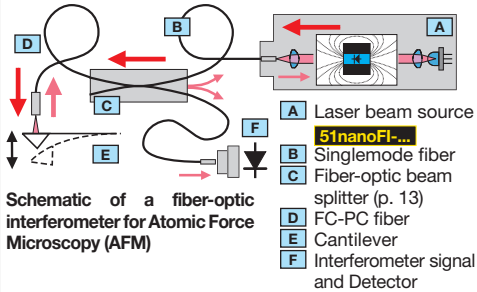
Connectors

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

Dimensions Laser diode beam source 51nanoFI...



Application: AFM (Atomic Force Microscopy) Interferometric measurement of cantilever position



With singlemode fibers, it is possible to create a compact interferometer. The light leaving the fiber is back-reflected at the fiber end-face (approx. 4%) and at a moving mirror or cantilever. The back-coupled light is guided through a fiber-optic beam splitter, where one portion is redirected onto a detector for the interference measurement and the other is blocked by the Faraday Isolator.

Fiber-optic Fabry-Perot Interferometer Signals

The signals from fiber-optic Fabry-Perot interferometers benefit from the power and wavelength stability of the 51nanoFI. The reduced coherence length is an additional advantage, as disturbing interference is suppressed and only interference between the surfaces of interest contribute to the interferometer signal.

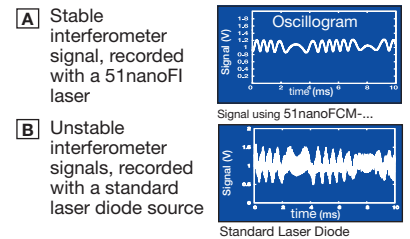


Table 2 Laser Diode Beam Source 51nanoFI...

Cur. No.	Type	Version	1	2	3	4	5	6	7	8	9	10	11	12	13
			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** (µm)	Power adjust-ment %	
1	51nanoFI	S	405	18	M29	P	12	..	..	..	..	A	2.9	<1 - 100	
2	51nanoFI	S	514	4.5	X09	P	12	..	..	..	..	B	4.4	<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	27	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	12	..	..	..	..	D	5.9	<1 - 100	
10	51nanoFI	S	1080	18	EY10	P	12	..	..	..	..	D	7.6	<1 - 100	
11	51nanoFI	S	1310	0.9	M06	P	12	..	..	..	..	D	9.2	<1 - 100	
12	51nanoFI	S	1550	0.9	M15	P	12	..	..	..	..	D	10.9	<1 - 100	

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

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 mm² 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.

Special Fiber Options / Accessories

As an option, the **51nanoFI.....** can be supplied directly coupled with vacuum feed-through **V...** or fiber-optic beam splitter. Information and order codes on page 13. For fiber collimators **60FC....**, see from page 15 or visit www.SuKHamburg.com