

# Multimode (MM) High Energy Q-switched Nd:YAG Lasers



Typical external view of NanoFlux N5k10 system (actual design might vary)

High energy NanoFlux MM series lasers are designed to produce high energy nanosecond pulses at 1064 nm. High pulse energy, excellent pulse-to-pulse energy stability, superior beam quality makes these systems well suited for applications like OPO or Ti: Sapphire pumping, material processing and plasma diagnostics and others.

NanoFlux MM series Q-switched oscillators are designed as extremely reliable and stable nanosecond seeding sources producing hundreds mJ pulses from a compact sized body. Simple access to critical compartments of the oscillator allows for easy maintenance. The higher M<sup>2</sup> version uses a pro-longed oscillator design that allows a much higher number of modes to oscillate which results in M<sup>2</sup> value up to 90. In this case the beam profile becomes very homogenous and flat which can be useful in a number of applications.

NanoFlux series linear amplifiers are cost effective solution for high energy nanosecond systems. Advanced beam shaping ensures smooth, without hot spots beam spatial profile at the laser output. Low light depolarization level allows high efficiency generation of up to 4th harmonic with optional

build-in harmonic generators. The simple and field proven design ensures easy maintenance and reliable long-term operation of the NanoFlux MM series laser.

Angle-tuned non-linear crystals harmonic generators mounted in temperature stabilized heaters are used for second, third and fourth harmonic generation. Harmonic separation system is designed to ensure high spectral purity of radiation and direct it to the output ports. Harmonic generators can be integrated into laser head or placed outside laser head into auxiliary harmonic generator module. Output wavelength switching is done manually. Motorized wavelength switching is available by request.

Triggering of the laser is possible from built-in internal or external pulse generator. Pulses with TTL levels are required for external triggering. Laser pulses have less than 0.5 ns RMS jitter with respect to Q-switch triggering pulse in both cases.

System control is available through control pad, USB and LAN interfaces (RS232 as optional). The system can be controlled from personal computer with supplied software for Windows operating system.

## NanoFlux MM SERIES

### FEATURES

- ▶ High energy nanosecond lasers
- ▶ Up to **10 J** pulse energies
- ▶ **5 ns** pulse duration
- ▶ Up to **20 ns** pulse duration options available
- ▶ **10 or 20 Hz** pulse repetition rate
- ▶ Better than **0.5% RMS** pulse energy stability
- ▶ Up to **90 M<sup>2</sup>** version available
- ▶ High efficiency pump chambers and advanced beam shaping for maximum pulse energy extraction
- ▶ Relay imaging between amplifier stages for smooth beam profile at the laser output
- ▶ Thermally induced birefringence compensated
- ▶ Optional temperature stabilized second, third, fourth and fifth harmonic generators
- ▶ Low jitter internal/external synchronization
- ▶ Robust and stable laser head
- ▶ Control through keypad, USB and LAN interfaces with supplied Windows control software (RS232 as optional)

### APPLICATIONS

- ▶ OPO, Ti: Sapphire, dye laser pumping
- ▶ Material processing
- ▶ Plasma generation and diagnostics
- ▶ Nonlinear spectroscopy
- ▶ Remote sensing

## SPECIFICATIONS

Model	N3k10	N5k10	N7k10	N10k10
<b>MAIN SPECIFICATIONS <sup>1)</sup></b>				
Output energy				
at 1064 nm	3 000 mJ	5 000 mJ	7 000 mJ	10 000 mJ
at 532 nm <sup>2) 3)</sup>	1 500 mJ	2 500 mJ	3 500 mJ	5 000 mJ
at 355 nm <sup>2)</sup>	1 000 mJ	1 300 mJ	1 700 mJ	2 000 mJ
at 266 nm <sup>2)</sup>	270 mJ	400 mJ	500 mJ	700 mJ
Pulse repetition rate	10 Hz	10 Hz	10 Hz	10 Hz
Pulse duration <sup>4)</sup>	5 ± 1 ns			
Pulse energy stability <sup>5)</sup>				
at 1064 nm	≤ 0.6 %	≤ 0.6 %	≤ 0.6 %	≤ 0.6 %
at 532 nm	≤ 1 %	≤ 1 %	≤ 1 %	≤ 1 %
at 355 nm	≤ 2 %	≤ 2 %	≤ 2 %	≤ 2 %
at 266 nm	≤ 3 %	≤ 3 %	≤ 3 %	≤ 3 %
Long-term power drift <sup>6)</sup>	± 2 %	± 2 %	± 2 %	± 2 %
Beam spatial profile <sup>7)</sup>	Super-Gaussian	Super-Gaussian	Super-Gaussian	Super-Gaussian
M <sup>2</sup> <sup>8)</sup>	~5	~5	~5	~5
Beam diameter <sup>9)</sup>	~18 mm	~18 mm	~25 mm	~25 mm
Beam pointing stability <sup>10)</sup>	≤ 50 µrad	≤ 50 µrad	≤ 50 µrad	≤ 50 µrad
Beam divergence	≤ 0.5 mrad	≤ 0.5 mrad	≤ 0.5 mrad	≤ 0.5 mrad
Optical pulse jitter <sup>11)</sup>	≤ 0.5 ns	≤ 0.5 ns	≤ 0.5 ns	≤ 0.5 ns
Linewidth	≤ 1 cm <sup>-1</sup>			
Polarization	Linear	Linear	Linear	Linear
<b>PHYSICAL CHARACTERISTICS <sup>12)</sup></b>				
Laser head size (W×L×H mm)	460 × 1250 × 260	500 × 1300 × 300	600 × 1800 × 300	700 × 2000 × 300
Power supply size (W×L×H mm)	550 × 600 × 1250	550 × 600 × 1250	550 × 600 × 1250	550 × 600 × 1640
Umbilical length <sup>13)</sup>	5 m	5 m	5 m	5 m
<b>OPERATING REQUIREMENTS <sup>14)</sup></b>				
Power requirements <sup>15)</sup>	208, 380 or 400 V AC, three phase, 50/60 Hz	208, 380 or 400 V AC, three phase, 50/60 Hz	208, 380 or 400 V AC, three phase, 50/60 Hz	208, 380 or 400 V AC, three phase, 50/60 Hz
Power consumption <sup>16)</sup>	≤ 5 kVA	≤ 6 kVA	≤ 7 kVA	≤ 8 kVA
Water supply <sup>16)</sup>	< 5 l/min, 2 Bar, max 15 °C	< 5 l/min, 2 Bar, max 15 °C	< 12 l/min, 2 Bar, max 15 °C	< 12 l/min, 2 Bar, max 15 °C
Operating ambient temperature	22 ± 2 °C			
Storage ambient temperature	15 – 35 °C			
Relative humidity (non-condensing)	≤ 80 %	≤ 80 %	≤ 80 %	≤ 80 %
Cleanliness of the room	ISO Class 7	ISO Class 7	ISO Class 7	ISO Class 7

- <sup>1)</sup> Due to continuous improvement, all specifications are subject to change without notice. The parameters marked 'typical' are indications of typical performance and will vary with each unit we manufacture. Presented parameters can be customized to meet customer's requirements. All parameters measured at 1064 nm if not stated otherwise.
- <sup>2)</sup> Harmonic outputs are optional. Specifications valid with respective harmonic module purchased. Outputs are not simultaneous.
- <sup>3)</sup> Second harmonic is available with LBO crystal then the conversion efficiency is increased to 70%. If TH/FH options are orders second harmonic efficiency is reduced to ~50 %.
- <sup>4)</sup> Standard pulse duration is 5 ns. Other pulse durations can be ordered within range of 10 – 20 s. Output energy might differ depending on duration.
- <sup>5)</sup> Under stable environmental conditions, normalized to average pulse energy (RMS, averaged from 60 s).

- <sup>6)</sup> Measured over 8 hours period after 30 min warm-up when ambient temperature variation is less than ±2 °C.
- <sup>7)</sup> Super-Gaussian spatial mode of 6-11th order in near field.
- <sup>8)</sup> M<sup>2</sup> value of ~5 is standard. Versions with M<sup>2</sup> in the range of 20 – 90 can be ordered.
- <sup>9)</sup> Beam diameter is measured at signal output at 1/e<sup>2</sup> level for Gaussian beams and FWHM level for Super-Gaussian beams.
- <sup>10)</sup> Beam pointing stability is evaluated as movement of the beam centroid in the focal plane of a focusing element (RMS, averaged from 60 s).
- <sup>11)</sup> Optical pulse jitter with respect to electrical outputs: Trig out > 3.5 V @ 50 Ω.
- <sup>12)</sup> System sizes are preliminary and depend on customer lab layout and additional options purchased.
- <sup>13)</sup> Longer umbilical with up to 10 m available upon request.

- <sup>14)</sup> The laser and auxiliary units must be settled in such a place void of dust and aerosols. It is advisable to operate the laser in air conditioned room, provided that the laser is placed at a distance from air conditioning outlets. The laser should be positioned on a solid worktable. Access from one side should be ensured.
- <sup>15)</sup> Voltage fluctuations allowed are +10 % / -15 % from nominal value.
- <sup>16)</sup> Power consumption and water supply requirements deviate depending on system configuration.



## OPTIONS

Option	Description	Comment
- G	Provides a Gaussian-like beam profile	Pulse energies are typically lower in comparison to standard version by 80 %
- M20...90	Provides a flat, smooth beam profile, without hot spots and diffraction rings in the near and medium field	$M^2 > 20$ or $M^2 > 90$
- RLI	Optional Relay Imaging for smooth beam profile	
- AW	Water-air cooling option	Replaces or supplements Water-to-Water cooling unit. Heat dissipation equals total power consumption
- N10...N20	10 – 20 ns pulse duration	

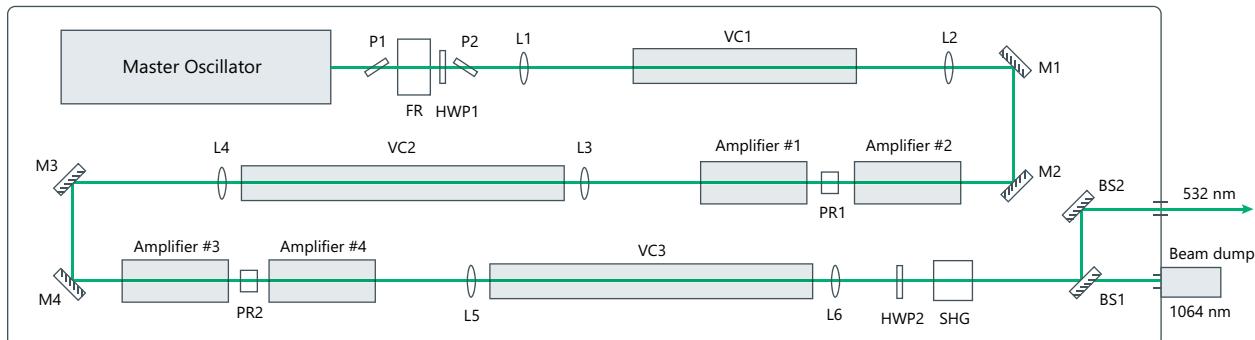


Fig 1. Principal optical layout of NanoFlux N10k10-SH (actual layout might vary)

## PERFORMANCE

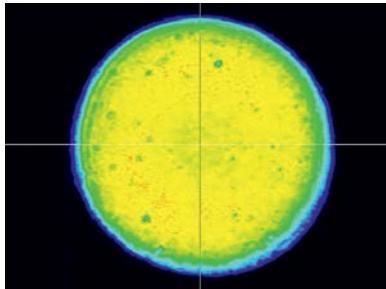


Fig 2. Typical beam profile of NanoFlux MM laser system at 1064 nm (imaged from amplifier exit)

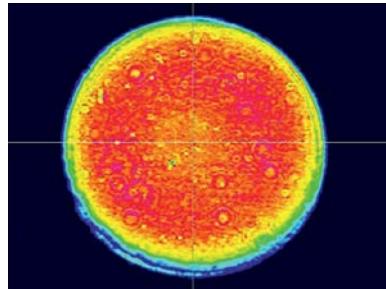


Fig 3. Typical beam profile of NanoFlux MM laser system at 532 nm (imaged from SH crystal)

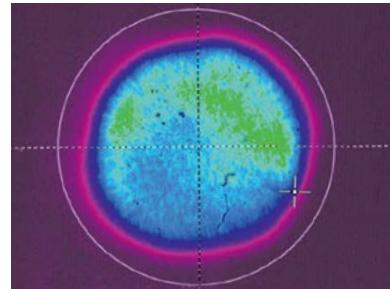
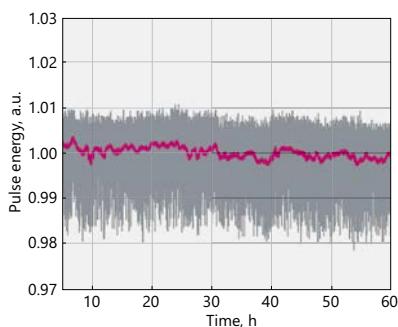
Fig 4. Typical beam profile of high  $M^2$  version of NanoFlux MM laser system at 532 nm (imaged from SH crystal)

Fig 5. Typical long-term energy stability of High Energy NanoFlux system



Fig 6. Typical external view of NanoFlux N10k10-MM (actual design might vary)

## OUTLINE DRAWINGS

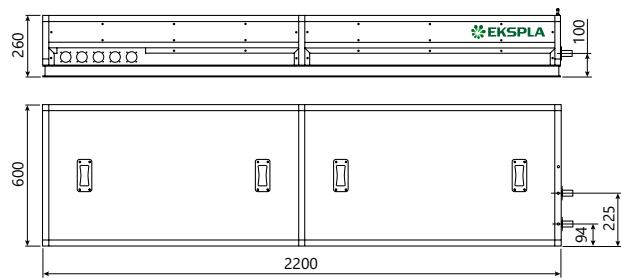


Fig 7. NanoFlux N7k10 or NanoFlux N10k10 laser head outline drawing (actual dimensions might vary)

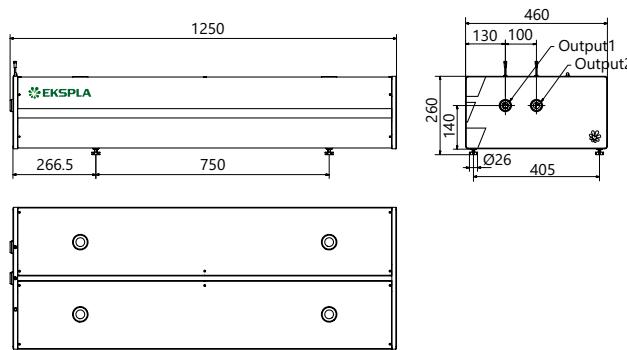


Fig 8. NanoFlux N3k10 or NanoFlux N5k10 laser head outline drawing (actual dimensions might vary)

## POWER SUPPLY

Cabinet	Usable height	Height H, mm	Width W, mm	Depth D, mm
MR-9	9 U	455.5 (519 <sup>1)</sup> )	553	600
MR-12	12 U	589 (653 <sup>1)</sup> )	553	600
MR-16	16 U	768 (832 <sup>1)</sup> )	553	600
MR-20	20 U	889 (952 <sup>1)</sup> )	553	600
MR-25	25 U	1167 (1231 <sup>1)</sup> )	553	600
MR-34	34 U	1640 (1709 <sup>1)</sup> )	553	600

<sup>1)</sup> Full height with wheels.

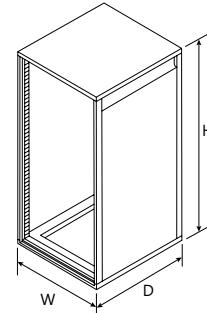


Fig 9. Typical NanoFlux laser system power supply dimensions (MR rack used depends on the laser model)

## ORDERING INFORMATION

**Note:** Laser must be connected to the mains electricity all the time. If there will be no mains electricity for longer than 1 hour then laser (system) needs warm up for a few hours before switching on.

## NanoFlux N(1)(2)-(3)

Energy level:  
2k → 2 J  
5k → 5 J  
7k → 7 J  
10k → 10 J

Any additional options:  
See 'Options' table

Pulse repetition rate:  
SS → Single Shot  
10 → 10 Hz