

# High Energy Flash Lamp Pumped Picosecond Amplifiers

## PicoFlux HE SERIES



### FEATURES

- ▶ **Flash lamp pumped picosecond amplifiers**
- ▶ Pulse energies up to **2.2 J**
- ▶ **20 – 300 ps** pulse duration
- ▶ **10 Hz** pulse repetition rate
- ▶ Diode pumped regenerative amplifier
- ▶ Internal or external seeding source
- ▶ Advanced beam shaping for high pulse energy
- ▶ Thermally induced birefringence compensated design
- ▶ Less than **10 ps RMS** jitter synchronization pulses for streak camera triggering
- ▶ Control through USB and LAN interfaces with supplied Windows control software (RS232 optional)
- ▶ Vacuum image relay system
- ▶ Optional temperature stabilized second, third and fourth harmonic generators
- ▶ Optional extremely precise synchronization to external RF signal with PLL option
- ▶ Optional Gaussian like spatial beam profile with Gaussian fit > 85% in near field
- ▶ Optional reduced pulse duration to 20 ps

High energy PicoFlux series amplifiers are designed to produce high energy picosecond pulses at 1064 nm. High pulse energy, excellent pulse-to-pulse energy stability, superior beam quality makes these amplifiers well suited for applications like OPCPA pumping, non-linear optics and others.

### Regenerative amplifier / Power amplifier design

PicoFlux series amplifiers are designed to be seeded by external seeding source. Diode pumped regenerative amplifier ensures amplification of seed signal to stable mJ level pulse

for amplification in linear amplifiers. 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. Alternatively Ekspla can offer an internal seeder meeting customer's requirements.

### Build-in harmonic generators

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.

### Simple and convenient laser control

For customer convenience the amplifier can be controlled through USB and LAN interfaces (RS232 as optional). The amplifier can be controlled from personal computer with supplied software for Windows operating system.

### APPLICATIONS

- ▶ Time resolved spectroscopy
- ▶ SFG/SHG spectroscopy
- ▶ Nonlinear spectroscopy
- ▶ OPCPA pumping
- ▶ OPG/OPA pumping
- ▶ Remote laser sensing
- ▶ Satellite ranging
- ▶ Other spectroscopic and nonlinear optics applications...

# SPECIFICATIONS

| Model                                          | P30010                                   | P60010                                   | P1k10                                                      | P2k10                                                      |
|------------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------------------------|------------------------------------------------------------|
| <b>MAIN SPECIFICATIONS <sup>1)</sup></b>       |                                          |                                          |                                                            |                                                            |
| Output energy                                  |                                          |                                          |                                                            |                                                            |
| Fundamental                                    | 300 mJ                                   | 600 mJ                                   | 1000 mJ                                                    | 2 200 mJ <sup>2) 3)</sup>                                  |
| SH output <sup>4) 5)</sup>                     | 200 mJ                                   | 400 mJ                                   | 650 mJ                                                     | 1400 mJ                                                    |
| TH output <sup>4)</sup>                        | 90 mJ                                    | 180 mJ                                   | 300 mJ                                                     | 660 mJ                                                     |
| FH output <sup>4)</sup>                        | 30 mJ                                    | 60 mJ                                    | 100 mJ                                                     | 220 mJ                                                     |
| Pulse repetition rate                          | 10 Hz                                    | 10 Hz                                    | 10 Hz                                                      | 10 Hz                                                      |
| Pulse duration <sup>6)</sup>                   | 90 ± 10 ps                               | 90 ± 10 ps                               | 90 ± 10 ps                                                 | 90 ± 10 ps                                                 |
| Pulse energy stability <sup>7)</sup>           |                                          |                                          |                                                            |                                                            |
| Fundamental                                    | ≤ 0.6 %                                  | ≤ 0.6 %                                  | ≤ 0.6 %                                                    | ≤ 0.6 %                                                    |
| SH output <sup>4)</sup>                        | ≤ 0.8 %                                  | ≤ 0.8 %                                  | ≤ 0.8 %                                                    | ≤ 0.8 %                                                    |
| TH output <sup>4)</sup>                        | ≤ 2 %                                    | ≤ 2 %                                    | ≤ 2 %                                                      | ≤ 2 %                                                      |
| FH output <sup>4)</sup>                        | ≤ 3 %                                    | ≤ 3 %                                    | ≤ 3 %                                                      | ≤ 3 %                                                      |
| Long-term power drift <sup>8)</sup>            | ± 2 %                                    | ± 2 %                                    | ± 2 %                                                      | ± 2 %                                                      |
| Beam spatial profile                           | Super-Gaussian <sup>9)</sup>             | Super-Gaussian <sup>9)</sup>             | Super-Gaussian <sup>9)</sup>                               | Super-Gaussian <sup>9)</sup>                               |
| Beam diameter <sup>10)</sup>                   | 9 mm                                     | ~11 mm                                   | ~17 mm                                                     | ~23 mm                                                     |
| Beam pointing stability <sup>11)</sup>         | ≤ 30 µrad                                | ≤ 30 µrad                                | ≤ 30 µrad                                                  | ≤ 30 µrad                                                  |
| Beam divergence                                | ≤ 0.5 mrad                               | ≤ 0.5 mrad                               | ≤ 0.5 mrad                                                 | ≤ 0.5 mrad                                                 |
| Pre-pulse contrast <sup>12)</sup>              | > 200:1                                  | > 200:1                                  | > 200:1                                                    | > 200:1                                                    |
| Optical pulse jitter <sup>13)</sup>            |                                          |                                          |                                                            |                                                            |
| Trig out                                       | ≤ 100 ps                                 | ≤ 100 ps                                 | ≤ 100 ps                                                   | ≤ 100 ps                                                   |
| Pre-Trig out                                   | ≤ 50 ps                                  | ≤ 50 ps                                  | ≤ 50 ps                                                    | ≤ 50 ps                                                    |
| With –PLL option                               | ≤ 2 ps                                   | ≤ 2 ps                                   | ≤ 2 ps                                                     | ≤ 2 ps                                                     |
| Polarization                                   | Linear                                   | Linear                                   | Linear                                                     | Linear                                                     |
| <b>PHYSICAL CHARACTERISTICS <sup>14)</sup></b> |                                          |                                          |                                                            |                                                            |
| Laser head size (W×L×H mm)                     | 600 × 1200 × 300                         | 600 × 1500 × 300                         | 600 × 1800 × 300                                           | 900 × 1800 × 300                                           |
| Power supply size (W×L×H mm)                   | 553 × 600 × 650                          | 553 × 600 × 830                          | 553 × 600 × 1230                                           | 553 × 600 × 1230                                           |
| Umbilical length <sup>15)</sup>                | 2.5 m                                    | 2.5 m                                    | 2.5 m                                                      | 2.5 m                                                      |
| <b>OPERATING REQUIREMENTS <sup>16)</sup></b>   |                                          |                                          |                                                            |                                                            |
| Electrical power                               | 200 – 240 V AC, single-phase, 47 – 63 Hz | 200 – 240 V AC, single-phase, 47 – 63 Hz | 208, 380 or 400 V AC, three-phase, 50/60 Hz <sup>17)</sup> | 208, 380 or 400 V AC, three-phase, 50/60 Hz <sup>17)</sup> |
| Power consumption <sup>18)</sup>               | ≤ 2 kVA                                  | ≤ 2.5 kVA                                | ≤ 4.5 kVA                                                  | ≤ 7 kVA                                                    |
| Water supply                                   | ≤ 3 l/min, 2 Bar, max 20 °C              | ≤ 6 l/min, 2 Bar, max 20 °C              | ≤ 12 l/min, 2 Bar, max 20 °C                               | ≤ 14 l/min, 2 Bar, max 15 °C                               |
| Operating ambient temperature                  | 22 ± 2 °C                                | 22 ± 2 °C                                | 22 ± 2 °C                                                  | 22 ± 2 °C                                                  |
| Storage ambient temperature                    | 15 – 35 °C                               | 15 – 35 °C                               | 15 – 35 °C                                                 | 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> 2 200 mJ energy is achieved with Super-Gaussian spatial beam profile of 11<sup>th</sup> or higher order (with steep edges). If lower order Super-Gaussian is required maximum pulse energy will be limited to 2 000 mJ.

<sup>3)</sup> 2 500 mJ output energy is available upon request with longer pulse duration.

<sup>4)</sup> Harmonic outputs are optional. Specifications valid with respective harmonic module purchased. Outputs are not simultaneous.

<sup>5)</sup> Second harmonic specification is valid when only SH option is ordered. If TH/FH options are ordered second harmonic efficiency is reduced to ~50 %.

<sup>6)</sup> Standard pulse duration is 90 ps. Other pulse durations can be ordered within range of 20 ps – 300 ps. Shortening the pulse duration below 90 ps will reduce the output energy proportionally.

<sup>7)</sup> Under stable environmental conditions, normalized to average pulse energy (RMS, averaged from 60 s).

<sup>8)</sup> Measured over 8 hours period after 30 min warm-up when ambient temperature variation is less than ±2 °C.

<sup>9)</sup> Super-Gaussian spatial mode of 6-11<sup>th</sup> order in near field.



- <sup>10)</sup> Beam diameter is measured at signal output at  $1/e^2$  level for Gaussian beams and FWHM level for Super-Gaussian beams.
- <sup>11)</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>12)</sup> 1000:1 contrast available upon request.
- <sup>13)</sup> Optical pulse jitter with respect to electrical outputs:  
 – Trig out > 3.5 V @ 50  $\Omega$   
 – Pre-Trig out > 1 V @ 50  $\Omega$   
 – PLL option > 1 V @ 50  $\Omega$

- <sup>14)</sup> System sizes are preliminary and depend on customer lab layout and additional options purchased.
- <sup>15)</sup> Longer umbilical with up to 10 m available upon request.
- <sup>16)</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>17)</sup> Voltage fluctuations allowed are +10 % / -15 % from nominal value.
- <sup>18)</sup> Required current rating can be calculated by dividing power rating by mains voltage. Power rating is given in apparent power (kVA) for systems with flash lamp power supplies and in real power (kW) for systems without flash lamp power supplies where reactive power is neglectable.

## OPTIONS

| Option     | Description                                                   | Comment                                                                                                                               |
|------------|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| -P20...300 | Custom pulse duration between 20 ps and 300 ps                | Available with internal and external seeder. Shortening the pulse duration below 90 ps will reduce the output energy proportionally   |
| -G         | Gaussian like spatial beam profile                            | Reduces the output energy of fundamental by ~80 %                                                                                     |
| -FS        | External seeder input via motorized spectral broadening stage | Requires > 1.5 nJ per pulse @ 800 nm, $\leq$ 100 fs                                                                                   |
| -PLL       | Phase Lock Loop option for precise lock to external RF signal | Electrical to optical signal jitter $\leq$ 3 ps                                                                                       |
| -SH/TH/FH  | Second, third and fourth harmonic outputs                     | Conversion efficiency from fundamental respectively ~50 %, ~30 % and ~10 %. Harmonic outputs not simultaneous with fundamental output |
| -AW        | Water-to-Air cooling                                          | Replaces or supplements Water-to-Water cooling unit. Heat dissipation equals total power consumption                                  |

## 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         |

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

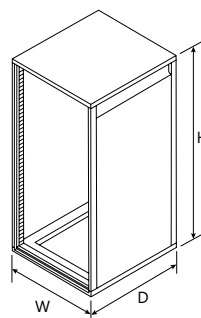


Fig 1. Typical PicoFlux laser system power supply dimensions (MR rack used depends on the laser model)



Fig 2. Integrated multi-channel high energy PicoFlux pump lasers into OPCPA

## PERFORMANCE

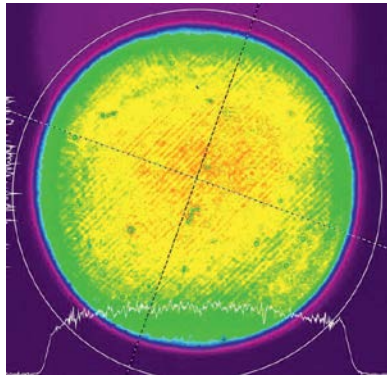


Fig 3. Typical High Energy PicoFlux amplifier system near field beam profile at 1064 nm (imaged from laser output)

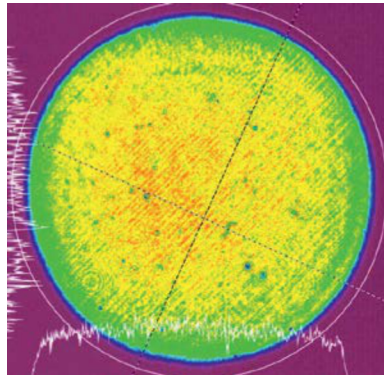


Fig 4. Typical High Energy PicoFlux amplifier system near field beam profile at 532 nm (imaged from SH crystal)

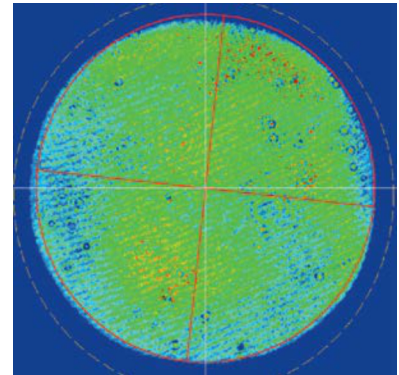


Fig 5. Typical High Energy PicoFlux amplifier system near field beam profile at 355 nm (imaged from TH crystal)

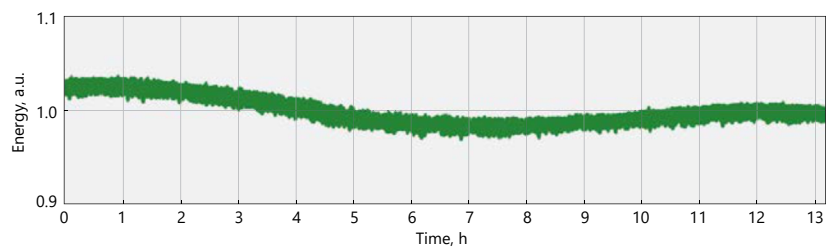


Fig 6. Typical long-term energy stability of High Energy PicoFlux system

## OUTLINE DRAWINGS

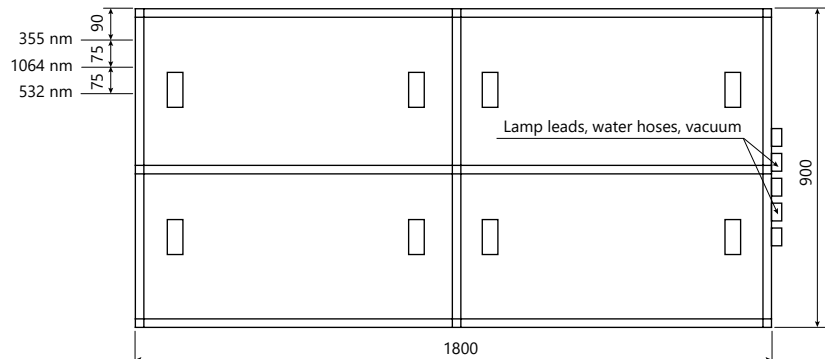


Fig 7. Typical PicoFlux P2k10 laser system external dimensions

## 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.

### PicoFlux P(1)(2)-(3)

Energy level:  
300 → 300 mJ  
600 → 600 mJ  
1k → 1000 mJ  
2k → 2200 mJ

Any additional options:  
See 'Options' table

Pulse repetition rate:  
SS → Single Shot  
5 → 5 Hz  
10 → 10 Hz