# Multiple Channel Custom Picosecond Amplifiers

## APL Custom


### APPLICATIONS

- *Multi-stage OPCPA pumping*
- *Non-linear optics*
- *Other spectroscopic and nonlinear optics applications...*

### FEATURES

- *Two versions available:*
  – *flash lamp pumped APL systems providing **4 channels × 2200 mJ @ 10 Hz***
  – *diode pumped APL systems providing **8 channels × 130 mJ @ 1 kHz***
- *Each of the channels can be **tailored according to pumping requirements***
- ***20 – 300 ps** pulse duration*
- *From Single Shot to **2 kHz** pulse repetition rate*
- *Internal or external seeding source*
- *Advanced beam shaping for high pulse energy*
- *Thermally induced birefringence compensated*
- *Low jitter synchronization pulses below **10 ps RMS jitter***
- *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*

Multiple Channel APL series picosecond amplifiers were designed and manufactured for multiple stage OPCPA pumping. Systems can be specially tailored for customer's needs and have up to 8 pumping channels with different wavelength, energy, pulse duration, spatial and temporal profiles, adjustable delay, image translation to customers specified location and various other features. Short pulse duration, excellent pulse-to-pulse stability, superior beam quality makes APL series picosecond amplifiers well suited for other applications as well.

### Regenerative amplifier / Power amplifier design

APL 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 LBO and/or BBO crystals 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

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


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## SPECIFICATIONS

| Model | APL2k10-x4 | APL1301k-x8 |
|---|---|---|
| **MAIN SPECIFICATIONS** [1] | | |
| Output energy | | |
| Fundamental | 4 × 2 200 mJ [2] [3] | 8 × 130 mJ |
| SH output [4] [5] | 4 × 1 400 mJ / 2 × 2 500 mJ | 8 × 85 mJ / 4 × 150 mJ |
| TH output [4] | 4 × 660 mJ / 2 × 1 300 mJ | 8 × 50 mJ / 4 × 100 mJ |
| FH output [4] | 4 × 220 mJ / 2 × 450 mJ | 8 × 15 mJ / 4 × 30 mJ |
| Pulse repetition rate | 10 Hz | 1 kHz |
| Pulse duration [6] | 90 ± 10 ps | 90 ± 10 ps |
| Pulse energy stability [7] | | |
| Fundamental | ≤ 0.6 % | ≤ 0.5 % |
| SH output [4] | ≤ 0.8 % | ≤ 0.8 % |
| TH output [4] | ≤ 2 % | ≤ 2 % |
| FH output [4] | ≤ 3 % | ≤ 3 % |
| Long-term power drift [8] | ± 2 % | ± 1.5 % |
| Beam spatial profile | Super-Gaussian [9] | Super-Gaussian [9] |
| Beam diameter [10] | ~ 23 mm | ~ 7 mm |
| Beam pointing stability [11] | ≤ 30 µrad | ≤ 20 µrad |
| Beam divergence | ≤ 0.5 mrad | ≤ 0.5 mrad |
| Pre-pulse contrast [12] | > 200:1 | > 200:1 |
| Optical pulse jitter [13] | | |
| Trig out | ≤ 50 ps | ≤ 50 ps |
| Pre-Trig out | ≤ 10 ps | ≤ 10 ps |
| With –PLL option | ≤ 3 ps | ≤ 3 ps |
| Polarization | Linear | Linear |
| **PHYSICAL CHARACTERISTICS** [14] | | |
| Laser head size (W×L×H mm) | 1500 × 3600 × 500, 2 pc. | 1500 × 3600 × 500, 4 pc. |
| Power supply size (W×L×H mm) | 553 × 600 × 1800, 4 pc. | 553 × 600 × 1800, 4 pc. |
| Umbilical length [15] | 5 m | 2.5 m |
| **OPERATING REQUIREMENTS** [16] | | |
| Electrical power | 208, 380 or 400 V AC, three-phase, 50/60 Hz [17] | 208, 380 or 400 V AC, three-phase, 50/60 Hz [17] |
| Power consumption [18] | ≤ 40 kVA | ≤ 60 kW |
| Water supply | ≤ 40 l/min, 2 Bar, max 15 °C | ≤ 40 l/min, 2 Bar, max 15 °C |
| Operating ambient temperature | 22 ± 2 °C | 22 ± 2 °C |
| Storage ambient temperature | 15 – 35 °C | 15 – 35 °C |
| Relative humidity (non-condensing) | ≤ 80 % | ≤ 80 % |
| Cleanness of the room | ISO Class 7 | ISO Class 7 |

1) 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.

2) 2 200 mJ energy is achieved with Super-Gaussian spatial beam profile of 11th or higher order (with steep edges). If lower order Super-Gaussian is required maximum pulse energy will be limited to 2 000 mJ.

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

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

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

6) 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.

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

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

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

10) Beam diameter is measured at signal output at 1/e2 level for Gaussian beams and FWHM level for Super-Gaussian beams.

11) Beam pointing stability is evaluated as movement of the beam centroid in the focal plane of a focusing element (RMS, averaged from 60 s).

12) 1000:1 contrast available upon request.

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13) Optical pulse jitter with respect to electrical outputs:
– Trig out > 3.5 V @ 50 Ω
– Pre-Trig out > 1 V @ 50 Ω
– PLL option > 1 V @ 50 Ω

14) System sizes are preliminary and depend on customer lab layout and additional options purchased.

15) Longer umbilical with up to 10 m for flash lamp pumped and up to 5 m for diode pumped systems available upon request.

16) 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.

17) Voltage fluctuations allowed are +10 % / -15 % from nominal value.

18) 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 |
| -50/100 | 50 Hz or 100 Hz pulse repetition rate | Energy can be increased ~4 times compared to 1 kHz systems |
| -2k | 2 kHz pulse repetition rate | Reduces the output energy of fundamental by ~50 % |
| -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, 100 fs |
| -PLL | Phase Lock Loop option for precise lock to external RF signal | Electrical to optical signal jitter ≤ 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 |

## PERFORMANCE

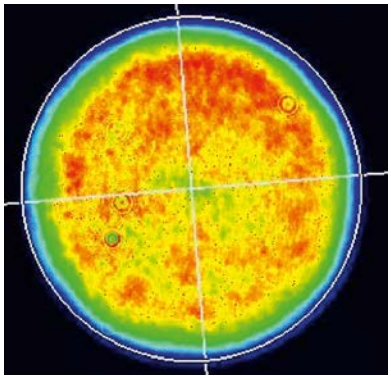

*Fig 1.* Typical High repetition rate APL amplifier system near field beam profile at 1064 nm (imaged from laser output)

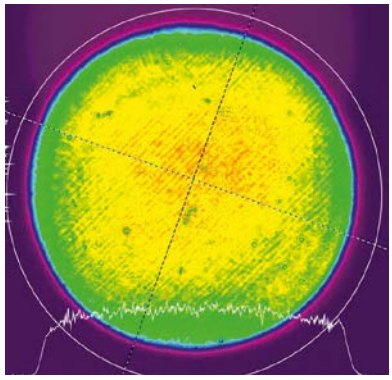

*Fig 2.* Typical High Energy APL amplifier system near field beam profile at 1064 nm (imaged from laser output)

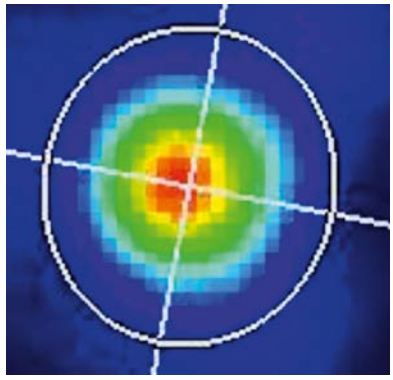

*Fig 3.* Typical High repetition rate APL amplifier system far field beam profile at 532 nm (imaged from SH crystal)

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## STABILITY

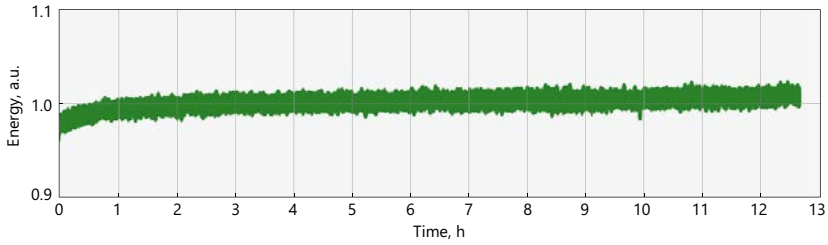


*Fig 5.* Typical long-term energy stability of High repetition rate APL system

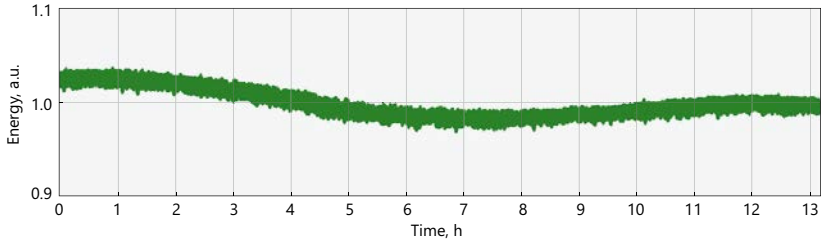


*Fig 6.* Typical long-term energy stability of High Energy APL system

## DELIVERED SYSTEMS


*Fig 7.* Typical external view of APL1301k-x4-SH laser system pumping OPCPA (ELI-ALPS, SYLOS2A system)

## ORDERING INFORMATION

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

**APL (1)(2)-x(3)-(4)**

- (1) Model
- (2) Energy level:
  130 → 130 mJ
  2k → 2200 mJ
- (3) Number of channels:
  x4 → four channels
  x8 → eight channels
- (4) Any additional options:
  See 'Options' table

Pulse repetition rate:
10 → 10 Hz
1k → 1 kHz