

# Spirit® HE

High Power, High Pulse Energy  
Industrial Femtosecond Lasers



The Spirit HE industrial femtosecond laser product line delivers high energy, and high average power for applications requiring reliable and robust 24/7 operation. With direct diode pumped technology developed by Spectra-Physics, Spirit's innovative and simple architecture offers truly unique performance.

The Spirit platform offers impressive versatility to serve the needs of industrial and scientific customers. High average power ( $>30$  W) and high pulse energy ( $>120$   $\mu$ J) enable femtosecond micromachining applications with high throughput and excellent cost-performance. Pulse energy and repetition rate adjustability (single shot – 1 MHz) make Spirit HE the ideal source for medical device manufacturing, material ablation and high aspect ratio drilling. The integrated pulse picker available in all models offers full control of the laser output with single pulse selection and fast power control via an analog input signal. This simplifies the integration of the lasers.

Optionally, the available burst mode offers higher ablation efficiencies and therefore higher throughput.

The optional, high efficiency Second Harmonic Generation (SHG) module is integrated in the laser head and enables the fabrication of smaller and more accurate structures. A pulse energy of  $>60$   $\mu$ J at 520 nm is available. The fundamental and SHG output beams are collinear at the laser exit for easy integration and beam delivery. The end user can easily switch between the 1040 nm and 520 nm outputs using either the communication interface (TCP/IP) or the user control software.

Fully automated and computer controlled, Spirit is manufactured with high reliability and quality in mind. Spirit's design is optimized for easy integration and for superb power and beam pointing stability (typically  $<20$   $\mu$ rad for 100 hours) during 24/7 operation, ensuring high precision and reproducibility in every application.

## The Spirit HE Advantage

- High average power ( $>30$  W) and high pulse energy ( $>120$   $\mu$ J)
- User adjustable repetition rate (single shot – 1 MHz)
- Integrated pulse-picker with analog-in triggering
- Integrated SHG module (optional)
- User adjustable pulse duration between 400 fs and 10 ps (optional)
- Superb beam pointing stability ( $<20$   $\mu$ rad for 100 hours)
- Fully automated and computer controlled
- Proven, dependable performance for 24/7 operation



## Applications

- Femtosecond micromachining
- Material processing
- Medical device fabrication
- Time resolved femtosecond spectroscopy
- Optical parametric amplifier pumping

## Spirit HE Specifications<sup>1, 8</sup>

|                                                             | Spirit HE 1040-16                                              | Spirit HE 1040-16-SHG                  | Spirit HE 1040-30  | Spirit HE 1040-30-SHG |
|-------------------------------------------------------------|----------------------------------------------------------------|----------------------------------------|--------------------|-----------------------|
| Output Characteristics                                      |                                                                |                                        |                    |                       |
| Wavelength                                                  | 1040 nm ±8 nm                                                  |                                        |                    |                       |
| Output Power                                                | >16 W                                                          |                                        | >30 W              |                       |
| Pulse Energy                                                | >120 μJ at 100 kHz                                             |                                        | >120 μJ at 250 kHz |                       |
| Wavelength (SHG)                                            | NA                                                             | 520 ±3 nm                              | NA                 | 520 ±3 nm             |
| Output Power (SHG)                                          | NA                                                             | >6 W at 100 kHz<br>>8 W at 200 kHz     | NA                 | >15 W at 250 kHz      |
| Max Pulse Energy (SHG)                                      | NA                                                             | >60 μJ at 100 kHz<br>>40 μJ at 200 kHz | NA                 | >60 μJ at 250 kHz     |
| Repetition Rate <sup>1,2</sup>                              | 100 kHz, 200 kHz or 1 MHz                                      |                                        | 250 kHz or 1 MHz   |                       |
| Pulse Selection                                             | Integrated pulse picker (AOM)                                  |                                        |                    |                       |
| Pulse Width                                                 | <400 fs                                                        |                                        |                    |                       |
| Pulse Width Tunability <sup>3, 4</sup>                      | <400 fs to 10 ps at 1040 nm                                    |                                        |                    |                       |
| Burst Mode <sup>5, 6, 7</sup>                               | >120 μJ/burst at 1040 nm, up to 14 sub-pulses                  |                                        |                    |                       |
| Power Stability                                             | <1% rms over 100 hours                                         |                                        |                    |                       |
| Pulse-to-Pulse Stability                                    | <2% rms                                                        |                                        |                    |                       |
| Spatial Mode                                                | TEM <sub>00</sub> (M <sup>2</sup> <1.2)                        |                                        |                    |                       |
| Beam Diameter at Exit                                       | 2.5 mm ±0.5 mm                                                 |                                        |                    |                       |
| Beam Divergence, Full Angle                                 | <1 mrad (1040 nm); <0.5 mrad (520 nm)                          |                                        |                    |                       |
| Pre-Pulse Contrast Ratio                                    | >250:1                                                         |                                        |                    |                       |
| Polarization                                                | Horizontal                                                     |                                        |                    |                       |
| Cold Start Time                                             | <30 min                                                        |                                        |                    |                       |
| Warm Start Time                                             | <15 min                                                        |                                        |                    |                       |
| Environmental Specifications                                |                                                                |                                        |                    |                       |
| Operating Temperature                                       | 18–30°C (64–86°F)                                              |                                        |                    |                       |
| Relative Humidity                                           | <65%, non-condensing                                           |                                        |                    |                       |
| Cooling Requirements                                        |                                                                |                                        |                    |                       |
| Laser Head                                                  | Water-cooled                                                   |                                        |                    |                       |
| Power Supply                                                | Air-cooled                                                     |                                        |                    |                       |
| Utility Requirements                                        |                                                                |                                        |                    |                       |
| Voltage                                                     | Laser controller (including chiller): 100-240 V, 50 Hz / 60 Hz |                                        |                    |                       |
| Current                                                     | <15 A                                                          |                                        |                    |                       |
| Laser Head Physical Characteristics                         |                                                                |                                        |                    |                       |
| Dimensions (L x W x H)                                      | 32.5 x 14 x 6.5 in (875 x 340 x 160 mm)                        |                                        |                    |                       |
| Weight                                                      | 155 lb (70 kg)                                                 |                                        |                    |                       |
| Rack with Power Supply and Chiller Physical Characteristics |                                                                |                                        |                    |                       |
| Dimensions (L x W x H)                                      | 23.6 x 22.0 x 29.4 in (600 x 560 x 746 mm)                     |                                        |                    |                       |
| Weight                                                      | 176 lb (80 kg)                                                 |                                        |                    |                       |

1. Due to our continuous product improvement program, specifications are subject to change without notice.

2. Additional, pre-calibrated repetition rates upon request; please contact Spectra- Physics. For Spirit HE 16 and Spirit HE 30, the maximum pre-calibrated repetition rate is 1 MHz.

3. Pulse duration tunability is optional; if implemented, pulse duration is software tunable.

4. Conversion efficiency for SHG module will be lower for longer pulse width. Conversion efficiency for SHG is not specified for longer pulse width.

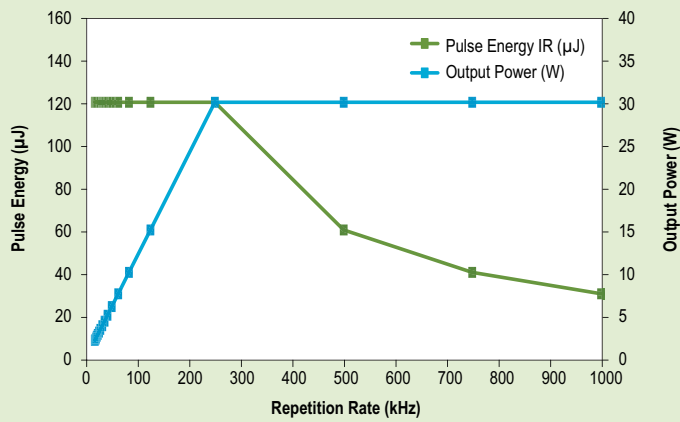
5. Burst mode operation is optional; if implemented the number of pulses per burst (<14 pulses) can be selected in GUI.

6. Pre-calibrated repetition rates are limited to  $\leq$  500 kHz for Spirit HE lasers with the burst mode option.

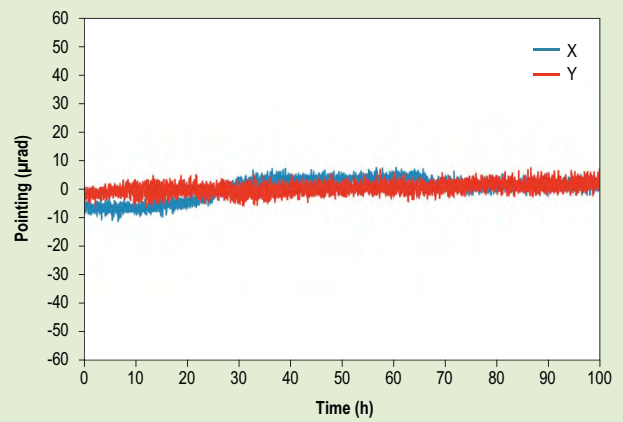
7. Conversion efficiency for SHG module will be lower in the burst mode operation. Conversion efficiency for SHG is not specified for the burst mode operation.

8. The Spirit HE is a Class IV – High Power Laser, whose beam is, by definition, a safety and fire hazard. Take precautions to prevent exposure to the direct and reflected beams. Diffuse as well as specular reflections can cause severe skin or eye damage.

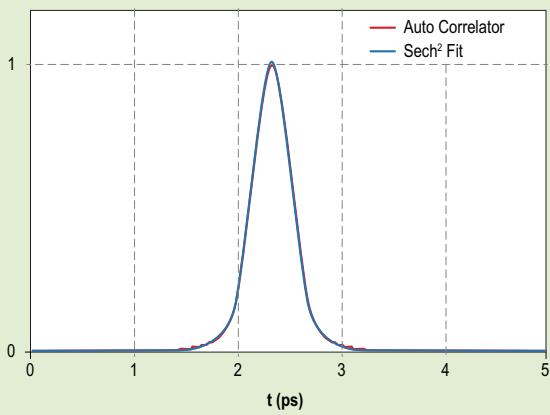
Pulse Energy and Output Power vs. Repetition Rate<sup>1</sup>



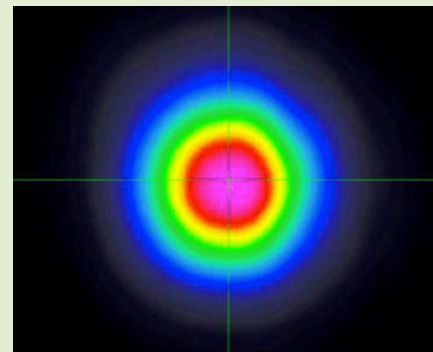
Beam Pointing Stability over 100 hours<sup>1</sup>



Pulse Duration and Pulse Shape fitted with the Sech<sup>2</sup> Function<sup>1</sup>

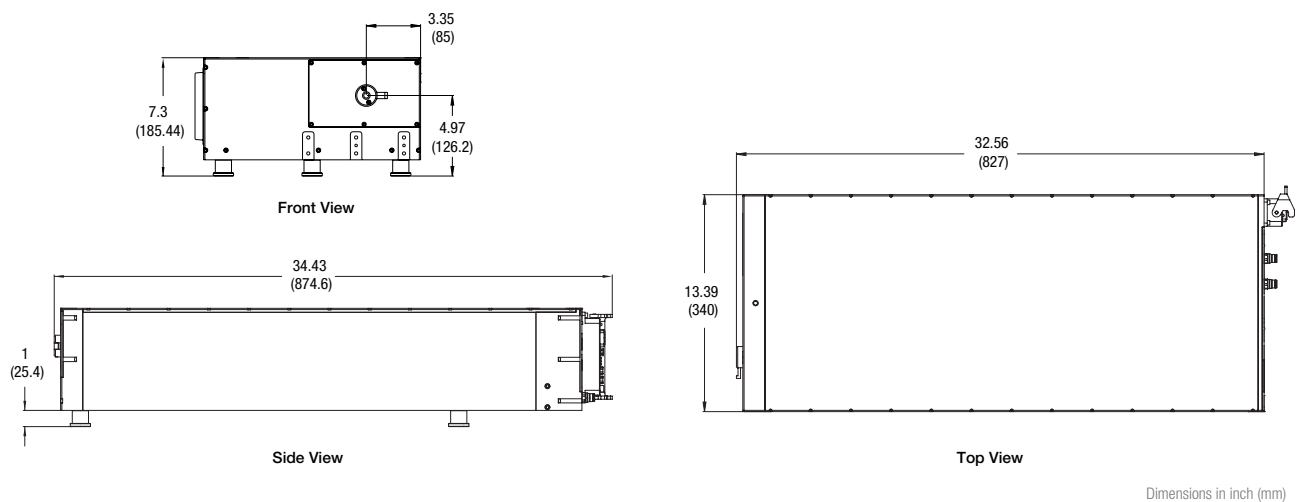


Beam Pointing Stability over 100 hours<sup>1</sup>



1. Typically measured performance; not a guaranteed or warranted specification.

## Spirit HE Dimensional Drawing



## Rack with Power Supply and Chiller Drawing

