

CARBIDE

NEW

Unibody-Design Femtosecond Lasers for Industry and Science

FEATURES

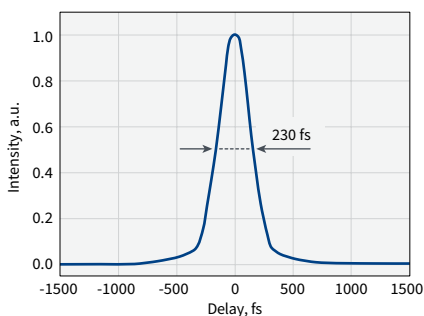
- Tunable pulse duration, 190 fs – 20 ps
- Maximum output of 120 W, 1 mJ or 80 W, 2 mJ
- Single-shot – 2 MHz repetition rate
- Pulse-on-demand and BiBurst for pulse control
- Up to 5th harmonic or tunable extensions
- Air-cooled model
- Compact industrial-grade design



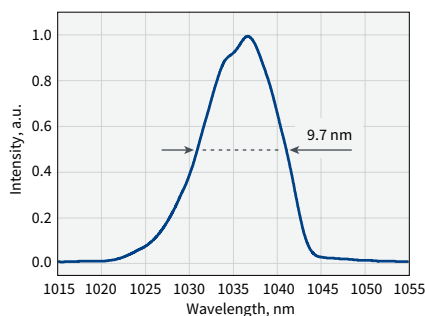
CARBIDE-CB3

CARBIDE is a series of femtosecond lasers combining high average power and excellent power stability. CARBIDE features market-leading output parameters without compromises to beam quality and stability. A compact and robust optomechanical CARBIDE design allows a variety of applications in top-class research centers, as well as display, automotive, LED, medical, and other industries. The reliability of CARBIDE has been proven by hundreds of systems operating 24/7 in the industrial environment.

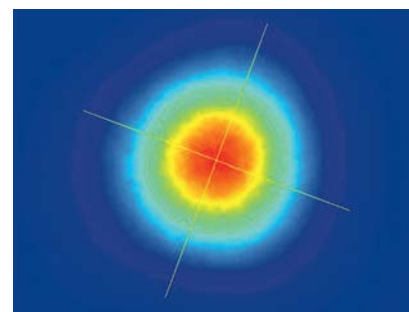
CARBIDE features high-power water-cooled (CB3) and air-cooled (CB5) models. The tunability of CARBIDE lasers enables our customers to discover the most efficient manufacturing processes. Tunable parameters include pulse duration (190 fs – 20 ps), repetition rate (single-shot – 2 MHz), pulse energy (up to 2 mJ), and average power (up to 120 W). A pulse-on-demand mode is available using the built-in pulse picker. The CARBIDE lasers can be equipped with industrial-grade modules, including but not limited to harmonic generators and optical parametric amplifiers.



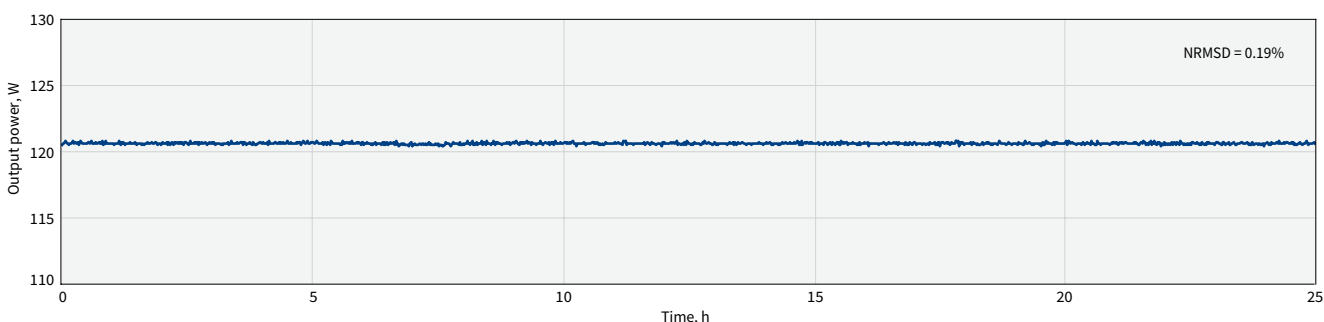
Typical pulse duration of CARBIDE-CB3



Typical spectrum of CARBIDE-CB3



Typical beam profile of CARBIDE-CB3



Long-term power stability of CARBIDE-CB3-120W

CARBIDE-CB3 SPECIFICATIONS

NEW

Model	CB3-20W		CB3-40W		CB3-80W		CB3-120W
OUTPUT CHARACTERISTICS							
Cooling method	Water-cooled						
Center wavelength ¹⁾	1030 ± 10 nm						
Maximum output power	20 W	40 W	80 W		120 W		
Pulse duration ²⁾	< 250 fs				< 350 fs ³⁾		< 250 fs
Pulse duration tuning range	250 fs – 10 ps				350 fs – 10 ps		250 fs – 10 ps
Maximum pulse energy	0.4 mJ		0.8 mJ		2 mJ		1 mJ
Repetition rate	Single-shot – 1 MHz	Single-shot – 1 MHz (2 MHz on request)		Single-shot – 2 MHz		Single-shot – 1 MHz (2 MHz on request)	
Pulse selection	Single-shot, pulse-on-demand, any fundamental repetition rate division						
Polarization	Linear, vertical; 1 : 1000						
Beam quality, M ²	< 1.2						
Beam diameter ⁴⁾	3.9 ± 0.4 mm		4.2 ± 0.4 mm		5.1 ± 0.7 mm	4.5 ± 0.5 mm	
Beam pointing stability	< 20 µrad/°C						
Pulse picker	FEC ⁵⁾						
Pulse picker leakage	< 0.25%						
Pulse-to-pulse energy stability, 24 h ⁶⁾	< 0.5%						
Long-term power stability, 100 h ⁶⁾	< 0.5%						

MAIN OPTIONS

Oscillator output ⁷⁾	< 0.5 W, 120 – 250 fs, 1030 ± 10 nm, ≈ 65 MHz	
Harmonic generator ⁸⁾	515 nm, 343 nm, 257 nm, or 206 nm; <i>see page 23</i>	
Optical parametric amplifier ⁹⁾	320 – 10000 nm; <i>see page 30</i>	–
BiBurst option	Tunable GHz and MHz burst with burst-in-burst capability; <i>see page 17</i>	

PHYSICAL DIMENSIONS

Laser head (L × W × H)	632 × 305 × 174 mm						
Chiller (L × W × H)	585 × 484 × 221 mm			680 × 484 × 307 mm			
24 V DC power supply (L × W × H) ¹⁰⁾	280 × 144 × 49 mm			320 × 200 × 75 mm			

ENVIRONMENTAL AND UTILITY REQUIREMENTS

Operating temperature		15 – 30 °C		
Relative humidity		< 80% (non-condensing)		
Electrical requirements	Laser	100 V AC, 7 A – 240 V AC, 3A; 50 – 60 Hz	100 V AC, 12 A – 240 V AC, 5 A; 50 – 60 Hz	
	Chiller	100 – 230 V AC; 50 – 60 Hz	200 – 230 V AC; 50 – 60 Hz	
Rated power	Laser	600 W	1000 W	2000 W
	Chiller	1400 W	2000 W	
Power consumption	Laser	500 W	900 W	1400 W
	Chiller	1000 W	1300 W	1700 W

¹⁾ Precise center wavelength for specific models available upon request.

²⁾ Assuming Gaussian pulse shape.

³⁾ Pulse duration can be reduced to < 250 fs if pulse peak intensity of > 50 GW/cm² is tolerated by the customer setup.

⁴⁾ FW 1/e², using maximum pulse energy.

⁵⁾ Provides fast energy control; external analog control input available. Response time – next available RA pulse.

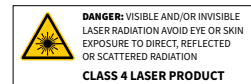
⁶⁾ Under stable environmental conditions. Expressed as NRMSD (normalized root mean squared deviation).

⁷⁾ Available simultaneously, requires scientific interface. Contact sales@lightcon.com for details or customized solutions.

⁸⁾ Integrated. For external harmonic generator, refer to HIRO.

⁹⁾ Integrated. For more options and OPAs for -4mJ and -UP models, refer to ORPHEUS series of OPAs.

¹⁰⁾ Power supply can be different if optional 2 MHz version is selected.



CARBIDE-CB5 (AIR-COOLED) SPECIFICATIONS

Model	CB5		CB5-SP
OUTPUT CHARACTERISTICS			
Cooling method	Air-cooled ¹⁾		
Center wavelength ²⁾	1030 ± 10 nm		
Maximum output power	6 W	5 W	
Pulse duration ³⁾	< 290 fs		< 190 fs
Pulse duration tuning range	290 fs – 20 ps		190 fs – 20 ps
Maximum pulse energy	100 μJ	83 μJ	100 μJ
Repetition rate	Single-shot – 1 MHz		
Pulse selection	Single-shot, pulse-on-demand, any fundamental repetition rate division		
Polarization	Linear, vertical; 1 : 1000		
Beam quality, M ²	< 1.2		
Beam diameter ⁴⁾	2.1 ± 0.4 mm		
Beam pointing stability	< 20 μrad/°C		
Pulse picker	Included	Included ⁵⁾	Included
Pulse picker leakage	< 2 %	< 0.1 %	< 2 %
Pulse-to-pulse energy stability, 24 h ⁶⁾	< 0.5%		
Long-term power stability, 100 h ⁶⁾	< 0.5%		

MAIN OPTIONS

Oscillator output	n/a
Harmonic generator ⁷⁾	515 nm, 343 nm, 257 nm, or 206 nm; see page 23
Optical parametric amplifier ⁸⁾	320 – 10000 nm; see page 30
BiBurst option	n/a

PHYSICAL DIMENSIONS

Laser head (L × W × H)	631 × 324 × 162 mm
Chiller	Not required
24 V DC power supply (L × W × H)	220 × 95 × 46 mm

ENVIRONMENTAL AND UTILITY REQUIREMENTS

Operating temperature	17 – 27 °C
Relative humidity	< 80% (non-condensing)
Electrical requirements	100 V AC, 3 A – 240 V AC, 1.3 A; 50 – 60 Hz
Rated power	300 W
Power consumption	150 W

¹⁾ Water-cooled version available on request.

²⁾ Precise center wavelength for specific models available upon request.

³⁾ Assuming Gaussian pulse shape.

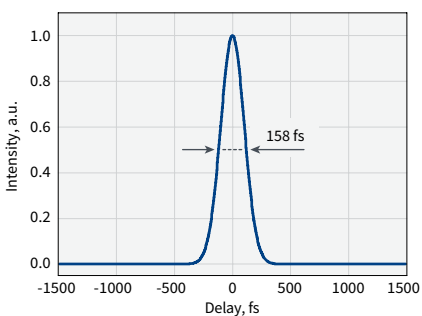
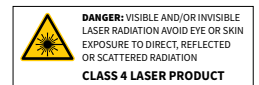
⁴⁾ $FW\ 1/e^2$, using maximum pulse energy.

⁵⁾ Enhanced contrast AOM. Provides fast amplitude control of output pulse train.

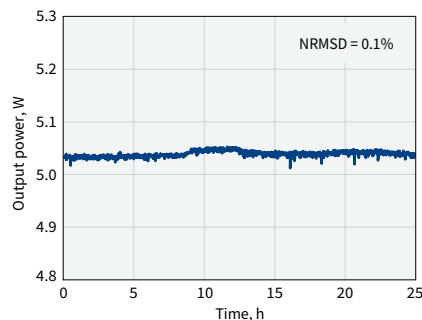
⁶⁾ Under stable environmental conditions. Expressed as NRMSD (normalized root mean squared deviation).

⁷⁾ Integrated. For external harmonic generator, refer to HIRO.

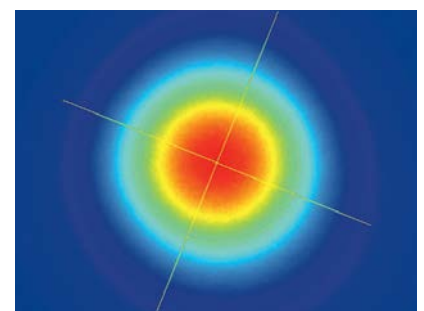
⁸⁾ Integrated. For stand-alone OPAs, refer to ORPHEUS series of OPAs.



Typical pulse duration of CARBIDE-CB5

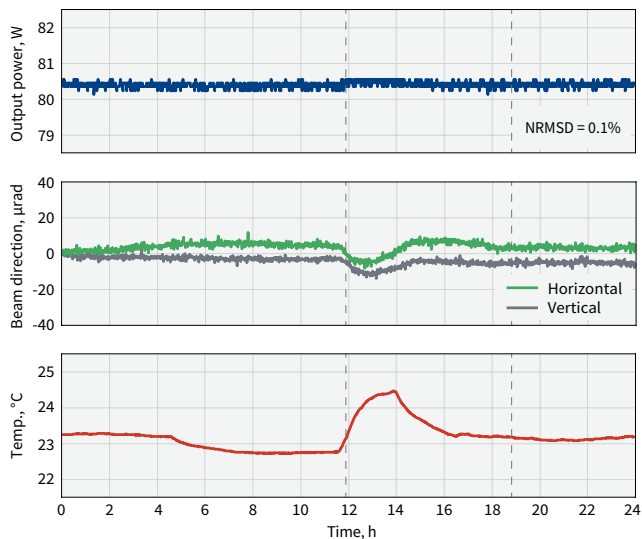


Long-term power stability of CARBIDE-CB5

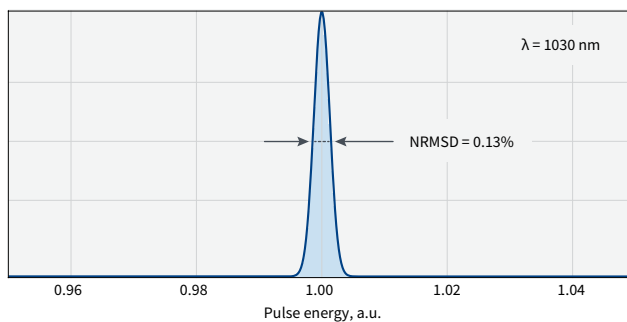


Typical beam profile of CARBIDE-CB5

STABILITY MEASUREMENTS

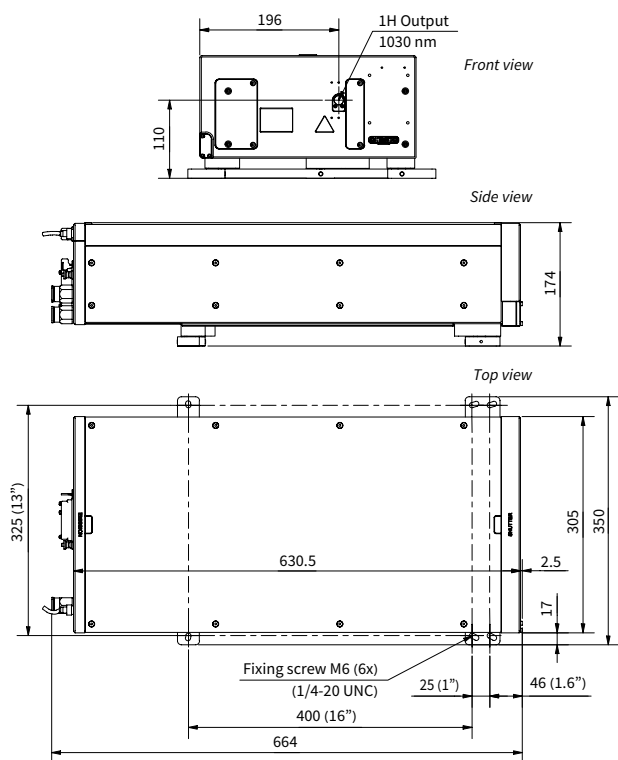


CARBIDE-CB3 output power and beam direction with power lock enabled, under varying environmental conditions

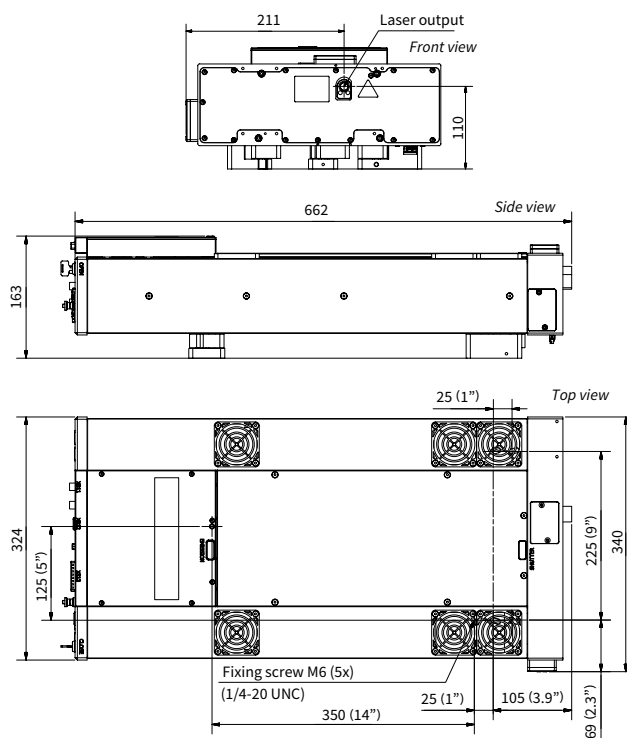


Typical pulse-to-pulse energy stability

DRAWINGS



Drawing of CARBIDE-CB3



Drawing of air-cooled CARBIDE-CB5 with attenuator

CARBIDE | CB3-UV

NEW

High-Power UV Femtosecond Lasers

FEATURES

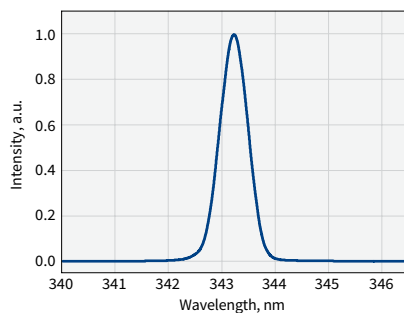
- Maximum output of 50 W
- 500 fs pulse duration
- Up to MHz repetition rate
- High beam quality and stability
- Compact industrial-grade design



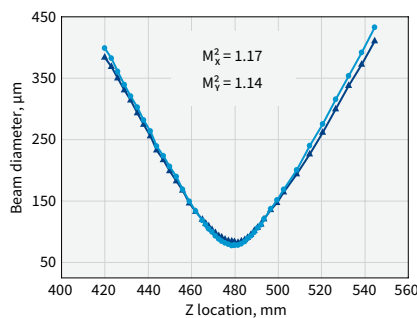
CARBIDE-CB3-UV

CARBIDE-CB3-UV is a series of femtosecond lasers for high-power ultraviolet (UV) applications. As indicated by its name, the CARBIDE-CB3-UV laser is based on a market-proven industrial-grade CARBIDE laser platform. It emits 500 fs pulses at a 343 nm wavelength and fits into the footprint of $84 \times 35 \text{ cm}^2$, making it the most compact 50 W UV femtosecond laser currently available in the market.

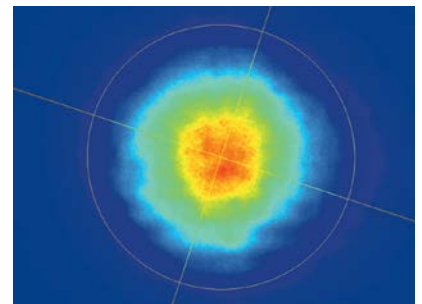
The CARBIDE-CB3-UV ensures long-term performance without the need for user intervention. The high power comes with the advantage of splitting the beam into multiple parts, thereby parallelizing the micromachining processes and subsequently increasing throughput. The CARBIDE platform ensures simple integration into industrial 24/7 workstations.



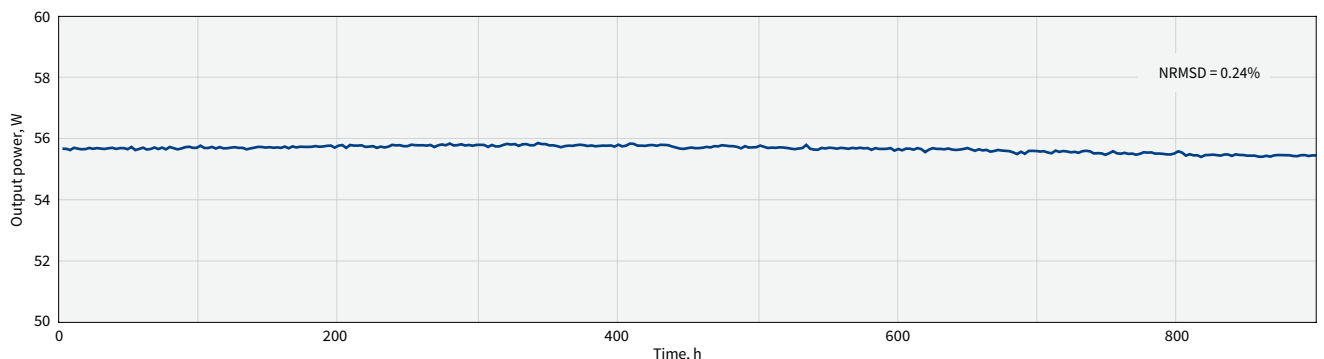
Typical spectrum of CARBIDE-CB3-UV



Typical M^2 measurement data of CARBIDE-CB3-UV



Beam profile of CARBIDE-CB3-UV-50W



Long-term power stability of CARBIDE-CB3-UV-50W

SPECIFICATIONS

Model	CB3-UV-30W	CB3-UV-50W
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NEW

OUTPUT CHARACTERISTICS

Cooling method	Water-cooled	
Center wavelength	343 ± 3 nm	
Maximum output power	> 30 W	> 50 W
Pulse duration ¹⁾	≈ 500 fs	
Output pulse energy	35 – 150 μJ	
Repetition rate	200 – 800 kHz	300 – 1200 kHz
Polarization	Linear, vertical; 1 : 200	
Beam quality, M ²	< 1.3	
Beam diameter ²⁾	2.5 – 5 mm	
Long-term power stability, 12 h ³⁾	< 0.5%	
Lifetime	10000 h or 1 year	

MAIN OPTIONS

Optional amplifier outputs	1030 nm, 515 nm
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PHYSICAL DIMENSIONS

Laser head (L × W × H)	832 × 350 × 174 mm
Chiller (L × W × H)	680 × 484 × 307 mm
24 V DC power supply (L × W × H)	320 × 200 × 75 mm

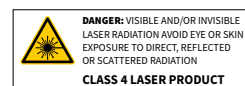
ENVIRONMENTAL AND UTILITY REQUIREMENTS

Operating temperature	15 – 30 °C	
Relative humidity	< 80% (non-condensing)	
Electrical requirements	Laser	100 V AC, 12 A – 240 V AC, 5 A
	Chiller	200 – 230 V AC; 50 – 60 Hz
Rated power	Laser	1000 W
	Chiller	2000 W
Power consumption	Laser	900 W
	Chiller	1300 W

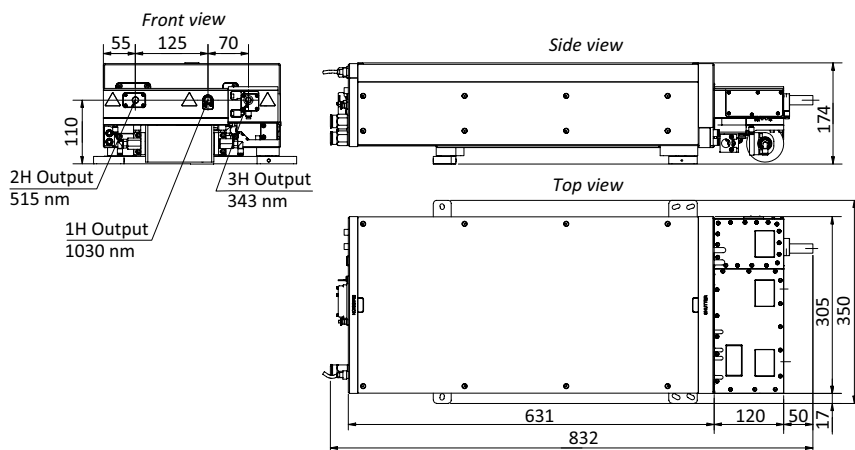
¹⁾ Assuming Gaussian pulse shape.

²⁾ FW 1/e², using maximum pulse energy.

³⁾ Under stable environmental conditions. Expressed as NRMSD (normalized root mean squared deviation).



DRAWINGS



Drawing of CARBIDE-CB3-UV

BiBurst option

Tunable GHz and MHz Burst with Burst-in-Burst Capability

PHAROS and CARBIDE-CB3 lasers have an option for tunable GHz and MHz burst with burst-in-burst capability – called BiBurst.

In standard mode, a single pulse is emitted at some fixed frequency. In burst mode, the output consists of pulse packets instead of single pulses. Each packet consists of a certain number of equally separated pulses. MHz-Burst contains N pulses with a nanosecond period, GHz-Burst contains P pulses with a picosecond period. If both bursts are used, the equally separated pulse packets contain sub-packets of pulses (burst-in-burst, BiBurst).

PHAROS and CARBIDE lasers with the BiBurst option bring new capabilities to high-tech manufacturing industries such as consumer electronics, integrated photonic chip manufacturing, future display manufacturing, and quantum technologies. The applications include:

- brittle material drilling and cutting
- deep engraving
- selective ablation
- volume modification of transparent materials
- hidden marking
- surface polishing
- surface functionalization

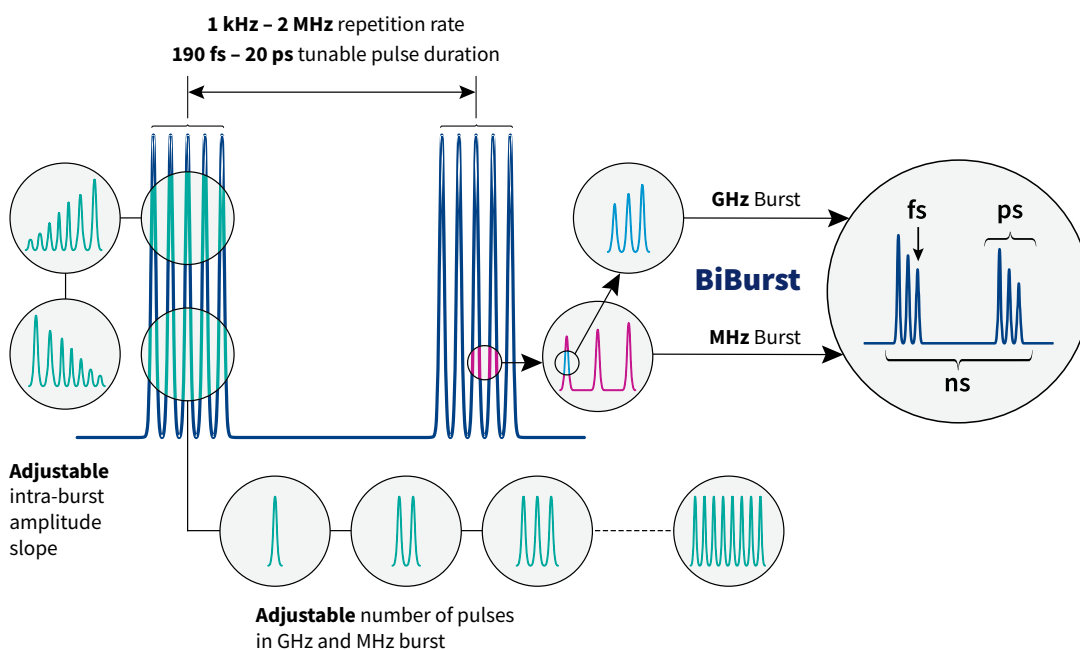
SPECIFICATIONS

Model		CARBIDE-CB3	PHAROS
GHz Burst	Intra burst pulse period ¹⁾	440 ± 40 ps	200 ± 40 ps
	Number of pulses, P ²⁾	1 – 10	1 – 25
MHz Burst	Intra burst pulse period	≈ 15 ns	
	Number of pulses, N	1 – 10	1 – 9 (7 with FEC ³⁾)

¹⁾ Custom spacing is available on request.

²⁾ Maximum number of pulses in a burst depends on the laser repetition rate and the energy. Custom number of pulses is available on request.

³⁾ Fast energy control option. Enables formation of any pulse envelope at laser pulse repetition rate.



HG | CARBIDE

Automated Harmonic Generators

FEATURES

- 515 nm, 343 nm, or 257 nm output
- Automated harmonic selection
- Mounted directly on the laser head
- Industrial-grade design
- 50 W UV model



CARBIDE-CB3 with 2H-3H

CARBIDE lasers equipped with automated harmonic generators (HGs) provide a selection of fundamental (1030 nm), second (515 nm), third (343 nm), or fourth (257 nm) harmonic outputs using software control.

HGs are perfect for industrial applications that require a single-wavelength output. Modules, mounted directly at the output of the laser, are fully integrated into the system.

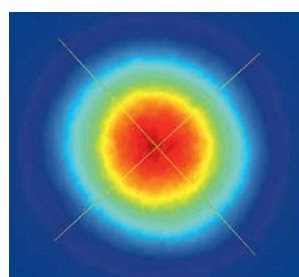
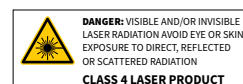
SPECIFICATIONS

Model	2H	2H-3H	2H-4H	30W UV ¹⁾	50W UV ¹⁾
Output wavelength ²⁾ (automated selection)	1030 nm 515 nm	1030 nm 515 nm 343 nm	1030 nm 515 nm 257 nm	1030 nm 515 nm 343 nm	1030 nm 343 nm
Pump pulse energy	20 – 2000 μ J	50 – 2000 μ J	20 – 2000 μ J	80 – 400 μ J	120 – 400 μ J
Pump pulse duration	< 300 fs			\approx 500 fs	
Conversion efficiency / Output power	> 50% (2H)	> 50% (2H) > 25% (3H)	> 50% (2H) > 10% (4H) ³⁾	40 W (2H) 30 W (3H)	50 W (3H)
Beam quality (M^2) typical values	\leq 400 μ J pump	< 1.15 (2H) < 1.2 (3H)	< 1.15 (2H) n/a (4H)	< 1.2 (2H) < 1.3 (3H)	< 1.3 (3H)
	> 400 μ J pump	< 1.2 (2H) < 1.3 (3H)	< 1.2 (2H) n/a (4H)	n/a	

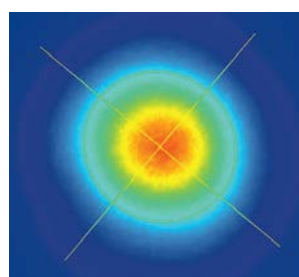
¹⁾ Refer to CARBIDE-CB3-UV for more details.

²⁾ Depends on pump laser model. Up to 5th harmonic available; contact sales@lightcon.com for details.

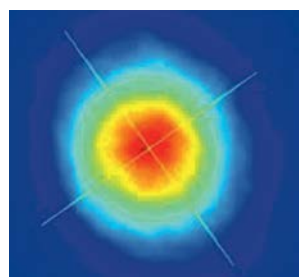
³⁾ Maximum output power of 2 W.



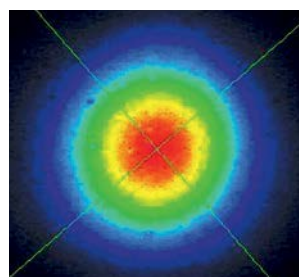
Typical 1H beam profile
of CARBIDE-CB5 (100 kHz, 6 W)



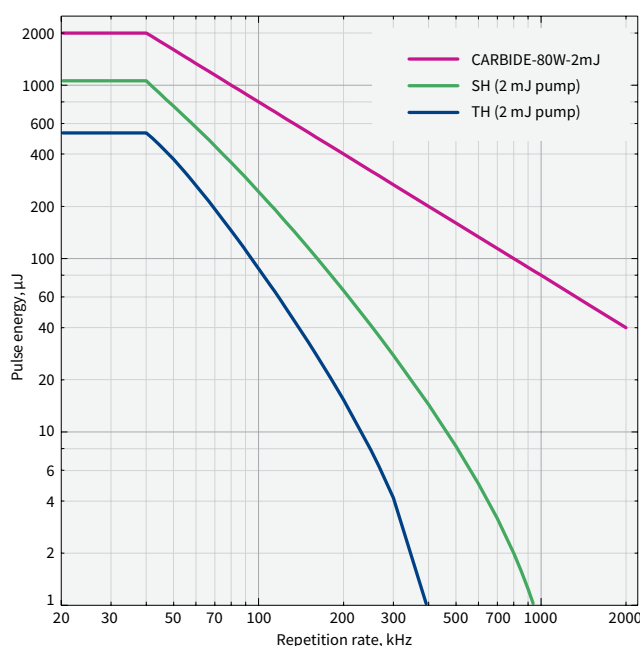
Typical 2H beam profile
of CARBIDE-CB5 (100 kHz, 3.4 W)



Typical 3H beam profile
of CARBIDE-CB5 (100 kHz, 2.2 W)



Typical 4H beam profile
of CARBIDE-CB5 (100 kHz, 100 mW)



Pulse energy vs repetition rate of CARBIDE-CB3-80W with HG

I-OPA

Industrial-Grade Optical Parametric Amplifier

FEATURES

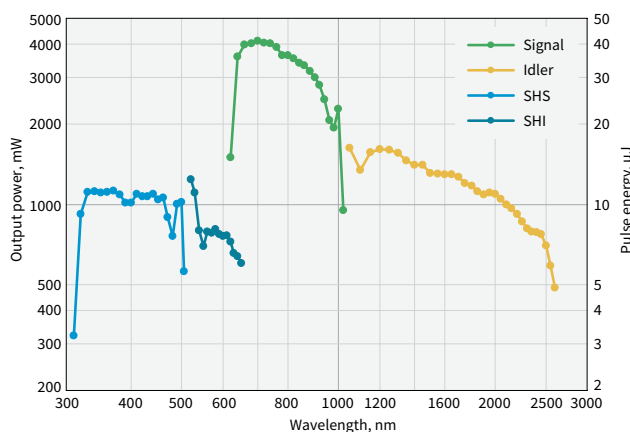
- Wavelength tunability in an industrial design
- Single-box solution
- Tunable or fixed-wavelength models
- Plug-and-play installation and robust performance
- The most compact OPA in the market



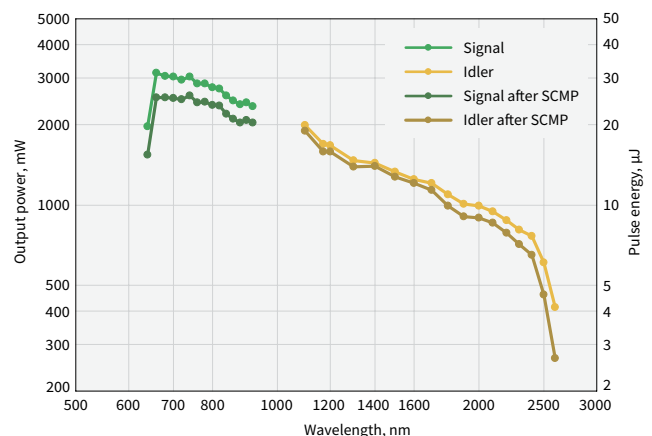
I-OPA-TW on air-cooled CARBIDE-CB5

The industrial-grade optical parametric amplifier I-OPA series marks a new era of simplicity in the world of wavelength-tunable femtosecond sources. Based on decades of experience with optical parametric amplifiers, this solution combines wavelength tunability with robust industrial design. The I-OPA is a rugged module integrated into our PHAROS or CARBIDE lasers, providing stability comparable to that of industrial harmonic generators. The sealed design provides mechanical stability and eliminates the effects of air turbulence, minimizing energy fluctuations and ensuring stable long-term performance.

The tunable I-OPA provides a wide tuning range and is primarily intended for spectroscopy and microscopy applications. In particular, the -HP model is targeted to be coupled with our HARPIA spectroscopy system as a pump beam source for ultrafast pump-probe spectroscopy. The -F model is primarily designed as a light source for multiphoton microscopy, the -ONE model – for IR spectroscopy, and other applications where high-energy MIR pulses are desired. All models can also be used for micromachining and other industrial applications. The fixed-wavelength I-OPA is a cost-effective solution when a single wavelength is desired.



Typical I-OPA-TW-HP tuning curves.
Pump: 40 W, 400 μ J, 100 kHz



Typical I-OPA-TW-F tuning curves.
Pump: 40 W, 400 μ J, 100 kHz

SPECIFICATIONS

Model	I-OPA-HP	I-OPA-F	I-OPA-ONE
Configuration	ORPHEUS	ORPHEUS-F	ORPHEUS-ONE
Pump power	Up to 40 W		
Pump pulse energy	20 – 400 μ J		
Repetition rate	Up to 2 MHz		
Tuning range ¹⁾	640 – 1010 nm (Signal) 1050 – 2600 nm (Idler)	650 – 920 nm (Signal) 1200 – 2500 nm (Idler)	1350 – 2000 nm (Signal) 2100 – 4500 nm (Idler)
Conversion efficiency	> 7% @ 700 nm (40 – 400 μ J pump; up to 1 MHz)		> 9% @ 1550 nm (40 – 400 μ J pump; up to 1 MHz)
	> 3.5% @ 700 nm (20 – 40 μ J pump; up to 2 MHz)		> 6% @ 1550 nm (20 – 40 μ J pump; up to 2 MHz)
Spectral bandwidth ²⁾	80 – 220 cm^{-1} @ 700 – 960 nm	200 – 1000 cm^{-1} @ 650 – 920 nm 150 – 1000 cm^{-1} @ 1200 – 2000 nm	60 – 150 cm^{-1} @ 1450 – 2000 nm
Pulse duration ^{2) 3)}	120 – 250 fs	< 55 fs @ 800 – 920 nm < 70 fs @ 650 – 800 nm < 100 fs @ 1200 – 2000 nm	100 – 300 fs
Long-term power stability, 8 h ⁴⁾	< 1% @ 800 nm		< 1% @ 1550 nm
Pulse-to-pulse energy stability, 1 min ⁴⁾	< 1% @ 800 nm		< 1% @ 1550 nm
Wavelength extension options	320 – 505 nm (SHS) ⁵⁾ 525 – 640 nm (SHI) ⁵⁾	Contact sales@lightcon.com	4500 – 10000 nm (DFG) ⁶⁾
Pulse compression options ²⁾	n/a	SCMP (Signal pulse compressor) ICMP (Idler pulse compressor) GDD-CMP (Compressor with GDD control)	n/a

¹⁾ In case of fixed wavelength (FW), a single wavelength can be selected from the Signal or Idler range.
Signal may have accessible Idler pair, and vice versa.

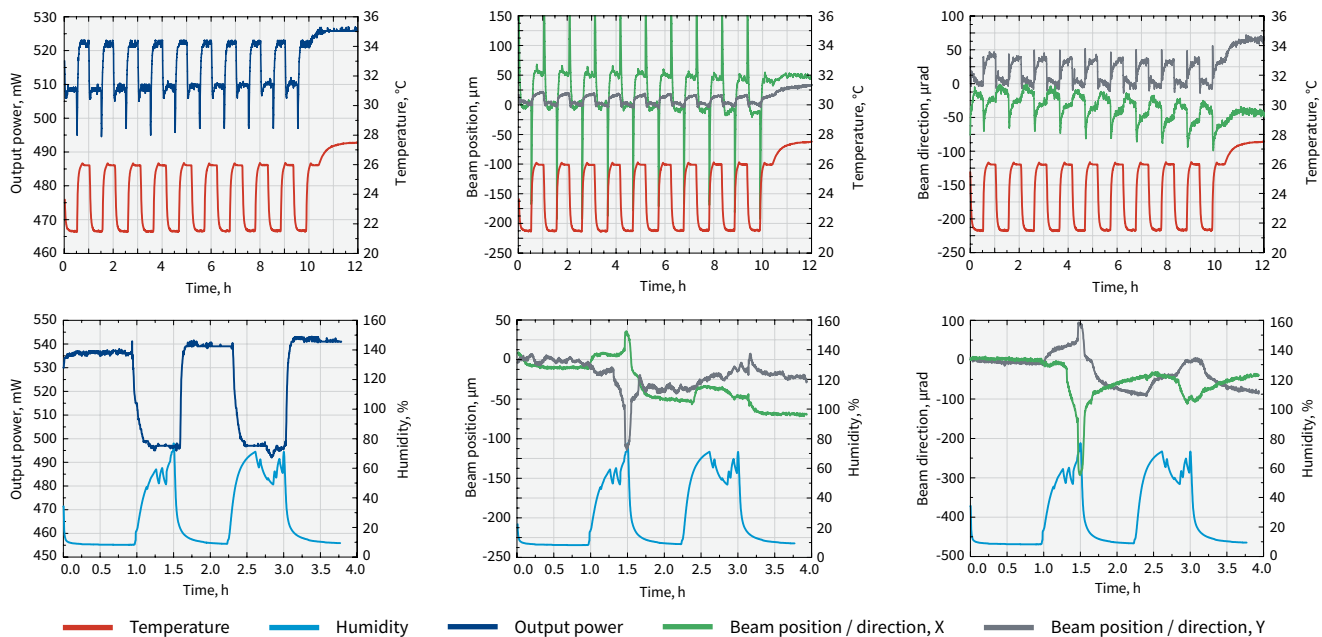
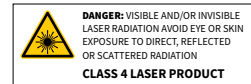
²⁾ I-OPA-F broad-bandwidth pulses are compressed externally. Typical pulse duration before compression:
120 – 250 fs, after compression: 25 – 70 fs @ 650 – 920 nm, 40 – 100 fs @ 1200 – 2000 nm.

³⁾ Output pulse duration depends on the selected wavelength and pump laser pulse duration.

⁴⁾ Expressed as NRMSD (normalized root mean squared deviation).

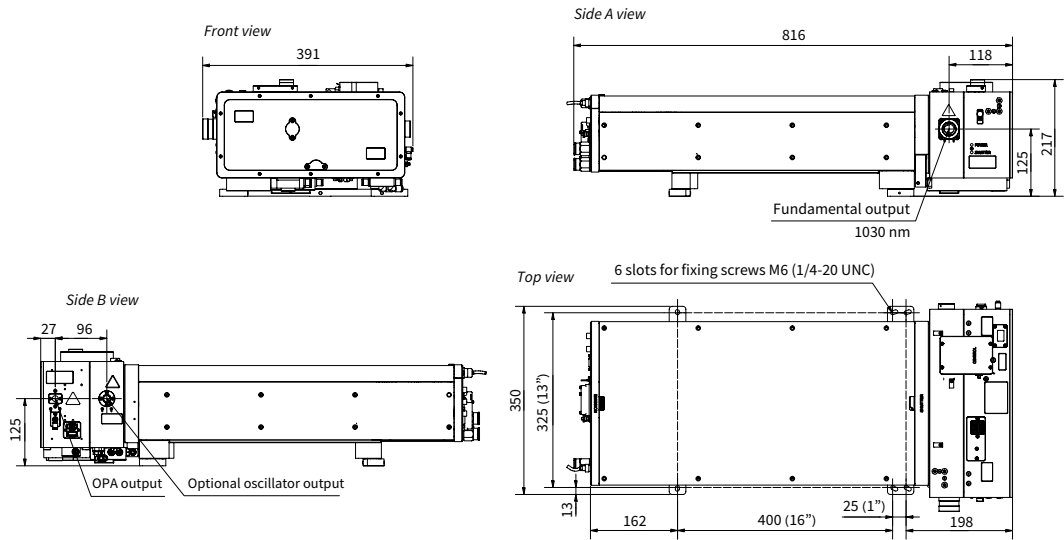
⁵⁾ Conversion efficiency is 1.2% at peak; specified as the percentage of pump power.

⁶⁾ Up to 16 μ m tuning range is accessible with an external difference frequency generator.

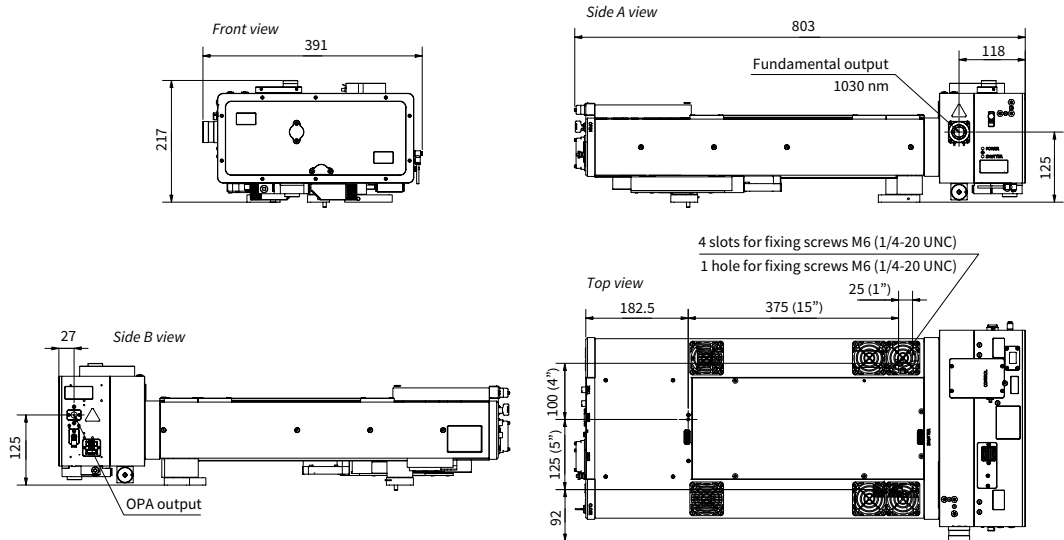


I-OPA output power, beam position, and beam direction under harsh environmental conditions

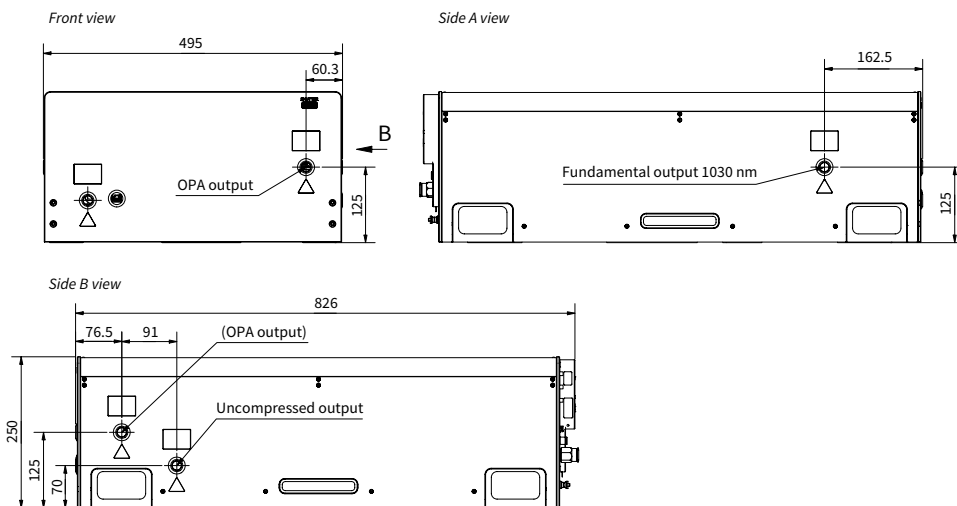
DRAWINGS



Drawing and output ports of CARBIDE-CB3 with wavelength-tunable/fixed I-OPA-HP



Drawing and output ports of CARBIDE-CB5 with wavelength-tunable/fixed I-OPA-HP



Drawing and output ports of PHAROS-PH2 with wavelength-tunable/fixed I-OPA-HP