CARBIDE

Unibody-Design Femtosecond Lasers for Industry and Science

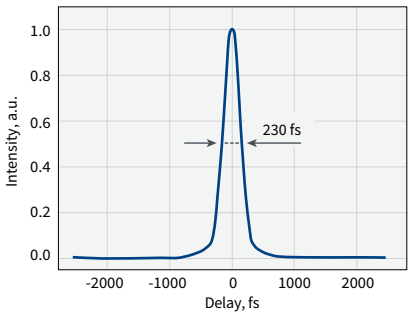
FEATURES

- Tunable pulse duration, 190 fs – 20 ps
- Maximum output of 80 W and 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

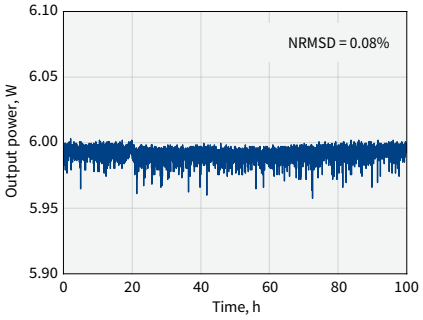
CARBIDE-CB3

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.

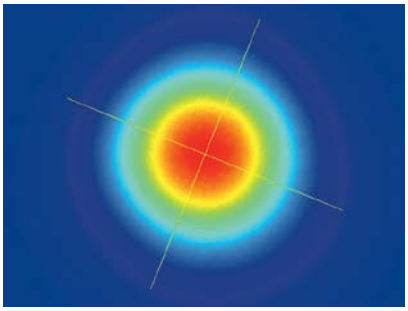
The tunability of CARBIDE lasers enables our customers to discover the most efficient manufacturing processes. Tunable parameters include pulse duration (190 fs – 20 ps), repetition rate (single-shot – 2 MHz), pulse energy (up to 2 mJ), and average power (up to 80 W). A pulse-on-demand mode is available using the built-in pulse picker. The CARBIDE lasers can be equipped with industrial-grade modules, including but not limited to high-power harmonic generators.



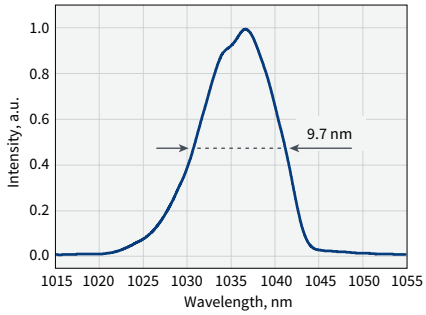
Typical pulse duration of CARBIDE laser



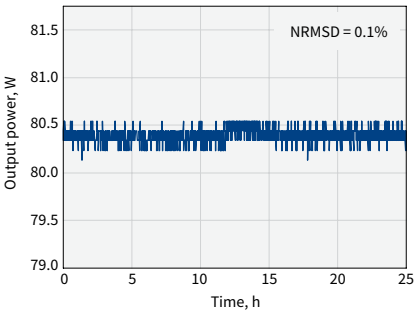
Long-term power stability of CARBIDE-CB5



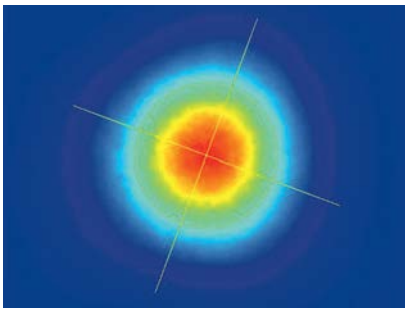
Typical beam profile of CARBIDE-CB5



Typical spectrum of CARBIDE laser



Long-term power stability of CARBIDE-CB3



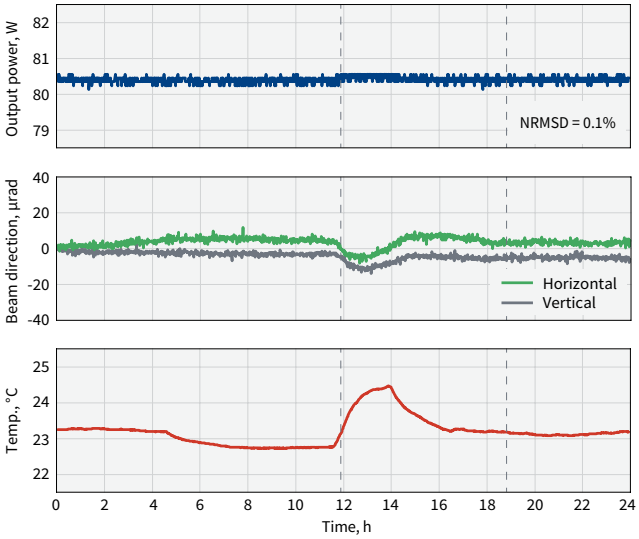
Typical beam profile of CARBIDE-CB3

SPECIFICATIONS

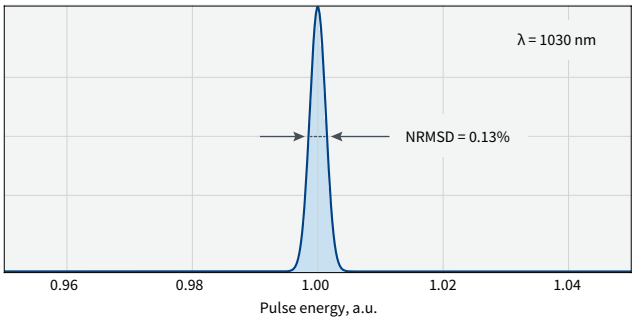
Model	CB3-20W	CB3-40W	CB3-80W		CB5		CB5-SP
OUTPUT CHARACTERISTICS							
Cooling method	Water-cooled				Air-cooled [1]		
Maximum output power	20 W	40 W	80 W		6 W	5 W	
Pulse duration [2]	< 250 fs			< 350 fs	< 290 fs		< 190 fs
Pulse duration tuning range	250 fs – 10 ps			350 fs – 10 ps	290 fs – 20 ps		190 fs – 20 ps
Maximum pulse energy	0.4 mJ		0.8 mJ	2 mJ	100 µJ	83 µJ	100 µJ
Repetition rate	Single-shot – 1 MHz	Single-shot – 1 MHz (2 MHz on request)	Single-shot – 2 MHz		Single-shot – 1 MHz		
Pulse selection	Single-shot, pulse-on-demand, any fundamental repetition rate division						
Center wavelength [3]	1030 ± 10 nm						
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	2.1 ± 0.4 mm		
Beam pointing stability	< 20 µrad/°C						
Pulse picker	FEC [5]				included	included [6]	included
Pulse picker leakage	< 0.5%				< 2%	< 0.1%	< 2%
Pulse-to-pulse energy stability [7]	< 0.5% RMS deviation [8] over 24 h						
Long-term power stability [7]	< 0.5% RMS deviation [8] over 100 h						
MAIN OPTIONS							
Oscillator output	< 0.5 W, 120 – 250 fs, 1030 ± 10 nm, ≈ 65 MHz [9]				n/a		
Harmonic generator [10]	515 nm, 343 nm, 257 nm, or 206 nm; *see page 19*						
Optical parametric amplifier [10] [11]	320 – 10000 nm; *see page 26*						
BiBurst option [10]	Tunable GHz and MHz burst with burst-in-burst capability; *see page 13*			n/a			
PHYSICAL DIMENSIONS							
Laser head (L × W × H)	632 × 305 × 173 mm				631 × 324 × 167 mm		
Chiller (L × W × H)	680 × 484 × 307 mm				Not required		
24 V DC power supply (L × W × H)	280 × 144 × 49 mm		320 × 200 × 75 mm		220 × 95 × 46 mm		
ENVIRONMENTAL & UTILITY REQUIREMENTS							
Operating temperature	15 – 30 °C (59 – 86 °F)				17 – 27 °C (62 – 80 °F)		
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		100 V AC, 3 A – 240 V AC, 1.3 A; 50 – 60 Hz		
Electrical requirements – Chiller	100 – 230 V AC; 50 – 60 Hz		200 – 230 V AC; 50 – 60 Hz		not required		
Rated power – Laser	600 W		1000 W		300 W		
Rated power – Chiller	1400 W		2000 W		not required		

1) *Water-cooled version available on request.*
2) *Assuming Gaussian pulse shape.*
3) *Precise center wavelength for specific models available upon request.*
4) *FW $1/e^2$, using maximum pulse energy.*
5) *Provides fast energy control; external analog control input available. Response time – next available RA pulse.*
6) *Enhanced contrast AOM. Provides fast amplitude control of output pulse train.*
7) *Under stable environmental conditions.*
8) *Normalized to average pulse energy, NRMSD.*
9) *Available simultaneously, requires scientific interface. Contact sales@lightcon.com for details or customized solutions.*
10) *Integrated. For external harmonic generator, refer to HIRO.*
11) *Integrated. For external OPA refer to ORPHEUS OPAs.*

STABILITY MEASUREMENTS

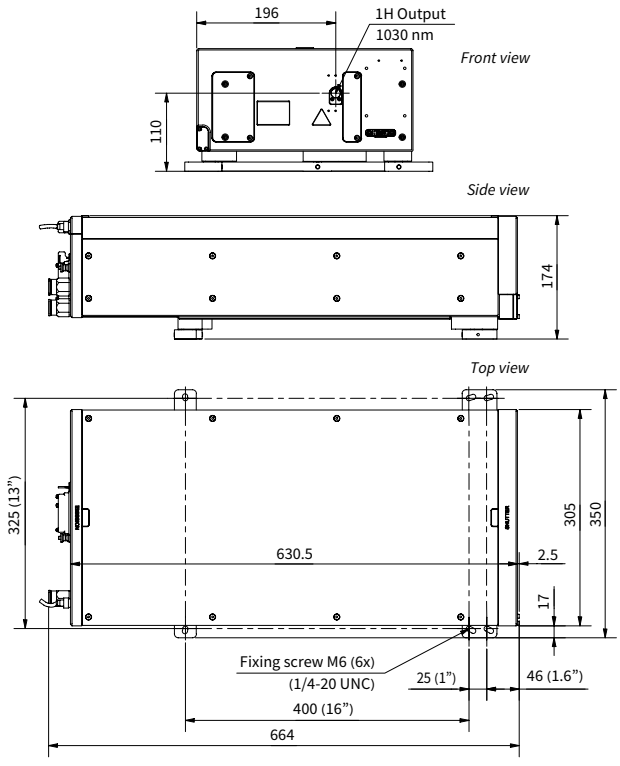


CARBIDE-CB3 output power and beam direction with power lock enabled, under varying environmental conditions

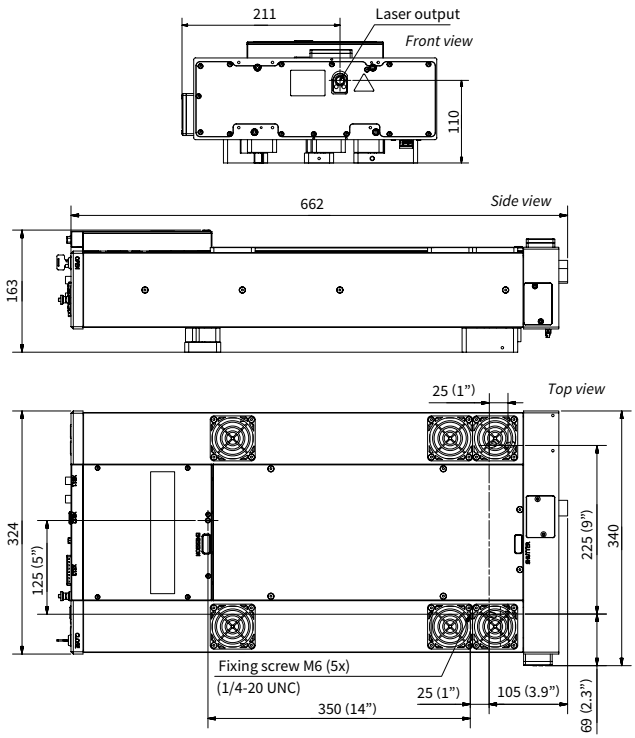


Typical pulse-to-pulse energy stability

DRAWINGS



Drawing of CARBIDE-CB3



Drawing of air-cooled CARBIDE-CB5 with attenuator

CARBIDE | 120W IR

NEW

High-Power IR Femtosecond Laser

CARBIDE-CB3-120W

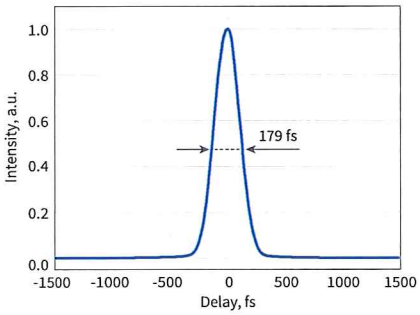
FEATURES

- Maximum output of 120 W and 1 mJ
- Tunable pulse duration, 190 fs – 20 ps
- Pulse-on-demand and BiBurst for pulse control
- Up to 5th harmonic or tunable extensions
- Compact industrial-grade design

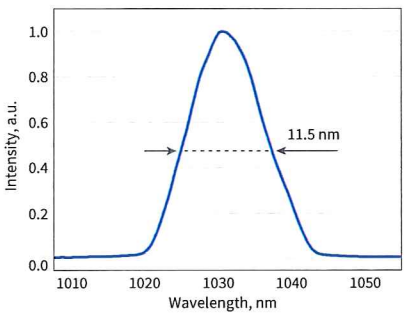
SPECIFICATIONS

Model	CB3-120W
OUTPUT CHARACTERISTICS	
Cooling method	Water-cooled
Maximum output power	120 W
Pulse duration [1]	< 250 fs
Pulse duration tuning range	250 fs – 10 ps
Maximum pulse energy	1 mJ
Repetition rate	120 – 2000 kHz
Pulse selection	Single-shot, pulse-on-demand, any fundamental repetition rate division
Center wavelength [2]	1030 ± 10 nm
Polarization	Linear, vertical; 1 : 1000
Beam quality, M^2	< 1.2
Beam diameter [3]	4.5 ± 0.5 mm
Beam pointing stability	< 20 µrad/°C
Pulse picker	FEC [4]
Pulse picker leakage	< 0.25 %
Pulse-to-pulse energy stability [5]	< 0.5% RMS deviation [6] over 24 h
Long-term power stability [5]	< 0.5% RMS deviation [6] over 100 h
MAIN OPTIONS	
Oscillator output	< 0.5 W, 120 – 250 fs, 1030 ± 10 nm, ≈ 65 MHz [7]
Automated harmonic generator [8]	515 nm, 343 nm, 257 nm, or 206 nm
BiBurst option [8]	Tunable GHz and MHz burst with burst-in-burst capability

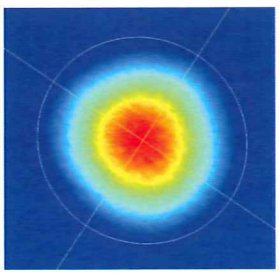
1) *Assuming Gaussian pulse shape.*
2) *Precise center wavelength for specific models available upon request.*
3) *FW 1/e², using maximum pulse energy.*
4) *Provides fast energy control; external analog control input available. Response time – next available RA pulse.*
5) *Under stable environmental conditions.*
6) *Expressed as NRMSD (normalized root mean squared deviation).*
7) *Available simultaneously, requires scientific interface. Contact sales@lightcon.com for details or customized solutions*
8) *See respective datasheets for more details, incl. 30 W UV model. For stand-alone harmonic generator, refer to HIRO.*



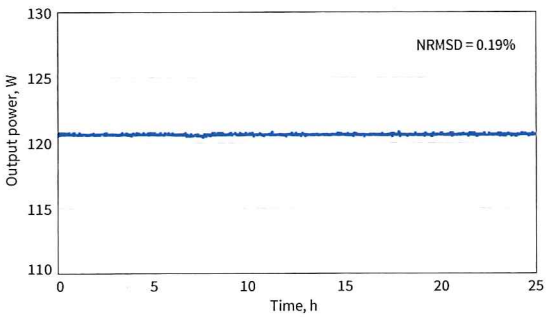
Typical pulse duration of CARBIDE-CB3-120W



Typical spectrum of CARBIDE-CB3-120W



Beam profile of CARBIDE-CB3-120W



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

CARBIDE | 50W UV

NEW

High-Power UV Femtosecond Laser

FEATURES

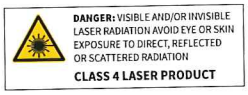
- 343 nm output
- Industrial-grade design
- High beam quality and stability
- Compact footprint

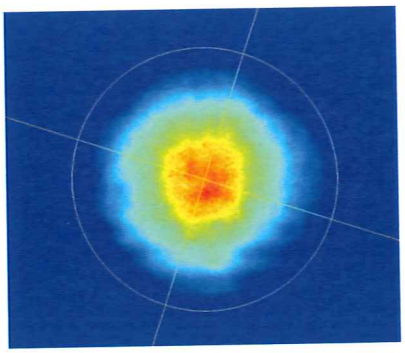
CARBIDE-CB3-50W-UV

SPECIFICATIONS

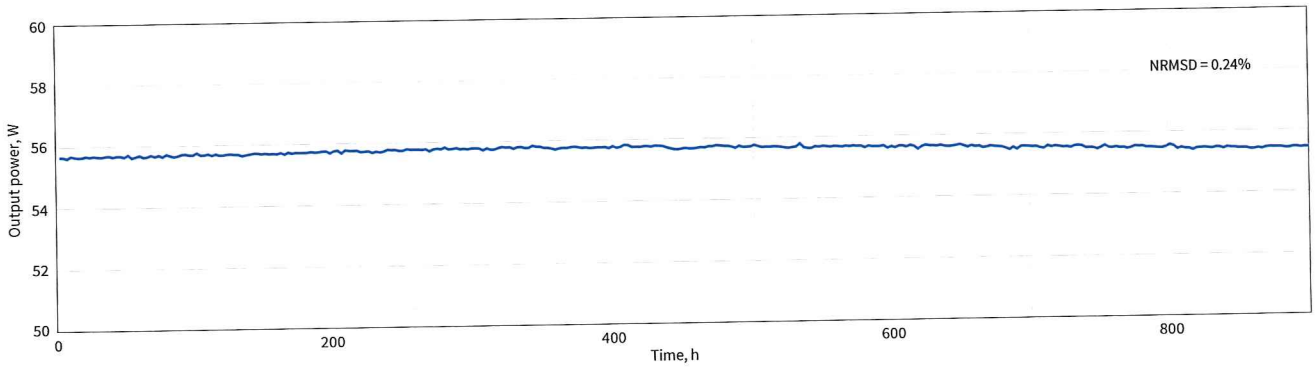
Model	CB3-50W-UV
OUTPUT CHARACTERISTICS	
Output wavelength	343 nm
Maximum output power	50 W
Pulse energy	40 – 160 µJ
Pulse duration [1]	≈ 500 fs
Repetition rate	120 – 1000 kHz
Beam quality, M^2	< 1.3

[1] *Assuming Gaussian pulse shape.*





Beam profile of CARBIDE-CB3-50W-UV



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

HG | CARBIDE

Automated Harmonic Generators

CARBIDE-CB3 with 2H-3H

FEATURES

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

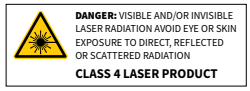
CARBIDE lasers equipped with automated harmonic generators (HGs) provide a selection of fundamental (1030 nm), second (515 nm), third (343 nm), or fourth (257 nm) harmonic outputs using software control.

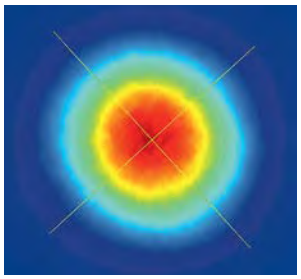
HGs are perfect for industrial applications that require a single-wavelength output. Modules, mounted directly at the output of the laser, are fully integrated into the system.

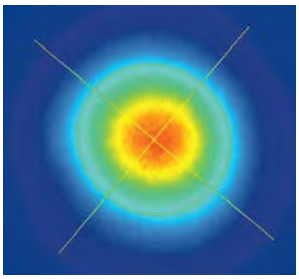
SPECIFICATIONS

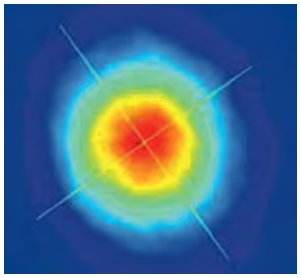
Model		2H	2H-3H	2H-4H	2H-3H (30W UV) [1]
Output wavelength [2] (automated selection)		1030 nm 515 nm	1030 nm 515 nm 343 nm	1030 nm 515 nm 257 nm	1030 nm 515 nm 343 nm
Pump pulse energy		20 – 2000 µJ	50 – 2000 µJ	20 – 2000 µJ	80 – 400 µJ
Pump pulse duration		< 300 fs			≈ 500 fs
Conversion efficiency /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

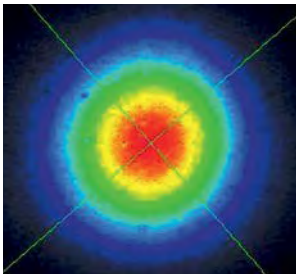
[1] Available only for CARBIDE-CB3-80W with maximum output power; 1 year lifetime.
[2] Depends on pump laser model. Up to 5th harmonic available; contact sales@lightcon.com for details.
[3] Maximum output power of 1 W.

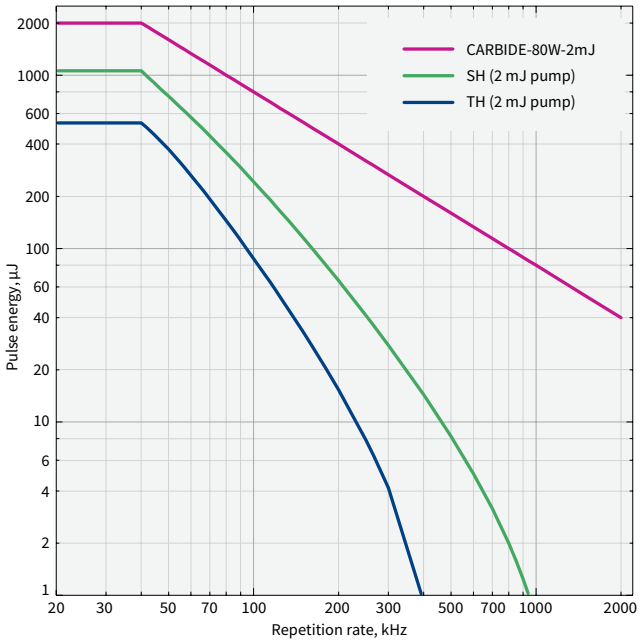



Typical 1H beam profile of CARBIDE-CB5 (100 kHz, 6 W)


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

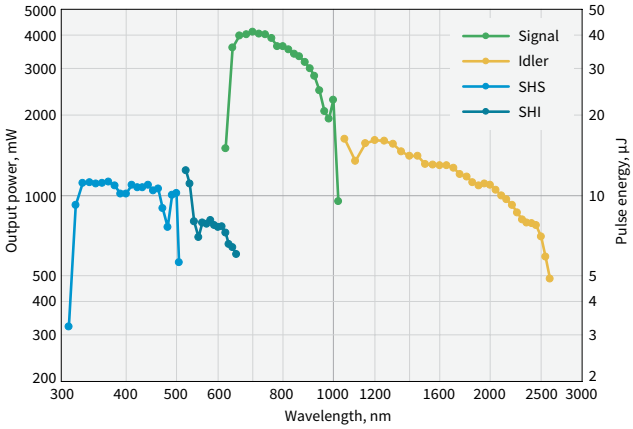
- Wavelength tunability in an industrial design
- Single-box solution
- Tunable or fixed-wavelength models
- Plug-and-play installation and robust performance
- The most compact OPA in the market

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

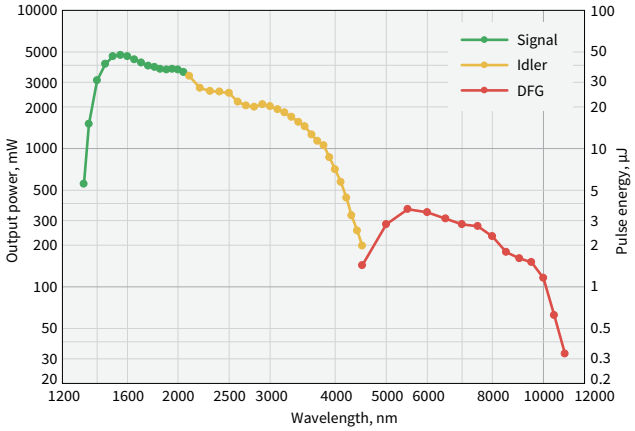
The industrial-grade optical parametric amplifier I-OPA series marks a new era of simplicity in the world of wavelength-tunable femtosecond sources. Based on decades of experience with optical parametric amplifiers, this solution combines wavelength tunability with robust industrial design.

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 µJ, 100 kHz



Typical I-OPA-TW-ONE tuning curves.
Pump: 40 W, 400 µJ, 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 µJ		
Repetition rate	Up to 2 MHz		
Tuning range [1]	640 – 1010 nm (Signal) 1050 – 2600 nm (Idler)	650 – 900 nm (Signal) 1200 – 2500 nm (Idler)	1350 – 2000 nm (Signal) 2100 – 4500 nm (Idler)
Conversion efficiency	> 7% @ 700 nm (40 – 400 µJ pump; up to 1 MHz)		> 9% @ 1550 nm (40 – 400 µJ pump; up to 1 MHz)
	> 3.5% @ 700 nm (20 – 40 µJ pump; up to 2 MHz)		> 6% @ 1550 nm (20 – 40 µJ pump; up to 2 MHz)
Spectral bandwidth [2]	80 – 220 cm^{-1} @ 700 – 960 nm	200 – 1000 cm^{-1} @ 650 – 900 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 – 900 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.*

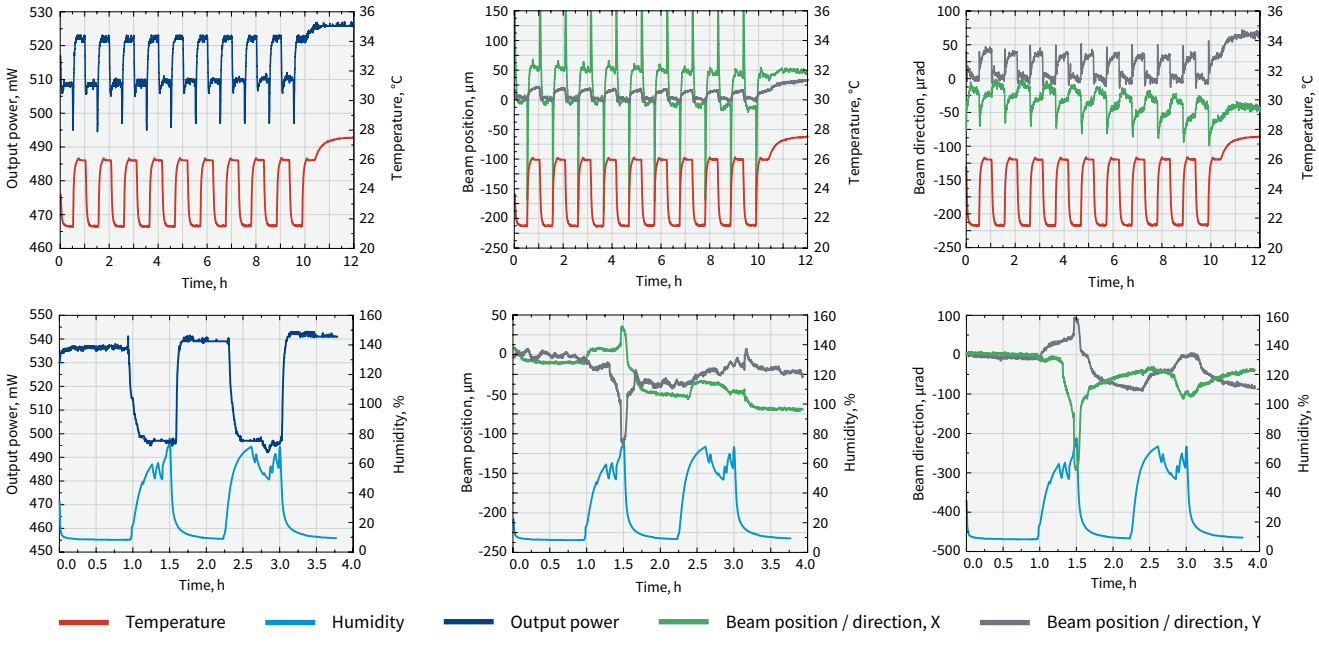
[2] *I-OPA-F broad-bandwidth pulses are compressed externally. Typical pulse duration before compression: 120 – 250 fs, after compression: 25 – 70 fs @ 650 – 900 nm, 40 – 100 fs @ 1200 – 2000 nm.*

[3] *Output pulse duration depends on the selected wavelength and pump laser pulse duration.*

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

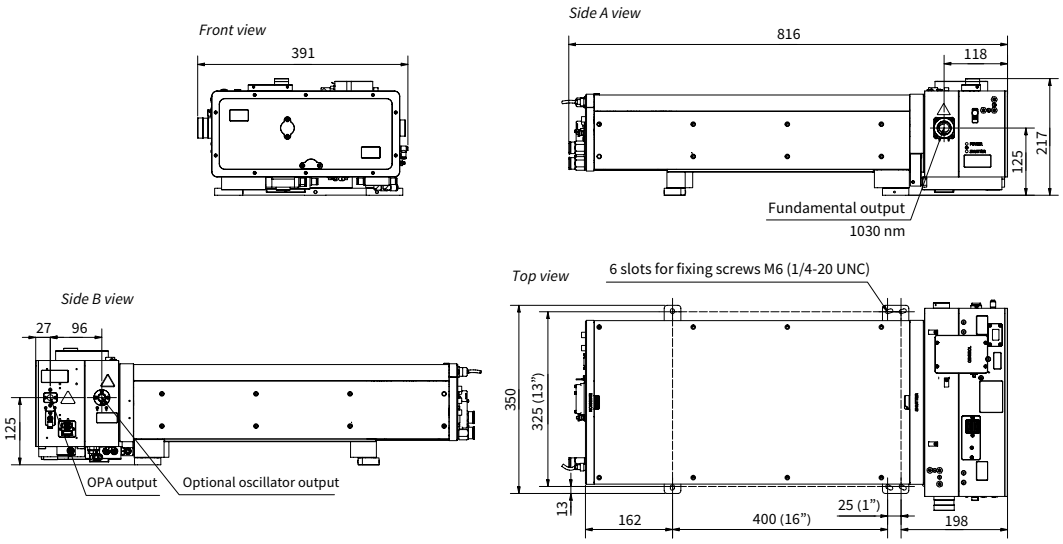
[5] *Conversion efficiency is 1.2% at peak; specified as the percentage of pump power.*

[6] *Up to 16 µm tuning range is accessible with an external difference frequency generator.*

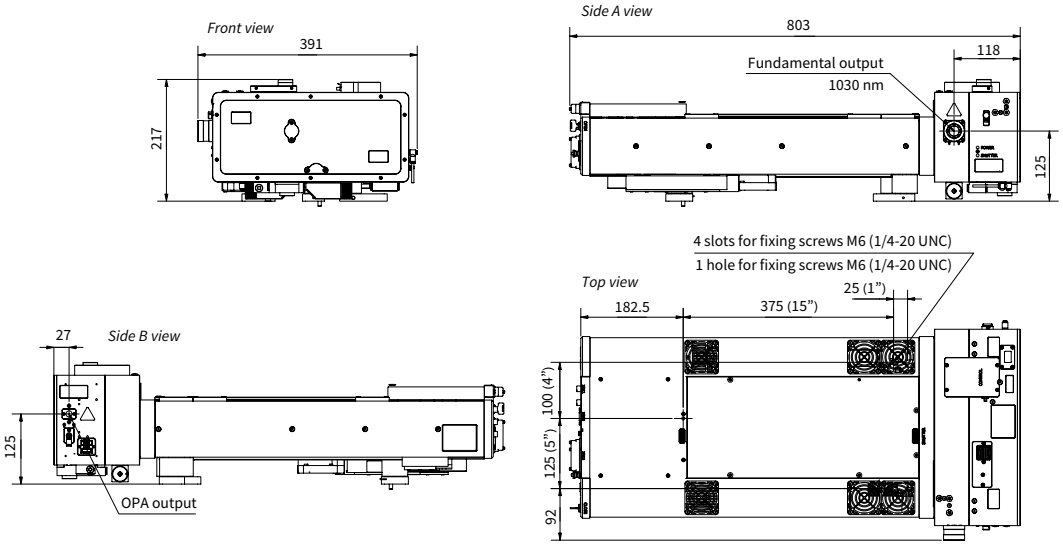


I-OPA (FW) output power, beam position, and beam direction under harsh environmental conditions

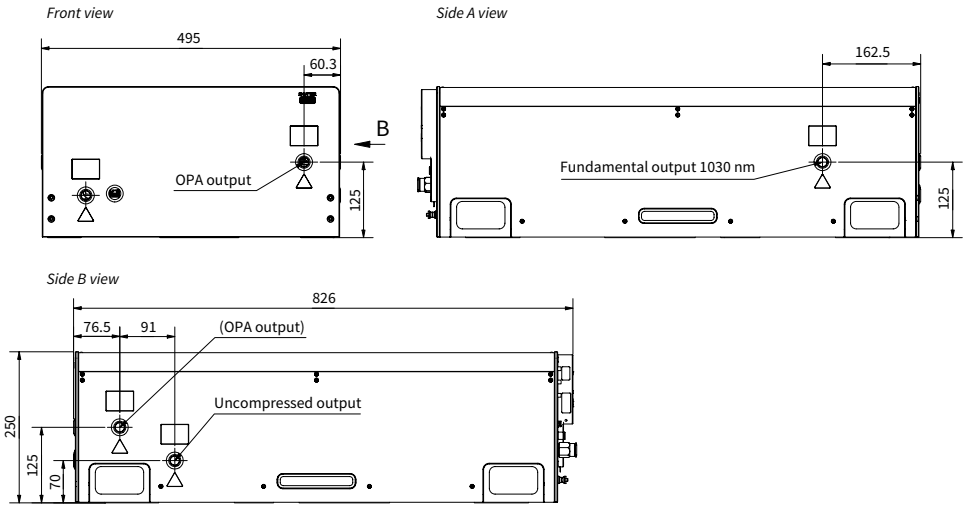
DRAWINGS



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



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



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

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).

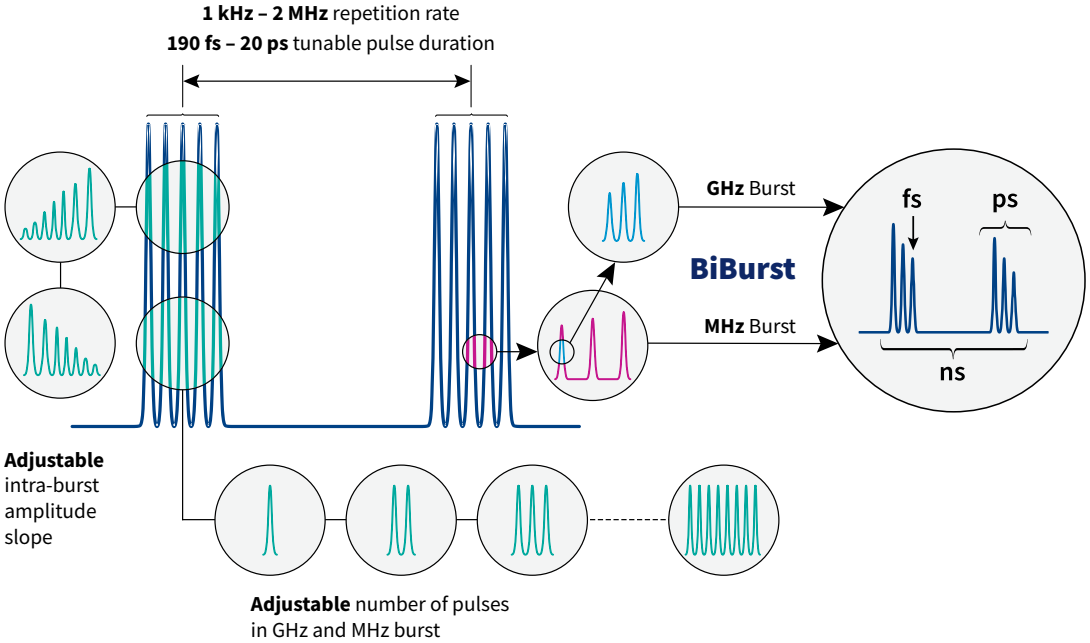
PHAROS and CARBIDE lasers with the BiBurst option bring new capabilities to high-tech manufacturing industries such as consumer electronics, integrated photonic chip manufacturing, future display manufacturing, and quantum technologies. The applications include:

- 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.*



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フォトテクニカ株式会社
〒336-0017 埼玉県さいたま市南区南浦和 1-2-17
TEL:048-871-0067 FAX:048-871-0068
e-mail:voc@phototechnica.co.jp

SCI-M | CARBIDE

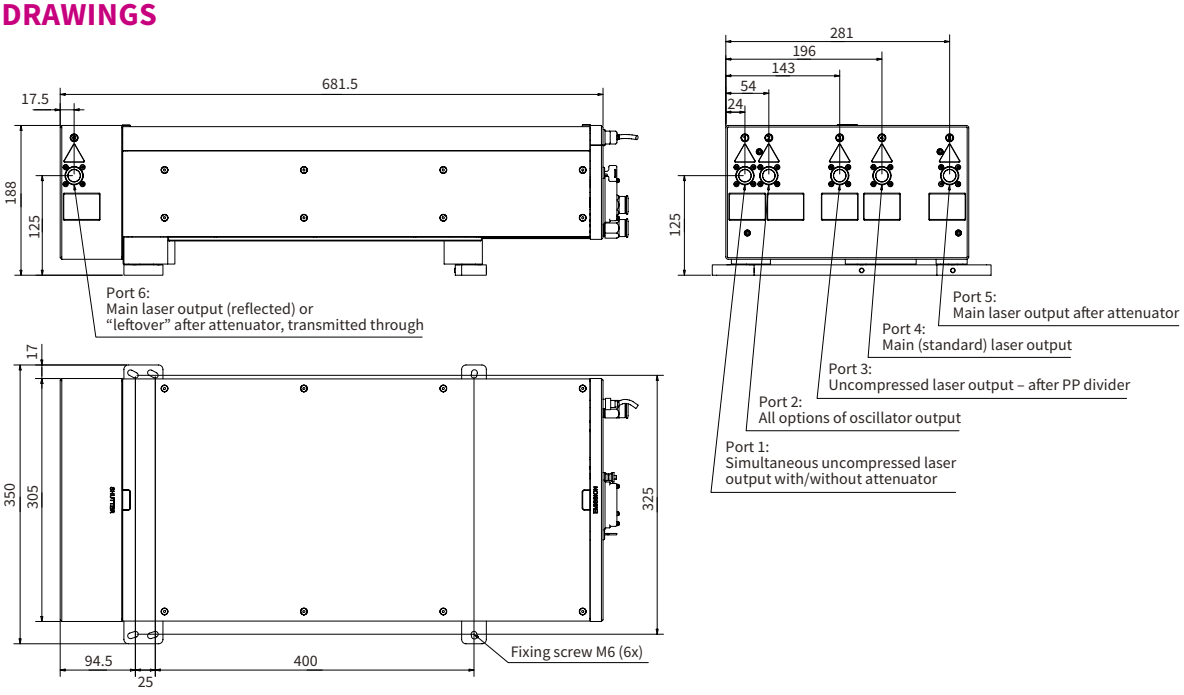
Scientific Interface Module for CARBIDE

FEATURES

- Simultaneous or separate oscillator output
- Uncompressed laser output
- Seeding by an external oscillator
- Beam-splitting options

The CARBIDE scientific interface module extends the versatility of the industrial-grade laser and makes it particularly attractive to scientific applications. This module incorporates multiple options such as a simultaneous or separate oscillator output, a second compressed or uncompressed laser output, and seeding by an external oscillator. For example, using it, the CARBIDE laser can be seeded by an oscillator from another CARBIDE laser, thus ensuring a precise optical synchronization between the two lasers. All the aforementioned outputs can be equipped with automated power attenuators. All options are compatible in between.

DRAWINGS



Drawing of CARBIDE-CB3-40-200 with scientific interface module

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フォトテクニカ株式会社
〒336-0017 埼玉県さいたま市南区南浦和 1-2-17
TEL:048-871-0067 FAX:048-871-0068
e-mail:voc@phototechnica.co.jp