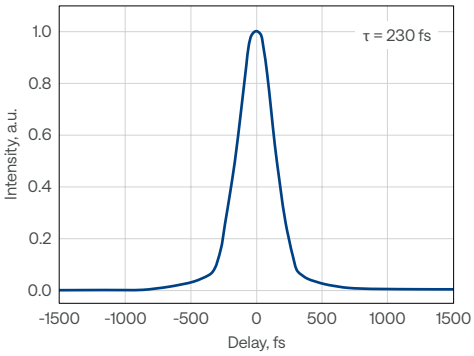
CARBIDE

Unibody-Design Femtosecond Lasers for Industry and Science

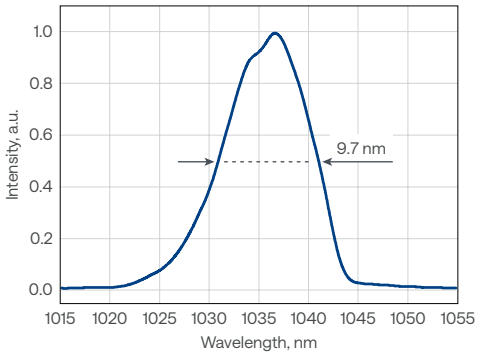
CARBIDE-CB3

- Tunable pulse duration, 190 fs – 20 ps
- Maximum output of 120 W, 1 mJ or 80 W, 2 mJ
- Single-shot – 10 MHz repetition rate (NEW)
- Pulse-on-demand and BiBurst for pulse control
- Up to 5th harmonic or tunable extensions
- Air-cooled and water-cooled models
- Compact industrial-grade design

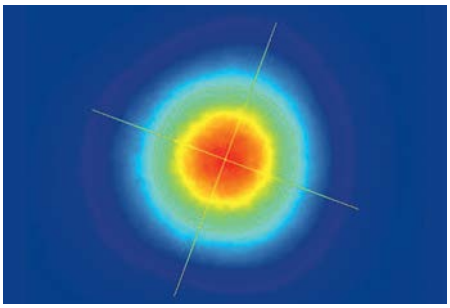
CARBIDE-CB3
Typical pulse duration



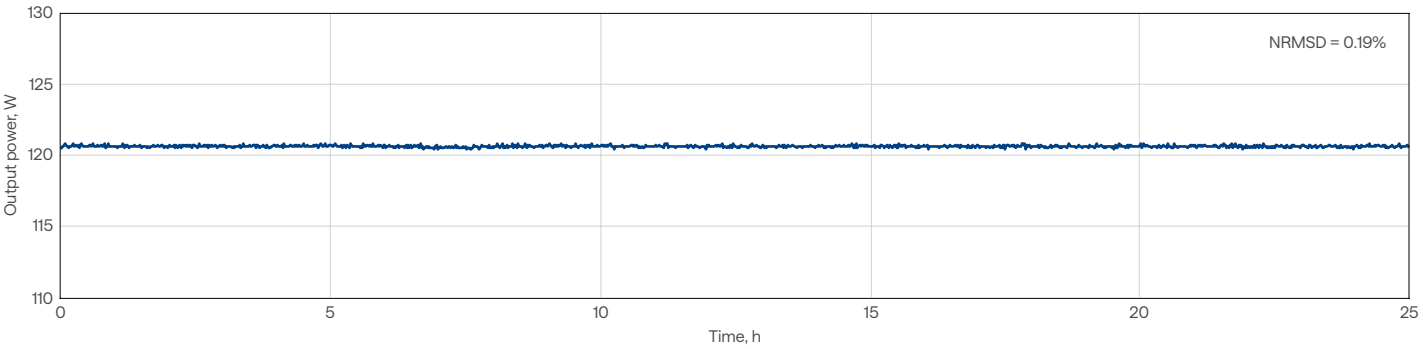
CARBIDE-CB3
Typical spectrum



CARBIDE-CB3
Typical beam profile



CARBIDE-CB3-120W
Long-term power stability



CARBIDE-CB3 specifications

NEW

Model	CB3-20W	CB3-40W	CB3-80W	CB3-120W
OUTPUT CHARACTERISTICS				
Cooling method	Water-cooled			
Center wavelength	1030 ± 10 nm			
Maximum output power	20 W	40 W	80 W	120 W
Pulse duration [1]	< 250 fs		< 350 fs [2]	< 250 fs
Pulse duration tuning range	250 fs – 10 ps		350 fs – 10 ps	250 fs – 10 ps
Maximum pulse energy	0.4 mJ	0.2 mJ	0.8 mJ	2 mJ / 1 mJ
Repetition rate	Single-shot – 1 MHz	Single-shot–1 MHz (2 MHz on request)	Single-shot – 10 MHz	Single-shot – 2 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 [3]	3.9 ± 0.4 mm		4.2 ± 0.4 mm	5.1 ± 0.7 mm / 5 ± 0.5 mm
Beam pointing stability	< 20 µrad/°C			
Pulse energy control	FEC [4]	Attenuator [5]	FEC [4]	
Pulse picker leakage	< 0.25%	< 0.5%	< 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	< 0.5 W, 120 – 250 fs, 1030 ± 10 nm, ≈ 65 MHz [7]			
Harmonic generator [8]	515 nm, 343 nm, 257 nm, or 206 nm; *see page 22*			
Optical parametric amplifier [9]	320 – 10000 nm; *see page 30*			n/a
BiBurst option	Tunable GHz and MHz burst with burst-in-burst capability; *see page 13*			
PHYSICAL DIMENSIONS				
Laser head (L × W × H)	633 × 350 × 174 mm			
Chiller (L × W × H)	585 × 484 × 221 mm		680 × 484 × 307 mm	
24 V DC power supply (L × W × H)	280 × 144 × 49 mm [10]		320 × 200 × 75 mm	376 x 449 x 88 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	100 V AC, 15 A – 240 V AC, 7 A 50 – 60 Hz
Electrical requirements – Chiller	100 – 230 V AC; 50 – 60 Hz		200 – 230 V AC; 50 – 60 Hz	
Rated power – Laser	600 W		1000 W	2000 W
Rated power – Chiller	1400 W		2000 W	
Power consumption – Laser	500 W		900 W	1500 W
Power consumption – Chiller	1000 W		1300 W	1800 W

[1] *Assuming Gaussian pulse shape.*

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

[3] *FW 1/e², using maximum pulse energy.*

[4] *Fast energy control (FEC) provides fast, full-scale individual pulse energy control; an external analog control input is available.*

[5] *Waveplate-based variable optical attenuator (VOA); an external analog control input is available.*

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

[7] *Available simultaneously, requires a scientific interface. Contact sales@lightcon.com for more details or customized solutions.*

[8] *Integrated. For external harmonic generator, refer to HIRO.*

[9] *Integrated. For more options and OPAs, refer to www.lightcon.com.*

[10] *Power supply can be different if optional 2 MHz version is selected.*

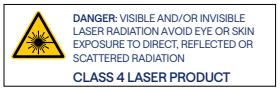
DANGER: VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT, REFLECTED OR SCATTERED RADIATION

CLASS 4 LASER PRODUCT

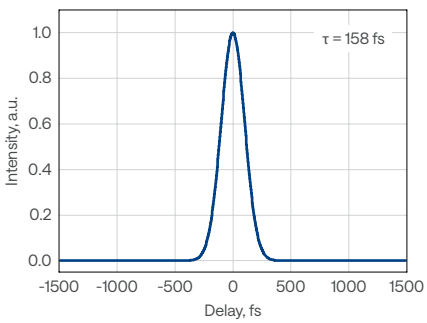
CARBIDE-CB5 (air-cooled) specifications

Model	CB5		CB5-SP
OUTPUT CHARACTERISTICS			
Cooling method	Air-cooled [1]		
Center wavelength	1030 ± 10 nm		
Maximum output power	6 W	5 W	
Pulse duration [2]	< 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 [3]	2.1 ± 0.4 mm		
Beam pointing stability	< 20 µrad/°C		
Pulse energy control	Attenuator [4]	AOM [5]	Attenuator [4]
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 22*		
Optical parametric amplifier [8]	320 – 10000 nm; *see page 30*		
BiBurst option	n/a		
PHYSICAL DIMENSIONS			
Laser head (L × W × H)	633 × 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		

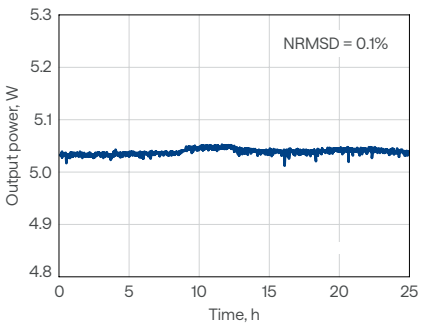
1) *Water-cooled version available on request.*
2) *Assuming Gaussian pulse shape.*
3) *FW 1/e², using maximum pulse energy.*
4) *Waveplate-based variable optical attenuator (VOA); an external analog control input is available.*
5) *Enhanced contrast AOM. Provides fast amplitude control of output pulse train.*
6) *Under stable environmental conditions. Expressed as normalized root mean squared deviation (NRMSD).*
7) *Integrated. For external harmonic generator, refer to HIRO.*
8) *Integrated. For stand-alone OPAs, refer to www.lightcon.com.*



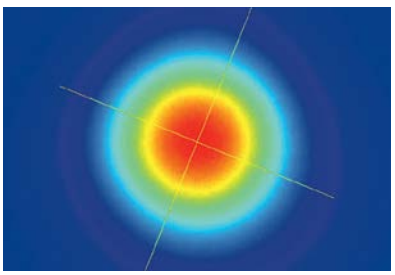
CARBIDE-CB5-SP
Typical pulse duration



CARBIDE-CB5
Long-term power stability

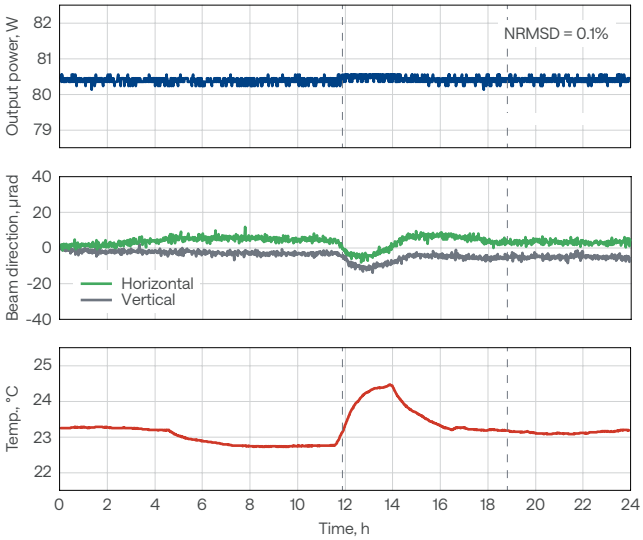


CARBIDE-CB5
Typical beam profile

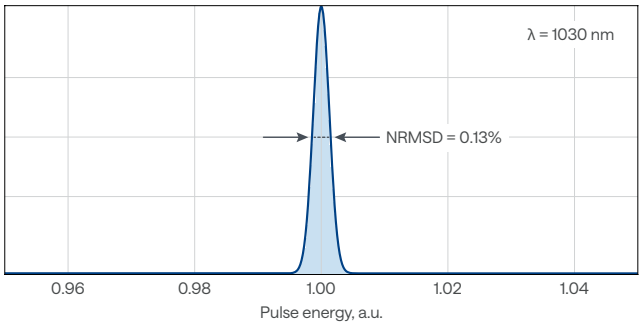


Stability measurements

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

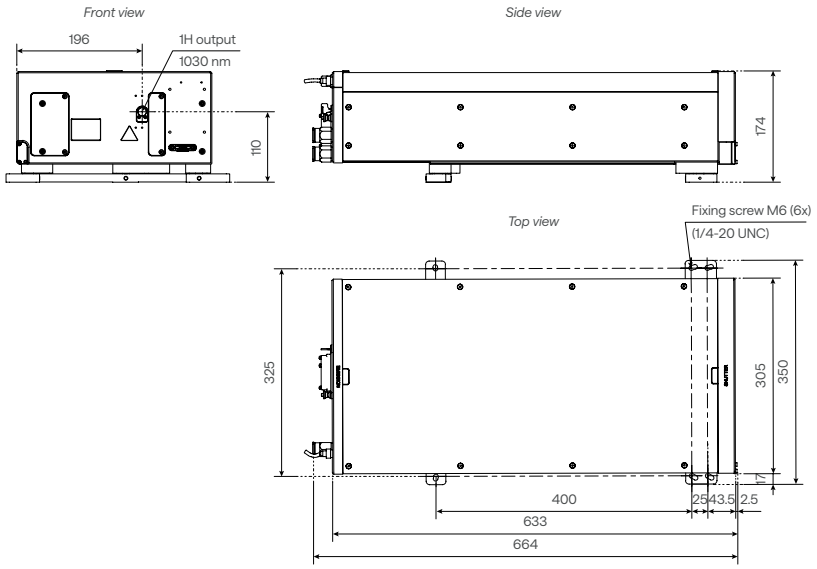


CARBIDE-CB3
Typical pulse-to-pulse energy stability

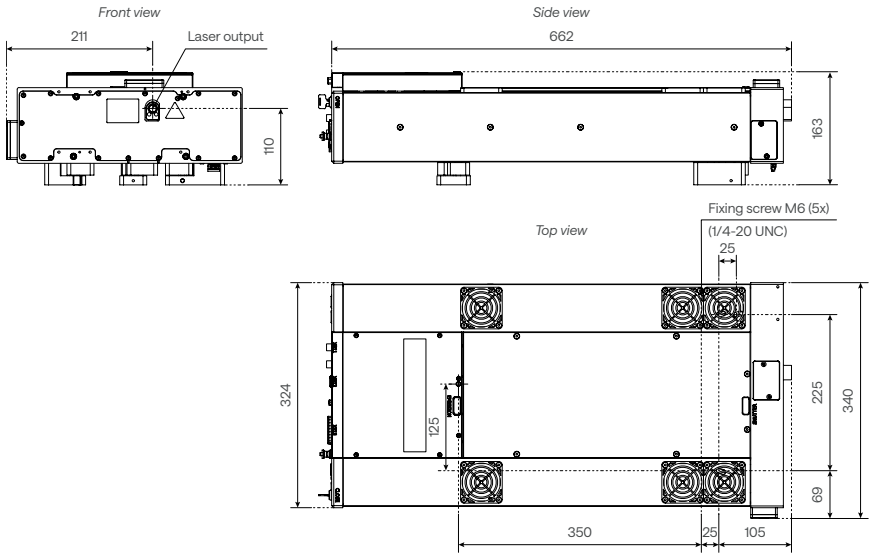


Drawings

CARBIDE-CB3 drawing



Air-cooled **CARBIDE-CB5** with attenuator drawing



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HG | CARBIDE

Automated Harmonic Generators

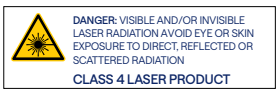
CARBIDE-CB3 with 2H-3H

- 515 nm, 343 nm, 257 nm, or 206 nm output
- Automated harmonic selection
- Mounted directly on the laser head
- Industrial-grade design
- 50 W UV model

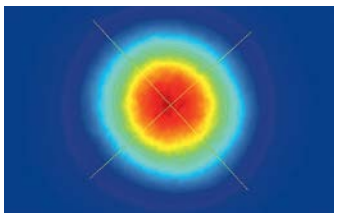
Specifications

Model		2H	2H-3H	2H-4H	2H-5H	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 206 nm	1030 nm 515 nm 343 nm	1030 nm 515 nm 343 nm
Pump pulse energy		20 – 2000 µJ	50 – 2000 µJ	20 – 2000 µJ	100 -1500 µJ	80 – 400 µJ	120 – 400 µJ
Pump pulse duration		< 300 fs				≈ 500 fs	
Conversion efficiency / Output power		> 50% (2H)	> 50% (2H) > 25% (3H)	> 50% (2H) > 10% (4H) [3]	> 50% (2H) > 5% (5H) [4]	30 W (3H)	50 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)	n/a	< 1.3 (3H)	< 1.3 (3H)
	> 400 µJ pump	< 1.2 (2H)	< 1.2 (2H) < 1.3 (3H)	< 1.2 (2H) n/a (4H)	n/a		

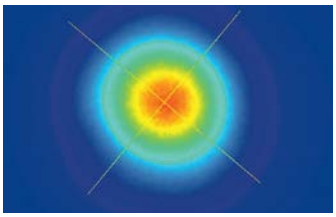
[1] *Refer to CARBIDE-CB3-UV for more details.*
[2] *Depends on pump laser model. Up to 5th harmonic available; contact sales@lightcon.com for more details.*
[3] *Maximum output power of 5 W. More than 4 W is available at 50 – 400 µJ pump energies and ≈ 500 fs pump pulse duration.*
[4] *Maximum output power of 0.2 W.*



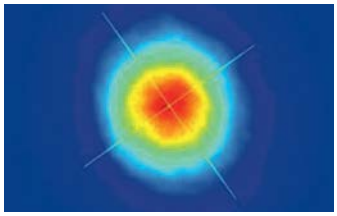
CARBIDE-CB5 (100 kHz, 6 W)
Typical 1H beam profile



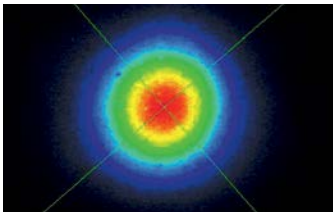
CARBIDE-CB5 (100 kHz, 3.4 W)
Typical 2H beam profile



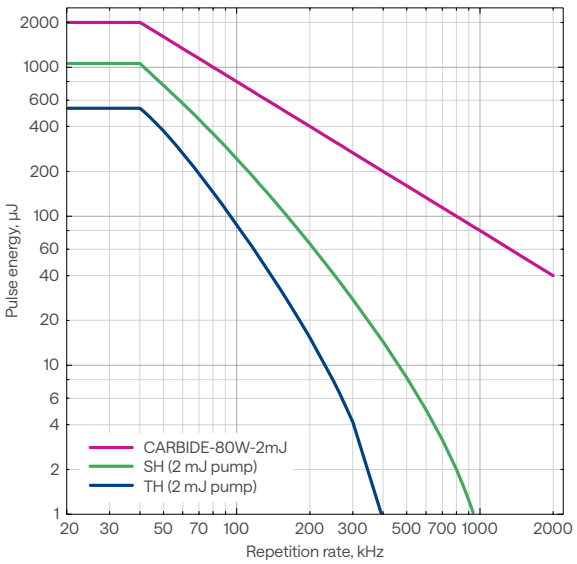
CARBIDE-CB5 (100 kHz, 2.2 W)
Typical 3H beam profile



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



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



LIGHT CONVERSION
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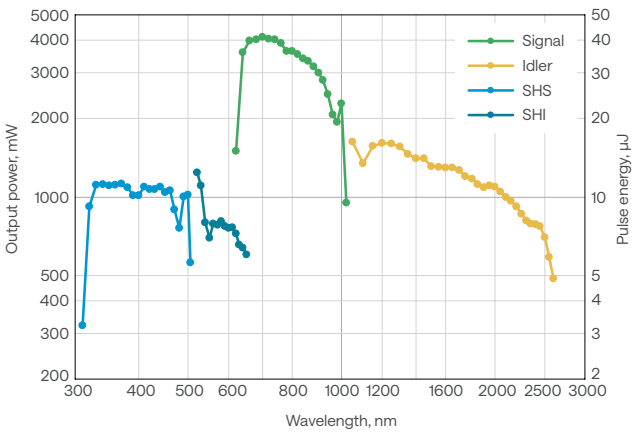
I-OPA

Industrial-Grade Optical Parametric Amplifier

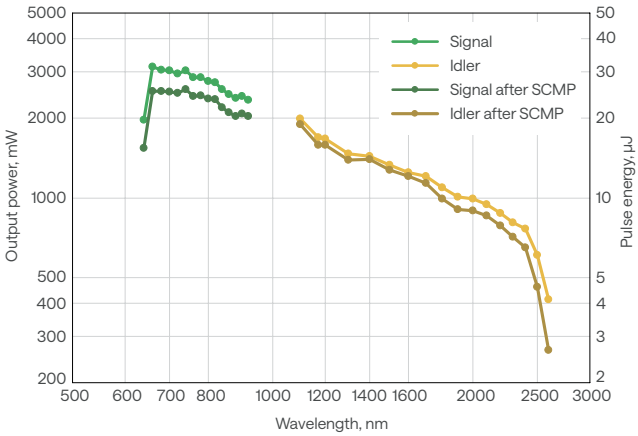
I-OPA-TW on air-cooled CARBIDE-CB5

- 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-HP typical tuning curves
Pump: 40 W, 400 µJ, 100 kHz



I-OPA-F typical 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 – 920 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 – 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)
Pulse compression options [2]	n/a	SCMP (signal pulse compressor) ICMP (idler pulse compressor) GDD-CMP (compressor with GDD control)	n/a

PUMP LASER REQUIREMENTS

Pump laser	PHAROS or CARBIDE
Center wavelength	1030 ± 10 nm
Maximum pump power	40 W
Maximum repetition rate	Up to 2 MHz
Pump pulse energy	20 – 400 µJ
Pulse duration	180 – 300 fs

ENVIRONMENTAL & UTILITY REQUIREMENTS

Operating temperature [6]	19 – 25 °C (air conditioning recommended)
Relative humidity [6]	20 – 70% (non-condensing)
Electrical requirements	n/a [7]

[1] *In case of fixed wavelength (FW), a single wavelength can be selected from the signal or idler range. The signal may have an 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.*

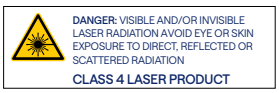
[3] *Output pulse duration depends on selected wavelength and pump laser pulse duration.*

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

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

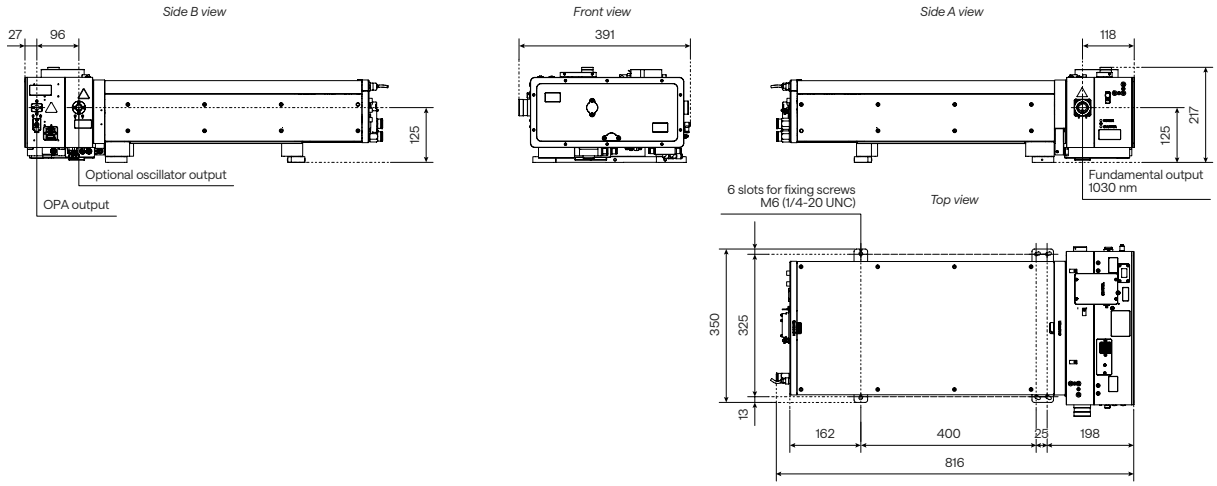
[6] *Specifications are guaranteed for a maximum temperature variation of ± 1 °C and humidity variation of ± 10%.*

[7] *I-OPA is powered by the same electrical source as the pump laser. Thus, refer to the pump laser electrical requirements.*

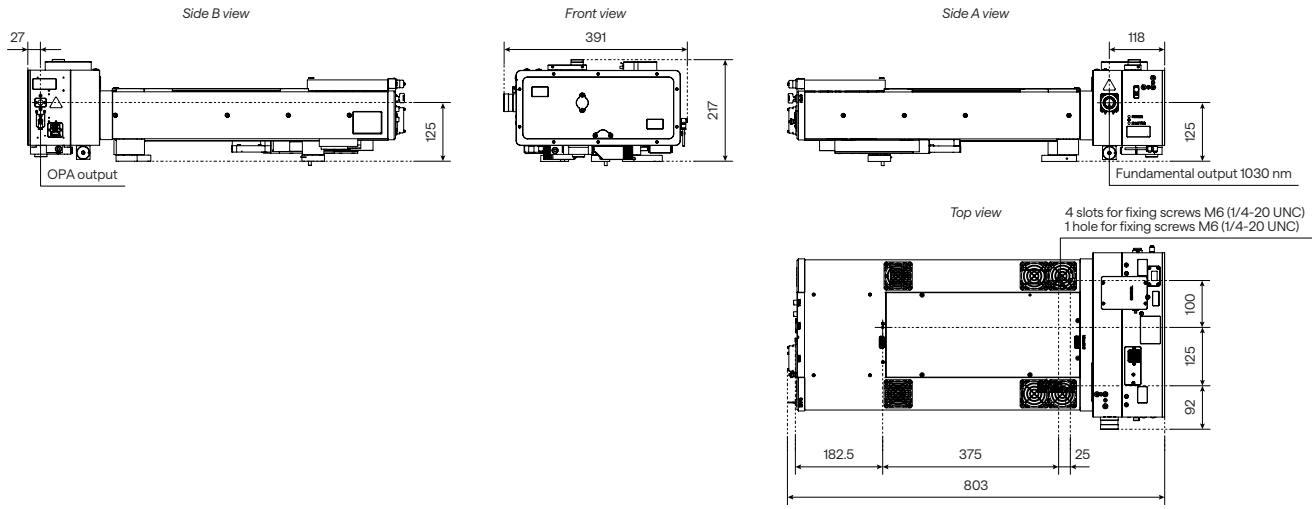


Drawings

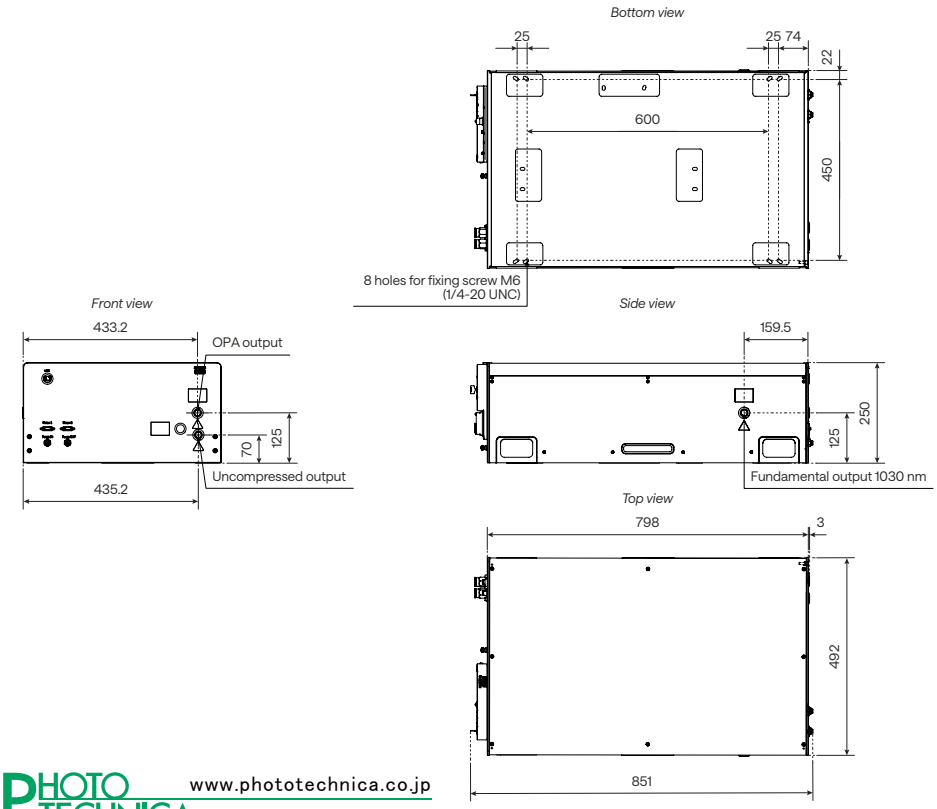
CARBIDE-CB3 with **I-OPA-HP** drawing and output ports



CARBIDE-CB5 with **I-OPA-HP** drawing and output ports



PHAROS-PH2 with **I-OPA-HP** drawing and output ports



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BiBurst | OPTION

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

PHAROS and **CARBIDE-CB3** lasers offer an option for tunable GHz and MHz burst with burst-in-burst capability, known as BiBurst.

In standard mode, a single pulse is emitted at a fixed frequency. In burst mode, the output consists of pulse packets rather than single pulses. Each packet comprises a certain number of equally spaced pulses. MHz-Burst contains N pulses with a nanosecond period, while GHz-Burst contains P pulses with a picosecond period. When both GHz and MHz burst modes are used simultaneously, the equally spaced pulse packets contain sub-packets of pulses, known as burst-in-burst or BiBurst.

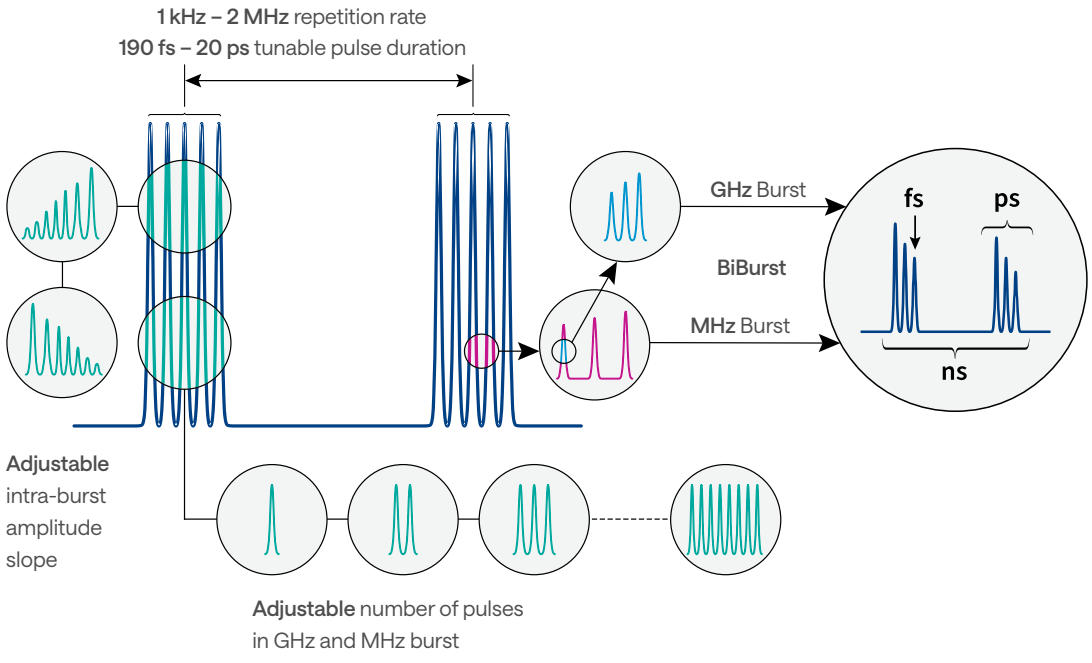
PHAROS and **CARBIDE** lasers with the BiBurst option bring new capabilities to high-tech manufacturing industries such as consumer electronics, integrated photonic chip manufacturing, future display manufacturing, and quantum technologies. The applications include:

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

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 [3]	1 – 25
MHz Burst	Intra burst pulse period	≈ 15 ns	
	Number of pulses, N	1 – 10	1 – 9 (7 with FEC [4])

[1] *Custom spacing is available upon request.*
[2] *The maximum number of pulses in a burst depends on the laser repetition rate and energy.*
[3] *A custom number of pulses (up to 400) is available upon request.*
[4] *Fast energy control option. Enables the formation of any pulse envelope at the laser pulse repetition rate.*



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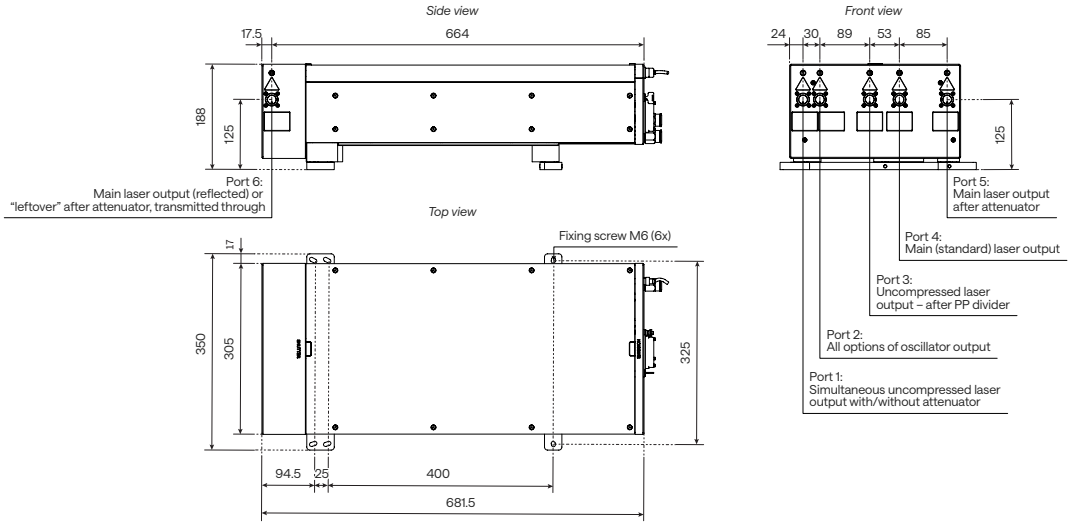
SCI-M | CARBIDE

Scientific Interface Module for CARBIDE

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

Drawings

CARBIDE-CB3-40W with a scientific interface module drawing



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