

### 780 nm High Power Femtosecond Fiber Laser



#### Applications

- Multiphoton microscopy
- Optical metrology
- Materials characterization
- Terahertz radiation
- 3D-microprinting
- Nonlinear spectroscopy
- Ophthalmology
- Replacement of a Ti:sapphire laser

#### Features

- High power stability (up to 1W)
- < 90 fs pulse widths
- Outstanding beam quality ( $M^2 < 1.1$ )
- Exceptional beam pointing stability
- Optional **OptaPower™**, pulse/power stabilization
- All air-cooled, no chiller required
- Remote system diagnostics
- Expected lifetime > 10,000 hours

The Carmel X-series is a range of high power, air-cooled, fiber-based femtosecond lasers with output powers from 0.2 to greater than 2.5 W and pulse widths of less than 90 fs in the industry's most compact, user-friendly package. The Carmel X-780 provides the perfect 780 nm source for a wide range of ultrafast laser applications, including bio-imaging, multiphoton microscopy, optical metrology, 3D-microprinting, terahertz imaging and ophthalmology. It is offered as both a scientific version with front panel controls and an OEM version controlled through an RS-232 interface. The Carmel X-780 can be configured for dual wavelength output to enable alternating access to 780 and 1550 nm outputs (see the Carmel X-780/1550 data sheet for details).

The system features a rack mountable controller with a robust armored cable interface to the compact laser head, which facilitates its incorporation into OEM designs. It is over 100 times smaller than many Ti:sapphire lasers with a similar output power level. A simple key switch interface provides for manual operation with full remote access through computer control. The X-series includes the capability of remote data logging, power monitoring, system diagnostics, and automated adjustments for prolonged lifetime and OEM preventative maintenance. The rugged design supports 24/7 operation with an expected lifetime of > 10,000 hours.

The building block of the X-series is Calmar's renowned ultrafast fiber seed laser platform, which utilizes the proprietary Mendocino saturable absorber technology developed and perfected over a twenty year period to deliver reproducible and reliable mode-locking at turn-on. The system provides an output pulse width of < 90 fs with minimal pulse pedestal and excellent long term pulse-to-pulse stability (<1% rms) over a wide operating temperature range (17-30°C). An exceptional output beam quality ( $M^2 < 1.1$ ) enables a near diffraction-limited spot size with suitable microscope objectives for demanding multiphoton and 3D microprinting applications. Repetition rates can be specified from 10 to 80 MHz with an RF synchronization output provided as a trigger signal.

For multiphoton microscopy applications, the Carmel X-780 provides an ideal ultrafast laser solution for optimum two-photon fluorescence and second harmonic cellular tissue imaging with minimal scatter and reduced risk of photodamage. The compact laser head and associated armored fiber cable make for straight forward integration into existing microscopes with minimal delivery optics.

The X-780 now offers a new optional feature, the OptaPower power and pulse width stabilization system. This is designed for those applications that require hours of data acquisition to measure incredibly small signal levels. The system ensures ultra-stable power and pulse width performance irrespective of wide variations in the ambient temperature. Over a temperature change of 17 to 32°C, OptaPower provides a factor of two improvement in the rms pulse width stability and an order of magnitude improvement in rms power stability.

If the performance parameters do not quite fit your application requirements or to learn if OptaPower can complement your project, please contact us at [sales@calmarlaser.com](mailto:sales@calmarlaser.com) to discuss a customized solution.

# 780 nm High Power Fiber Based Femtosecond Laser

## Technical Specifications<sup>1</sup>

Model Number	CFL-04RFF	CFL-05RFF	CFL-10RFF
<b>OPTICAL</b>			
Central Wavelength (nm)	780 ± 3		
Pulse Width <sup>2</sup> (fs)	< 90		
Pulse Width Stability over 8 hours <sup>3</sup> (% RMS)	< 1.5		
Average Power (W)	0.25	0.50	1.0
Repetition Rate <sup>4</sup> (MHz)	50 or 80	50 or 80	80
Pulse Energy <sup>5</sup> (nJ)	> 5 or 3	> 10 or 6	> 12.5
Spectrum Width (FWHM, nm)	8 - 10		
Power Stability over 8 hours <sup>6,7</sup> (% RMS)	< 1.0		
Beam Quality (M <sup>2</sup> )	< 1.1		
Beam Diameter at Exit (typical, mm)	1.3		
Beam Roundness (%)	> 90		
Polarization Extinction Ratio (dB)	> 20		
Output/Termination	Free space, collimated beam		
<b>ELECTRICAL</b>			
Electrical Synchronization (V)	~ 0.5, SMA connector		
Supply Voltage	85 - 264 VAC at 47 – 63 Hz, autoranging		
Power Consumption (W)	200		
<b>MECHANICAL</b>			
Operating Temperature (°C)	17 - 30		
Storage Temperature (°C)	0 - 50		
Connection between Controller and Head <sup>8</sup>	1 m fixed armored cable		
Laser Head Dimensions (cm)	9.0(W) x 18(D) x 3.5(H)		
Laser Controller Dimensions (cm)	48.2(W) x 46.7(D) x 10(H); 19 inch 2U		
Laser Head Weight (kg)	0.8 (typical)		
Laser Controller Weight (kg)	13.6 (typical)		
Cooling	Controller air-cooled by low noise fan		
Warm-up Time (min)	< 10		
<b>I/O CONTROL</b>			
Communication Interface <sup>9</sup>	RS-232 Serial Port, Monitor Port		
Front Panel Control Interface	Power Switch, Laser Key Switch, Emergency Stop Button		

1. Due to our continuous improvement philosophy, all product specifications are subject to change without prior notice. Please contact sales@calmarlaser.com for customized specifications.

2. A sech<sup>2</sup> pulse shape (deconvolution factor of 0.65) is used to determine the pulse width from the second harmonic autocorrelation trace.

3. Requires the OptaPower option and an ambient temperature of 20 to 30°C

4. For the -04 and -05 models, the repetition rate needs to be specified at the time of purchase. For other repetition rates, please contact sales@calmarlaser.com.

5. The absolute pulse energy will depend on the version and specified repetition rate.

6. Requires an ambient temperature control of ± 1.0°C and appropriate mounting for the laser head.

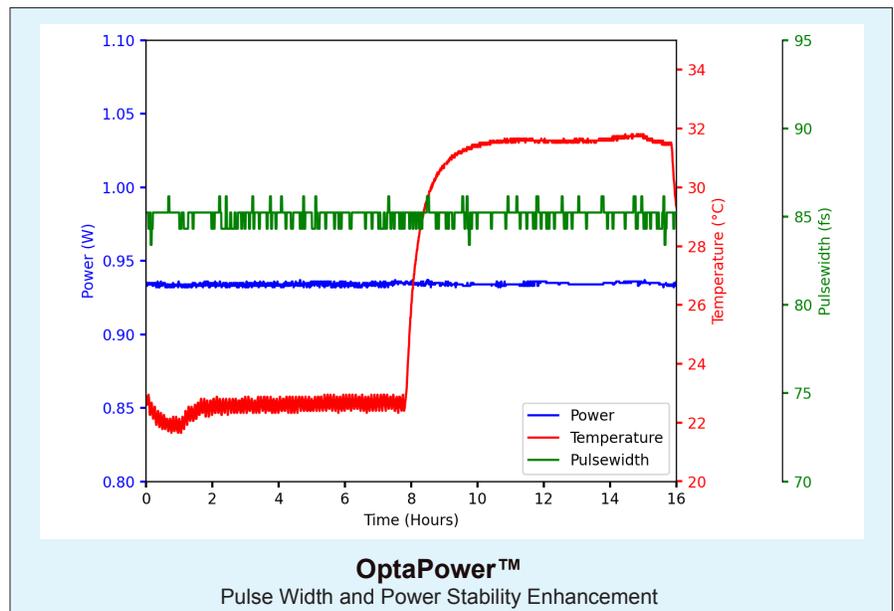
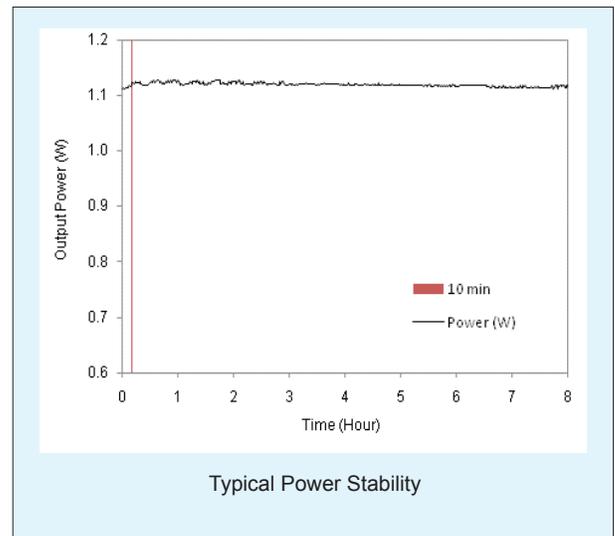
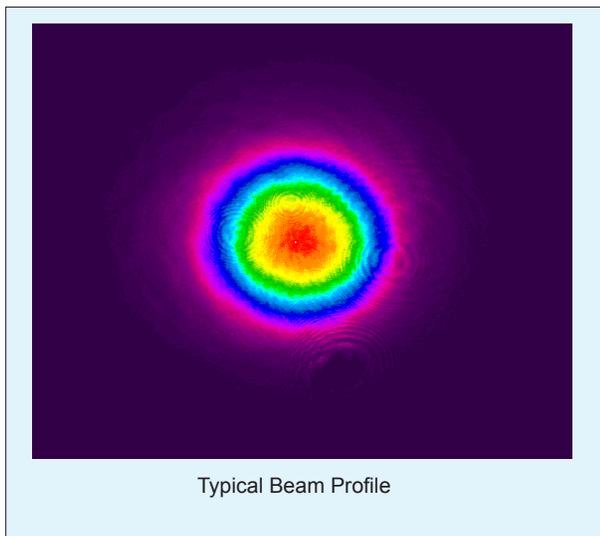
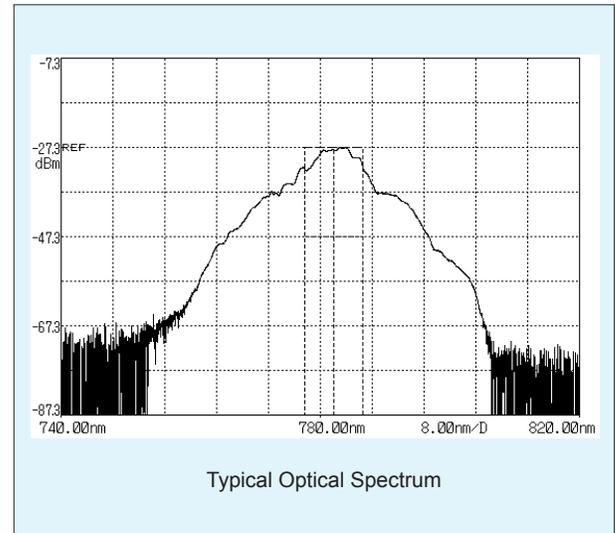
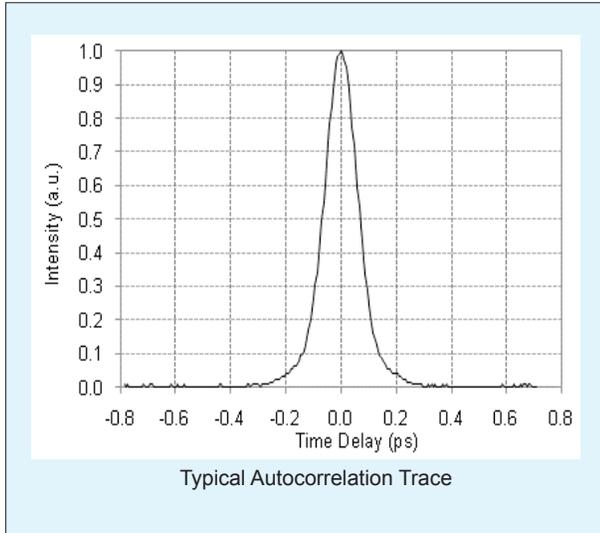
7. With the OptaPower option, the ambient temperature range is extended to 20 to 30°C with appropriate mounting of the head.

8. For other cable length options, please contact sales@calmarlaser.com.

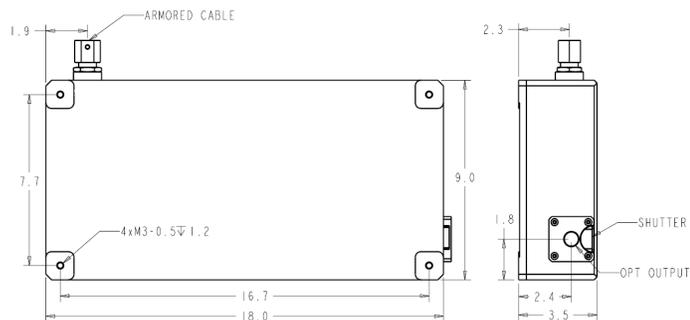
9. Standard on the OEM version, for the scientific version please contact sales@calmarlaser.com.



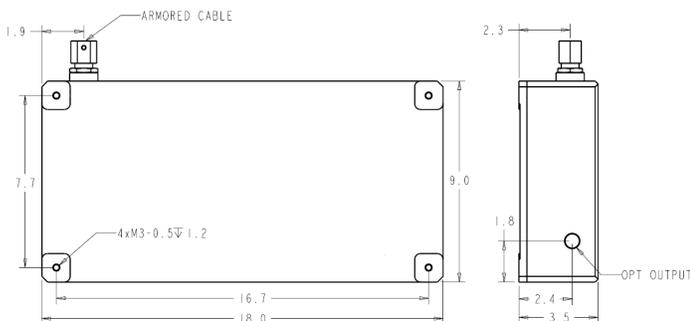
## Optical Characterization



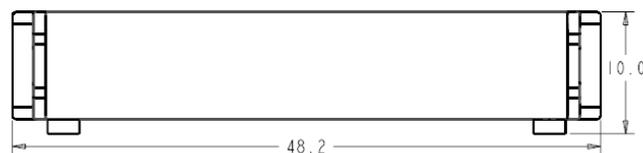
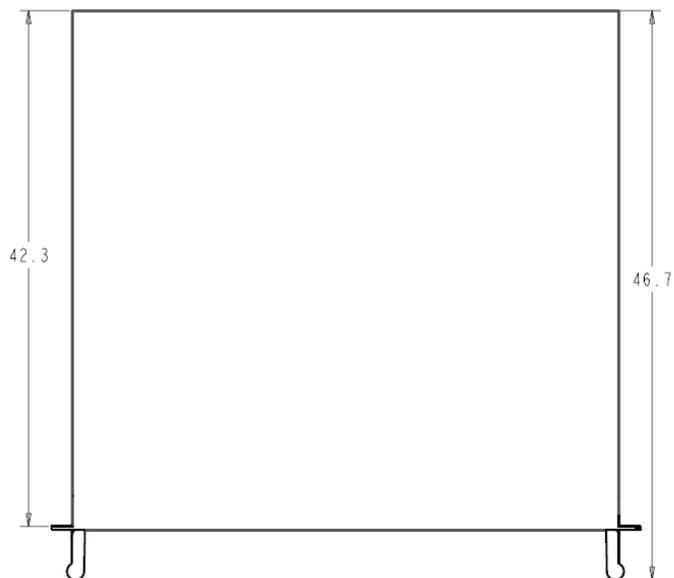
## Mechanical Dimensions



Dimensions of Laser Head for Scientific Model (cm)



Dimensions of Laser Head for OEM Model (cm)



Dimensions of Laser Controller (cm)



### 780/1550 nm High Power Femtosecond Fiber Laser



#### Applications

- Multiphoton microscopy
- Optical metrology
- Materials characterization
- Terahertz radiation
- 3D-microprinting
- Nonlinear spectroscopy
- Ophthalmology
- Replacement of a Ti:sapphire laser

#### Features

- High power stability (up to 2 W)
- < 90 fs pulse widths
- Outstanding beam quality ( $M^2 < 1.1$ )
- Exceptional beam pointing stability
- All air-cooled, no chiller required
- Turn-key operation and full computer control
- Remote system diagnostics
- Expected lifetime > 10,000 hours

The Carmel X-series is a range of high power, air-cooled, fiber-based femtosecond lasers with output powers from 0.2 to greater than 2.5 W and pulse widths of less than 90 fs in the industry's most compact, user-friendly package. The Carmel X-780/1550 provides switchable 780 nm and 1550 nm outputs for a wide range of ultrafast laser applications, including bio-imaging, multiphoton microscopy, optical metrology, 3D-microprinting, terahertz imaging and ophthalmology. It is offered as both a scientific version with front panel controls and an OEM version controlled through an RS-232 interface. A simple slide switch on the laser head enables the output to be toggled from between 780 and 1550 nm outputs.

The system features a rack mountable controller with a robust armored cable interface to the compact laser head, which facilitates its incorporation into OEM designs. It is over 100 times smaller than many Ti:sapphire lasers with a similar output power level. A simple key switch interface provides for manual operation with full remote access through computer control. The X-series includes the capability of remote data logging, power monitoring, system diagnostics, and automated adjustments for prolonged lifetime and OEM preventative maintenance. The rugged design supports 24/7 operation with an expected lifetime of > 10,000 hours.

The building block of the X-series is Calmar's renowned ultrafast fiber seed laser platform, which utilizes the proprietary Mendocino saturable absorber technology developed and perfected over a twenty year period to deliver reproducible and reliable mode-locking at turn-on. The system provides an output pulse width of < 90 fs with minimal pulse pedestal and excellent long term pulse-to-pulse stability (<1% rms) over a wide operating temperature range (17-30°C). An exceptional output beam quality ( $M^2 < 1.1$ ) enables a near diffraction-limited spot size with suitable microscope objectives for demanding multiphoton, 3D microprinting and materials processing applications. Repetition rates can be specified from 10 to 80 MHz with an RF synchronization output provided as a trigger signal.

For multiphoton microscopy applications, the Carmel X-780/1550 provides an ideal ultrafast laser solution for optimum multiphoton fluorescence and second and third harmonic cellular tissue imaging with minimal scatter and reduced risk of photodamage. The compact laser head and associated armored fiber cable make for straight forward integration into existing microscopes with minimal delivery optics.

If the performance parameters do not quite fit your application requirements, please contact us at [sales@calmarlaser.com](mailto:sales@calmarlaser.com) to discuss a customized solution.

# 780/1550 nm High Power Fiber Based Femtosecond Laser

## Technical Specifications<sup>1</sup>

Model Number	CFL-04RCFF		CFL-05RCFF		CFL-10RCFF	
OPTICAL	Port 1	Port 2	Port 1	Port 2	Port 1	Port 2
Central Wavelength (nm)	780 ± 3	1550 ± 4	780 ± 3	1550 ± 4	780 ± 3	1550 ± 4
Pulse Width <sup>2</sup> (fs)	< 90					
Average Power (W)	0.25	0.5	0.5	1.0	1.0	2.0
Repetition Rate <sup>3</sup> (MHz)	50 or 80	50 or 80	50 or 80	50 or 80	80	80
Pulse Energy <sup>4</sup> (nJ)	5 or 3	10 or 6	10 or 6	20 or 12	12.5	25
Spectrum Width (FWHM, nm)	8 - 10	> 30	8 - 10	> 30	8 - 10	> 30
Power Stability over 8 hours <sup>5</sup> (% , RMS)	< 1.0					
Beam Quality (M <sup>2</sup> )	< 1.1					
Beam Diameter at Exit (typical, mm)	1.3	1.6	1.3	1.6	1.3	1.6
	Beam roundness > 90%					
Polarization Extinction Ratio (dB)	> 20	> 18	> 20	> 18	> 20	> 18
Output/Termination	Free space, collimated beam					
<b>ELECTRICAL</b>						
Electrical Synchronization (V)	~ 0.5, SMA connector					
Supply Voltage	85 - 264 VAC at 47 – 63 Hz, autoranging					
Power consumption (W)	200					
<b>MECHANICAL</b>						
Operating Temperature (°C)	17 - 30					
Storage Temperature (°C)	0 - 50					
Connection between Controller and Head <sup>6</sup>	1 m fixed armored cable					
Laser Head Dimensions (cm)	9.0(W) x 18(D) x 3.5(H)					
Laser Controller Dimensions (cm)	48.2(W) x 46.7(D) x 10(H); 19 inch 2U					
Laser Head Weight (kg)	0.8 (typical)					
Laser Controller Weight (kg)	13.6 (typical)					
Cooling	Controller air cooled by low noise fan					
Warm-up Time (min)	< 10					
<b>I/O CONTROL</b>						
Communication Interface <sup>7</sup>	RS-232 Serial Port, Monitor Port					
Front Panel Control Interface	Power Switch, Laser Key Switch, Emergency Stop Button					

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2. A sech<sup>2</sup> pulse shape (deconvolution factor of 0.65) is used to determine the pulse width from the second harmonic autocorrelation trace.

3. For the -04 and -05 models, the repetition rate needs to be specified at the time of purchase. For other repetition rates, please contact sales@calmarlaser.com.

4. The absolute pulse energy will depend on the version and specified repetition rate.

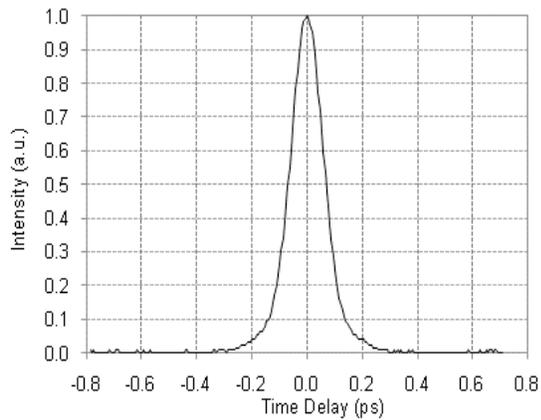
5. Requires an ambient temperature control of ± 1.0°C and appropriate mounting for the laser head.

6. For other cable length options, please contact sales@calmarlaser.com.

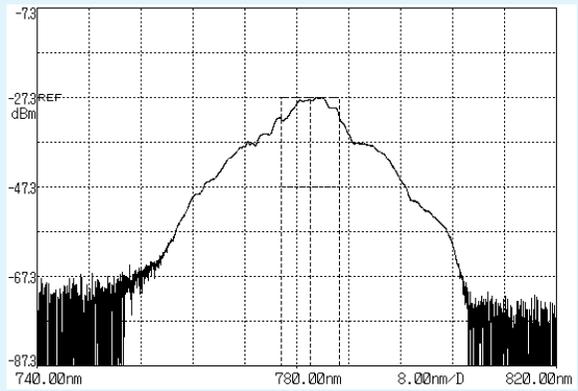
7. Standard on the OEM version, for the scientific version please contact sales@calmarlaser.com.



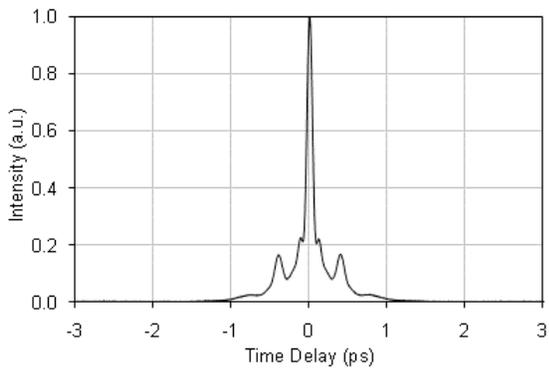
## Optical Characterization



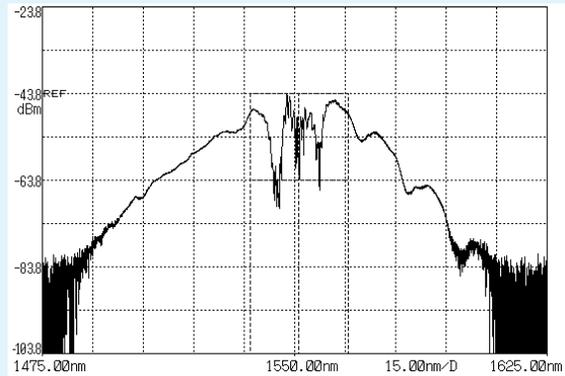
Typical Autocorrelation Trace for Port 1 (780 nm)



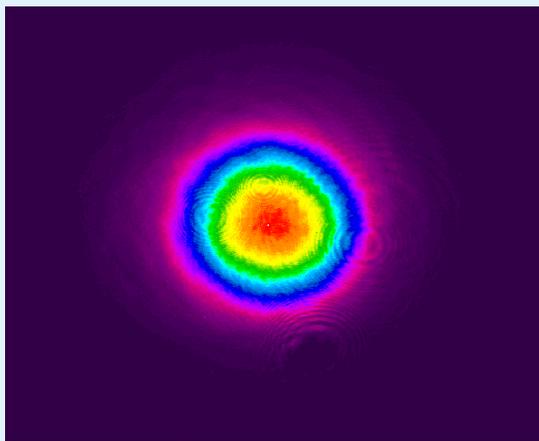
Typical Optical Spectrum for Port 1 (780 nm)



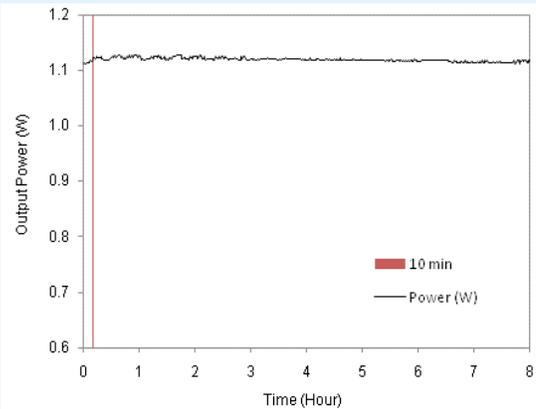
Typical Autocorrelation Trace for Port 2 (1550 nm)



Typical Optical Spectrum for Port 2 (1550 nm)

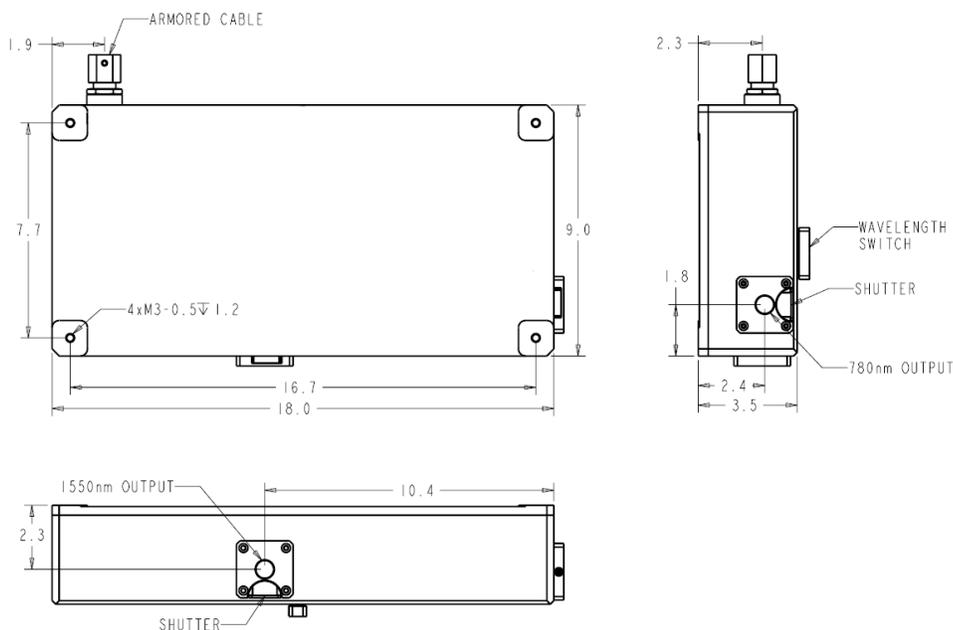


Typical Beam Profile for Port 1 (780 nm)

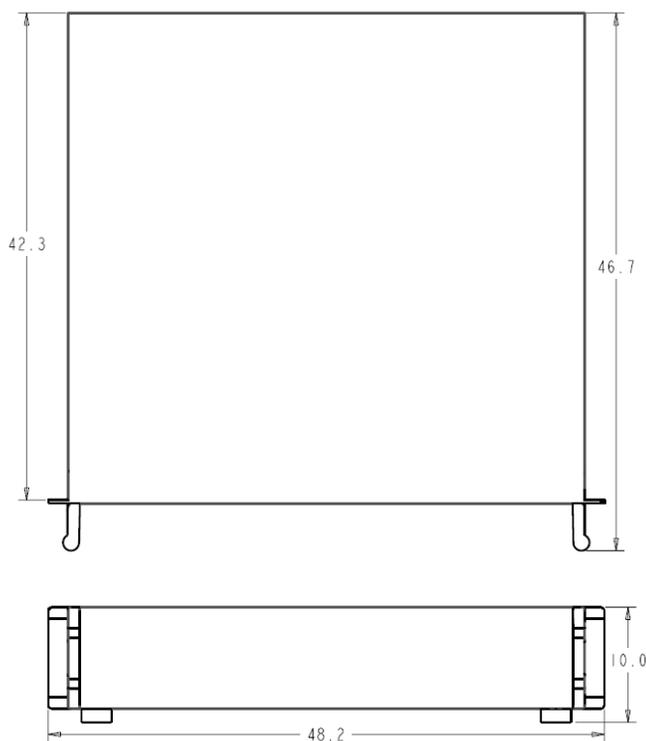


Typical Power Stability for Port 1 (780 nm)

## Mechanical Dimensions



Dimensions of Laser Head (cm)



Dimensions of Laser Controller (cm)



### 1550 nm High Power Femtosecond Fiber Laser



#### Applications

- Multiphoton microscopy
- Optical metrology
- Two photon integrated circuit testing
- Materials characterization
- Terahertz radiation
- Nonlinear spectroscopy
- Micro-machining and materials processing
- Seeding high output lasers

#### Features

- High power stability (up to 2.5 W)
- < 90 fs pulse widths
- Outstanding beam quality ( $M^2 < 1.1$ )
- Exceptional beam pointing stability
- Optional 780 nm output
- All air-cooled, no chiller required
- Remote system diagnostics
- Expected lifetime > 10,000 hours

The Carmel X-series is a range of high power, air-cooled, fiber-based femtosecond lasers with output powers from 0.2 to greater than 2.5 W and pulse widths of less than 90 fs in the industry's most compact, user-friendly package. The Carmel X-1550 provides the perfect 1550 nm source for a wide range of ultrafast laser applications, including multiphoton microscopy, optical metrology, two photon integrated circuit testing and micro-machining. It is offered as both a scientific version with front panel controls and an OEM version controlled through an RS-232 interface. The Carmel X-1550 can be configured for dual wavelength output to enable alternating access to 1550 and 780 nm outputs (see the Carmel X-780/1550 data sheet for details).

The system features a rack mountable controller with a robust armored cable interface to the compact laser head, which facilitates its incorporation into OEM designs. A simple key switch interface provides for manual operation with full remote access through computer control. The X-series includes the capability of remote data logging, power monitoring, system diagnostics, and automated adjustments for prolonged lifetime and OEM preventative maintenance. The rugged design supports 24/7 operation with an expected lifetime of > 10,000 hours.

The building block of the X-series is Calmar's renowned ultrafast fiber seed laser platform, which utilizes the proprietary Mendocino saturable absorber technology developed and perfected over a twenty year period to deliver reproducible and reliable mode-locking at turn-on. The system provides an output pulse width of < 90 fs with minimal pulse pedestal and excellent long term pulse-to-pulse stability (<1% rms) over a wide operating temperature range (17-30°C). An exceptional output beam quality ( $M^2 < 1.1$ ) enables a near diffraction-limited spot size with suitable microscope objectives for demanding multiphoton and materials processing applications. Repetition rates can be specified from 10 to 80 MHz with an RF synchronization output provided as a trigger signal.

For multiphoton microscopy applications, the Carmel X-1550 provides an ideal ultrafast laser solution for optimum multiphoton fluorescence and third harmonic cellular tissue imaging with minimal scatter and reduced risk of photodamage. The compact laser head and associated armored fiber cable make for straight forward integration into existing microscopes with minimal delivery optics.

If the performance parameters do not quite fit your application requirements, please contact us at [sales@calmarlaser.com](mailto:sales@calmarlaser.com) to discuss a customized solution

# 1550 nm High Power Fiber Based Femtosecond Laser

## Technical Specifications<sup>1</sup>

Model Number <sup>2</sup>	CFL-ZCFF
<b>OPTICAL</b>	
Central Wavelength (nm)	1550 ± 4
Pulse Width <sup>3</sup> (fs)	< 90
Average Power (W)	Up to 2.5
Repetition Rate <sup>4</sup> (MHz)	10 - 80
Pulse Energy <sup>5</sup> (nJ)	Up to 50
Spectrum Width (FWHM, nm)	> 30
Power Stability over 8 hours <sup>6</sup> (% , RMS)	< 1.0
Beam Quality, M <sup>2</sup>	< 1.1
Beam Diameter at Exit (typical, mm)	1.2 (beam roundness > 90%)
Polarization Extinction Ratio (dB)	> 18
Output/Termination	Free space, collimated beam
<b>ELECTRICAL</b>	
Electrical Synchronization (V)	~ 0.5, SMA connector
Supply Voltage	85 - 264 VAC at 47 – 63 Hz, autoranging
Power consumption (W)	200
<b>MECHANICAL</b>	
Operating Temperature (°C)	17 - 30
Storage Temperature (°C)	0 - 50
Connection between Controller and Head <sup>7</sup>	1 m fixed armored cable
Laser Head Dimensions (cm)	9.0(W) x 18(D) x 3.5(H)
Laser Controller Dimensions (cm)	48.2(W) x 46.7(D) x 10(H); 19 inch 2U
Laser Head Weight (kg)	0.8 (typical)
Laser Controller Weight (kg)	13.6 (typical)
Cooling	Controller air-cooled by low noise fan
Warm-up Time (min)	< 10
<b>I/O CONTROL</b>	
Communication Interface <sup>8</sup>	RS-232 Serial Port, Monitor Port
Front Panel Control Interface	Power Switch, Laser Key Switch, Emergency Stop Button

1. Due to our continuous improvement philosophy, all product specifications are subject to change without prior notice. Please contact sales@calmarlaser.com for customized specifications.

2. Z depends on the output power: Z = 04 (> 0.25W), 05 (> 0.5 W), 10 (> 1 W), 20 (> 2.0 W), or 25 (> 2.5W). Power needs to be specified at the time of purchase.

3. A sech<sup>2</sup> pulse shape (deconvolution factor of 0.65) is used to determine the pulse width from the second harmonic autocorrelation trace.

4. The repetition rate needs to be specified at the time of purchase. For other repetition rates, please contact sales@calmarlaser.com.

5. The absolute pulse energy will depend on the version and specified repetition rate.

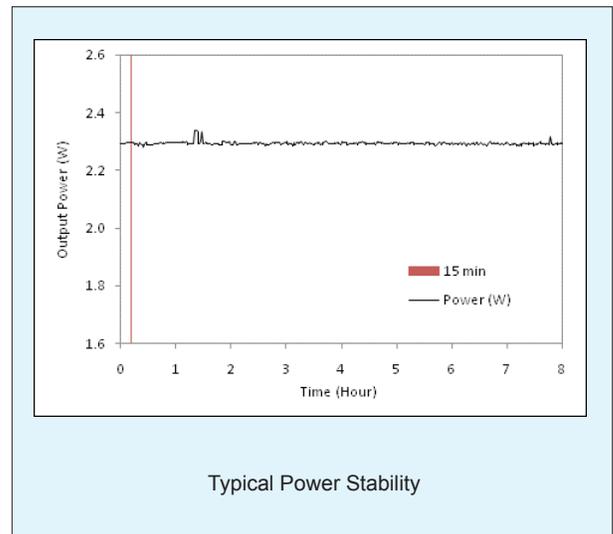
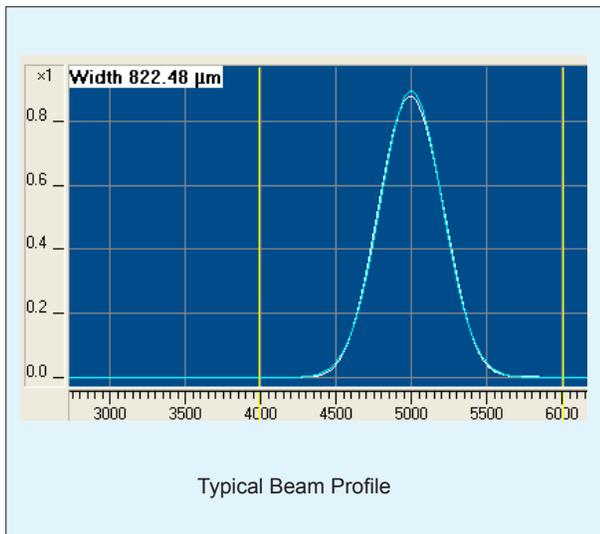
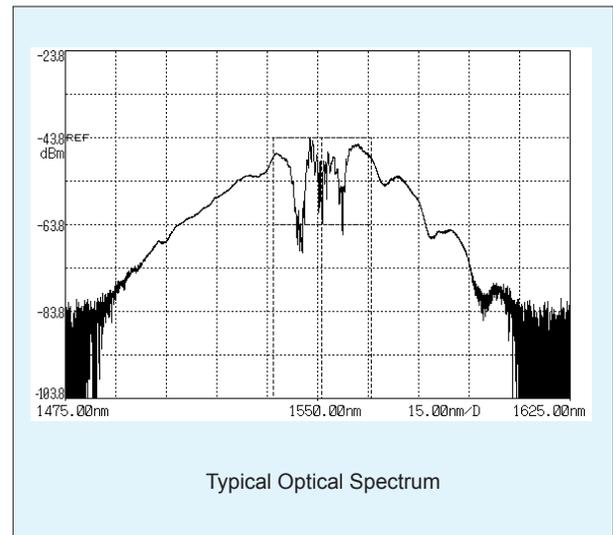
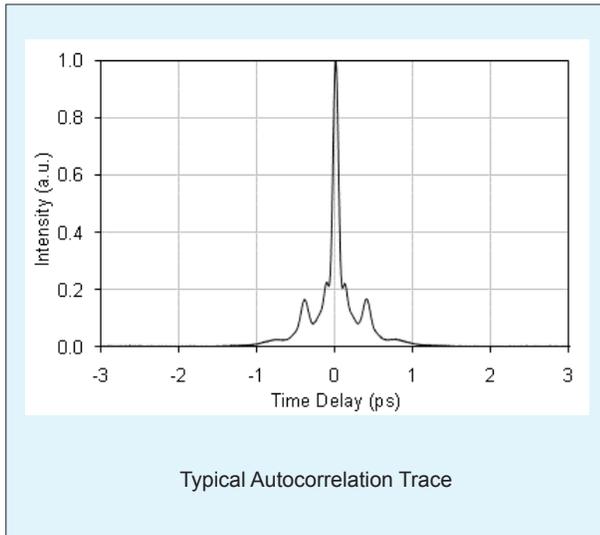
6. Requires an ambient temperature control of ± 1.0°C and appropriate mounting for the laser head.

7. For other cable length options, please contact sales@calmarlaser.com.

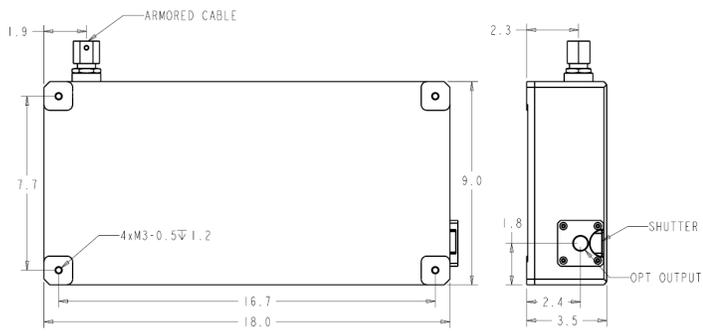
8. Standard on the OEM version, for the scientific version please contact sales@calmarlaser.com.



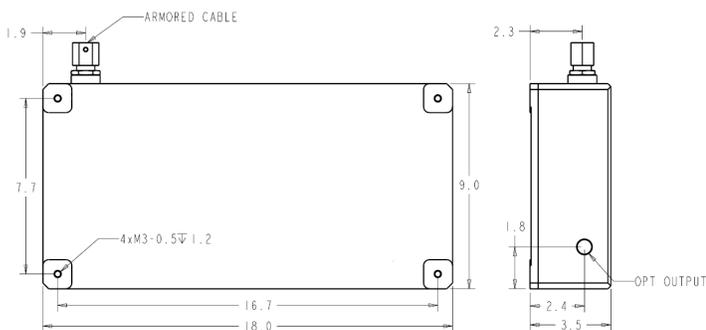
## Optical Characterization



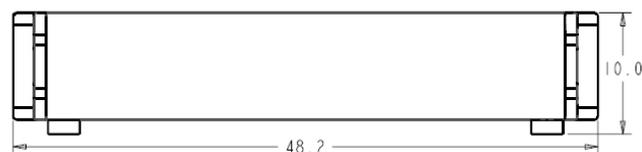
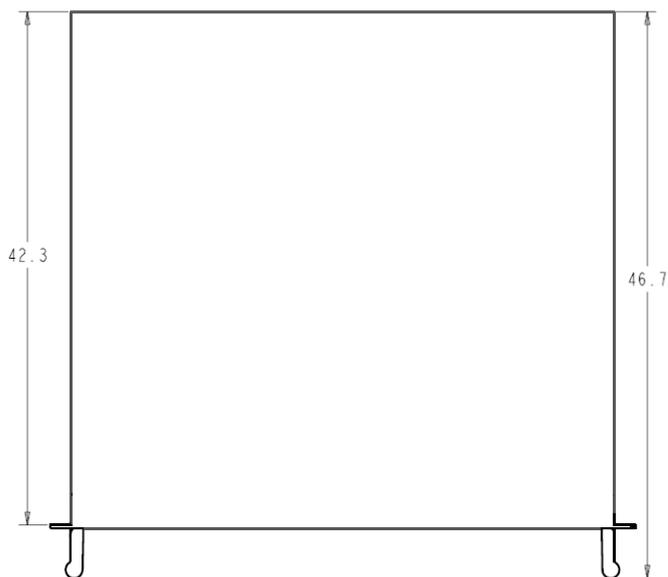
## Mechanical Dimensions



Dimensions of Laser Head for Scientific Model (cm)



Dimensions of Laser Head for OEM Model (cm)



Dimensions of Laser Controller (cm)

