MenloSystems Inc.

A Strategic Partner of Thorlabs

orange one – Single-Frequency CW Fiber Laser

orange one

The orange one combines a unique ultra-narrow linewidth with high output power to provide a single-frequency, turnkey, fiber laser system. This compact laser package is ideal for applications requiring low noise and stable performance. The integrated seed laser is a single frequency fiber laser module from NKT Photonics. The near infrared output can be efficiently converted to the visible in a PPLN waveguide frequency doubler.

Applications

- Optical Metrology
- Interferometry
- High-Resolution Spectroscopy
- Atom Trapping
- LIDAR Sensing
- Optical Data Storage

Features

- Ultra-Narrow Linewidth
- Stable, Single-Frequency Operation
- High-Power Output
- Burst Noise-Free Operation
- Mode-Hop-Free Tuning
- Vibration-Free Analog Fine Tuning, Ready-to-Lock
- Digital Coarse Tuning
- Low Phase Noise and Low Intensity Noise
- Single Mode Fiber Output (FC/APC)
- Stand-Alone Unit in a 19" Rack System with Integrated Power Supply

Specifications

Linewidth (120 µs)	<100 kHz
Wavelength Range*	1020 - 1121 nm
Center Wavelength Tolerance	±0.1 nm
Temperature Tuning Range	>450 pm (-0.3/+0.15 nm), 26 pm °C^{-1}
Piezo Tuning Range	>9 pm; 0.1 pm/V
Piezo Voltage	0 - 200 V
Output Power	1 W or 2 W (Model and Wavelength Dependent)
Output Port	PM, Non-PM (1 m Patch Cord Included)
ASE Level	<10%
Power and Environmental Requirements	
Operating Voltage	110/115/230 VAC
Frequency	50 to 60 Hz
Power Consumption	200 W
Cooling Requirements	No Water Cooling Required
Laser Head Stabilization	Temperature Stabilized with Peltier Elements
Operating Temperature	22 ± 5 °C
Dimensions	448 mm x 132 mm x 437 mm (17.6" x 5.2" x 17.2")
Weight	20 kg

*Specify center wavelength when ordering

ITEM #	$	£	€	RMB	DESCRIPTION
orange one-1PM	CALL				>1 W (up to 2 W)* Single-Frequency Fiber Laser with PM Output
orange one-SHG	CALL				>200 mW Single-Frequency Fiber Laser with Frequency Doubler**
orange one-1	CALL				>1 W (up to 2 W)* Single-Frequency Fiber Laser
orange one-2	CALL				>2 W (up to 4 W)* Single-Frequency Fiber Laser

*Output power depends on user-selected wavelength

**Frequency doubler directly spliced to output of orange one-1PM

For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

FC1500-250-WG: Er-Doped Optical Frequency Synthesizer

The FC1500-250-WG Optical Frequency Synthesizer is a compact and flexible fiber-based femtosecond frequency comb system. With an extension package for the visible spectral range, the system provides a stabilized optical frequency comb for frequency metrology in both the visible and near infrared spectral regions. A wide range of optional units enables us to tailor this versatile system to customer-specific metrology solutions.

The optical frequency comb technology and its stabilization are covered by several international patents (e.g., see EU patent EP 1161782 and US patent 6,785,303 B1). Menlo Systems holds the exclusive rights on the patents. The 2005 Nobel Prize in Physics was awarded to one of the founders of Menlo Systems, Theodor W. Hänsch, and J. Hall for their invention of the frequency comb technology.

FC1500-250-WG

Base Unit

- **FC1500-250-WG** M-Comb oscillator, P250 PULSE-EDFA amplifier, XPS 1500 wave guided f:2f interferometer with electronic control tower

Optional Units

- **M-NIR** extension package extends the stabilized comb spectrum to the 1050 - 2100 nm range
- **M-VIS** extension package extends the stabilized comb spectrum to the 530 - 900 nm range
- **P250 PULSE-EDFA** erbium-doped fiber amplifier for high-power output at 1560 nm
- **780 Measurement Port** for high-power output at 780 nm
- **HMP** high-power measurement port for high-precision measurement of low-power lasers for user-defined wavelengths
- **BDU-FS, BDU-FC,** and **BDU-FF** broadband free-space and adjustment-free, fiber-coupled beat detection units
- **SYNCRO-LLE** electronics to phase lock the external CW lasers to the stabilized comb
- **GPS 5-10** 10 MHz frequency reference to serve as RF reference for the frequency comb

Specifications

Comb Spacing	250 MHz
Accuracy*	10^{-14}
Stability*	$5x10^{-13}$ in 1 s
Tuning Range of Spacing Between Individual Comb Lines	>2 MHz
Tuning Range of CEO Frequency	>250 MHz
Optical Output Ports	
LC/APC Ports – Three Fiber-Coupled, Elliptically Polarized	
Center Wavelength	1560 nm
Spectral Range	>35 nm
Average Output Power	>18 mW from Each Port
Extension Package to the Near Infrared	
NIR Measurement Port – Free-Space, Unpolarized	
Spectral Range	1050 - 2100 nm
Average Output Power	>200 mW
Extension Package to the Visible	
VIS Measurement Port – Free-Space, Unpolarized	
Spectral Range	530 - 900 nm
Average Output Power	>60 mW
Additional Amplifier at 1560 nm	
Average Output Power	>400 mW
Pulse Length	<90 fs
Optional Port at 780 nm	
Average Output Power	>150 mW
High-Power Measurement Port HMP633**	
Average Output Power	>5 mW

* Same as reference, whichever applies first

** In 3 nm window at 633 nm, available for other user-defined wavelengths.

The M-NIR extension package amplifies the light from the femtosecond fiber laser and then spectrally broadens the amplified output in a highly nonlinear optical fiber. This supercontinuum comprises a comb of frequency lines, separated by the laser repetition rate and with an arbitrary frequency offset. By phase locking the comb spacing and the offset frequency to a radio frequency (RF) reference source, the comb will form an accurate frequency ruler for the 1050 to 2100 nm region.

The operational range can be extended to the visible part of the spectrum by amplifying and frequency doubling part of the fiber laser output and then broadening it in a photonic crystal fiber. The visible comb spanning 530 - 900 nm retains the phase stability.

The frequency comb provides a direct link between the optical and microwave frequencies in both directions. Phase-locked to an RF reference, any unknown optical frequency can then be measured by simply comparing its frequency to that of the nearest tooth of the stabilized frequency comb. The accuracy of the measurement is only limited by the reference.

Conversely, by phase locking one tooth of the frequency comb to a continuous wave (CW) laser that is locked to a narrow atomic transition or high-finesse resonator, the frequency comb divides the extremely rapid optical oscillations of this optical reference to countable microwave frequencies.

ITEM #	$	£	€	RMB	DESCRIPTION
FC1500-250-WG	CALL				Erbium Optical Frequency Synthesizer

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FC1000-250: Yb-Doped Optical Frequency Synthesizer

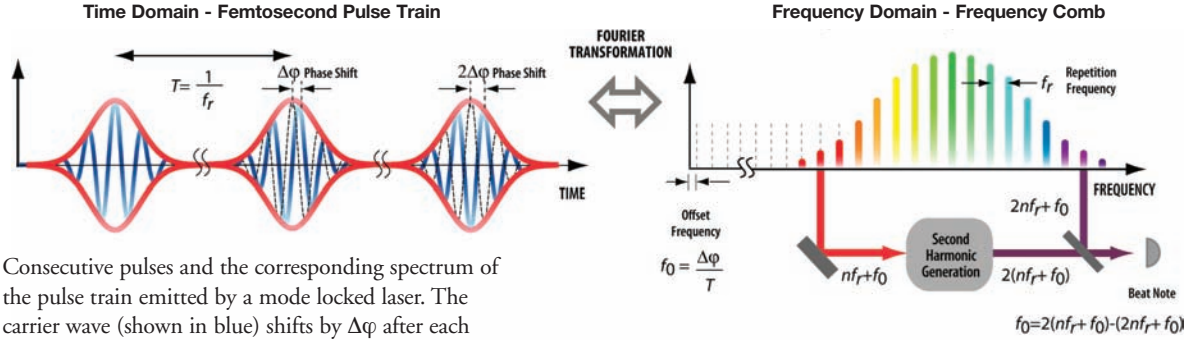

FC1000-250

Femtosecond optical frequency combs have led to a revolution in our ability to measure the frequency of light. This approach vastly enhances and simplifies dimensional metrology and enables new directions in physics.

With the FC1000-250 we introduce our latest model of the Optical Frequency Synthesizer. The FC1000-250 measures optical frequencies with unprecedented accuracy (up to 14 digits) and stability. It is based on a mode-locked Ytterbium-doped oscillator and provides 500,000 precise laser lines with equal spacing of 250 MHz. The output is spectrally broadened to generate an octave-spanning spectrum. The offset frequency beat is generated in a stable, rigid f:2f interferometer. The system is designed and engineered for 24/7 operation.

Applications

- Dimensional Metrology
- Optical Clocks
- High-Resolution Spectroscopy
- Low-Noise Microwave Synthesis
- Absolute Distance Measurements
- Transfer of Ultrastable Timing Signal and Frequency Standards



Consecutive pulses and the corresponding spectrum of the pulse train emitted by a mode locked laser. The carrier wave (shown in blue) shifts by $\Delta\varphi$ after each round trip with respect to the pulse envelope (shown in red). This continuous shift results in a frequency offset $f_0=\Delta\varphi/T$ of the comb.

Stabilization of the offset frequency and the pulse to pulse phase slippage by frequency doubling the infrared part of the comb and observation of the beat with the blue part.

Specifications

Comb Frequency Spacing	250 MHz
Accessible Optical Range	Octave-Spanning Spectrum Centered at 1030 nm
Accuracy*	10^{-14}
Stability*	5×10^{-13} in 1 s
Input Requirements	10 MHz Reference, Power Level +7 dBm

Options

P250 PULSE-YB Yb-Doped Amplifier:
Additional amplifier at 1030 nm provides average output power levels in the 500 mW - 1 W range

BDU-FS, BDU-FC, and BDU-FF Beat Detection Units:
These units generate and measure the beat signal between the frequency comb and an external CW laser. Available for various spectral ranges, these free-space or fiber-coupled units are matched to the laser frequencies of the customer.

SYNCRO-LLE Locking Electronics Unit:
This unit phase locks an external CW laser to the stabilized frequency comb and is field-tested using lasers from major suppliers.

GPS 5-10 10 MHz Frequency Reference:
Provides RF reference input signal for the frequency comb

*Or same as reference, whichever applies first
Note: When beating the comb with an SM-diode laser (output >2 mW) or any other comparable optical signal, a SNR of >30 dB in 100 kHz bandwidth will be achieved.

ITEM #	$	£	€	RMB	DESCRIPTION
FC1000-250	CALL				Ytterbium Optical Frequency Synthesizer

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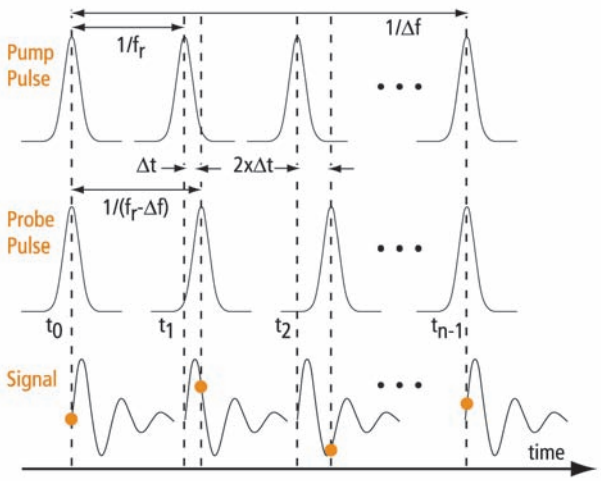
Asynchronous Optical Sampling (ASOPS)

The asynchronous optical sampling technique allows high-speed scanning over a few nanoseconds of time delay without a mechanical delay line. The ultrafast lasers delivering the pump and probe pulses are locked together at a tunable repetition rate difference.

Advantages of the ASOPS technique over conventional sampling techniques requiring a mechanical delay stage include faster data acquisition times and the absence of limitations that are common to moving components (e.g., beam pointing instability and limited scanning speed).




ASOPS TWIN 250

Applications

- Two-Color Pump-Probe Spectroscopy
- Time-Domain THz Spectroscopy
- Material Characterization

Specifications

Within the C-Fiber (100 MHz) or M-Fiber (250 MHz) series, any pair of Menlo Systems' femtosecond fiber lasers can be combined on one platform. Here we specify just two of the possible system configurations.

ASOPS SYSTEM	TWIN 250	DUAL COLOR 1560/780	
Repetition Rate	250 MHz	100 MHz	
Repetition Rate Offset Tuning Range	1 Hz - 10 kHz	1 Hz - 10 kHz	
Time Measurement Window	4 ns	10 ns	
Scan Duration*	1 s - 0.1 ms	1 s - 0.1 ms	
Data Point Increment**	0.016 - 160 fs	0.1 fs - 1 ps	
RMS Timing Jitter (0.1 Hz - 500 kHz)	<150 fs	<150 fs	
LASER HEADS	**TWIN M-Fiber Sync**	**C-Fiber Sync**	**C-Fiber Sync 780**
Wavelength	1560 nm	1560 nm	780 nm
Average Output Power	>75 mW (from each laser)	>30 mW	>65 mW
Output Port	Fiber-Coupled FC/APC	Free Space	Free Space
Pulse Length	<150 fs after 6 m PM fiber	<150 fs	100 - 120 fs
Tuning Range with Piezo	>625 Hz	>100 Hz	
Piezo Bandwidth	>30 kHz	>30 kHz	
Tuning Range with Stepper Motor	>2 MHz	>330 kHz	
Trigger Signal	TTL level at offset frequency, <25 ns rise time		

* Scales inversely with the repetition rate offset

**Scales with the ratio of the repetition rate offset and the repetition rate squared ($\Delta f/f^2$)

ITEM #	$	£	€	RMB	DESCRIPTION
ASOPS TWIN 250	CALL				250 MHz ASOPS System for 1560 nm
ASOPS Dual Color	CALL				100 MHz ASOPS System for 1560 and 780 nm

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Femtosecond Phase Stabilization

The phase stabilization technology is covered by several international patents (e.g., see EU patent EP 1161782 and US patent 6,785,303 B1). Menlo Systems holds the exclusive rights on these patents and is proud to have a close collaboration with major laser companies that use these products and our patented technology as OEM integrators.

Applications

- Control Strong-Field Processes in Extreme Nonlinear Optics
- High Harmonic Attosecond Pulse Generation
- Phase-Sensitive Experiments

XPS800 Femtosecond Phase Stabilization

The XPS800 Femtosecond Phase Stabilization Unit gives you control of your ultrashort pulses and their carrier envelope offset phase.

Operation Principle

The pulses from the femtosecond laser are broadened in a nonlinear photonic crystal fiber to achieve an octave-spanning spectrum. A nonlinear interferometer subsequently generates the signal for offset frequency stabilization by beating the frequency-doubled infrared part with the green part of the spectrum. This beat signal is filtered, amplified, and fed to the locking electronics. The offset frequency is phase locked to ¼ of the repetition frequency. For this task, the repetition frequency is divided by 4 and sent to Port 1 of our digital phase detector. The input for Port 2 of the phase detector is the amplified and filtered offset frequency signal. A proportional-integral-feedback circuit that drives an acousto-optical modulator or a piezo actuator closes the control loop.

XPS800

Specifications

Repetition Frequency	70 - 90 MHz
Offset Frequency	1/4 of the Repetition Frequency
Linewidth Offset Frequency	< 1Hz
Input Requirements	200 mW Average Power in <15 fs Pulses
Optical Breadboard Dimensions	360 mm x 460 mm (14.2" x 18.1")
Stabilization Electronics	in 19" Rack

ITEM #	$	£	€	RMB	DESCRIPTION
XPS800	CALL				Femtosecond Phase Stabilization Unit

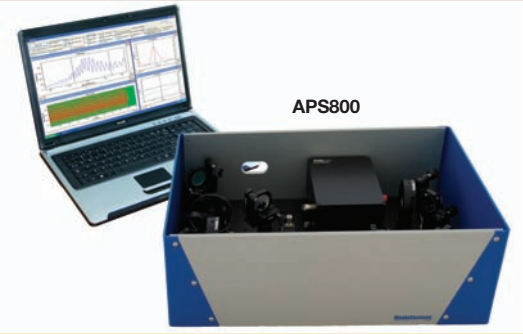
APS800 Amplifier Phase Stabilization

During amplification of phase-stabilized femtosecond pulses, slow carrier-envelope phase drifts occur. Menlo Systems' APS800 is used to monitor and stabilize this phase relation after the amplifier. The APS800 expands full phase control to the regime of high-power optical pulses used in today's most demanding experiments of attophysics and related areas.

Operation Principle

To monitor the slow carrier-envelope phase drifts, a small part of the amplifier output is split off and spectrally broadened in a sapphire plate. In an optical interferometer, the green part of the resulting octave-spanning spectrum is overlapped with the frequency-doubled infrared part.

With the help of a spectrometer and control software algorithms, the resulting interferogram is analyzed, and a slow correction signal is generated. This signal is fed into the corresponding input port of the phase stabilization electronics XPS800 or similar control electronic setups.


APS800

Specifications

Amplifier Carrier Wavelength	800 nm
Energy Fluctuations	<1% (Pulse-to-Pulse, rms)
Repetition Rate	1 - 10 kHz
Input Energy	>10 µJ/Pulse
Pulse Length	<50 fs
Beam Diameter	5 - 15 mm
Optical Setup Dimensions	410 mm x 230 mm x 140 mm (16.1" x 9.1" x 5.5")

ITEM #	$	£	€	RMB	DESCRIPTION
APS800	CALL				Amplifier Phase Stabilization Unit

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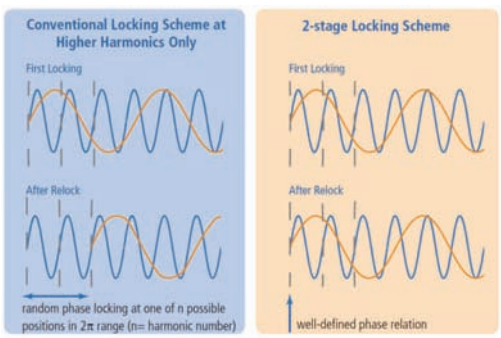
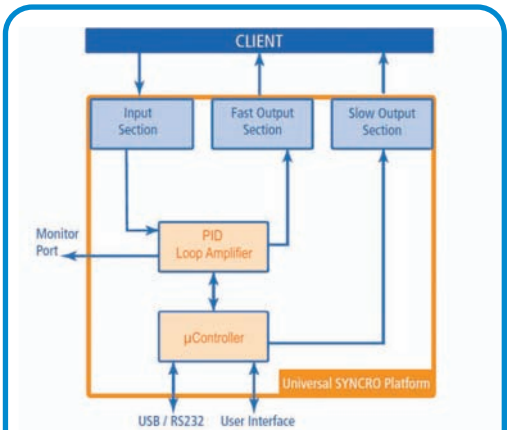
SYNCRO: Platform for Locking Applications

SYNCRO-RRE

Features

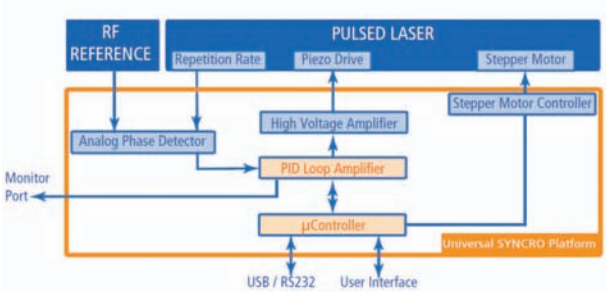
- Full Automation
- High Bandwidth Up to 1.5 MHz (3 dB)
- Bandwidth Depends on Other Components in the Complete Control Loop
- "Track" Function for Long-Term Operation (Slow Integrator)
- User-Friendly Operation
- Front Panel Touch Screen or Remote Control with PC (RS232 or USB)
- 2 Stage Locking Scheme





Generic system schematic for the SYNCRO platform. The platform can be adapted to several configurations, of which, four are described here.

The modular design of our new locking electronics allows us to configure the phase lock loop for various locking tasks. Developed to serve in our optical frequency comb systems for repetition rate and offset frequency stabilization, it can be used to phase lock various external devices, such as lasers, cavities, or fiber-links, in today's most demanding experiments. The former RRE100 repetition rate synchronization electronics can be replaced by the new SYNCRO platform.



Schematic of SYNCRO-RRE. This example shows the implementation of the SYNCRO platform to phase lock a pulsed laser to a radio frequency reference.

SYNCRO-RRE

These electronics phase lock the repetition rate of a pulsed laser to a radio frequency reference, derived from a radio frequency clock. An example can be seen above.

Alternatively, the SYNCRO-RRE can be configured for locking to an optical reference clock. A beat signal detection unit between the laser and the optical reference provides the input signal, and a preamplifier and digital phase detector is used in the input section of the electronics.

SYNCRO-LLE

These locking electronics phase lock the frequency of a CW laser to a stabilized mode of an optical frequency comb system. Depending on the type of CW laser, the fast and slow output sections of the electronics can be configured to provide the proper control signal requested by the CW laser.

SYNCRO-XPS

The SYNCRO-XPS is designed for stabilization of the phase relation between the carrier and envelope of the pulses emitted from a femtosecond laser. The stabilization is based on the frequency comb technology.

SYNCRO-FLS

These locking electronics are designed to create a distribution of stable optical timing signals by stabilizing the length of the fiber-optic link.

ITEM #	$	£	€	RMB	DESCRIPTION
SYNCRO-RRE	CALL				Repetition Rate Synchronization Electronics
SYNCRO-LLE	CALL				Locking Electronics for an External CW Laser
SYNCRO-XPS	CALL				Femtosecond Phase Stabilization Unit
SYNCRO-FLS	CALL				Locking Electronics for Fiber Link Stabilization

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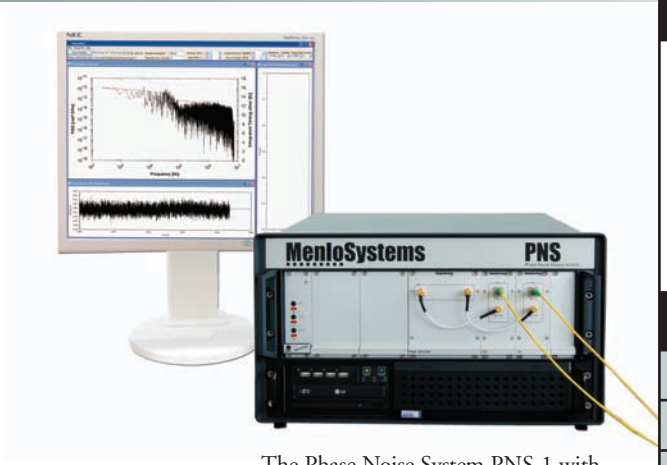
PNS: Phase Noise System

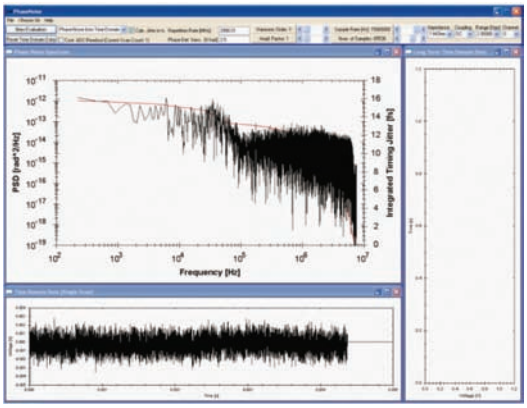
Menlo Systems' Phase Noise System PNS provides a flexible approach for the measurement and evaluation of phase noise and timing jitter. It can be easily adapted to customer requirements, like sampling noise floor and frequency range. The system has three different modes of operation: phase noise detection from RF spectrum analyzer data, phase noise detection from time domain data, and relative intensity noise detection. Due to the Phase Noise System's versatility, a wide span of applications can be covered.



The Phase Noise System PNS-1 with the Phase Detection Setup in a 19" Rack, A/D Converter, and PC

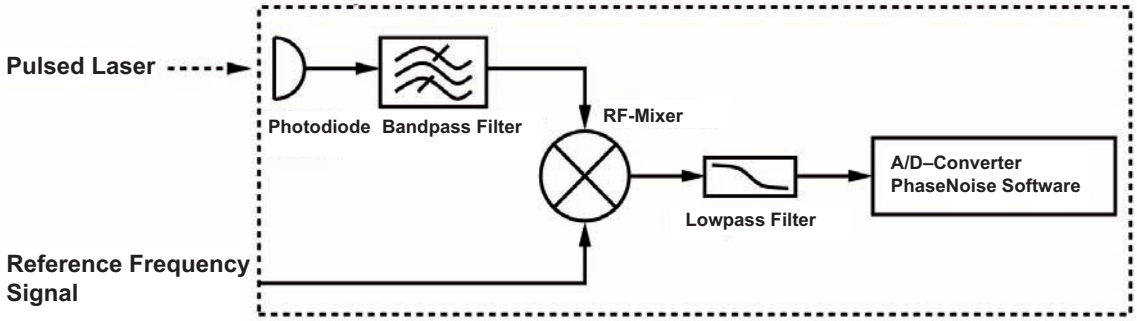
Applications

- Characterization of Mode-Locked Lasers
- Characterization of Control Loops in Synchronized Systems
- Timing Distribution Systems in Accelerator Facilities
- Optical Communications Systems
- Optical Sampling Applications
- Time-Domain Spectroscopy
- THz Physics



In order to be able to measure such low timing jitter values, a detection system with a low enough noise floor and high enough frequency range is required. Additionally, the measurement of phase noise and timing jitter should be fast and automated. A graphical display of the measurement results is important as well.

The image to the left shows a measurement of the relative timing jitter between an example pulsed laser and an ultra-low-noise RF reference frequency signal. The setup schematic for the measurement is shown below.



Basic setup for the detection of the timing jitter between a pulsed laser and a RF reference frequency signal. Using a 16-Bit resolution A/D converter the sampling noise floor is -156 dBc/Hz at a sample rate of 1 MS/s.

ITEM #	$	£	€	RMB	DESCRIPTION
PNS-1	CALL				Phase Noise Software, PC with A/D Converter, Phase Detection Setup
PNS-2	CALL				Phase Noise Software, PC and High-Resolution A/D Converter, Phase Detection Setup with Low-Noise Amplifier

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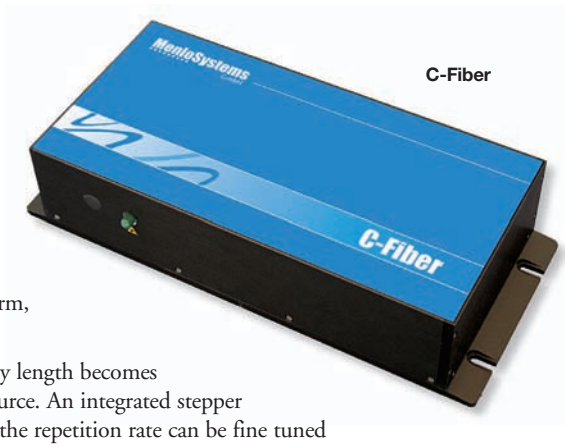
C-Fiber/M-Fiber: 1560 nm Femtosecond Fiber Lasers

C-Fiber Laser Series

The C-Fiber laser series consists of erbium-doped fiber lasers, each with a 100 MHz repetition rate. They are available with various power levels and offer a high degree of flexibility, including user-defined repetition rates and freely configurable optical output ports.

The passively mode-locked, state-of-the-art laser allows turnkey operation through an embedded microcontroller and is the ideal choice for demanding applications in the ultrafast world of science and industry.



M-Fiber Laser Series

The M-Fiber lasers run at a 250 MHz repetition rate on our scientific platform, delivering pulses with power levels above 400 mW.

By adding the SYNC option to the C-Fiber and the M-Fiber series, the cavity length becomes tunable, and the repetition rate can be synchronized to an external pulsed source. An integrated stepper motor allows for coarse adjustment, and with the help of the piezo actuator, the repetition rate can be fine tuned and locked to an external reference frequency. For details on the synchronization electronics, see the information on SYNCRO-RRE, which can be found on page 1526.

Advanced Features and Benefits

- Average Output Power: >400 mW @ 250 MHz
- Pulse Length: <90 fs
- Synchronization to External Clock Signal
- Highest Stability, Reliable Operation
- Truly Turnkey Operation by Self-Starting Mode-Locking Mechanism
- Embedded Microcontroller for Trouble-Free Operation
- Long Lifetime and Low Cost of Ownership

Applications

- Time-Resolved Spectroscopy
- Diagnostics and Imaging in Biology and Medicine
- Timing Distribution Systems
- THz Generation, THz Spectroscopy

Specifications

	C-Fiber	C-Fiber HP	C-Fiber A	M-Fiber	M-Fiber A
Wavelength	1560 ± 20 nm				
Repetition Rate	100 MHz			250 MHz	
Average Output Power	>30 mW	>150 mW	>250 mW	>75 mW	>400 mW
Pulse Width	<150 fs	<90 fs		<150 fs	<90 fs
Repetition Rate Tuning Range*	>330 kHz			>2 MHz	

* with SYNC100 or SYNC250 Option

The scientific lasers of the C-Fiber and M-Fiber series are also available with an added second harmonic generation stage. Please see C-Fiber/M-Fiber A 780 on page 1529 or visit www.menlosystems.com.

ITEM #	$	£	€	RMB	DESCRIPTION
C-Fiber	CALL				fs Fiber Laser, >30 mW @ 100 MHz
C-Fiber HP	CALL				fs Fiber Laser, >150 mW @ 100 MHz
C-Fiber A	CALL				fs Fiber Laser, >250 mW @ 100 MHz
M-Fiber	CALL				fs Fiber Laser, >75 mW @ 250 MHz
M-Fiber A	CALL				fs Fiber Laser, >400 mW @ 250 MHz

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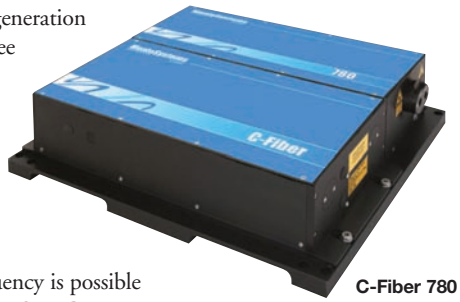
C-Fiber 780/M-Fiber A 780: 780 nm Femtosecond Fiber Lasers

C-Fiber 780 Laser Series

Building upon the success of our erbium-doped C-fiber laser series, a second harmonic generation stage has been added. This results in a laser with 780 nm centered pulses. The high degree of flexibility of our C-fiber lasers, including user-defined repetition rates and variable cavity lengths, is also available for this series.



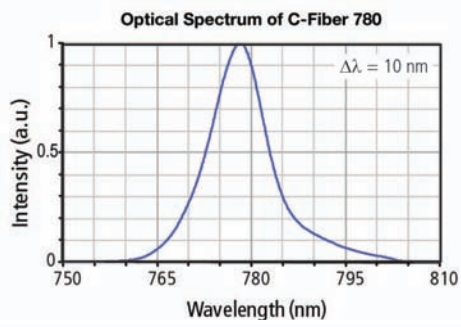
C-Fiber 780

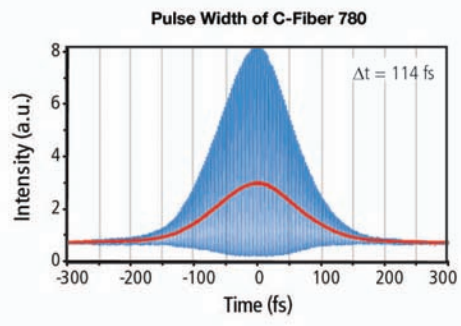
Using an external F-Femtoscale compressor, the C-Fiber 780 can deliver <70 fs pulses.

M-Fiber A 780 Lasers

The M-Fiber A 780 lasers run at a 250 MHz repetition rate and are built on our scientific platform. They deliver pulses with power levels in excess of 150 mW.

Synchronization of the repetition rate to a pulsed source or to an external reference frequency is possible by adding the SYNC option to the C-Fiber laser series or to the M-Fiber A 780 laser. The SYNC option is comprised of an integrated stepper motor and a piezo actuator, which allows for coarse and fine-tuning of the repetition rate, respectively. For details on synchronization electronics, please see the SYNCRO-RRE presentation on page 1526.





Advanced Features and Benefits

- Average Output Power: >180 mW @ 100 MHz
- Pulse Length: <70 fs
- Synchronization to External Clock Signal
- Highest Stability, Reliable Operation
- Truly Turnkey Operation by Self-Starting Mode-Locking Mechanism
- Embedded Microcontroller for Trouble-Free Operation
- Long Lifetime and Low Cost of Ownership

Applications

- Time-Resolved Spectroscopy
- Material Characterization
- Multi-Photon Excitation
- Bioimaging
- THz Generation, THz Spectroscopy

Specifications

	C-Fiber 780	C-Fiber A 780	M-Fiber A 780
Wavelength	780 ± 10 nm		
Repetition Rate	100 MHz		250 MHz
Average Output Power	>65 mW	>180 mW	>150 mW
Pulse Width	<70 fs[a], 100 - 120 fs[b]	<150 fs	100 - 120 fs
Repetition Rate Tuning Range[c]	>330 kHz		>2 MHz
Repetition Rate Instability	1 ppm		

[a] With use of External F-Femtoscale Compressor [b] Directly from Laser [c] With SYNC100 or SYNC250 Option

ITEM #	$	£	€	RMB	DESCRIPTION
C-Fiber 780	CALL				fs Fiber Laser, >65 mW @ 100 MHz
C-Fiber A 780	CALL				fs Fiber Laser, >180 mW @ 100 MHz
M-Fiber A 780	CALL				fs Fiber Laser, >150 mW @ 250 MHz

For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

orange: 1030 nm Femtosecond Fiber Laser

orange

The orange femtosecond laser oscillator provides high performance and reliable operation for scientific and industrial applications. The laser oscillator is based on ytterbium-doped fiber, which allows for amplification to high power levels. The combination of a broad spectrum and high peak power can also be exploited for frequency upconversion into the visible spectral range.

The oscillator produces chirped femtosecond pulses that are >1 ps in duration. For the orange laser, the pulses can be compressed to <100 fs using the external Yb-Compressor. The pulses from the orange A laser can be compressed to <150 fs using the Yb-TOD-Compressor.

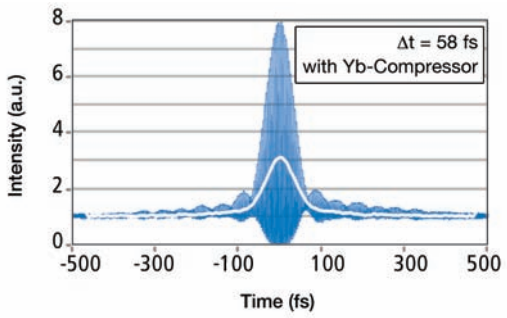
By adding the SYNC option, the laser can have a variable cavity length, allowing an integrated stepper motor to make coarse changes to the repetition rate and a piezo to make fine changes to the repetition rate for locking purposes. This feature can be used along with the SYNCRO-RRE electronics to lock the repetition rate of the laser to a pulsed laser source or to a stable RF reference.

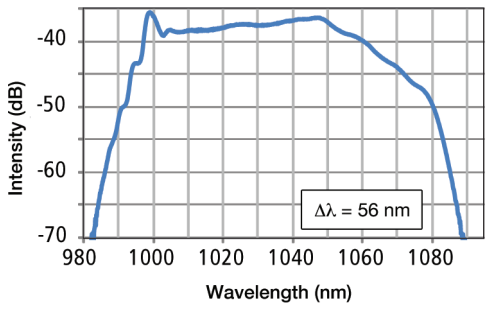
Features

- Turnkey Operation, Self-Starting Laser Configuration
- Compact Size: 413 mm x 178 mm x 120 mm
- Front Panel or Remote Operation
- Active Temperature Control of Laser Head
- Maintenance Free
- Low Cost of Ownership

Applications

- Ultrafast Spectroscopy
- Material Characterization
- Microfabrication
- Bioimaging
- Cell Manipulation
- Nonlinear Optics





Specifications

	orange	orange A
Wavelength	1030 - 1050 nm	1050 - 1070 nm
Average Output Power	>40 mW	>1 W
Spectral Bandwidth	>40 nm	>25 nm
Pulse Width without Compressor	1 - 4 ps	30 - 50 ps
Compressed Pulse Width	<100 fs[a]	<150 fs[a]
Repetition Rate	100 ± 1 MHz[b]	
Repetition Rate Tunability[c]	>330 kHz	
Output Port - Standard	Free Space, Linearly Polarized	
Beam Height	75 mm	
Output Port - Optional Configuration	Fiber-Coupled FC/APC	N/A

[a] After External Compressor, Available as Optional Unit [b] Other Repetition Rates Available upon Request [c] SYNC option required for variable repetition rate

The orange series are also available with an added second harmonic generation stage. Please see orange A 515 on page 1531 or visit www.menlosystems.com for more details.

ITEM #	$	£	€	RMB	DESCRIPTION
orange	CALL				Mode-Locked, Ytterbium-Doped Fiber Laser
orange A	CALL				Amplified Ytterbium-Doped Fiber Laser
SYNC100*	CALL				Repetition Rate Synchronization, Vary Cavity Length by >330 kHz
SYNCRO-RRE**	CALL				Repetition Rate Stabilization – Complete Phase Lock Loop
Yb-Compressor	CALL				External Compressor for orange, Pulse Length <100 fs, Transmission 80%
Yb-TOD-Compressor	CALL				External Compressor for orange A, Pulse Length <150 fs, Transmission 80%

* Option is Not Retrofittable, Please Order Together with Laser ** Requires SYNC100 Option in Laser Head

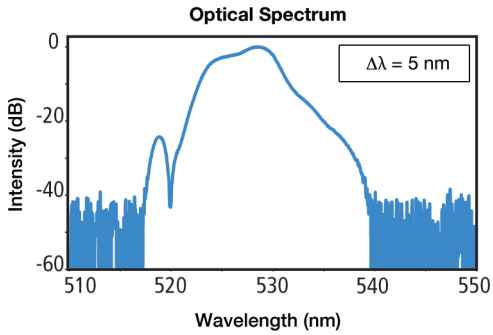
For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

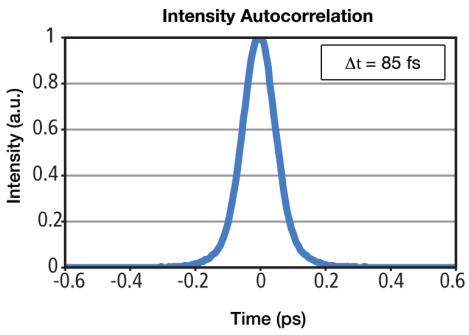
orange A 515: 515 nm Femtosecond Fiber Laser

The fundamental wavelength of the ytterbium-doped fiber oscillator at 1030 nm can be effectively converted to 515 nm via frequency doubling in a periodically poled potassium titanyl phosphate (PPKTP) crystal. The orange A 515 is comprised of an orange oscillator with amplifier, pulse compressor, and SHG unit.

As with the orange lasers on page 1530, this laser can be equipped with a variable cavity length by adding the SYNC option. The SYNC option and the SYNCRO-RRE electronics allow the user to lock the repetition rate of the laser to a pulsed source or an RF reference. Please see page 1526 for more details on Menlo Systems' synchronization electronics.


orange A 515





Specifications

	orange A 515
Wavelength	510 - 525 nm
Average Output Power	>250 mW
Spectral Bandwidth	>4 nm
Pulse Width without Compressor	N/A
Compressed Pulse Width	<150 fs
Repetition Rate	100 ± 1 MHz*
Repetition Rate Tunability**	>330 kHz
Output Port - Standard	Free Space, Linearly Polarized
Beam Height	75 mm

*Other Repetition Rates Available upon Request

**SYNC Option Required for Variable Repetition Rate

Features

- Turnkey Operation, Self-Starting Laser Configuration
- Compact Size
- Front Panel or Remote Operation
- Active Temperature Control of Laser Head
- Maintenance Free
- Low Cost of Ownership

Applications

- Ultrafast Spectroscopy
- Material Characterization
- Nonlinear Optics
- Asynchronous Optical Sampling (ASOPS)
- Bioimaging
- Cell Manipulation

ITEM #	$	£	€	RMB	DESCRIPTION
orange A 515	CALL				Femtosecond Fiber Laser, >250 mW at 515 nm
SYNC100	CALL				Repetition Rate Synchronization, Vary Cavity Length by >330 kHz
SYNCRO-RRE	CALL				Repetition Rate Stabilization - Electronics

For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

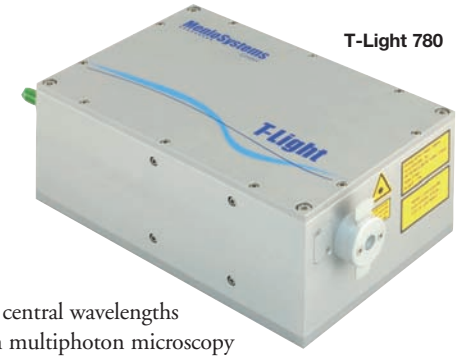
T-Light: 780 nm and 1560 nm Femtosecond Fiber Lasers

Features

- Compact Design: 234 mm x 151 mm x 96 mm
- Truly Turnkey Operation by Self-Starting Mode-Locking Mechanism
- Free-Space or Fiber-Coupled Output
- Long Lifetime
- Excellent Price/Performance Ratio

Applications

- Amplifier Seeding
- Ultrafast Spectroscopy
- Material Characterization
- Microfabrication
- Bioimaging
- THz Physics

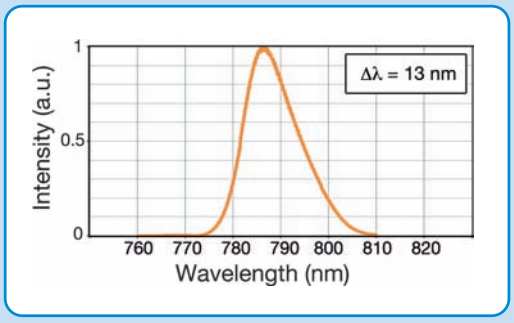


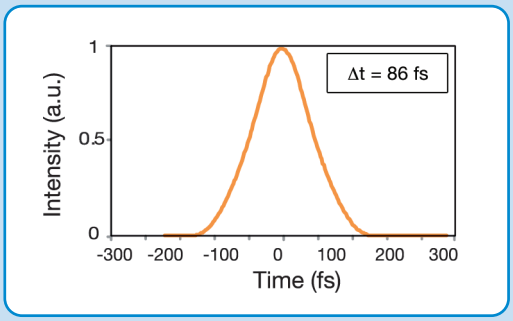
T-Light 780

The T-Light Series of robust turn-key femtosecond fiber lasers, which are available with central wavelengths of 780 nm or 1560 nm, offer exceptional performance for a variety of applications from multiphoton microscopy to micro-material processing.

With their 24/7 operation cycle, these fiber lasers are ideal for OEM integration. Our T-Light laser is the best choice if you need a compact and cost-effective solution.

T-Light 780 Spectrum and Pulse Width





Specifications

	T-Light 780	T-Light
Wavelength	780 ± 10 nm	1560 ± 20 nm
Average Output Power	>65 mW	>150 mW
Pulse Width	100 - 120 fs	<90 fs
Compressed Pulse Width	<70 fs*	N/A
Spectral Width	10 - 12 nm	>40 nm
Repetition Rate	100 ± 1 MHz	
Repetition Rate Instability	<1 ppm	
Output Port – Standard	Free-Space, Linearly Polarized	
Beam Height	60 mm	
Output Port – Optional Configuration	N/A	Fiber-Coupled FC/APC**

* T-Femtoscale Pulse Compressor Unit.
** Two Fiber-Coupled Output Ports, FC/APC, PM Fiber, Linearly Polarized. Total Average Power >100 mW, Pulse Length <90 fs (After 1 m Patch Cord). Power Ratio Between the Two Ports is Tunable.

The scientific lasers of the C-Fiber and M-Fiber series are also available with an added second harmonic generation stage. Please call for more details or visit www.menlosystems.com.

ITEM #	$	£	€	RMB	DESCRIPTION
T-Light 780	CALL				fs Fiber Laser, >65 mW @ 780 nm
T-Light	CALL				fs Fiber Laser, >150 mW @ 1560 nm
T-Femtoscale	CALL				Pulse Compressor Unit for Pulse Length <70 fs, Transmission 90%

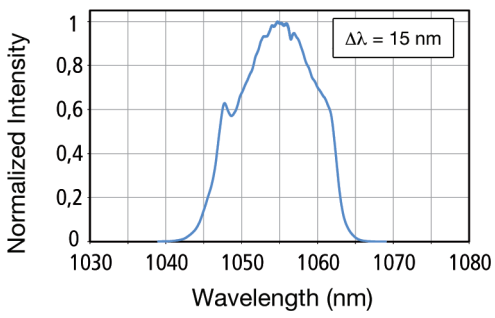
For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

o-Light: 1054 nm Femtosecond Fiber Laser

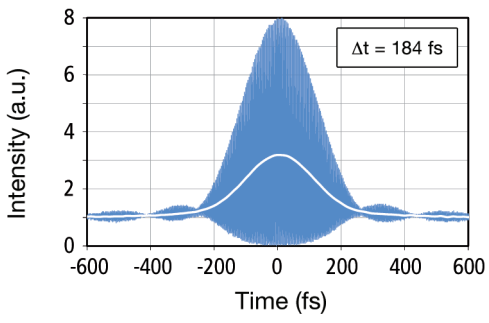
The o-Light is a fiber coupled femtosecond fiber oscillator on Menlo Systems' industrial platform. It is a robust turnkey system based on ytterbium-doped fibers. The o-Light oscillator has been designed for seeding Yb-based fiber and solid state amplifiers with multi µJ pulse energies.

The control unit is integrated into the laser housing, making the o-Light a compact and cost-efficient solution ideal for OEM integration. This 50 MHz repetition rate laser is designed for 24/7 operation.

Optical Spectrum



Pulse Width After Compression



Features

- Turnkey Operation, Self-Starting Laser Configuration
- Compact Size
- Integrated Control Unit (12 V Power Supply Required)
- Voltage Signal Based Remote Operation
- Temperature Stabilization
- Maintenance Free
- 50 MHz Repetition Rate

Applications

- Amplifier Seeding
- OEM Integration
- Ultrafast Spectroscopy
- Material Characterization
- Bioimaging
- Cell Manipulation

Specifications

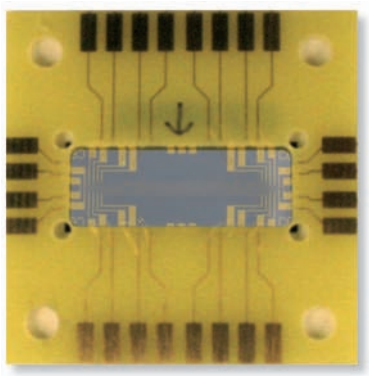
Central Wavelength	1054 nm*
Spectral Bandwidth (FWHM)	>12 nm
Average Output Power	>10 mW
Pulse Duration	Several ps; Compressible to < 250 fs
Repetition Rate	50 MHz ± 1 MHz
Output Port Configuration	Fiber-Coupled (FC/APC), PM980 2 m Fiber Patch Cord**; Linearly Polarized

*Customer Specific Center Wavelength on Request **Included

ITEM #	$	£	€	RMB	DESCRIPTION
o-Light	CALL				Mode-Locked Ytterbium-Doped Fiber Oscillator, >10 mW at 50 MHz

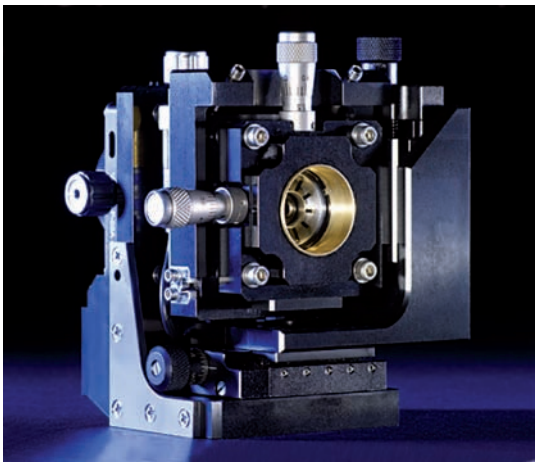
For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

TERA8: THz Antenna for 800 nm

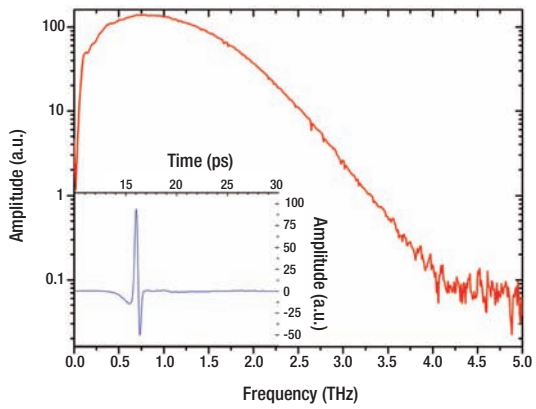


TERA8

The TERA8 is comprised of six dipole structures on one chip. With the "6 in 1" approach, highest bandwidth and highest sensitivity on one chip become a reality. Each chip can be used as an emitter or as a detector. Menlo Systems brings TERA8 to the market with its collaborator, the Fraunhofer Institute for Physical Measurement Techniques IPM.



T8-H1 Holder for photoconductive THz antenna including focusing lens for optical beam and Si lens for THz waves.



Spectrum of Emitted THz Radiation (Insert Shows Data Plot of Electrical Field as Function of Time)

Features

- Photoconductive Switch Optimized for Lasers Around 800 nm and Pulse Widths <150 fs at 100 MHz Repetition Rate
- 6 Dipole Structures on Each Chip
- Low-Temperature-Grown GaAs Dipole Structure
- Each Device is Tested and Ships with its own Individualized Test Report

Specifications

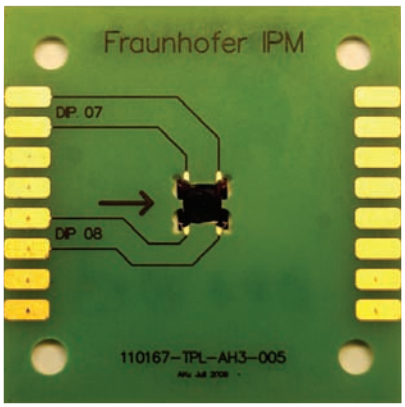
Bonded Structure	
6 Dipole Structures	10 µm: Generation of THz Radiation with Highest Bandwidth
	20 µm: Our Standard Length for High Bandwidth and High Sensitivity*
	40 µm: High Dynamic Range at Medium Bandwidth
	60 µm: Generation of THz Waves with Highest Dynamic Range
Gap Size	5 µm
Substrate Size	25.8 mm x 10.2 mm x 0.35 mm
Chip Mounting	Comes Mounted on a 40 mm x 40 mm PCB
Optional Alignment Package	T8-H1 can be Ordered Separately
Recommended Optical Light Sources	
Menlo Systems Femtosecond Lasers	T-Light-780, C-Fiber-780

* There are 3 dipole structures of this length on each chip.

ITEM #	$	£	€	RMB	DESCRIPTION
TERA8	CALL				THz Antenna for 800 nm
T8-H1	CALL				Mount for TERA8

For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

TERA8-1: THz Antenna for 800 nm

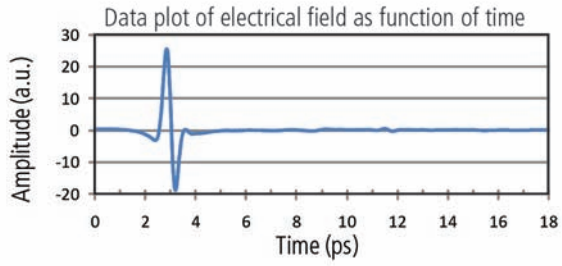


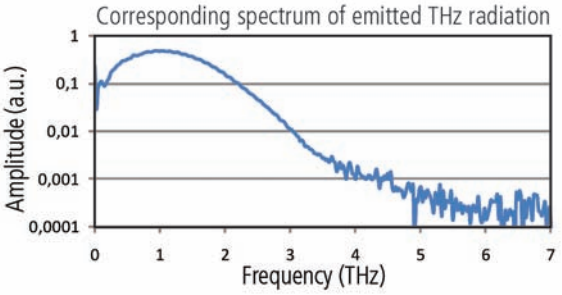
TERA8-1

The TERA8-1 is a single dipole structure. The antenna can be used as an emitter or as a detector. We introduced the TERA8-1 to the market with our collaborator IPM, Fraunhofer Institut für Physikalische Messtechnik.

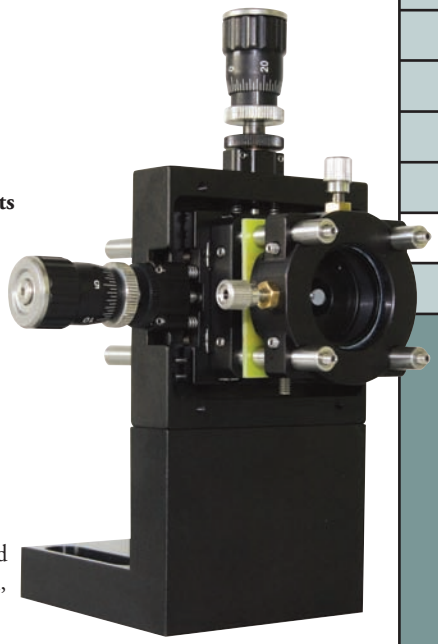
Features

- Photoconductive Switch Optimized for Lasers Around 800 nm and Pulse Widths <150 fs at 100 MHz Repetition Rate
- 1 Wrapped Dipole Structure on Each Chip
- Low-Temperature-Grown GaAs Dipole Structure
- Each Device is Tested and Ships with Individualized Test Report





Test Conditions for Data Plots
Optical source: Menlo Systems fs fiber laser operating at 780 nm with 130 fs pulse width. Data recorded with 20 µm dipole used on emitter and detector sides, mechanical chopper at 1 kHz, lock-in detection with 30 ms integration time, 10 mW of optical input power at emitter and detector sides, electrical output of receiver pre-amplified by 10^7 before lock-in detection, 45 V bias at emitter.



T8-H2 Holder for Photoconductive THz Antenna Including Focusing Lens for Optical Beam and Si Lens for THz Waves.

Specifications

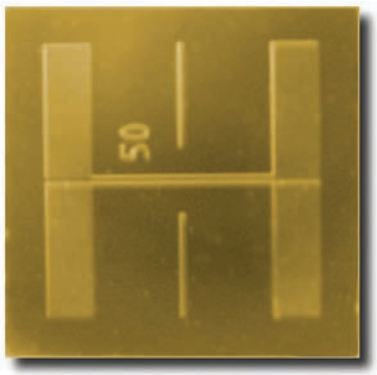
Bonded Structure	Wrapped Dipole
Bandwidth	Up to 4 THz
Dipole Length	20 µm
Gap Size	5 µm
Substrate Size*	5.0 mm x 5.0 mm
Alignment Package	T8-H2
Recommended Optical Light Sources	
Menlo Systems Femtosecond Lasers	T-Light-780, C-Fiber-780

* Antenna is mounted on 40 mm x 40 mm PCB board

ITEM #	$	£	€	RMB	DESCRIPTION
TERA8-1	CALL				Dipole THz Antenna
T8-H2	CALL				THz Alignment Package

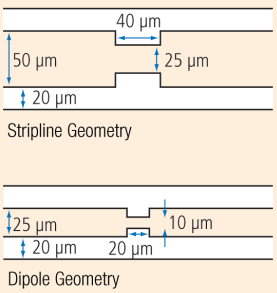
For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

TERA15: THz Antenna for 1550 nm



TERA15

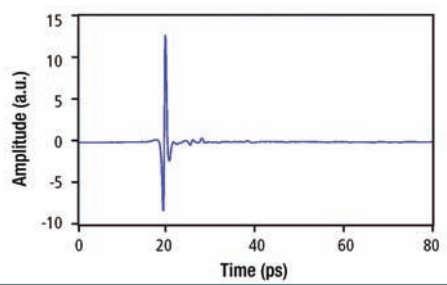
The TERA15 THz-antennas can be incorporated into OEM systems and are used in Menlo Systems' TERA15-FC fiber-coupled antenna modules seen on page 1537. The emitter and detector antennas have optimized structures for <150 fs optical pulses at 1560 nm to increase signal-to-noise ratio. Menlo Systems brings the newest generation of the TERA15 to the market with its collaborator, the Fraunhofer-Institut für Nachrichtentechnik Heinrich-Hertz-Institut.



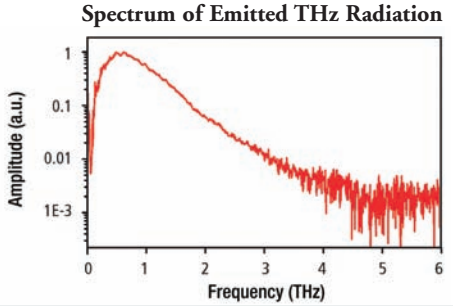
Features

- Optimized for Lasers Around 1560 nm and Pulse Widths <150 fs at 100 MHz Repetition Rate
- Patented LT InGaAs/In-AlAs on InP Multi-Layer Quantum Well System with Mesa Structure
- Antenna Design Specified for Emitter/Receiver Applications
- Each Device is Tested and Ships with Individualized Test Report

Electrical Field as Function of Time



Spectrum of Emitted THz Radiation



Test Conditions for Plots

Laser model: Menlo Systems C-Fiber HP, 1560 nm center wavelength, 100 MHz repetition rate, dispersion precompensated for 10 m of SMF, pulse width at antenna <100 fs, 30 mW of optical input power at emitter and detector, electrical input at emitter of 10 V, 1 kH modulation, electrical output of receiver pre-amplified by 10^7 before lock-in detection.

Specifications

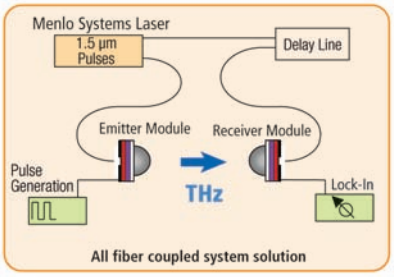
	Emitter SL25	Detector DP25
Photoconductive Material	LT InGaAs/InAlAs	LT InGaAs/InAlAs
Photosensitivity	Up to 1.57 µm	Up to 1.57 µm
Antenna Type	Strip Line 25 µm	Dipole 25 µm, Gap 10 µm
Chip Size	4 mm x 4 mm, d = 0.35 mm	4 mm x 4 mm, d = 0.35 mm
Optical Power at 100 MHz Repetition Rate	<40 mW	<40 mW
Bias Voltage	±10 V	N/A
Characteristics Measured in Fiber Testbed		
THz pulse Shape	Peak-to-Peak Time Difference <700 fs	
Maximum of Fourier Spectrum	>0.5 THz	
1/10 Bandwidth of Fourier Spectrum	>1.5 THz	
Noise Floor	>3 THz	
Recommended Optical Light Sources		
Menlo Systems Femtosecond Fiber Lasers	T-Light, C-Fiber HP, M-Fiber	

ITEM #	$	£	€	RMB	DESCRIPTION
TERA15-SL25	CALL				THz Emitter, Strip Line 25 µm
TERA15-DP25	CALL				THz Detector, Dipole 25 µm, Gap 10 µm

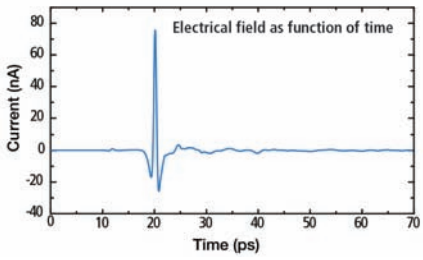
For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

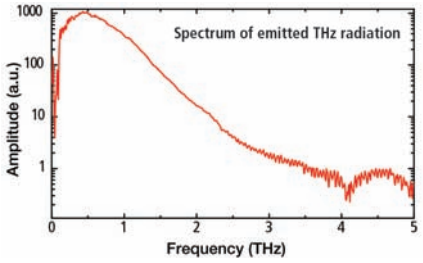
TERA15-FC: Fiber-Coupled THz Antennas for 1550 nm

The TERA15-FC THz Antennas are optimized for 1560 nm and are used in the fully fiber-coupled TERAK15 terahertz spectrometer. Menlo Systems, in collaboration with the Fraunhofer-Institut für Nachrichtentechnik Heinrich-Hertz-Institut, continues to make THz products more user friendly.



All Fiber-Coupled THz Schematic with TERA15-FC Antennas





Test Conditions for Plots

Laser model: Menlo Systems C-Fiber HP, 1560 nm center wavelength, 100 MHz repetition rate, dispersion pre-compensated for SMF of 10 m length, pulse width at antenna <100 fs, 30 mW of optical input power at emitter and detector, electrical input at emitter, 10 V, 1 kHz modulation, electrical output of receiver pre-amplified by 10^7 before lock-in detection 45 V bias at emitter.

Features

- Optimized for Lasers Around 1560 nm and Pulse Widths <150 fs at 100 MHz Repetition Rate
- Based on Novel Mesa-Structured InGaAs/InAlAs Photoconductive Layers
- Antenna Design Specified for Emitter/Receiver Applications
- Each Device is Tested and Ships with Individualized Test Report

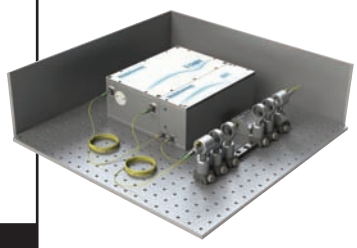
Specifications

	Emitter SL25	Detector DP25
Photoconductive Material	LT InGaAs/InAlAs	LT InGaAs/InAlAs
Photosensitivity	Up to 1.57 µm	Up to 1.57 µm
Antenna Type	Strip Line 25 µm	Dipole 25 µm; Gap 10 µm
Chip Size	4 mm x 4 mm, d = 0.35 mm	4 mm x 4 mm, d = 0.35 mm
Optical Power at 100 MHz Repetition Rate	<40 mW	<40 mW
Bias Voltage	±10 V	N/A
Characteristics Measured in Fiber Testbed		
THz pulse Shape	Peak-to-Peak Time Difference <700 fs	
Maximum of Fourier Spectrum	>0.5 THz	
1/10 Bandwidth of Fourier Spectrum	>1.5 THz	
Noise Floor	>3 THz	
Recommended Optical Light Sources		
Menlo Systems Femtosecond Fiber Lasers	T-Light, C-Fiber HP, M-Fiber	

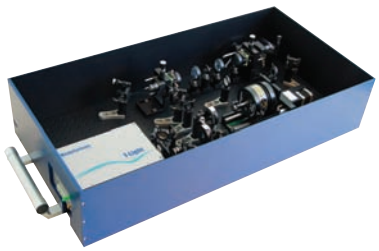
ITEM #	$	£	€	RMB	DESCRIPTION
TERA15-SL25-FC	CALL				Fiber-Coupled THz Emitter, Strip Line 25 µm
TERA15-DP25-FC	CALL				Fiber-Coupled THz Detector Dipole 25 µm; Gap 10 µm

For local and updated pricing, please call Menlo Systems, Inc. in North America 973-300-4490, Menlo Systems GmbH in Europe +49-89-189-1660, or Thorlabs Japan, Inc. in Asia +81-3-5979-8889, or email sales@menlosystems.com.

TERA K8/K15: Time-Domain THz Spectrometer



Our assembled THz Laboratory Kit Solutions provide a flexible approach for time domain THz spectroscopy. The THz spectrometer includes a femtosecond laser source, optical beam line with delay line, THz wave path with THz emitter, THz detector, THz optics, lock-in detection electronics, and PC with data acquisition software. Free space and fiber-coupled solutions are available.

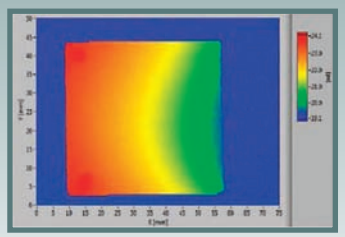


System Components

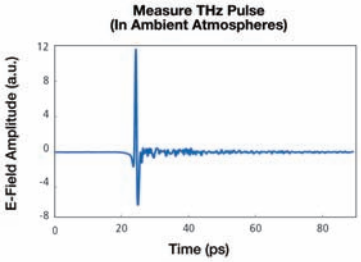
- Femtosecond Laser Source
- Optical Delay Line
- Optical Breadboard with THz Emitter and Receiver Modules
- THz Optics

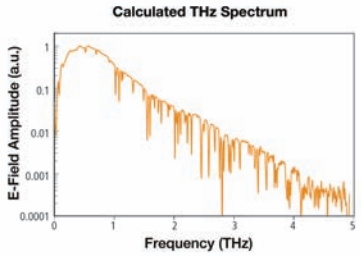
Applications

- Time Resolved THz Spectroscopy
- Chemical Fingerprinting
- Material Characterization
- THz Imaging



Images taken from TERA Image. This product includes an XY translation stage with 10 cm x 10 cm scan range and software package for image reconstruction. X-resolution 150 µm, Y-resolution 500 µm.





THz pulse waveform and calculated THz spectrum measured in ambient atmosphere with TERA K8 spectrometer.

Specifications

	TERA K8	TERA K15
Antenna Structure	**TERA 8**	**TERA 15**
Spectral Range (min)	>3 THz	
Dynamic Range	>55 dB (Typical 60 dB)	
Scan Range	300 ps*	300 ps
Laser Model	**T-Light 780**	**T-Light**
Repetition Rate	100 MHz	
Wavelength	780 nm	1560 nm
Pulse Duration	100 - 120 fs	<90 fs, After 2 m Patch Cord
Output Port	Free Space	Two Fiber-Coupled FC/APC, PM Fiber
Total Average Output Power	>65 mW	>80 mW

* Other Ranges Available Upon Request.

Control Electronics

- TC1550 Control Electronics for the Laser Head
- HVG110 Electrical Chopper for Emitter Antenna, 0.1 - 75 kHz, up to ±60 V
- Control Electronics for the Delay Line
- Analog Lock-In Amplifier
- Data Acquisition Platform, 16-Bit, 250 kS/s
- PC and Software Package for Measurement and Data Analysis

ITEM #	$	£	€	RMB	DESCRIPTION
TERA K8	CALL				Complete Free-Space Optics THz System for 780 nm with T-Light 780
TERA K8-NL	CALL				THz Kit for 780 nm without Laser
TERA K15	CALL				Complete Fiber-Coupled THz System for 1560 nm with T-Light
TERA K15-NL	CALL				THz Kit for 1560 nm without Laser
TERA IMAGE	CALL				TERA K8/TERA K15 Extension Unit for Automated THz Imaging

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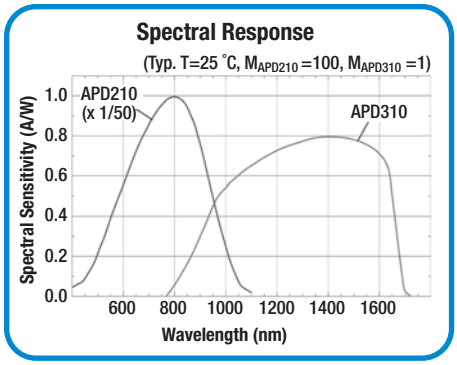
APD Series of High-Sensitivity Avalanche Photodetectors

APD310

Applications

- Detection of Fast Laser Pulses
- For Beat Signals of Low-Level Inputs
- LIDAR (Light Detection and Ranging)
- Testing of Optical Components



Features

- High-Speed Response up to 1 GHz
- Continuously Adjustable Gain
- 400 - 1000 nm and 850 - 1650 nm Wavelength Ranges Available
- SM05 Threaded for Lens Tube and Cage Assembly Integration

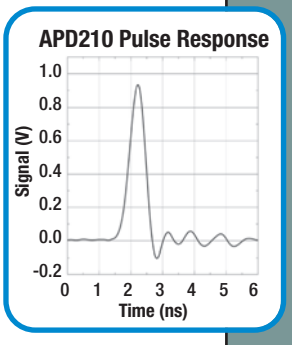
Menlo Systems' Avalanche Photodetector (APD) series provides an extremely light-sensitive alternative to traditional PIN photodiodes. The APDs are sensitive and fast enough for the characterization of pulsed lasers on the the order of nanoseconds. The silicon avalanche photodiode of the APD210 provides exceptional performance for low-light applications in the 400 - 1000 nm range, while the APD310 covers the InGaAs range of 850 - 1650 nm. The APD maintains high-gain stability over the operating temperature range by utilizing a temperature-compensation circuit, which adjusts the ~150 VDC bias to ensure operation near the breakdown voltage.

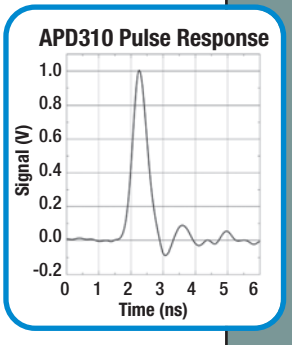
A 40 dB gain amplifier is integrated into the package and is AC-coupled to band the output BNC. The output is matched to a 50 Ω impedance. The detector has an electronic width of 1 MHz to 1 GHz and offers a user-accessible potentiometer, providing a continuous gain adjustment. The APD series has SM05 (0.535"-40) threads for easy integration into Thorlabs' entire family of lens tubes and cage assemblies. The bottom of the detector has a metric (M4) mounting hole and an M4 to 8-32 adapter is provided for post mounting. The compact packaging allows the APD to be substituted directly into an existing setup while maintaining a small footprint on the benchtop. These photodetectors are not suitable for pulses longer than 30 ns or continuous light levels. Please see the FPD510 series on page 1541 for alternatives.

Specifications

	APD210	APD310
Optical Input	Free-Space[a]	Free Space[a]
Supply Voltage	12 - 15 V[b]	12 - 15 V[b]
Current Consumption	200 mA	200 mA
Incident Power (Max)	10 mW	10 mW
Operating Temperature	10 - 40 °C	10 - 40 °C
Spectral Range	400 - 1000 nm	850 - 1650 nm
Detector Diameter	0.5 mm	0.03 mm
Frequency Range	1 - 1600 MHz	1 - 1800 MHz
3 dB Bandwidth	5 - 1000 MHz	5 - 1000 MHz
Rise Time	500 ps	500 ps
Gain Step Size	2500 V/W @ 1 GHz, 800 nm	250 V/W @ 1 GHz, 1500 nm
Gain (Max)[c]	2.5 x 10^5 V/W @ 1 GHz, 800 nm	2.5 x 10^4 V/W @ 1 GHz, 1500 nm
Dark State Noise Level[d]	-80 dBm	-80 dBm
NEP (Calculated)	0.4 pW/√Hz	2 pW/√Hz
Output Connectors	BNC	BNC
Output Impedance	50 Ω	50 Ω
Device Dimensions	60 mm x 56 mm x 47.5 mm	60 mm x 56 mm x 47.5 mm
Output Coupling	AC	AC

[a] With adapter for Thorlabs' SM05 Mount
[b] Power Supply included with adapters for EU/USA. Others available upon request.
[c] Gain Adjustable via Push Buttons
[d] Span: 5 MHz, Resolution Bandwidth 3 kHz





ITEM #	$	£	€	RMB	DESCRIPTION
APD210	$ 2,069.00	£ 1,489.70	€ 1.800,00	¥ 16,489.93	High-Speed Avalanche Detector, 1000 MHz, 400 - 1000 nm
APD310	$ 2,241.40	£ 1,613.80	€ 1.950,00	¥ 17,863.96	High-Speed Avalanche Detector, 1000 MHz, 850 - 1650 nm

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FPD310 Series of High-Sensitivity PIN Photodetectors: 10 MHz – 1 GHz

FPD310-F

For experiments requiring high bandwidths and extremely short rise times, choose Menlo Systems' FPD310 photodetector. It is an easy-to-use photodiode package with an integrated high-gain, low-noise, RF amplifier. Two models are available with an ultrafast free-space photoreceiver: FPD310-FV detects light from 400 – 1000 nm while FPD310-F detects light from 850 – 1650 nm. The third model (FPD310) is fiber coupled and detects light from 850 – 1650 nm. Rise times for all models are less than 1 ns. The user can switch between two gain settings. OEM integration can be achieved easily due to its compact housing.

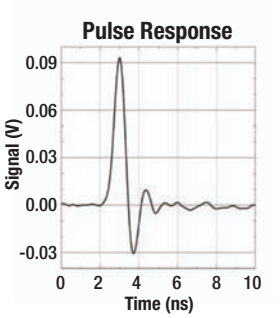
These photodetectors are not suitable for pulses longer than 30 ns or continuous light levels. Please see the FPD510 series on the next page for alternatives.

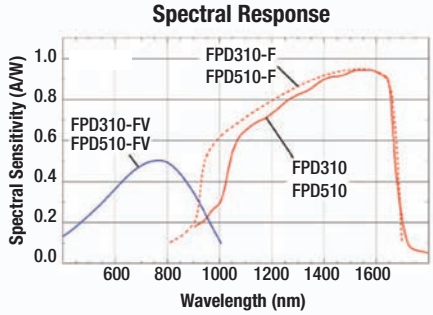
Features

- ~1 dB Bandwidth at 1 GHz
- Ultrafast Response (1 MHz – 1.8 GHz)
- OEM Package with FC/APC Pigtail (SMF-28e+) Fiber
- Spectral Range: 400 – 1650 nm
- Two Gain Settings

Applications

- Detection of Fast Laser Pulses
- Detection of Fiber-Coupled or Free-Space Low-Light Level Signals





Specifications

	FPD310	FPD310-F	FPD310-FV
Optical Input	Fiber[a]	Free Space	Free Space
Supply Voltage	8 – 20 V	8 – 20 V	8 – 20 V
Current Consumption	250 mA	250 mA	250 mA
Incident Power (Max)	2 mW	2 mW	2 mW
Operating Temperature	10 – 40 °C	10 – 40 °C	10 – 40 °C
Wavelength Range[b]	850 – 1650 nm	850 – 1650 nm	400 – 1000 nm
Detector Diameter	–	0.04 mm	0.4 mm
Frequency Range	1 – 1800 MHz	1 – 1800 MHz	1 – 1500 MHz
3 dB Bandwidth	10 – 1000 MHz	10 – 1000 MHz	10 – 900 MHz
Rise Time	0.5 ns	0.5 ns	0.7 ns
Gain Setting 1[c]	5 x 10^4 V/W	5 x 10^4 V/W	5 x 10^4 V/W
Gain Setting 2[c]	5 x 10^2 V/W	5 x 10^2 V/W	5 x 10^2 V/W
Dark State Noise Level[d]	-90 dBm	-90 dBm	-90 dBm
NEP (Calculated)	15.7 pW/√Hz	16.6 pW/√Hz	30 pW/√Hz
Output Connector	SMA	SMA	SMA
Output Impedance	50 Ω	50 Ω	50 Ω
Device Dimensions	60 mm x 50 mm x 27 mm	60 mm x 50 mm x 27 mm	60 mm x 50 mm x 27 mm
Output Coupling	AC	AC	AC

[a] SMF-28e+ Pigtail with FC/APC [b] Other Spectral Ranges Available upon Request [c] At 1 GHz, 1500 nm/750 nm [d] Span: 5 MHz, Resolution Bandwidth 3 kHz

ITEM #	$	£	€	RMB	DESCRIPTION
FPD310	$ 1,023.00	£ 736.56	€ 890,00	¥ 8,153.31	850 – 1650 nm High-Sensitivity PIN Detector, Fiber Coupled, 1 MHz – 1.8 GHz
FPD310-F	$ 1,023.00	£ 736.56	€ 890,00	¥ 8,153.31	850 – 1650 nm High-Sensitivity PIN Detector, Free Space, 1 MHz – 1.8 GHz
FPD310-FV	$ 1,023.00	£ 736.56	€ 890,00	¥ 8,153.31	400 – 1000 nm High-Sensitivity PIN Detector, Free Space, 1 MHz – 1.5 GHz

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FPD510 Series of High Sensitivity PIN Photodetectors: DC – 200 MHz

FPD510-FM

Features

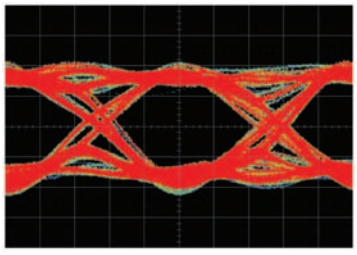
- High Signal-to-Noise Ratio
- Flat Spectral Response (Less than 3 dB up to 200 MHz)
- OEM Package with FC/APC Pigtail (SMF-28e+) or Free-Space Module

Menlo Systems' FPD510 series of High Sensitivity PIN Photodetectors are optimized for the highest signal-to-noise ratio when detecting low-level optical beat signals at frequencies up to 250 MHz. The unit is recommended, in particular, for applications in metrology when beat signals of weak power have to be detected in a highly efficient way. Models for both the visible and the near infrared spectral ranges are available. The FPD510 photodetectors feature ultrafast fiber-coupled or free-space photoreceivers with an integrated low-noise transimpedance amplifier. The 3 dB bandwidth of the DC-coupled device is 200 MHz. The compact design of these detectors allows for easy OEM integration.

Applications

- Detection of Chopped Light Sources
- Fiber-Coupled or Free-Space Low-Light Signals

The eye diagram is a useful tool for the quantitative analysis of signal transmission. The excellent signal-to-noise ratio of the FPD510 detector enables the evaluation of amplitude and phase jitter characteristics of an optical communication system based on amplitude modulated pulsed laser sources with low-light optical signals.



Specifications

	FPD510	FPD510-F	FPD510-FV
Optical Input	Fiber[a]	Free Space	Free Space
Supply Voltage	8 - 20 V	8 - 20 V	8 - 20 V
Current Consumption	50 mA	50 mA	50 mA
Incident Power (Max)	10 mW	10 mW	10 mW
Operating Temperature	10 - 40 °C	10 - 40 °C	10 - 40 °C
Spectral Range[b]	850 - 1650 nm	850 - 1650 nm	400 - 1000 nm
Detector Diameter	–	0.3 mm	0.4 mm
Frequency Range	0 - 250 MHz	0 - 250 MHz	0 - 250 MHz
3 dB Bandwidth	0 - 200 MHz	0 - 200 MHz	0 - 200 MHz
Rise Time	2 ns	2 ns	2 ns
Gain[c]	4 x 10^4 V/W	4 x 10^4 V/W	4 x 10^4 V/W
Dark State Noise Level[d]	-120 dBm	-120 dBm	-120 dBm
NEP (Calculated)	3 pW/√Hz	3.2 pW/√Hz	6 pW/√Hz
Output Connector	SMA	SMA	SMA
Output Impedance	50 Ω	50 Ω	50 Ω
Device Dimensions	60 mm x 50 mm x 27 mm	60 mm x 50 mm x 27 mm	60 mm x 50 mm x 27 mm
Output Coupling	DC	DC	DC

[a] SMF-28e+ Pigtail with FC/APC [b] Other Spectral Ranges Available on Request [c] At 200 MHz, 1500 nm/750 nm [d] 5 – 200 MHz, Span: 3 MHz, Resolution Bandwidth 3 KHz

ITEM #	$	£	€	RMB	DESCRIPTION
FPD510	$ 1,367.80	£ 984.82	€ 1.190,00	¥ 10,901.37	850 - 1650 nm, High-Sensitivity PIN Detector, Fiber-Coupled, 0 - 250 MHz
FPD510-F	$ 1,367.80	£ 984.82	€ 1.190,00	¥ 10,901.37	850 - 1650 nm, High-Sensitivity PIN Detector, Free Space, 0 - 250 MHz
FPD510-FV	$ 1,367.80	£ 984.82	€ 1.190,00	¥ 10,901.37	400 - 1000 nm, High-Sensitivity PIN Detector, Free Space, 0 -250 MHz

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