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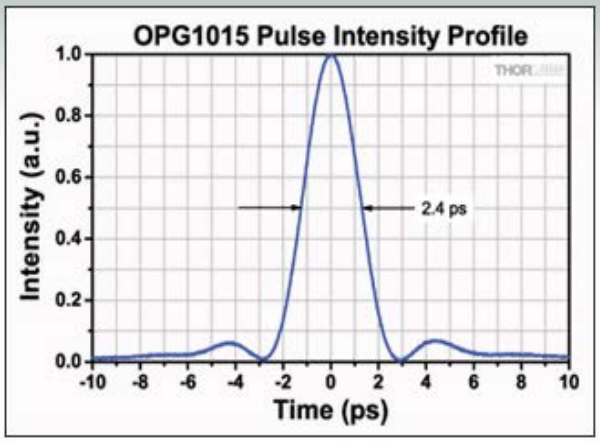
OPG1015 - February 13, 2018

Item # OPG1015 was discontinued on February 13, 2018. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

PICOSECOND OPTICAL PULSE GENERATOR

- **Produces ≤3 ps Pulses at 10 GHz Repetition Rate**
- **Broadly Tunable Wavelength (1520 - 1620 nm) and Repetition Rate (9.5 - 10.5 GHz)**
- **Easily Synchronized to an RF Clock or Ultrafast Laser**

OPG1015



A Typical Pulse From the OPG1015. The UTM-1500 Temporal Magnifier Expands the Pulse for Analysis with a Fast Photodiode and Sampling Oscilloscope

OVERVIEW

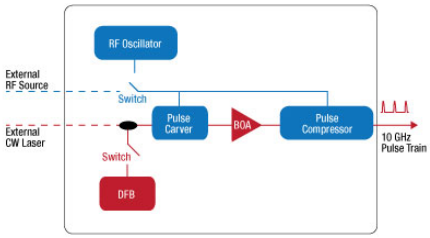
Features

- Provides ≤3 ps Pulses at 10 GHz Repetition Rate in the Telecommunication Band
- Directly Driven by RF Source without Mode Locking
- Tunable Wavelength from 1520 - 1620 nm (External Tunable Seed Laser)
- Variable High-Repetition Rate from 9.5 - 10.5 GHz (External RF Source)
- Easily Synchronized to Ultrafast Laser Sources and RF Clocks
- High Amplitude and Phase Stability

Specifications[a]	
Wavelength Tuning Range	1520 - 1620 nm
Pulse Width (1550 nm, 10 GHz)	≤3 ps
Repetition Rate Tuning Range (Ext. Clock)[b]	9.5 - 10.5 GHz
Average Output Power (1550 nm, Typical)	6 mW

- See *Specs* Tab for complete specifications
- The pulse width varies by 10% over the repetition rate tuning range.

Thorlabs' OPG1015 Optical Pulse Generator (OPG) creates pulses with widths ≤3 ps (see graph above) at a 10 GHz repetition rate between 1520 and 1620 nm. Driven by an RF source, this OPG uses pulse carving and coherent comb generation, based on Thorlabs' $LiNbO_3$ modulators, followed by linear pulse compression to convert a narrow-linewidth CW source into a high-repetition pulsed laser [1]. Using this method, mode locking is not required, and thus, the OPG1015 produces a broad, continuous repetition rate tuning range as well as shot-to-shot high amplitude and phase stability. A built-in broadband semiconductor optical amplifier (BOA) allows a large tuning range from 1520 - 1620 nm, which exceeds the tuning range of fiber-based mode-locked lasers. An FC/APC connector on the OPG couples the output pulse to an FC/APC SM patch cable (not included).



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Simplified Diagram of the OPG1015 System

The center wavelength of the output pulse is controlled with a CW seed laser, which can be sourced either internally or externally. The internal operation

utilizes a Distributed Feedback (DFB) laser at 1550 ± 5 nm; external operation requires a narrow-linewidth (<100 MHz) CW laser within 1520 - 1620 nm. Additionally, an external tunable laser may be used with the optical pulse generator, which allows the user to adjust the center wavelength over the entire supported range. An external laser source should utilize an FC/PC PM patch cable to interface with the OPG1015.

The RF drive can be supplied either internally or externally at half the desired repetition rate. The internal option is a 5 GHz (providing a 10 GHz repetition rate) free-running dielectric resonator oscillator and can source a >75 MHz tuning range of the repetition rate around the center frequency via a screw adjuster on the back panel of the device (see *Specs* tab for more details). An external source, such as a frequency synthesizer, can achieve a larger tuning range and higher frequency stability than that from the internal source. Using an external RF source with a frequency between 4.7 GHz and 5.3 GHz provides an easy and reliable way to synchronize the OPG to an external clock signal or an ultrafast optical oscillator with very low relative timing jitter. Please see the *Synchronization* tab for more information.

Due to its high phase coherence, this optical pulse generator is ideal for coherent optical communication applications. It can be used as transmitter or receiver optical clock in high-speed communication systems and for testing transmission networks. Additionally, the system can be used for optical sampling, pump-probe experiments, and component testing. The output spectrum provides a stable frequency comb with more than 30 lines separated by 10 GHz, which can be used in frequency metrology and optical communication applications. The pulses can be further compressed and the frequency comb bandwidth can be further expanded by sending the OPG output pulses into a nonlinear optical waveguide.

Shorter pulse widths, custom wavelengths, higher peak powers, a stabilized internal RF oscillator, or other repetition rates are available as well as select DFB wavelengths within the 1520 - 1620 nm range. Please contact Tech Support for more information.

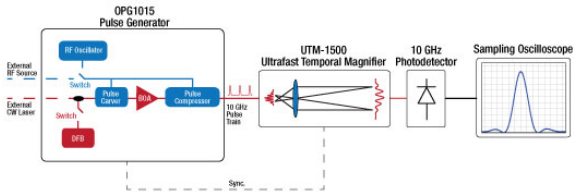
Please Note: Our Picosecond Optical Pulse Generator has not been CE certified. Hence, it is not available for sale in countries requiring this certification.

[1] T. Kobayashi, H. Yao, K. Amano, Y. Fukushima, A. Morimoto and T. Sueta, "Optical pulse compression using high-frequency electrooptic phase modulation," *IEEE J. Quantum Electron*., **24**, no. 2, pp.382-387 1988

SPECS

Specifications			
Absolute Maximum Ratings			
Input Optical Power	30 mW		
RF Input Power	15 dBm		
Electrical Tuning Voltage	+12 V		
Electrical Tuning Reverse Bias Voltage	0 V		
Operating Temperature	0 to 40 °C		
Storage Temperature	-10 to 65 °C		
Parameter	**Min**	**Typical**	**Max**
Pulse Width (1550 nm, 10 GHz)	-	2.5 ps	3 ps
Average Output Power (1550 nm)	3 mW	6 mW	-
Calculated Peak Power	100 mW	200 mW	-
Wavelegth Tuning Range (Ext. Laser Source)	1520 nm	-	1620 nm
Repetition Rate Tuning Range (Ext. Clock)[a]	9.5 GHz	-	10.5 GHz
RMS Timing Jitter (Relative to RF Source)[b]	-	100 fs	-
Internal DFB Laser Linewidth	-	4 MHz	-
Internal RF Source Frequency Stability[c]	-	-	15 ppm
Internal RF Source Tuning (Mechanical)	-	75 MHz	-
Internal RF Source Tuning (Electrical)	-	5 MHz	-
Internal RF Source Phase Noise (10 kHz)	-	-95 dBc/Hz	-
External RF Input Power	2 dBm	-	10 dBm
External Optical Input Power	2 mW	-	20 mW
External Optical Source Input Linewidth[b]	-	-	100 MHz

- The pulse width varies by 10% over the repetition rate tuning range.
- The relative jitter is specified for the system operating with the DFB seed laser. Increasing the laser linewidth increases the relative jitter by approximately 100 fs (jitter) per 100 MHz (linewidth). The timing jitter is measured by integrating the phase noise from 100 Hz to 10 MHz.
- Frequency stability is specified after a 30 minute warm-up time and for an environment with controlled temperature.



Click to Enlarge

The image above describes the measurement system used to characterize the output pulses of the OPG1015. The output of the pulse generator is fed into the UTM-1500 Ultrafast Temporal Magnifier. This device stretches the pulse in time, allowing for accurate measurement of pulse shape and linewidth. The stretched pulse is then measured by a fast photodetector and displayed on a sampling oscilloscope.

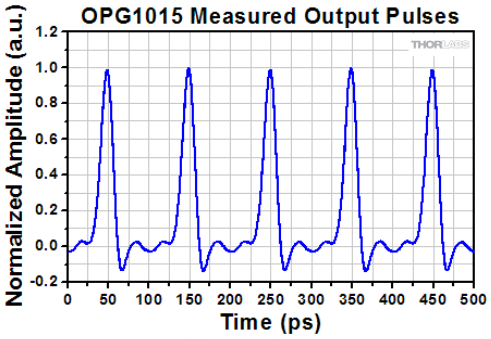
Click to Enlarge

The image above shows the front panel of the OPG1015. The RF Source Ext Input is an SMA input to interface an external RF source. The Optical In/Out features an FC/PC Input connector and an FC/APC Output connector.

Click to Enlarge

The image above shows the back panel of the OPG1015. A toggle switch allows the user to select the internal DFB or external laser source. The Voltage Controlled Oscillator (VCO) Control enables the user to tune the internal RF source via a screw adjuster. Alternatively, the VCO may be controlled with an external voltage source through the BNC connector. Please refer to the product manual for more information. An SMA connector enables the OPG1015 to be synced with another device.

GRAPHS



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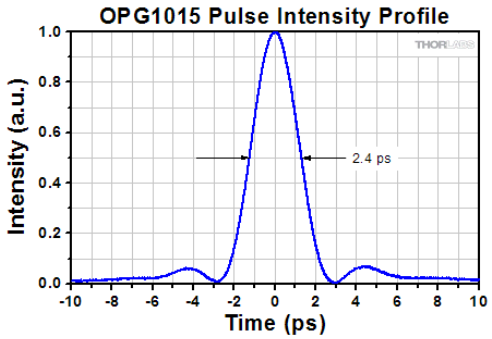
Measured with a 30 GHz detector and sampling oscilloscope. The linewidths in this graph are limited by detection resolution.



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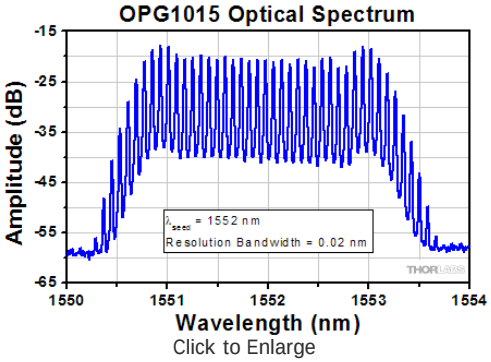
A typical pulse from the OPG1015 measured using the UTM-1500. The Temporal Magnifier expands the pulse for analysis with a fast photodiode and sampling oscilloscope.



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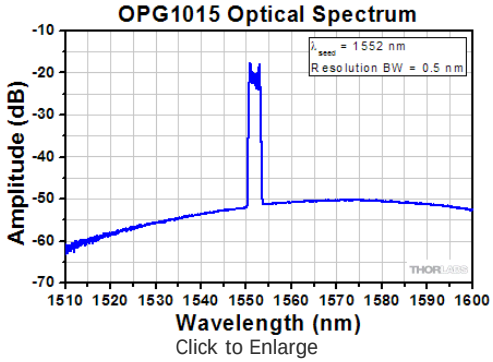

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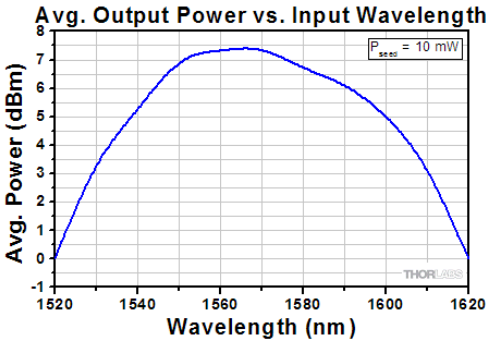

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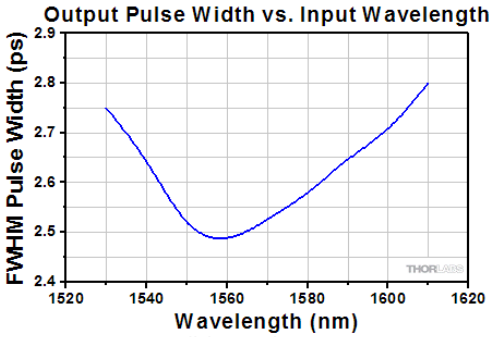

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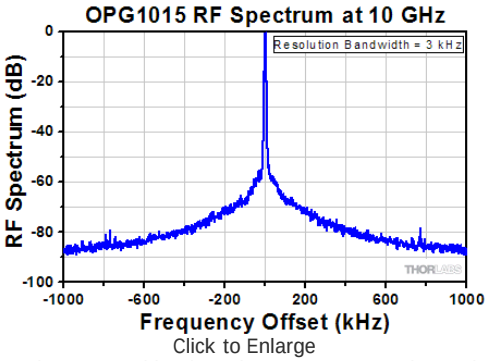
The rep rate for the graph above was 10 GHz (external RF source).



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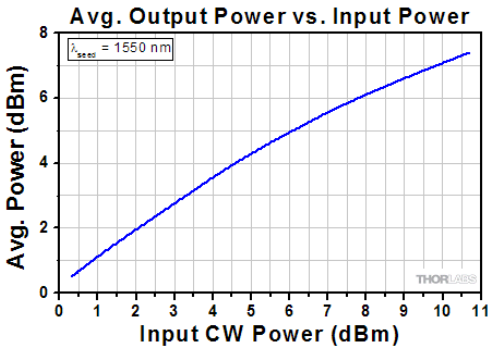
Spectrum is measured by detecting OPG output pulses using a 20 GHz detector and sending the output electrical signal into a RF spectrum analyzer.



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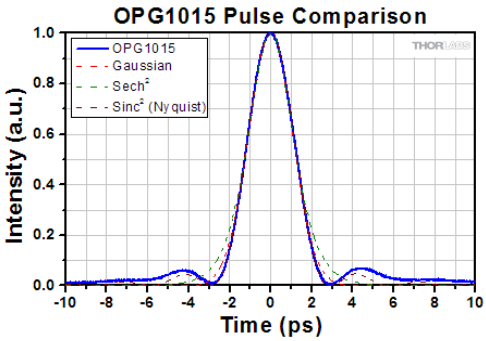

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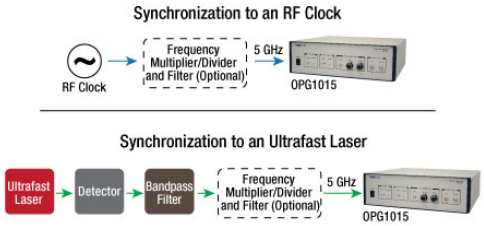
A typical pulse from the OPG1015 compared to common pulse shapes. The dashed curves are calculated.

SYNCHRONIZATION

Many applications, such as a pump/probe experiment, require the repetition rate of one pulsed laser to be synchronized to that of a second pulsed laser or to an external RF clock. The synchronization of the repetition rate is fundamentally simple and robust for the OPG system. Unlike mode-locked lasers, there is no need for adjusting the laser cavity length or phase-locked loops. The OPG can be directly driven with an external sinusoidal signal with a frequency from 4.7 GHz to 5.3 GHz and a power between 2 dBm and 10 dBm.



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In order to synchronize to an RF clock, a frequency multiplier or frequency divider can be used to generate an RF tone with a frequency between 4.7 GHz and 5.3 GHz from the RF clock source (see image to the right). For example, if the clock is at 10 GHz, a frequency divider (÷2) is used. Similarly, if the RF clock is at 1.25 GHz, a quadrupler (×4) is used. An RF amplifier or an attenuator may be necessary to adjust the power level between 3 dBm and 10 dBm.

In order to synchronize the OPG to an ultrafast laser system, for example a Ti:Sapphire laser or a mode-locked fiber laser, a harmonic of the laser repetition rate can be generated within the 9.5 - 10.5 GHz RF frequency range. This is achieved by using a fast photodetector and a bandpass filter to select the desired harmonic. Depending on the frequency of the selected harmonic, a frequency multiplier or divider may be necessary to generate the RF tone in the desired range. For example, to synchronize the OPG to a Ti:Sapphire laser with 80 MHz repetition rate, a detector (bandwidth > 5 GHz) is used to generate harmonics of the repetition rate. Then a 4.96 GHz bandpass filter with a bandwidth smaller than ~ 100 MHz can be used to select the 62nd harmonic of the Ti:Sapphire laser repetition rate. This component is then amplified and is used to drive the OPG. Similarly, a 2.48 GHz bandpass filter can be used along with a frequency doubler.

Part Number	Description	Price	Availability
OPG1015	Picosecond Optical Pulse Generator, 10 GHz, 1520 - 1620 nm	$36,516.00	Lead Time