Testing with 40 GHz Laser Sources

White Paper

PN 200-0500-00
Revision 1.1
January 2009

Overview

Calmar’s 40 GHz fiber lasers are actively mode-locked fiber lasers. Active mode-locking enables users to have greater control over pulse repetition rate, since mode-locking is driven by an external RF clock, and adjustments to the frequency of the RF clocking signal affect the modulator used to achieve mode-locking. Figure 1 is a schematic showing an active mode-locked fiber laser.

Since fiber lasers are manufactured from discrete components, dispersive and non-linear effects can be carefully controlled. Furthermore, fiber lasers, which usually include an EDFA, are typified by low timing jitter and low amplitude noise, a benefit stemming from the fact that EDFAs have lower noise and longer excited state lifetimes than alternatives.

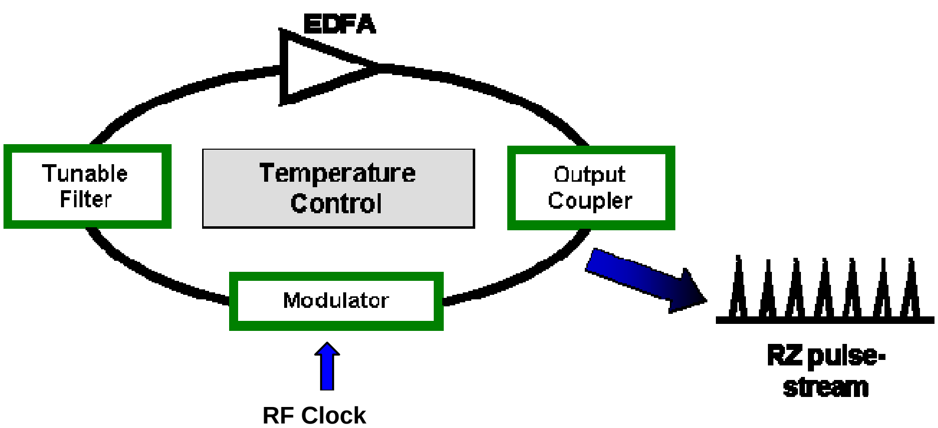

Figure 1 - Simplified Schematic for a Fiber Laser

Pulse widths for Calmar’s 40 GHz Picosecond lasers range from approximately 0.8 ps to 7 ps. Pulse shape benefits from the high extinction ratio and low chirp characteristic of fiber lasers.

The unique design of Calmar’s fiber lasers allows for the following features:

- Widely adjustable repetition rate
- Wavelength tunability over 1550 nm range
- Widely adjustable pulse width

All lasers in Calmar’s family of active mode-locked fiber lasers can be mode-locked manually or automatically. The automatic mode-locking feature enables users to start the laser without needing to manually optimize modulator phase lock.

Features

- Pulse widths < 1.0 ps
- Repetition rate adjustment 38 – 42 GHz
- Wavelength tunability 1535 – 1565 nm
- Average output power > 20 mW
- Low timing jitter
- Automatic and manual mode-locking
- Easy operation
- Long term stability

Applications

Picosecond fiber lasers, which can be used in a wide variety of high speed testing applications, are ideally suited for component and transmission network testing at bit-rates of 40 Gb/s, and higher.

The high extinction ratio, short pulse width, and low chirp make fiber lasers an ideal source for Optical Time Division Multiplexing (OTDM). A 40 GHz base rate provides the following advantages compared to a 10 GHz rate: elimination of pulse to pulse interference; pulse widths below 1.0 ps; peak output powers above 380 mW; and a more stable optical spectrum.

Optical Code Division Multiple Access (O-CDMA), an emerging technique used in high bandwidth data transmission, requires a stable spectral comb as well as very short pulse width. Calmar's lasers provide the highly stable spectrum and high quality pulses that this application demands.

Optical Analog-to-Digital (A/D) conversion greatly expands the capabilities of A/D conversion beyond what is achievable using electronics, because optical pulses widths are an order of magnitude narrower than the pulse widths attainable using electronics. Fiber lasers, in particular, are ideally suited to this application due to their low amplitude noise, along with very narrow pulse widths.

Technical Specifications

Calmar designs and manufactures two picosecond lasers with a 40 GHz pulse repetition rate, and the specifications for these lasers are provided in Table 1.

Specifications are subject to change without notice.

Model Number	**PSL-40-1T**	**PSL-40-2T**
Pulse Width (ps)	< 1.0	< 2.0
Output Wavelength (nm)	1535 - 1565	1535 – 1565
Repetition Rate (GHz)	38 - 42	38 - 42
Timing Jitter (fs)	< 70	< 70
Amplitude Noise (%)	1.0	1.0
Output Power (mW)	> 20	> 20
Operating Temp (°C)	15 - 30	15 - 30
Operating Voltage (V)	85 - 264 AC	85 - 264 AC
Dimensions (cm)	48(w) x 42(d) x 9(h)	48(w) x 42(d) x 9(h)

Table 1 – Specifications for 40 GHz Picosecond Lasers

Performance

The following test results give an indication of the performance of Calmar's 40 GHz fiber lasers. Figure 2 shows pulse width measured using an autocorrelator, and displayed on a linear scale. Pulse width was measured as 0.8 ps. An RF spectrum analyzer was used to product the result shown in figure 3. Sidemode suppression of 72 dB was achieved.

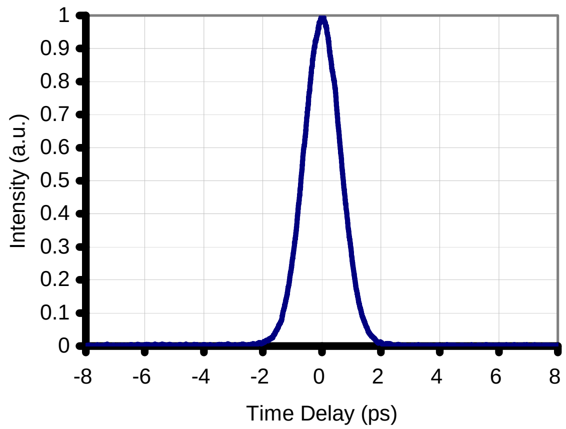

Figure 2 - Pulse Width FWHM of 0.8 ps (Calmar PSL-40-1)

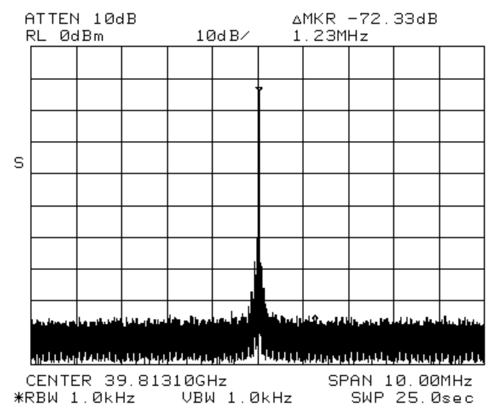

Figure 3 – Sidemode suppression of 72 dB (Calmar PSL-40-1)

Figures 4 shows the results of spectral width measurements. Figure 4 shows a spectral width of 3.4 nm. Figure 5, obtained from a spectrum analyzer, shows phase noise. From this graph, timing jitter was calculated to be 63 fs.

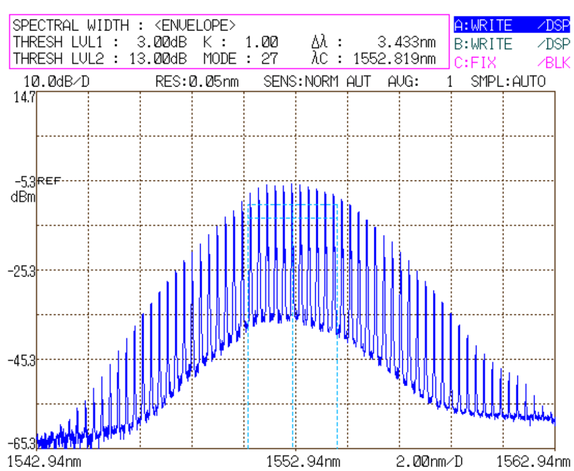

Figure 4 – Spectral Width of 3.4 nm (Calmar PSL-40-1)

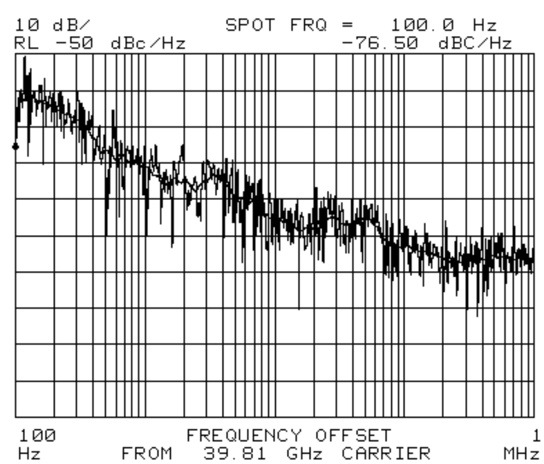

Figure 5 – Timing jitter of 63 fs

Pulse Width Adjustment

Calmar's optionally pulse width adjustment feature, enables users to change the signal pulse width quickly via the front panel. Pulse shape and quality are not impacted.

Figure 6 provides three examples of different pulse width that were obtained for one picosecond fiber laser. Pulse width is 1.8 ps in the first example, 4.6 ps in the second example, and 8.5 ps in the third example.

Calmar's fiber lasers are designed for optimum stability, and, as a result, pulse width adjustments are stable and repeatable.

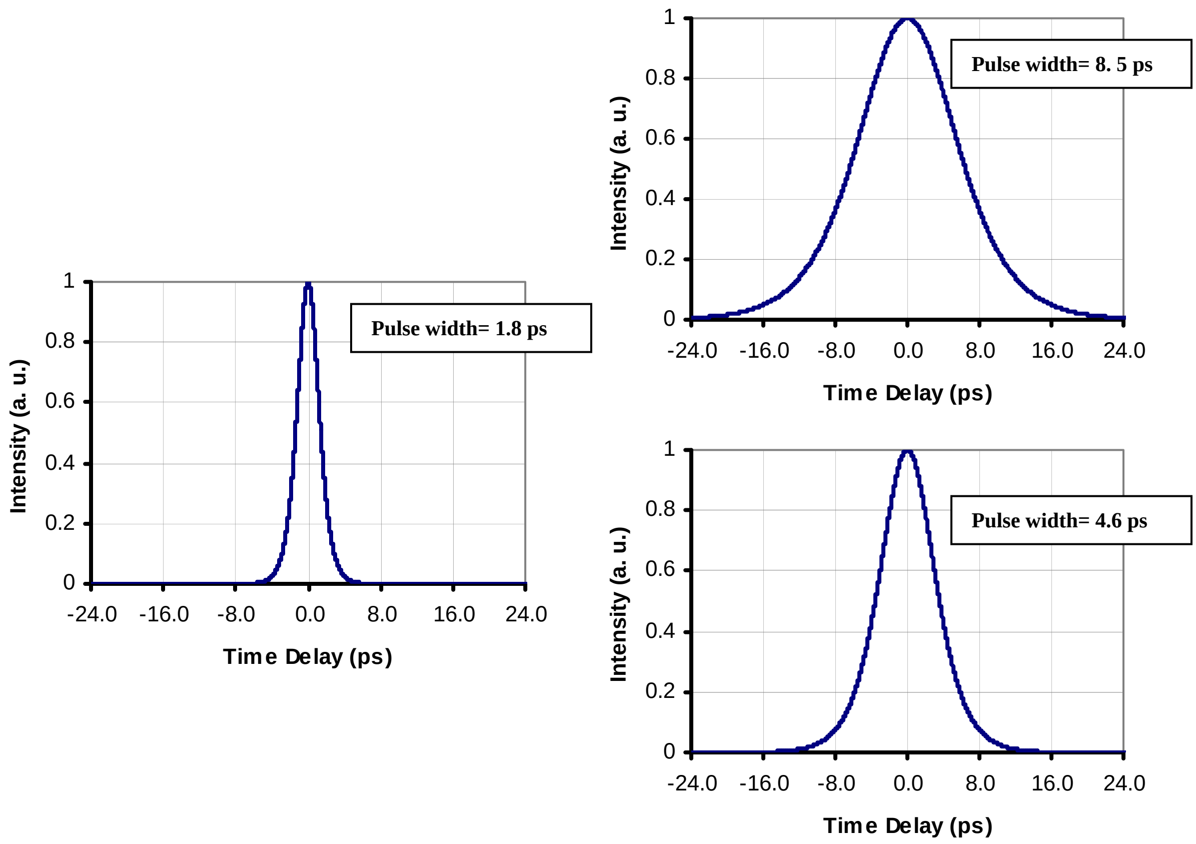

Figure 6 – Sample Results for Pulse Width

Remote Control

The advanced computer control feature of Calmar's 40 GHz fiber lasers uses the laser output to control laser status, and lock the laser for optimum performance. The control software ensures ease of use via readily accessible graphical controls viewable on the computer monitor.

The automatic mode-locking feature is especially advantageous for users that are not familiar with the operational requirements of actively mode-locked fiber lasers. As soon as the Picosecond Fiber Laser is turned on, the computer analyzes the laser status and locks it for best performance, a procedure accomplished in just a few minutes.

The computer automatically maintains the laser status, which is of special interest for life or long term testing of 10 Gb/s to 160 Gb/s transmission systems. Graphical laser performance indicators allow the user to monitor laser performance without the need for a sampling scope or equivalent instrument.

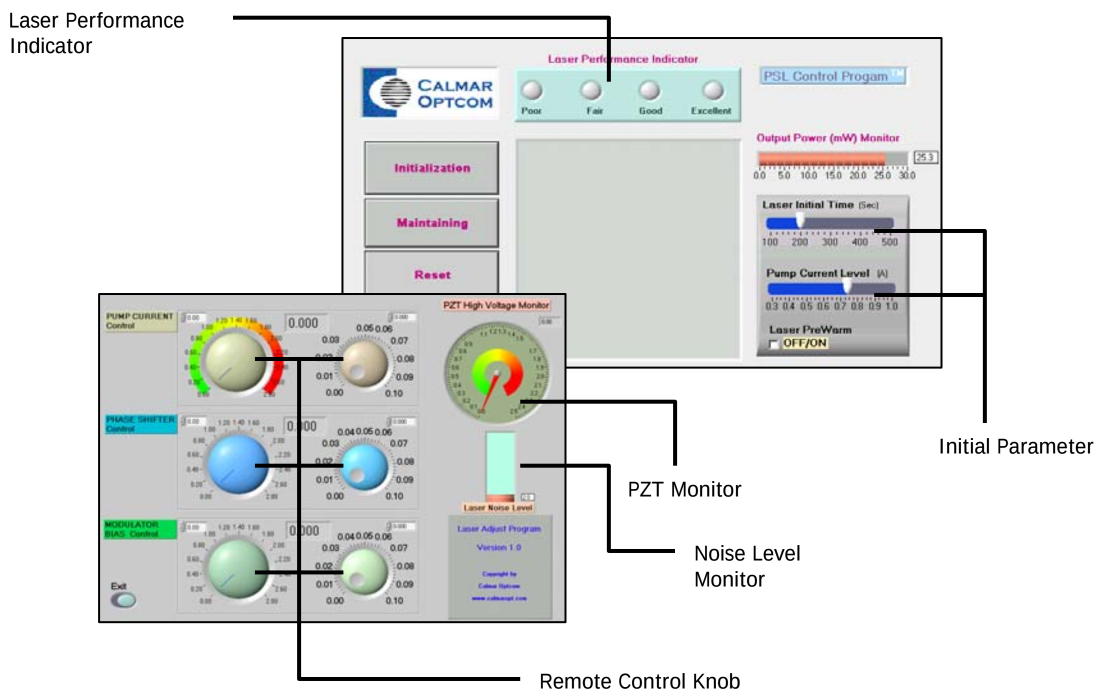

Figure 7 - Remote Control Interface

For more information on our Picosecond Fiber Laser series, Femtosecond Fiber Laser series, or any other Calmar products, please contact us.

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