Locking the Repetition Rate of a Menhir 1GHz Pulsed Laser with the D2-125

Vescent Photonics

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1 Introduction

Locking the repetition rate of a pulsed laser oscillator is one method of greatly improving its stability. By referencing the lock to a very stable source such as GPS, it is possible to transfer that stability to your oscillator. This application note describes a simple method for locking the repetition rate of the MENHIR-1550 SERIES 1GHz pulsed laser with the Vescent D2-125 laser servo and some commonly available 3rd-party components.

2 Setup

The scheme used to lock the Menhir with the D2-125 was to directly detect the repetition rate of the laser with a photodetector and mix this signal with a 1GHz reference from a stable oscillator. Then use the IF port output of the mixer as the error signal for the D2-125, which will control the output of a SLICE-DHV high-voltage amplifier that in turn will control the repetition rate of the Menhir via two PZTs. One of the PZTs has high bandwidth but modest stroke and the other PZT is low bandwidth but sufficient stroke to keep the system locked for extended periods of time.

The optical power output of the Menhir is 60mW, and the maximum input power for the EOT ET-3500 FEXT detector is 10mW. Therefore, an 80/20 splitter was inserted and the lower-power output was used. Further attenuation may be necessary to avoid damage to the detector. The RF signal was amplified by a Mini Circuits ZX60 3018G-S amplifier and split off using a Mini Circuits ZN2PD2-14W-S+ splitter. One side of the splitter was viewed on an Agilent 8596E spectrum analyzer. The other side of the splitter was routed to the LO input of a Mini Circuits ZX05-10L-S+ Level 4 Mixer, where it was combined with a 1GHz sine wave from a WindFreak SynthNV Pro on the RF port. The output of the IF port of the mixer acted as the error input for the D2-125.

The output swing of the D2-125 is ±15V, but the drive range of the PZT is 0-100 V. Therefore, a SLICE-DHV high-voltage amplifier was placed in between the D2-125 and the Menhir. This allowed for the addition of a DC bias on the PZTs, which were kept around 50V on both channels. The servo output of the D2-125 was connected to the modulation input for Ch 1 of the SLICE-DHV, which was set to a gain of 1V/V. This channel was used to control the fast PZT of the Menhir. The auxiliary output of the D2-125 was connected to the modulation input for Ch 2 of the SLICE-DHV, which was also set to a gain of 1V/V and used to control the slow PZT of the Menhir. The auxiliary servo ensured that, after locking, the fast PZT didn't drift out of range. Without servoing the slow PZT in this way, manual control would have to be used to keep the system from unlocking.

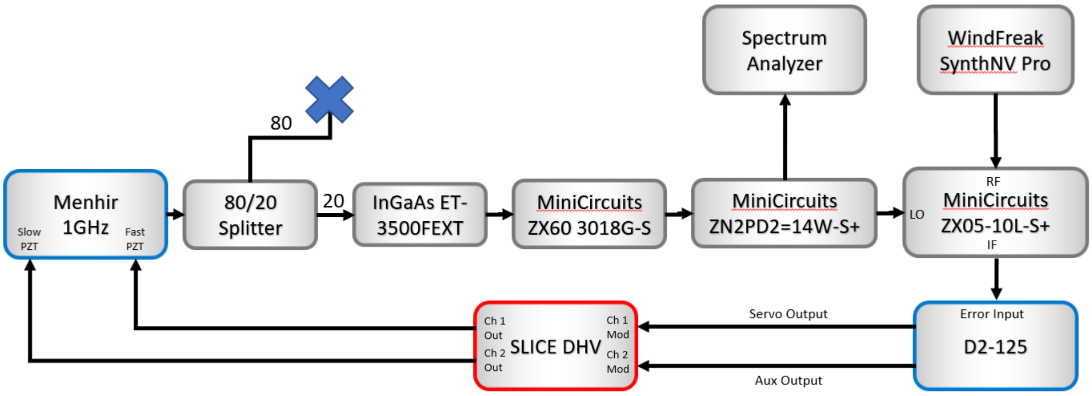

Figure 1: Block diagram of the test setup.

The PID parameters of the D2-125 were set to P_i=OFF, P_{pi}=2MHz, and D=1kHz. The gain switch on the D2-125 was set to the positive (up) position, and the differential gain was turned all the way up (CW). The proportional gain of the D2-125 was set to 0dB. The auxiliary gain was turned all the way down (CCW). This configuration was chosen because it experimentally minimized the noise on the locked error signal.

3 Locking the Menhir with the D2-125

To engage the lock, the signal from the WindFreak had to match the signal coming from the photodetector as closely as possible, both in signal strength (0 dBm) and in frequency. Because the Menhir was free running, it was necessary to tune either the WindFreak to match the signal of the Menhir, or vice versa, down to the sub-hertz level. The indicator for this was the frequency of the saw-tooth wave on the D2-125's DC Error Monitor, which measured the difference in frequency between the Menhir and the WindFreak. By tuning the WindFreak, which was simpler than tuning the Menhir, it was possible to minimize this frequency difference to the point where the signal appeared as a flat line. Alternatively, the Menhir can be tuned using the DC bias on Ch 2 of the SLICE-DHV. At this point, the lock on the D2-125 was engaged.

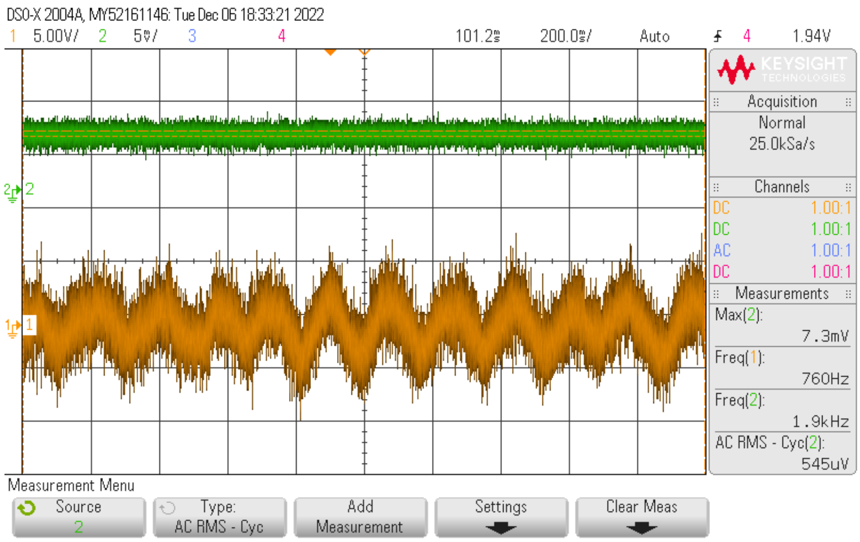

Figure 2: Servo Output (Orange) and Error Output (Green) monitors of the D2-125 while the Menhir was locked.

Using this configuration, the Menhir 1GHz Laser's repetition rate was locked with the D2-125. An AC RMS measurement of the noise on the Error Out monitor shows 545µV, which we characterize as a tight lock. It is worth noting that the Servo output of the D2-125 swings by about $10V_{pp}$, but so long as this output doesn't hit its rail at ±15V this is not of concern. The Menhir remained locked in this configuration for several hours without coming unlocked.

4 Summary

Locking the repetition rate of an oscillator is one way to greatly improve its stability. Using the D2-125, and some off-the-shelf RF components, it is possible to tightly lock the repetition rate of the Menhir-1550 series 1GHz pulsed laser to an external oscillator.

For more information, contact Vescent at:+1 (303) 296-6766, info@vescent.com, or visit our website at https://www.vescent.com