Achieve Higher RF Frequency Stability with Lower Phase Noise

Comparison Of Phase Noise Of The OEO With RF Filter And With Etalon (Normalized Power)

Improve radar, communications, and signal intelligence with interferometer-based optoelectronic oscillator

Optoelectronic oscillators (OEOs) provide a continuous, high quality factor (Q) modulated signal in order to obtain high spectral purity. OEOs are used for a variety of purposes, including a carrier wave for communications, and radar emissions. Most OEOs use an RF filter as the mode selector for signal generation.

However, there are some drawbacks with using the standard OEO. In order to compensate for the losses in the RF loop, a high gain RF amplifier is needed. It is expensive to make an ultra-narrow bandwidth RF filter required for a long optical delays, and in addition the loss from the RF filter decreases the cavity Q of the OEO, which increases phase noise. RF amplifiers also suffer from small temperature fluctuations resulting in a domino effect of adverse effects: fluctuations in peak position resonance change the RF filter phase, which then affects the microwave signal’s total round trip time, and ultimately changes the oscillation frequency.

UCF researchers have invented an OEO which replaces an RF filter with an interferometer, specifically a high finesse Fabry-Perot etalon, as the mode selector. This substitution provides lower phase noise and higher RF frequency stability due to the higher Q and ultralow temperature dependency of the Fabry-Perot etalon. This invention can enhance radar and signal intelligence, clock recovery, and communication broadcasting and receiving.

Technical Details

In this design, a 10.287 GHz OEO is coupled with a 1000 finesse Fabry-Perot etalon as the resonant mode selector. This sealed, ultralow expansion quartz etalon is protected from temperature, air pressure, and other environmental changes. This particular design also includes the standard OEO components: an electro-optic modulator (EOM), an optical delay line, a photodiode, and an RF amplifier. The periodic transmission function of the etalon only allows the oscillation of optical frequencies, which are separated by the etalon’s free spectral range (FSR). This function also eliminates the frequencies outside the resonance width. Additionally, the microwave oscillation frequency is determined by the etalon’s FSR.

Benefits

- Lower phase noise
- Higher RF frequency stability
- Less susceptible to environmental changes

Applications

- Radar
• Communication broadcasting and receiving
• Signal intelligence
• Signal processing
• Clock recovery
• Fiber optic communications
• Computer interconnects
• Medical imaging
• Spectroscopy

• Metrology
• Display technology

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