Optical Frequency Self Stabilization in a Coupled Optoelectronic Oscillator (COEO)

Advantages
- Inclusion of the etalon make a RF bandpass filter in a conventional COEO unnecessary
- Optical filtering of the etalon suppresses all but a single optical super-mode
- Use of a high finesse Fabry-Perot etalon with a longer optical cavity increases the effective microwave quality factor

Invention
Methods, systems and devices to provide optical frequency self-stabilization in a coupled optoelectronic oscillator (COEO).

Background
Low noise, high repetition rate mode-locked lasers have a number of potential applications in signal processing and coherent communications. For applications such as the generation of arbitrary Radio Frequency (RF) waveforms and photonic sampling, pulse-to-pulse timing and amplitude jitter are more important than optical frequency stability. Moreover, laser cavities can be designed that sacrifice optical stability in favor of increased timing stability. However, a number of applications such as Optical Code Division Multiple Access (OCDMA) and optical arbitrary waveform synthesis require a set of phase locked frequencies with multi-gigahertz spacing and high stability. A successful method to simultaneously achieve low timing, amplitude jitter and optical frequency stability is using an intra-cavity Fabry-Perot etalon (simplest form of an interferometer) in a harmonically mode-locked laser. The narrow optical line-widths produced are advantageous for high spectral efficiency coherent communication modulation formats, and the reduction of the spontaneous emission contribution to the timing jitter. In addition to spontaneous emission, a major source of timing jitter in an actively mode-locked laser is the phase noise of the RF source used for mode-locking. A way to remove this source of timing jitter is to exploit the high Q (fastness) of a mode-locked laser and convert it into a Coupled Optoelectronic Oscillator (COEO), which is an integrated optical and microwave oscillator capable of generating pico-second optical pulses. However, in the conventional COEO, no effort is made to generate a stabilized optical frequency comb, meaning a graphic representation of the spectrum of a mode-locked laser.

To solve the problems encountered with prior art, the present invention provides a completely self-contained optical frequency stabilized coupled COEO. It does so by incorporating a high finesse Fabry-Perot etalon (FPE) for optical frequency stabilization and super-mode suppression of an actively, harmonically mode-locked laser. In this way the nominal COEO frequency, stability of the optical frequencies, and long term stability of the COEO signal are all referenced to a single intra-cavity high finesse FPE. With the incorporation of a FPE, a COEO can be utilized for a host of new applications relying on a stabilized optical frequency comb.

Application
This technology has potential applications in optical communications and radar systems.

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Selected References