Researchers at the University of Central Florida have invented a chip-scale optical-to-RF link technology that clears a path for integrated photonics. Using a novel harmonic multitone injection locking technique, the invention down-converts frequency combs from the optical domain (>120GHz to THz) into the microwave domain (10s of GHz), where it can be easily photo-detected and controlled. Thus, as a timing signal generator or optical clock, the new technology provides enhanced timing precision for Position, Navigation and Timing (PNT) applications, such as secure communications in military GPS-denied environments. It may also provide a precise timing reference for high-bandwidth coherent telecommunications or a wavelength reference for metrology. Compared to existing technologies, the invention is simpler, since it relies on the natural phase-lock effect from the optical injection locking process instead of electronic phase-locked loops. It is also more robust, since it inherits from the stability of the injection locking process. Finally, the system is more efficient, since it requires little optical power for the harmonic injection locking process.

Technical Details

With its unique harmonic multi-tone injection locking technique, the invention expands the concept of optical injection locking, in which a slave laser is synchronized to a master laser. Figure 1 illustrates the new technique involving a widely-spaced optical frequency comb (OFC) at \(nf_{\text{rep}}\) and a slave mode-locked laser (MLL) at \(f_{\text{rep}}\). The master OFC injects multiple tones into the slave MLL at a harmonic of the fundamental repetition rate (\(f_{\text{rep}}\)), thereby down-converting a set of millimeter-wave or THz range separated optical tones into the GHz/microwave domain. When the multiple tones of the master laser coincide with adjacent comb lines of the MLL, the repetition rate stability from the master is transferred to the slave, as well. The technique effectively reduces the linewidth of the individual axial modes, stabilizes the repetition rate, and reduces the RF spectrum phase noise. The architecture is compatible with current fabrication processes and offers a SWaP (size, weight and power) system with a dramatic increase in accuracy and robust, long-term stability.

Benefits

- Compatible with current fabrication processes and offers a SWaP system
- Provides a dramatic increase in accuracy
- Simple, efficient, robust and stable

Applications

- Military defense
- PNT applications where microsecond accuracy is needed or when another timing reference (such as GPS) is not available

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• Telecommunications
• Wavelength reference for metrology

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