

VCSEL-Based Optoelectronic Oscillator for High-Speed Signal Processing: A Review

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In the new generation of communication networks, high-speed and reliable radio access represent an engineering challenge when mm-wave bands are considered (Iezekiel, 2016). This challenge is based on the capability of oscillators to keep a stable carrier with reduced noise to avoid information transmission degradation (Devgan, 2013).

A microwave photonics-based technique to generate signals at high frequency with good quality was proposed by Yao and Maleki in the 90's (Yao and Maleki, 1996). This is a hybrid topology known as the OEO (Optoelectronic Oscillator), it is composed of optical and electronic components: an intensity modulated laser source and an optical delay line that acts as a resonant cavity. Additionally, The OEO has a high-speed photodetector, a narrowband microwave filter and an amplifier that are used in a single loop to obtain a stable high frequency carrier with high spectral purity.

A variation of the initial design of the OEO was proposed in 2008 using a directly modulated Vertical-Cavity Surface-Emitting Laser (VCSEL) as the main laser source. The VCSEL is a low power consumption laser widely available in the telecommunication wavelengths. Optoelectronics oscillators with VCSELs at ISM bands have been implemented with promising results since 2006 (Varón-durán *et al.*, 2006; Le Kernec, Varon and Mollier, 2007).

Additional implementations have been reported in the last decade to enhance the performance of the direct modulation of the VCSEL in the optoelectronic oscillator. For instance, the optical injection locking technique of a VCSEL is proposed to enhance its modulation bandwidth and to reduce its relative intensity noise. This configuration increases the frequency generation capability in the X-band (10 and 12 GHz) (Coronel, Varón and Rissons, 2016; Coronel *et al.*, 2019).

This abstract proposes a 10-year review of the research on VCSEL-based OEOs where the most relevant results are presented, considering the performance parameters and the different architecture enhancements proposed through the years.