# Mode oscillation and harmonic distortions associated with sinusoidal modulation of semiconductor lasers

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## Abstract

This paper investigates mode dynamics, operation characteristics and signal distortions associated with sinusoidal modulation of semiconductor lasers. The study is based on intensive integrations of the multimode rate equation model of semiconductor lasers over wide ranges of the modulation frequency and depth. The rate equations take into account both spectral symmetric and asymmetric suppressions of modal gain. The higher harmonic distortions as well as the half harmonic distortion associated with the period doubling effect are investigated. The study is applied to both cases of single-mode and multimode oscillations of the non-modulated laser. The obtained results showed that the modulated signal has six distinct waveforms depending on the modulation conditions; three types have continuous periodic waveforms and the others have periodic pulsing waveforms. The modulated laser is found to oscillate in a single mode under weak modulation where the modulated signal is continuous, whereas the pulsing signals are associated with multimode oscillation. The higher harmonic distortions of single-mode laser are lower than those of two-mode lasers, and become serious at modulation frequencies around the relaxation oscillation frequency. These distortions are highest when the laser output is pulsating and the pulses are superposed by relaxation oscillations.

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