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## Multimode modeling of digital modulation in nearly single-mode semiconductor lasers

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### Abstract

We present multimode modeling of the digital modulation characteristics of nearly single-mode semiconductor lasers. The model takes into account the mechanisms of spectral suppression of modal gain; namely, symmetric and asymmetric gain suppressions. The digital modulation performance of the laser is quantitatively examined in terms of the turn-on jitter, on-off ratio and a Q-factor. We study the effect of the modulation parameters on the modulation characteristics of the laser. We also clarify the effect of the asymmetric gain suppression on the modulated signals of the oscillating modes. In addition, we examine the validity of modeling the digital modulation of the laser via a single-mode rate equation model. We show that the modulation characteristics improve with an increase in the bias and/or modulation current or with a decrease in the bit rate due to reduction in the bit-pattern effect. The asymmetric gain suppression does not affect the characteristics of the total laser signal, however it enhances the modulation of the nearest modes on the long-wavelength side of the gain spectrum.

### Keywords

**KeyWords Plus:** PSEUDORANDOM WORD MODULATION; ASYMMETRIC GAIN SATURATION; INJECTION-LASERS; COMPETITION; INTENSITY; JITTER; SIMULATION; OPERATION; NOISE; LIGHT

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