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Theoretical analysis of mode-competition noise in modulated laser diodes and its influence on the noise performance of fibre links

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Abstract

We analyse mode-competition (MC) noise in sinusoidally modulated laser diodes and assess its contribution to the noise performance of directly modulated fibre links. The noise figure (NF) is used to evaluate the noise performance of the link. The present analyses are based on a multimode rate equation model that takes into account both symmetric and asymmetric suppressions of the cross-modal gain. Variations of the MC relative intensity noise of both the total output and the oscillating modes with modulation conditions are investigated. The obtained results show that regardless of the fact that the non-modulated laser oscillates nearly in single-mode or in two-mode hopping, the modulated laser oscillates in single mode when the signal is continuous, and converts into multimode when the signal is pulsing. The contribution of MC noise to the NF of the link increases with an increase in the modulation depth and with a decrease in the modulation frequency, except when the signal has period doubling. This contribution is negligible under high modulation frequencies when the laser signal is continuous and uniform, and is most enhanced (similar to 53 dB) under low modulation frequencies when the signal is pulsing and superposed with non-uniform relaxation oscillations.

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