Analysis of timing jitter in external-cavity mode-locked semiconductor lasers

We develop a comprehensive theoretical description of passive mode-locking in external-cavity mode-locked semiconductor lasers based on a fully distributed time-domain approach. The model accounts for the dispersion of both gain and refractive index, nonlinear gain saturation from ultrafast processes, self-phase modulation, and spontaneous emission noise. Fluctuations of the mode-locked pulses are characterized from the fully distributed model using direct integration of noise-skirts in the phase-noise spectrum and the soliton perturbations introduced by Haus. We implement the model in order to investigate the performance of a MQW buried heterostructure laser. Results from numerical simulations show that the optimum driving conditions for achieving the shortest pulses with minimum timing jitter occur for large reverse bias in the absorber section at an optimum optical bandwidth limited by Gordon–Haus jitter.

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