Noise properties of semiconductor waveguides with alternating sections of saturable gain and absorption

Öhman, Filip; Bischoff, Svend; Tromborg, Bjarne; Mørk, Jesper

Link to article, DOI: 10.1109/CLEOE.2003.1312253

Publication date: 2003

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Noise properties of semiconductor waveguides with alternating sections of saturable gain and absorption

Filip Øhman, Svend Bischoff, Bjarne Tromborg and Jesper Mørk
COM, Technical University of Denmark, Build. 345; DK-2800 Kgs. Lyngby, Denmark (fo@com.dtu.dk)

Abstract
We investigate the dynamical noise properties of saturable semiconductor devices for optical signal processing. A trade-off between noise redistribution and extinction ratio improvement has to be made for all-optical regeneration.

Introduction
Semiconductor optical amplifiers (SOA) have many applications in the field of optical communication systems. In combination with a saturable absorber (SA), regeneration may be achieved. One promising implementation is a sectioned semiconductor waveguide with alternating forward and reverse bias. By concatenating several sections of saturable gain and absorption a significant reshaping of the signal can be obtained, but the noise properties may be compromised.

Noise properties
The noise of the output signal, which includes amplified noise of the input signal and amplified spontaneous emission (ASE) from the SOA, is determined by the small-signal method of [1] and by large-signal simulation. Figure 1 shows the relative intensity noise (RIN) spectra of the output signals. By taking the reciprocal of the integral of the RIN over a chosen bandwidth, the signal-to-noise ratio (SNR) can be calculated.

Conclusions
We have analysed the trade-off between extinction ratio improvement and noise redistribution in a 2R-regenerator based on a combination of saturable gain and absorption sections. The dynamical noise contributions of the gain and absorber sections partly counteract each other and need to be considered in detail.

References

Figure 1 RIN spectra at mark level of a single SOA and a single SA (a) and an SOA followed by the SA (b).

Figure 2 Transfer functions for the device, shifted to give equal output and input power at the chosen mark-level.

For a complete description of the noise properties, the probability density functions (pdf) also need to be known. In the presentation we will show how pdfs can be estimated by large signal simulations, static transfer functions as well as the use of an approximate Fokker-Planck equation.

0-7803-7734-6/03/$20.00 2003 IEEE