Genetic algorithm-based optical filter optimization for high speed wavelength conversion based on a semiconductor optical amplifier

DOI:
10.1109/CLEOE-IQEC.2007.4386431

Document status and date:
Published: 01/01/2007

Document Version:
Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Genetic algorithm-based optical filter optimization for high speed wavelength conversion based on a semiconductor optical amplifier

Zhonggui Li, Javier Molina Vázquez, Yong Liu, Eduward Tangdiongga, Shaoxian Zhang, G.D. Khoe, H.J.S. Dorren and Daan Lenstra(a) (Emai: Zhonggui.li@tue.nl)
COBRA Research Institute, Eindhoven University of Technology, The Netherlands.
(a) Department of Electrical Engineering, Mathematics and Computer Science, Delft University of Technology, The Netherlands.

We numerically optimize an optical filter through a Genetic Algorithms (GA) in the context of high speed non-inverted wavelength conversion based on a single semiconductor optical amplifier (SOA). An optical filter is critical in the SOA-based wavelength converter because it enables high-speed operation through converting the ultra-fast chirp dynamics of the probe into useful amplitude modulation [1, 2]. In this work we investigate how to optimize the filter to achieve optimal performance of the wavelength converted signal. Moreover, the robustness of the optimized filter against SOA operation conditions is also explored. Similar filter optimization has also been performed but in a manual way [3].

First we model the SOA-based wavelength conversion at 160 Gbit/s following the principle shown in Fig.1 and using a comprehensive pulse propagation model [4]. The numerical output from this model is the input to the GA filter optimization. This input does not change during the optimization. A fourth order Hermite-Gaussian sum series is used to describe the filter transfer function. The GA optimizes the coefficients of the sum series and the parameters of the Gaussian function to achieve the maximum fitness value, which is a weighted sum of the eye opening (EO) and the peak power of the output signal from the filter.

Fig.2(a) shows the spectrum of the input signal (solid) to the GA and the optimized filter transmission (dashed). It is noted that the optimized filter has a dip that coincides with the probe and suppresses it considerably. Fig.2 (b) shows the spectrum of the output signal from the optimized filter and the corresponding eye diagram (inset). A clear open eye diagram is observed (33 dB EO), indicating the excellent performance of the GA. It is seen that the optimized filter selects the blue-shifted side band of the probe and the output signal has a low power. A tradeoff between the EO and the output power is observed in the optimization.

The robustness of the optimum filter is tested through changing the input optical signal through adjusting the operation parameters, such as linewidth enhancement factor α, probe power, pump pulse energy and the injection current.. The dependences of the output signal quality, represented by the Q-factor and the EO on the SOA parameters are investigated. The results show that a larger α is beneficial for the output because both Q-factor and EO increase with increasing α. It is also shown that suggests that the EO reaches its maximum when the corresponding parameter reaches their default values, but the Q-factor changes monotonously. The optimum filter generated by the GA is robust against the SOA operation conditions (not shown). Our work also suggests that the optimum filter can be experimentally implemented through a combination of delay-interferometer and an optical bandpass filter, as was used in [1].

In summary, we apply a GA to optimize numerically the filter transfer function used in high-speed non-inverted wavelength conversion. Output signal with high EO has been achieved. The robustness of the optimized filter is tested against the SOA operation parameters and it is found that it offers a broad dynamic range.

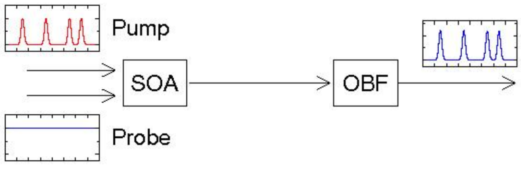

Fig.1 SOA-based wavelength conversion using OBF.

References:
[1] Y. Liu et al., OFC2006, PDP28, 2006.
[2] Y. Liu et al, IEEE JLT, Vol. 24, 230-236, 2006.
[3] Y. Ueno et al, Optics Express, Vol. 14, 12655-12664, 2006.
[4] X. Yang et al., Optics Communications, Vol. 223, 169-179, 2003.

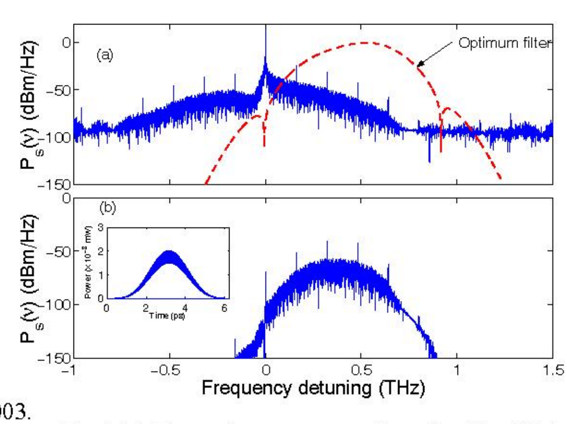

Fig.2 (a) The probe spectrum at the exit of the SOA (solid) and the transmission of the optimized filter (dashed). (b)The probe spectrum at the exit of the optimized filter and the corresponding eye diagram (inset).