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Chirped-Fiber-Grating-Integrated Optical Limiting Amplifier for Dispersion Compensation

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Introduction

Recently, erbium-doped fiber amplifiers (EDFAs') make rapidly progress in the 1.55-μm band optical fiber transmission. However, high bit rate transmission is restricted by large chromatic dispersion of the conventional simple mode fiber (SMF) unless compensating techniques are used [1-2]. The chirped fiber gratings (CFGs') are attractive as they are passively linear devices, highly related dispersion, compact size and relatively easy to fabricate [3]. Using CFGs' for dispersion compensation, the EDFAs' are inserted repeatedly between SMF and optical circulators (OCs) in order to amplify the signals. However, the repeated spacing is limited by the loss of CFGs, SMF and OCs. In this report, by inserting a bi-directional EDFA between the OC and CFG's, we proposed an optical limiting amplifier (OLA) [4] configuration in multi-wavelength for dispersion compensation. The link budget and dynamic range characteristics, bit-error-rate (BER) performance as well as eye-diagram of the modulated signals were investigated and discussed.

Experiments and results

Based on the general idea as shown in Fig. 1, two DFB lasers with central wavelengths of 1552.5-nm and 1533.0-nm were modulated with 700 Mb/s 2^{15}-1 NRZ signal using a $LiNbO_3$ external intensity modulator for feasibility investigation. The signals are amplified by an EDFA-boost amplifier, which was followed by a sectional of SMF and a variable optical attenuator (VA) to adjust the input power level. The features of these three configurations as shown inside these dot boxes were compared by locating a bi-directional EDFA a) in front of the port 1, b) after the port 2, or c) after the port 3 of the OC, respectively. In these three configurations, the modulated signals were 1) amplified then filtered, 2) amplified, filtered, and then amplified again, or 3) filtered then amplified, respectively. Each CFGs, which was used to reflect and compensate the specific modulated signal wavelength, is located after port 2 of the OC. The isolation of the OC from port 2/3 to port 1/2 is over 38 dB. The insertion loss of the OC is about 0.8 dB from port 1/2 to port 2/3. The saturated output power of bi-directional EDFA is about 14.0 dBm. Note that configuration "b" is exactly operated as an OLA, the signals were amplified before and after (i.e., two times) reflected by the narrow-band fiber gratings with 95% reflectivity at 1552.5-nm and 1533.0-nm, respectively. Fig. 2 shows the measured output signal power as a function of the input signal power @ 1552.5-nm. Configuration b has the highest dynamic range of over 35 dB. Fig. 3 shows the ratio of output signal to noise floor against different input power levels of these three configurations @ 1552.5-nm. Configuration b has the most flattened curve and the highest values of above 42 dB at high inversion region from -40 to -15 dBm. Compared with the conventional type of configuration a, the link budget of the OLA configuration is improved from 2.8 to 19.2 dB when the input power level is decreased from -15 to -35 dBm. The BER performance

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and eye-diagram of the 700 Mb/s modulated signals were not degraded by the bi-directional OLA when compares with the conventional EDFA's.

Summary

We have proposed, for the first time, an integrated OLA with CFGs' for multi-wavelength dispersion compensation. Compares with the conventional EDFAs', the bi-directional OLA type is compact cost effective. No optical isolators are required because negligible power penalty due to back reflection of the OLA was observed. It also has the highest dynamic range of over 35 dB and link budget. This chirped-fiber-grating-integrated optical amplifier is promising for multi-channel transmission when using CFGs' and OCs for dispersion compensation.

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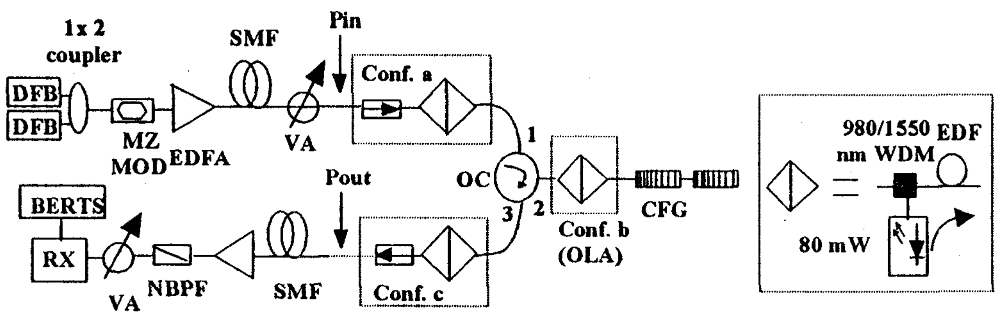
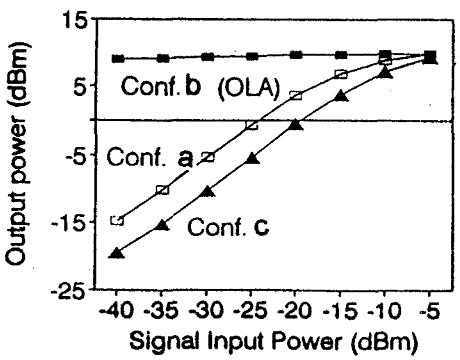


Fig. 1. Experimental setup: OLA: optical limiting amplifier; CFG: chirped fiber grating; NBPF: narrow band pass filter. VA: variable optical attenuator. OC: optical circulator.



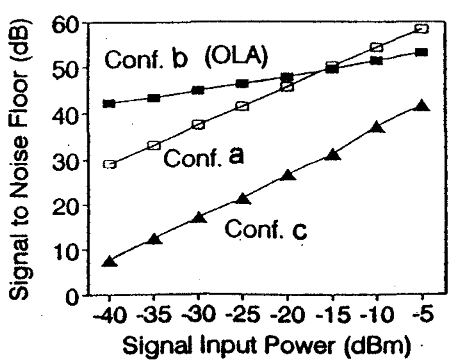


Fig. 2. The measured signal output power against input signal power @1552.5 nm.
Fig. 3. The measured output signal to noise floor versue signal input power @1552.5 nm.