Generation and Transmission of 17-GHz Optical Single Sideband Signals using a 2.5-Gb/s-grade DFB laser with Wavelength Selective Gain from an FP Laser

Hye-Seung Ryu, Young-Kwang Seo and Woo-Young Choi
Department of Electrical and Electronic Engineering, Yonsei University 134, Shinchon-Dong, Sudaemoon-Ku, Seoul, 120-749, Korea.
wchoi@yonsei.ac.kr

Abstract: We demonstrate a new scheme of effectively enhancing laser diode intensity modulation bandwidth and, simultaneously, generating optical single sideband. 17-GHz optical single sideband is generated and 155-Mb/s data transmission at 17 GHz is achieved.

OCIS codes: (060.4510) Optical communications; (140.5960) Semiconductor lasers

1. Introduction

In Radio-on-Fiber systems, intensity modulation of laser diodes (LDs) is a simple and cost-efficient approach for transmitting microwave (MW) signals over optical fiber. But LDs have limited modulation bandwidth and previous schemes [1] to enhance the modulation bandwidth suffer from the dispersion-induced power degradation problem [2]. A new scheme is proposed and demonstrated that can effectively enhance LD modulation bandwidth and, simultaneously, produce optical singe sideband that does not suffer from the dispersion-induced power degradation.

2. Operation Principle

Our scheme uses the wavelength-selective amplification characteristic of an LD under the modulated light injection. When several sideband signals (A, B, and C in Fig. 1) from directly modulated LD1 are injected into LD2, the lasing modes of LD2 can be suppressed and the modes (B and C) within a certain wavelength range can receive gain, but others (A) loss. Among the modes experiencing gain, the one at the longer wavelength (C) has larger gain than the one at shorter wavelength (B) [3]. With the amplification of the weak sidemode (C), the modulation bandwidth of LD1 is effectively enhanced, and with the resulting single sideband, the dispersion-induced power degradation is eliminated. The gain wavelength range is determined by the lasing wavelength and power of both LD1 and LD2, and is closed related to the injection-locking range of LD2 [3].

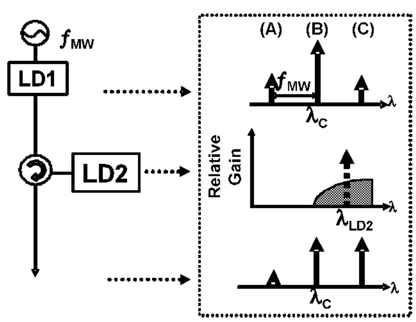
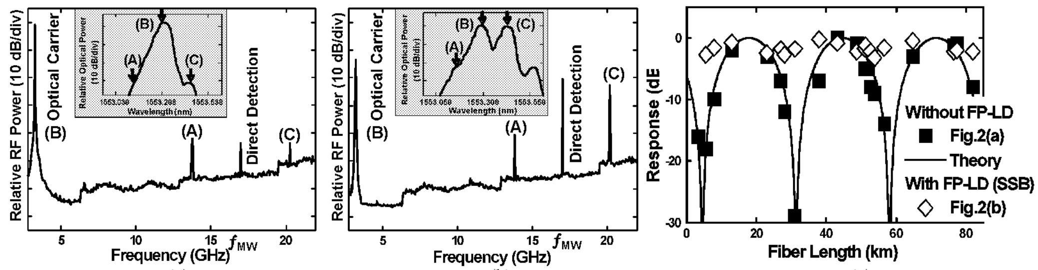


Fig. 1. Schematic explanation for our scheme. λ_{LD2} is the wavelength of free-running (without any injection) LD2.

3. Experiment and Results

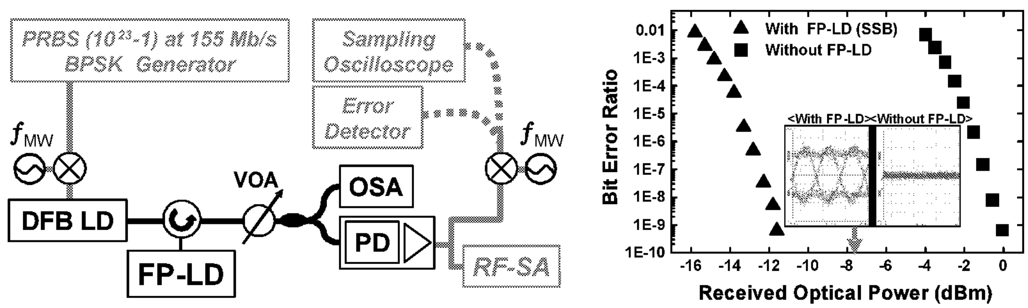
In order to demonstrate feasibility of our scheme, a commercial 2.5-Gb/s-grade DFB (LD1) was directly modulated at 17GHz and injected into a FP-LD (LD2) without an isolator. The insets in Fig. 2 (a) and (b) show the resulting optical spectra before and after LD2. In order to obtain spectra with higher resolution than was possible with our optical spectrum analyzer, a heterodyne spectrum analysis was performed by beating signals of interest with additional light having λ_{Ex} lower than λ_C by 3GHz and observing the resulting RF spectra. The peak at 17 GHz is due to beating of carrier (B) with sidemodes (A and C) and shown enhanced in Fig. 2(b) because of sidemode C intensity after LD2. The use of LD2 generated optical single sideband and effectively enhanced LD1 modulation bandwidth. In addition, photo-detected 17-GHz signal powers were measured as function of fiber transmission length and the results are shown in Fig. 2 (c). This result confirms that our scheme generates optical single sideband which is tolerant to fiber chromatic dispersion.



(a) (b) (c)

Fig. 2. Measured optical spectra for intensity-modulated signals without FP-LD (a) and for SSB signals with FP-LD (b) and measured RF power versus fiber length (c)

For a system demonstration, we modulated LD1 with the 17-GHz RF carrier mixed with 155-Mb/s BPSK data, using the set-up shown in Fig. 3(a), and then measured the received data BER for two cases with and without passing LD2, and the results are shown in Fig. 3 (b). For BER at 10^{-9}, 11-dB improvement in receiver sensitivity is obtained by using LD2. The inset shows eye diagrams for both cases at the received power of - 7.8dBm, showing the significant enhancement achieved with our scheme. It should be noted that this demonstration of the 155-Mb/s data at 17 GHz was limited by the receiver electronics available to us, and not by the scheme itself.



(a) (b)

Fig. 3. Experimental setup for system demonstration (a) and measured BERs versus received optical power with and without FPLD (b).

References

[1] A. Kaszubowska, P. Anandarajah, and L. P. Barry, "Improved Performance of a Hybrid Radio/Fiber System Using a Directly Modulated Laser Transmitter With External Injection," IEEE Photon. Technol. Lett. **14**, 233-235 (2002).

[2] G.. J. Meslener, "Chromatic dispersion induced distortion of modulated monochromatic light employing direct detection," IEEE J. Quantum Electron. **20**, 1208-1216 (1984).

[3] J. Troger, L. Thevenaz, P.-A. Nicati, and Ph. A. Rober, "Theory and experiment of a single-mode diode laser subject to external light injection from several laser," J. Lightwave Technol. **17**, 629-636 (1999).