The Fundamental and Applications of Mutual Injection-Locked Fabry-Perot Laser Diode and Erbium-Doped Fiber Amplifier

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ABSTRACT

In this thesis, the theory and experiment for side-mode suppression and linewidth reduction of mutually injection-locked EDFL-FPLD and EDFA-FPLD links are demonstrated by using Fabry-Perot laser diode (FPLD) as a resonant ultra-narrow band-pass filter in an Erbium-doped fiber amplified or laser (EDFA or EDFL). Based on the amplified feedback injection loop, the 3-dB linewidth of 3.4 MHz for the EDFA-FPLD link is determined by using self-heterodyne interferometric spectral analysis. The EDFA-FPLD link exhibits a nearly mode-beating noise free performance as compared to the EDFL-FPLD link. This is due to the release of the resonant cavity configuration in the EDFL-FPLD link at a cost of slightly lower side-mode suppression ratio (~42 dB). The maximum output power of the EFDA-FPLD link is 20 mW under an FPLD input power of 0.1 mW.

On the other hand, nonreturn-to-zero (NRZ) format data is transformed into a pseudo-return-to-zero (PRZ) format data at OC-48 data rate by injection-locking an Fabry-Perot laser diode operated at below threshold condition. The mechanism of the NRZ-to-PRZ format transformer results from the reduction of the effective threshold current due to the injection locking of the incoming NRZ data. With -2 dBm, wavelength-matched power injected into the FPLD, the maximum extinction ratio of 12.2 dB was obtained at the RF driving power of 24.4 dB. The best side mode suppression ratio of 40 dB, the shortest pulsewidth of 44 ps, the lowest timing jitter of 0.4 ps, and relatively low phase noise of -100 dBc/Hz at 5 kHz offset from carrier frequency of the PRZ data under injection power of 6 dBm were also obtained. Power penalty measured at a bit-error rate of 10-9 was 1.2 dB. In applications, by using such an NRZ-to-PRZ transformer an all-optical logical OR operation is also demonstrated.