Chirp Control of the Amplifier- and Modulator- integrated DFB Laser for the Transmission over 80km at 10Gb/s

Dongchurl Kim¹, Jongin Shim¹, In Kim², and Yungseon Eo¹

2) Telecommunication R&D center, Samsung Electronics, 416 Maetan-3 dong, Paldal Gu, Suwon, Kyunggi-do, 442-370, Korea.

Abstract
Transmission over 98km at 10Gb/s is demonstrated using the amplifier- and electroabsorption modulator integrated laser diode. We report the relations of the extinction ratio, the chirp, and transmission performance according to the operational conditions of the device.

The amplifier- and modulator-integrated laser diode (AML) is one of most cost-effective light sources for 10Gb/s metro solutions above 80km in fiber-optical transmission [1-2]. The device was originally proposed to compensate the insertion loss of an electroabsorption modulator in an electroabsorption modulated laser (EML). The EML has very good modulation performances such as high extinction ratio and small chirp with very low driving RF power. Furthermore, it has been known that the gain saturation characteristic of a semiconductor optical amplifier (SOA) allows compensating the laser chirp [3]. Thus, the AML is expected to have a high output power, a large extinction ratio, and a negligible chirp. However, there remain two major technical barriers to realize such high performances simultaneously. One is the amplification of the reflected optical signal at the output facet in the integrated SOA and the other is the large amplified spontaneous emission (ASE), which couples to the DFB laser and results in undesired instantaneous and adiabatic chirps. There have been several efforts to reduce the reflected lights in AML structures [4]. But the dependences of chirp and transmission characteristics on AML operations have not been reported in detail yet. In this paper, we report the chirp and transmission performance according to AML operation conditions.

The schematic of the AML device is shown in Fig. 1. We introduced a 50µm-long InP window structure, a 170µm-long extended waveguide tilted by 7°, and a 20µm-long attenuation inner-window in order to suppress residual facet reflection. The same waveguide width of 1.2µm is used. Current blocking structure with Fe-doped semi-insulating layers is adopted to lower parasitic capacitances for 10Gb/s modulation [2].

![Fig. 1 Schematic drawing of AML, (a) side view and (b) top view](image)

Fig. 2(a) shows the measured extinction curves as function of bias voltage for different operational conditions. The calculated differential extinction ratio (ER) is also shown. The peak-to-peak voltage $V_{pp}$ of 0.4V modulated at 10Gb/s is applied to the modulator. Case A and B represent the driving currents of laser diode and SOA are 50/100mA and 80/50mA, respectively. In these operational conditions, the SOA is expected to be driven at the gain-saturated mode. Fig. 2(b) shows the measured peak-to-peak frequency changes.
The data correspond to the total chirp which consists of the adiabatic and instantaneous chirps. It is revealed that the chirp of AML is strongly dependent on the laser output power as well as the SOA injection current. For good transmission performance, the minimum applied modulator voltage should be adjusted at the point where the total chirp begins to be negative. In this operational condition, we could achieve both the negative chirp and the high extinction ratio for the entire modulated voltage range, simultaneously.

We investigated the relations of the extinction curve, the large-signal chirp, and transmission performance. The method to find the optimum operational condition for long-haul transmission was suggested in AML devices.

Fig. 3 Bit error rate (BER) and eye pattern of back-to-back and after transmission over 98km

Reference


