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# Simultaneous signal transmission of different data-rates in a DWDM system employing external injection locking technique

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ABSTRACT

A novel architecture of DWDM-PON is proposed and demonstrated for downlink transmission of different data-rates of 622 Mbps, 1 Gbps, 1.25 Gbps and 2.5 Gbps simultaneously over a long-haul single mode fiber (SMF). The data rates are directly modulated by Fabry–Pérot laser diodes (FPLD), which are externally injection locked by asynchronous spontaneous emission (ASE) source. The transmission performances are checked by the bit error rate (BER), Quality (*Q*) factor and clear eye-diagrams. Since this proposed system consists of one ASE source, FPLDs and depends on the direct modulation technique, it reveals a prominent alternative with advantages in simplicity and cost.



## 1. Introduction

DWDM systems are the most preferred technology for high speed access networks, because it can offer several advantages including high capacity, large coverage range, upgradeability and cost effective configuration [1–3]. DWDM is applicable to various kinds of transmission protocols such as synchronous optical network (SONET), fiber-to-the-home (FTTH), synchronous digital hierarchy (SDH), etc. [4–6]. DFB-LDs [7] and LEDs [8] have been used as the light source in DWDM configurations to obtain single longitudinal mode characteristics. But these schemes [7,8] are expensive as different DFB-LDs or LEDs and external modulators are required to provide different services simultaneously. Signal performances are also limited by the non-linearity of external modulator [9]. Several configurations [10–13] have been developed using direct modulation with injection-locked Fabry–Pérot-laser-diode (FPLD) for making the system cost-effective and user friendly. The configurations [10–12] are limited to low data rates and over 30 km transmission distance. In this paper, a novel architecture has been proposed and demonstrated to transmit different signals of 622 Mbps, 1 Gbps, 1.25 Gbps and 2.5 Gbps data rates simultaneously over an 80 km SMF by employing direct modulation and external light injection technique. The direct modulation techniques offer advantages such as the reduction of chirp, increasing bandwidth distance product and decreasing the cost, etc. Four narrow band lightwave of appropriate wavelengths have been chosen from an ASE source and injected to four directly modulated FP LDs. ASE source is used due to its high output power, stochastic nature and low-cost over DFB-LD and LED. The injected light locked a single mode of FPLD and suppressed the other modes. The side mode suppression ratios (SMSR) are obtained $>45$ dB due to injection locking in all FP-LDs and this result is comparable with SMSR of DFB-LD [7] source. Very good eye diagram and excellent BER is observed in our proposed system. The *Q* factor degradation as a function of the increasing fiber length and the increasing data rates, have been plot and it supports the capability of the architecture to transmit different data-signals over 80 km fiber link simultaneously. The proposed configuration is suitable for different networks and services as the triple play services, FTTH, HDTV and SDH etc.

## 2. Experimental setup

The block diagram of our proposed scheme is shown in Fig. 1. The data signals of 622 Mbps, 1 Gbps, 1.25 Gbps and 2.5 Gbps are with pseudo-random-bit-sequence (PRBS) word length of $2^{11}-1$ and an output extinction ratio of $\sim$8 dB are directly modulated by the four injection locked FPLDs. The FPLDs have the threshold current $\sim$37 mA. Amplified spontaneous emission (ASE) source is used as broad band light source in the injection locking scheme. The central wavelengths of 1552.49 nm, 1551.61 nm, 1550.84 nm and 1550.03 nm, have been carefully chosen from the ASE source using four optical band pass filters to select the particular wavelengths for appropriate injection locking range within the four FPLDs. As to the light injection part, these wavelengths are coupled into the port 1 of four OCs to serve as light injection

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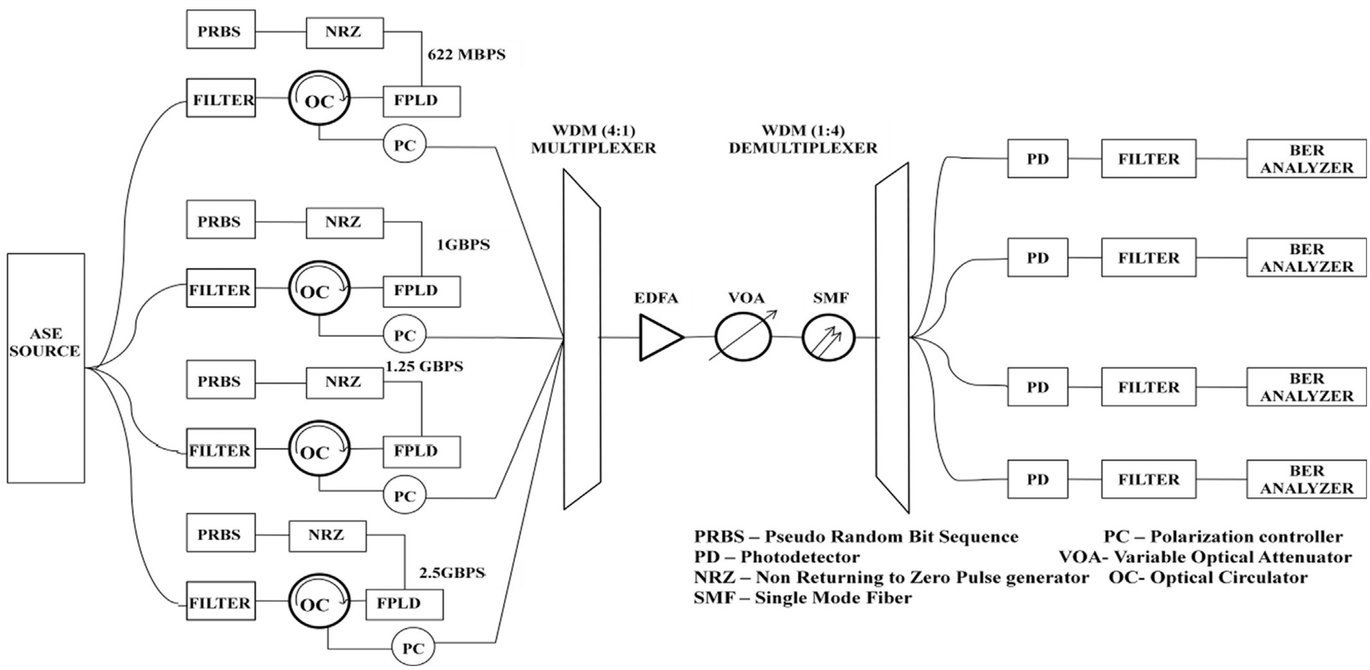


**Fig. 1.** Block diagram of experimental setup.

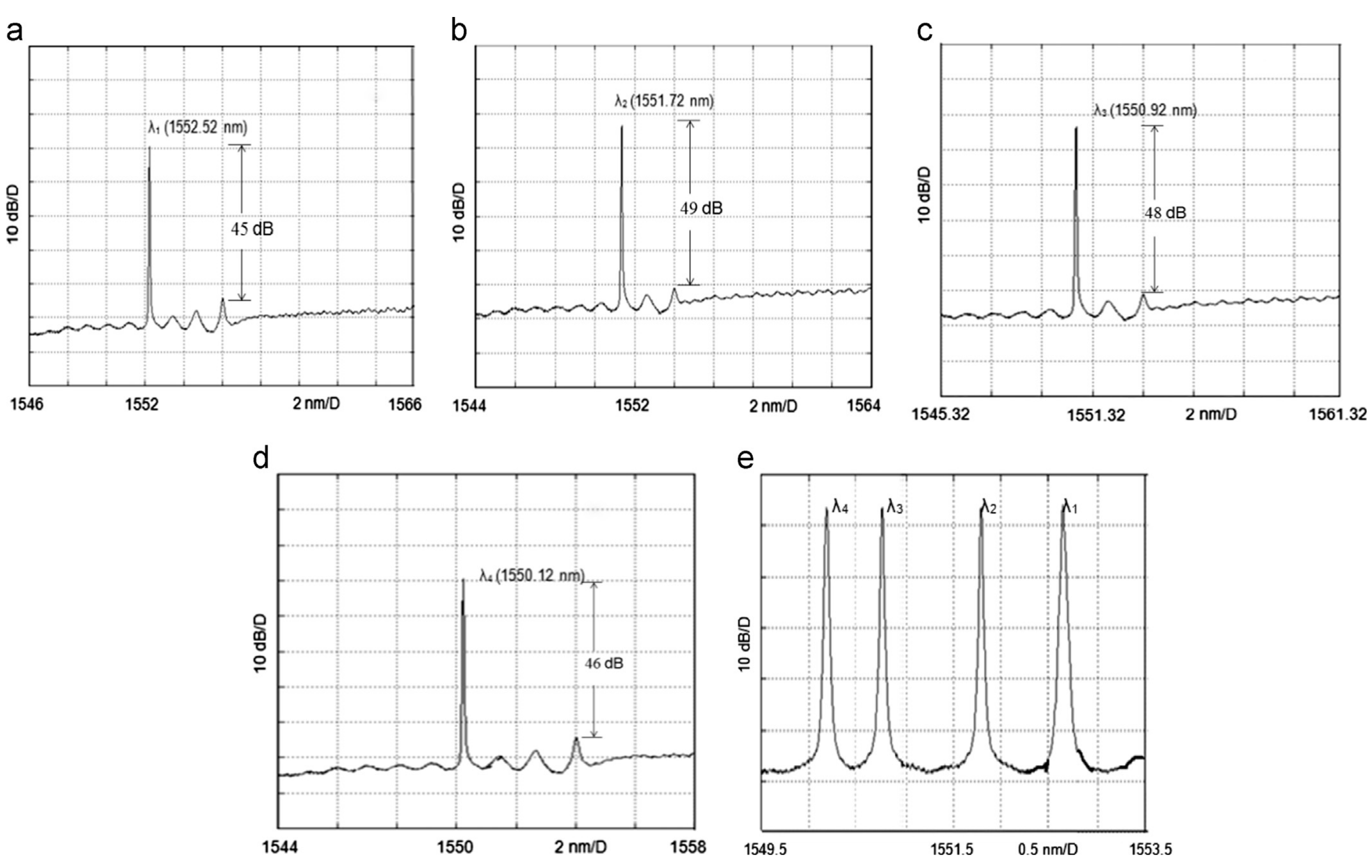


**Fig. 2.** The output spectrum of four injection locked FPLDs of output wavelengths (a) 1552.52 nm, (b) 1551.72 nm, (c) 1550.92 nm, (d) 1550.12 nm after PCs and (e) the combined optical spectrum of DWDM after multiplexer.

sources. The OCs has the return loss and isolation loss of 60 dB each. The directly modulated signals are transmitted through the polarization-controllers (PCs) via OCs and multiplexed by a $4 \times 1$ WDM multiplexer. The resultant wave is passing through an erbium doped fiber amplifier (EDFA), variable optical attenuator (VOA) and fed into the fiber backbone. The EDFA has the length of 5 m and gain of 16 dB and the VOA has the attenuation value of 10 dB. At the end of SMF transmission, the optical wave is divided into 4 parts by a $1 \times 4$ WDM demultiplexer. These light-waves are received by PIN photodetector and converted into the electrical