Microwave phase noise properties of optical links involving small signal and gain saturated optical amplifiers

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Noise in optical amplifiers is an important issue concerning phase noise performances in optical links. Optical amplifiers are indeed a major contributor to the radio frequency (RF) phase noise in these systems. Beyond telecommunications applications, many systems require low phase noise optical amplification in order to be used in radars or in high frequency reference signals distribution. Hence, the choice of the type of the amplifier and its operating conditions might be a difficult task.

Optical amplifiers are often characterized through their small signal gain, saturated output power and noise figure. But their phase noise performances do not only rely on these parameters. Operating conditions have a significant influence. The aim of this work is to highlight and compare the phase noise behavior between erbium doped fiber amplifiers (EDFA) and semiconductor optical amplifiers (SOA) in small signal and gain saturated state.

RF phase noise measurements have been carried out with a correlation phase noise bridge, such the one depicted in Fig. 1. The phase noise added to a microwave signal through an EDFA and a booster optical amplifier (BOA) has been studied for different saturation states and pump powers. Saturation state of the amplifier has an important impact on the noise floor since a difference higher than 10 dB has been measured with the linear regime. Besides, EDFA's noise floor is slightly lower than that of the BOA. Therefore, an all optical measurement of the noise figure of each amplifier has been performed to explain the different noise floor levels[1].

Although the EDFA exhibits better optical characteristics, BOA's phase noise performances close to the carrier are still interesting. Actually, the BOA presents a pure 1/f phase noise slope close to the carrier while the phase noise spectrum of the EDFA features a bump and a higher phase noise level compare to the SOA between 10 Hz and 1 kHz offset. The low frequency amplitude noise of both amplifiers has also been measured, and a correlation has been found with the shape of the phase noise spectrum. Thus, the main problem with these devices is probably related to amplitude to phase noise conversion in the setup, possibly on the photodiode[2].

As a perspective, we are about to minimize this effect through a careful choice of the optical power level on the photodiode.

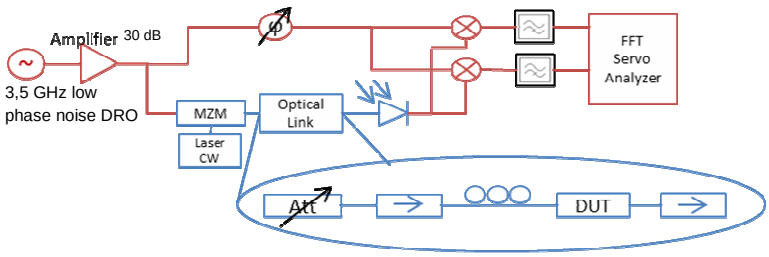

Fig. 1 : Configuration setup for phase noise measurement

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