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Simulation and Performance Analysis of SPM, XPM and FWM in Optical Fiber Communication System

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Abstract: In present era Focus on development of broadband optical communication systems is incredible since it offers combination of wide bandwidth and low losses unmatched by any other transmission medium. There are some limiting factors related to data rate and capacity in optical fiber communication system. These limiting factors can be linear or non-linear. We can compensate the linear effect such as dispersion and attenuation by using dispersion compensation methods. But the non-linear effect still accumulate with the increase in optical power levels. When all the input signal frequencies interact due to fiber nonlinearities, the output bit stream may behave in a complicated way giving adverse effects on system performance. In wavelength-division multiplexing (WDM) systems, inter-channel interference due to fiber nonlinearities may limit the system performance significantly. Therefore, it is crucial to understand fiber nonlinearities and their effects on fiber-optic communication systems. The main motivation of this work was to study theoretical and simulation studies of broad band optical communication systems due to fiber nonlinearities. Here, we investigate power effects on simulation of optical communication systems with Self Phase Modulation (SPM) and Four Wave Mixing(FWM), by using the parametric run feature in Optisystem. The eye diagram highlights the conversion due to the SPM and FWM. Specifically the eye opening decreases with increasing transmitted power.

Keywords: SPM, FWM, XPM, Optisystem

I. INTRODUCTION

Nonlinear optics (NLO) is the branch of optics that describes the behaviour of light in nonlinear media, that is, media in which the dielectric polarization P responds nonlinearly to the electric field E of the light. This nonlinearity is typically observed only at very high light intensities (values of the electric field comparable to inter atomic electric fields, typically 10^8 V/m) such as those provided by pulsed lasers. When an optical signal is transmitted through long haul communication systems (the transmission of a light signal over fiber for distances typically longer than 100 km) of optical fiber, a significant distortion will be seen in the received signal. Distortion could be result of chromatic and polarization mode dispersion in Time Division Multiplexing (TDM) and fiber nonlinearity's in Wavelength Division Multiplexing (WDM) impact transmission performance. Nonlinear effects play a major role in optical fiber with respect to transmission capacity and performance of the system. To achieve maximum transmission rate, combination of TDM and WDM is used and optimized configuration of combination depends on few factors such as dispersion and optical signal power. There are upsides and downsides of using nonlinear effects in optical fiber [4].