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Optical Delay-line Measurement System

ABSTRACT

OVERVIEW: Along with the advancements in optical fiber communications devices, accurate measurement techniques have to be developed as well. Fiber length, dispersion, and polarization-dependent devices are common factors needed to be taken into consideration when fiber optics experiments are conducted. Another important factor is the delay that signals acquire across optical paths or delay-lines. The sensing of this delay has become very critical for applications that involve dispersion measurements, optical fiber interferometers, optical filters, and optimal length for optical fibers selection.

STUDENT PROJECT: This project's objective was the setup of a system capable of measuring the optical signals' delay over an optical path. The approach was based on the phase-shift technique using the Analog Devices AD8302. With the use of this device the phase change and gain of signals were interpreted in terms of voltages. A linear approximation was used to process the voltage to phase change relation, and consequently to determine the change in delay with this relation:

$$\Delta\tau = \frac{\Delta\phi}{2\pi f_m}$$

From its realization we can conclude that since the AD8302 measures RF signals up to 2.7GHz and modulation bandwidths of DC-30MHz, this approach can achieve many orders of magnitude improvement in bandwidth and speed over implementations using conventional lock-in amplifiers and thus opens up many measurement possibilities, such as characterizing tunable optical devices and polling optical sensor arrays. Also, for measurements purposes, it was noticed that as the frequency increases the maximum phase output voltage decreases accordingly. For the tested frequency range of 2.0~2.5 GHz, the phase output voltage does not exceeded 1.6V; which is lower than 1.8V, the upper voltage limit for its outputs. Finally, in order to improve the accuracy of the $\Delta\tau$ results finer fitting techniques can be used. This project can find homeland security

applications in optical sensing where accurate measurements have to be taken such as surveillance systems, optical sensor design, and optical imaging. Also, it will be integrated to other systems with the purpose of characterization of integrated optic devices.