**Hybrid Photonics Modules for Variable Time Delay Signal Processing**

**Advantages**
- High resolution time delays (sub-picosecond)
- Fast speed (milliseconds to nanoseconds) for processing signals
- Little to no signal loss
- Noise suppression and little to no crosstalk

**Invention**
This invention provides means and methods for the creation of a variable optical delay line consisting of: an input circuit with an electro-optic modulator, a digital delay module, a switchless analog delay module, and non-dispersive single mode fibers.

**Background**
Searching and tracking fast moving objects requires high speed and high spatial resolution radar beams. To fulfill this need phased array antenna/radar equipment typically operates with wide instantaneous bandwidths that require true time delay radar beam-forming implemented with variable delay lines (time delays injected into incoming data). Radar systems operate over varied radar bands from X-band to S-band, and have a varying number of independently driven antenna elements and/or sub-arrays. To handle, process and modulate all these signals requires precisely controlled short delays (nanosecond to picoseconds). The ideal RF radar delay line would have a modular design to upgrade time delay ranges for beam-forming, high resolution time delay control (in sub-picoseconds), millisecond speed for radar testing to nanosecond for advanced radar beam-forming, noise suppression greater than 60 dB RF, low signal loss over the complete module and smooth time delay controls of more than 16 bits.

Scientists at UCF have created a modular variable fiber optic delay line capable of injecting variable time delays into incoming signals. This module consists of several components, including: an input circuit for receiving and modulating input signals and a switchless delay module for injecting a long time delay into an input signal to produce a time delayed output signal. The switch delay module is much preferred to the current fast optical switches, as they result in large signal losses, crosstalk and increased complexity. This module also contains a switchless analog delay module for injecting a short variable time delay into the modulated signal to produce an output signal with a delay equal to the long plus short time delay. Instead of using long spools of dispersive fiber the invention makes use of non-dispersive single mode optical fibers for transmission between the input circuit, the delay module and the analog variable delay module. The delay line makes use of wavelength division devices for wavelength selection/tuning to help generate near continuous time delays. This module can be used for radio frequency digital electrical signals requiring time delay and amplitude processing such as in programmable RF filters and optically controlled RF phased array antennas and radars.

**Application**
This technology can be utilized for electronic warfare, for buffering in data routers, in RF signal processors/transversal filters, and test instrumentation. The proposed modules can also be used in all-optical signal processing for communications and security systems.

Examples of businesses that would be interested are: Lockheed-Martin, Boeing, Northrup-Grumman, and Harris Corporation.

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**Selected References**

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