

High Speed Polarization Controller

White Paper



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High Speed Polarization Controller

Executive Summary:

Precise control of polarization behavior is becoming increasingly important to produce competitive, high-performing components and systems in today's optical industries. Device performance will be affected by different polarizations. Various polarization sensitive phenomena need special care in any optical design, including communication, sensing, imaging, and also optical security. The Lightwaves2020's high-speed polarization controller provides the ideal solution to polarization sensitive devices in these application areas.

The scenario:

Polarization must be precisely synthesized/adjusted at the input/output of the devices without changing other optical characteristics.

Polarization related issues/problems exist widely in telecommunication areas:

- Polarization mode dispersion (PMD) measurement
- PMD compensation
- Polarization dependent loss (PDL) measurement
- Polarization-dependent gain measurement in EDFA
- Polarization synthesis
- Polarization multiplexing
- Orthogonal frequency division multiplexing (OFDM)
- Coherent detection system
- Polarization stabilization
- Polarization scrambling
- Polarization switch
- Polarization instrumentation

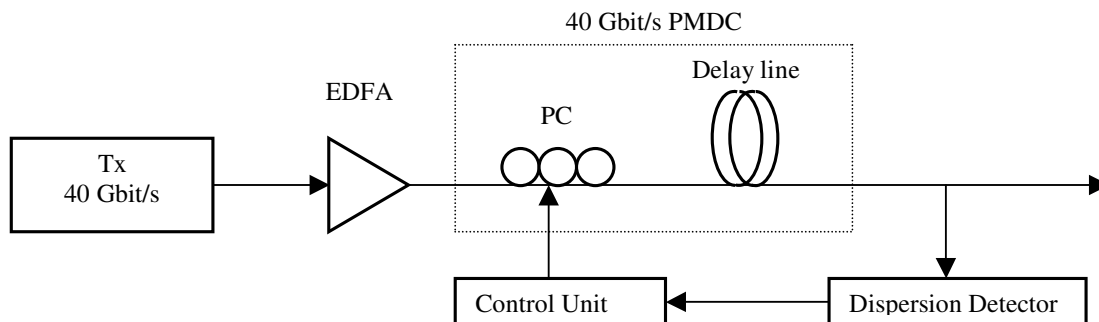


Fig 1: Block diagram of 40 Gbit/s PMDC system

Besides from telecommunication, optical sensing, imaging and security also require polarization controller. Although sometimes polarization independent devices are pursued, polarization affects the performance of any optical sensors and imaging systems in principle. Polarization control can essentially stabilize and optimize these devices and systems. For optical security systems, the information capacity and capability can be greatly improved by introducing the thousands of polarizations as the code carriers.

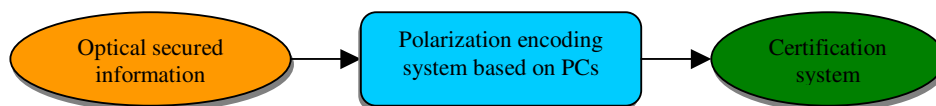


Fig 2: Conceptual block diagram of optical security system based on polarization encoding

The current state of play:

Polarization controller is a fundamental and crucial element in optical systems because it can convert any input to any desired output state of polarization (SOP).

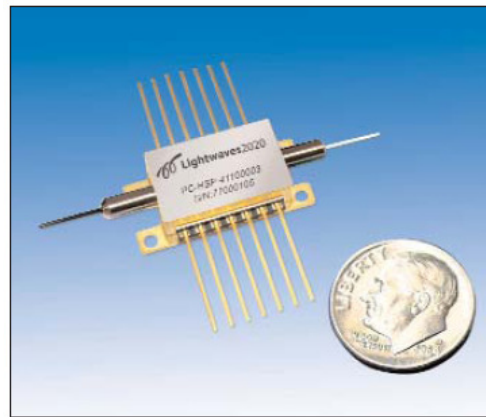
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In general, polarization controller devices are made of quarter-wave and half-wave plates to enable the transformation from one SOP on the Poincaré sphere to another and therefore create all possible polarization states. Cost-effectiveness, compact package, and flexible design are the basic requirements for these devices. Also, while adjusting the polarization to any desired state, the change of other optical characteristics such as PDL, PMD, and power level need to be minimized. With these features, the polarization controller has greatly improved the performance and efficiency of the optical system; life has been much easier when working with polarization sensitive devices/systems. However, in the current market, there is a limiting factor of the low response speed that inhibits the development of polarization controller in various applications. For instance, the current speed in *ms*-level is unsuitable for the demanding 40 Gbs PMDC applications due to the inverse square relationship between the response time and line rate.

The Lightwaves2020 solution:

The Lightwaves2020's high-speed polarization controller (HS-PC) is based on novel optical material offering fast response in μ s-level, in contrast with conventional polarization controllers with speed in *ms*-level. The dramatic increase in speed enables a significant improvement of polarization sensitive devices and systems and helps saving time and money.

Besides the unique high-speed advantage, our HS-PC provides an endless and continuous tuning ability due to the specific material property. Moreover, thermoelectric cooler (TEC) controller is packaged in our device to make the performance more stable and insensitive to the environmental temperature.



In addition, our new HS-PC has a compact butterfly package with low insertion loss, low PDL, low PMD, broadband wavelength ranges, no moving parts, and solid state technology. It also has options of three or four cell design; the fourth cell is for faster searching and controlling.

An optional driver-PCB, on which the polarization controller is mounted, is provided. The device is driven by 0-5 V DC voltage to produce 0- 2π phase retardation of polarization state.

Features	Lightwaves2020	Competitor #1	Competitor #2
Speed	$\leq 10 \mu$ s	$\leq 30 \mu$ s	$\leq 30 \mu$ s
Insertion loss	≤ 1.0 dB	≤ 3.0 dB	≤ 1.0 dB
Temperature Stability	TEC applied	N.A.	No TEC

Table 1: A comparison of Lightwaves2020's high-speed polarization controller with competitors' solutions.

All these features make the Lightwaves2020's high-speed polarization controller an important and perfect building block in various optical systems including high-data-rate communication, sensing, imaging, and also optical security.

More information can be found on our website: www.lightwaves2020.com