

# Lightvision

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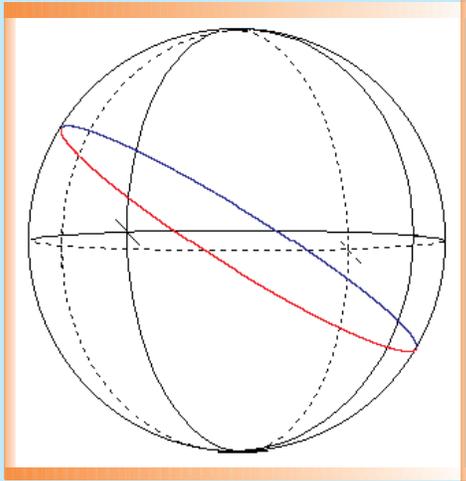
## Polarization Scrambler

*Simplicity,  
Low Cost, and Fast Speed*

*Polarization plays a crucial role in the application of light. In optical communication systems, polarization can trigger Polarization Dependent Loss (PDL) and Polarization Dependent Gain (PDG), both of which result in a decrease in the quality of transmitted signals. In measuring systems, polarization can generate excess errors due to PDL. In fiber sensing systems, polarization can induce unwanted phase noise to signals. To solve the aforementioned polarization-related problems, depolarized light is required. For most application using light source with linear polarized light and a high Degree of Polarization (DOP), Lightwaves2020 now offers a simple and cheap solution based on its advanced Liquid Crystal (LC) technology: the Polarization Scrambler.*

*This Polarization Scrambler is the next innovation developed from Lightwaves2020's LC Polarization Rotator which can rotate State of Polarization (SOP) by phase retardation. Lightwaves2020's Polarization Scrambler is capable of depolarizing all kinds of SOP with its special high frequency driver. As is known to all, every SOP can be represented by a point on the Poincare sphere. Lightwaves2020's Polarization Scrambler can rotate every SOP along an entire great circle on the Poincare sphere. The 360-degree rotation makes DOP equal to zero. The rotation of the Polarization Scrambler on a Poincare sphere can be seen in Figure 1.*





**Figure 1: Polarization Scrambler Output with DOP < 3%**

One of the advantages of Lightwaves2020's Polarization Scrambler is its simple and economic design. Customers can improve their system without noticeable cost increase or system changes. In addition, for better Signal to Noise Ratio (SNR), the Polarization Scrambler features no moving parts and exhibits low insertion loss, making it the ideal solution on the transmitting side of long-haul optical communication systems. The Polarization Scrambler also can minimize the PDG caused by optical amplifiers. Additionally, the Polarization Scrambler is the most economical solution for Device Under Test (DUT) applications including filters or bulk material for example, the performance of which are sensitive to polarization. By simply inserting the Polarization

Scrambler in front of the DUT, the customer can minimize undesirable influences of polarization such as PDL. Optical Spectrum Analyzers (OSAs) are another type of device that can be sensitive to polarization effects. Customers can simply place this Polarization Scrambler in front of the OSA to get better measuring results.

Features of the Polarization Scrambler include: a low-cost simple design, miniature size, and ultra-low PDL and activation losses (See Table 1). For more complex systems, Lightwaves2020 also offers the 3-cell/4-cell version of Polarization Scrambler, in which the polarization rotation covers entire surface of the Poincare sphere, as shown in Figure 2.

Structure	Features
1-Cell	Low-Cost Simple Design, Miniature Size, Non Moving Parts, Ultra-Low PDL and Insertion Loss
3-Cell	1-Cell Features + Works for All Kinds of Input SOP
4-Cell	1-Cell Features + 3-Cell Features + Faster Depolarizing Speed

**Table 1: Features of Polarization Scrambler Categorized by Structures**



**Figure 2: 3-Cell/4-Cell Polarization Scrambler Output**

Looking ahead, Lightwaves2020 is investigating a high-speed Polarization Scrambler with a faster depolarized rate based on Lightwaves2020's proven advanced high-speed Electro-Optic (EO) material technology. If you are interested in this device, please contact us for further information.



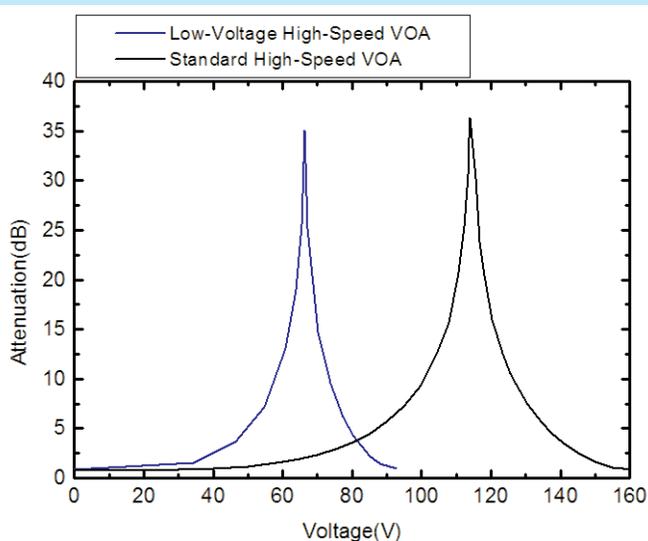
# The Low-Voltage Solution to High-Speed Variable Optical Attenuator (VOA)

## The Concept

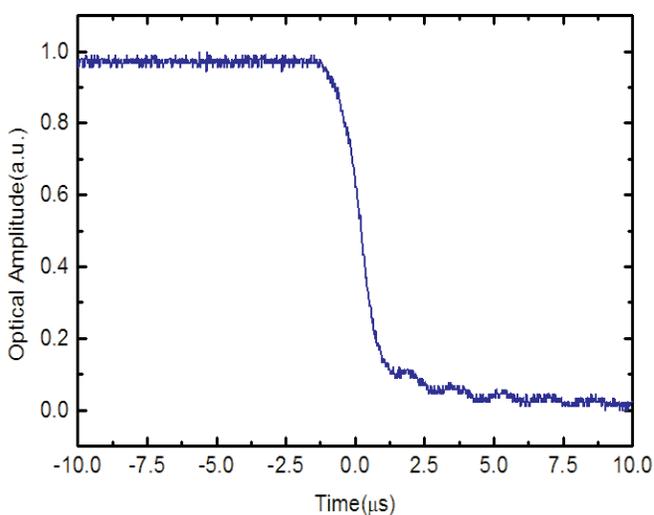
*Lightwaves2020 pioneers in developing Variable Optical Attenuators (VOAs). Its high-speed VOA which is made with novel optical materials offers fast response time in  $\mu\text{s}$ . Embracing the wave of Green Technology, Lightwaves2020 is experimenting on reducing this high-speed VOA's operating voltage,  $V\pi$ , to less than  $70\text{V}$  @  $T=23\pm 2^\circ\text{C}$  by revising the optical structure with increased effective optical path and using the similar optical material with higher Electro-Optical (EO) coefficient. The device is still in the engineering development stage; however, Lightwaves2020 does see its promising future in the telecom market.*

## The Performance

*The typical phase retardation vs. control voltage of Lightwaves2020's 2 types high-speed VOA is shown in Figure 1.*



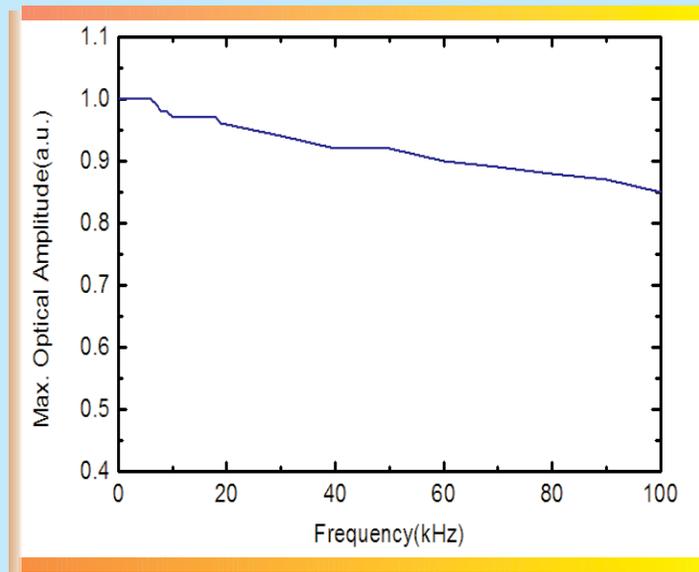
*Figure 1: Attenuation Curve vs. Control Voltage at Room Temperature*



*Figure 2: Response Time for Low-Voltage High-Speed VOA*

*With suitable electronic driving circuits, the low-voltage high-speed VOA can respond in less than  $2\mu\text{s}$  (See Figure 2). Aside from VOA applications, this device can be used as optical shutter and optical modulator.*

*Figure 3 illustrates the typical frequency response of the low-voltage high-speed VOA. The minimum insertion loss (IL) will slightly increase when operating frequency goes up. The maximum operating voltage can reach up to  $200\text{ kHz}$ .*



**Figure 3: Frequency Response of Low-Voltage High-Speed VOA**

### The Advantage

*It is believed that the dramatic decrease in the control voltage of the low-voltage high-speed VOA will provide more possibilities to system designers. Faster response time enables this low-voltage high-speed VOA to fulfill the demand of 40Gbs applications. Additionally, it can be applied to channel balancing in optical networks, power equalization in optical add/drop modules and optical cross-connects, gain-tilt and power adjustment in Erbium-Doped Fiber Amplifiers (EDFAs), receiver protection, and instrumentation. The features of this innovative device include: low-voltage high-speed ( $\mu$ s) attenuation control, no moving parts, continuous tuning, low Polarization Dependent Loss (PDL), and wide operating wavelength range.*



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