



## HIGH SPEED POLARIZATION CONTROLLER-SCRAMBLER

### Features

- Negligible insertion losses
- Negligible return losses
- Negligible Polarization Dependent Losses (PDL)
- Response speed up to 30 kHz
- Continuous polarization control capability
- Compact and PCB compatible

### Applications

- Polarization scrambling
- Polarization stabilization
- Polarization Mode Dispersion (PMD) mitigation
- Polarization Dependent Loss (PDL) mitigation
- Polarization Dependent Gain (PDG) mitigation
- PDL, DOP, and PMD Measurement Systems
- Interferometers and Sensors
- Fiber lasers
- Polarization demultiplexing
- Test instrumentation

**Preliminary**



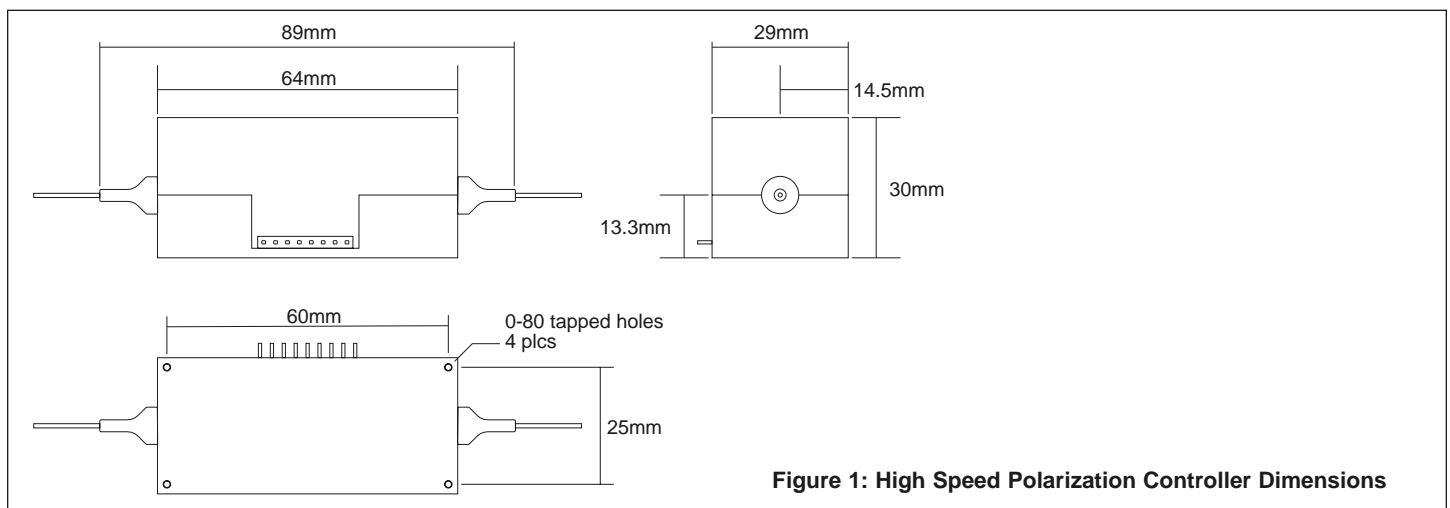
**High Speed Polarization Scrambler**

### Product Description

OZ Optics' High Speed Electrically Driven Polarization Controller (EPC) provides a simple, efficient means to quickly manipulate the state of polarization within a singlemode fiber. Employing a novel fiber squeezing technique, the device is controlled by either three or four (depending on the model) input voltages to provide endless polarization control and scrambling in a robust, easy to operate package. The controller's rapid response speed easily handles changes in polarization caused by the external environment, and is highly suitable for polarization controlling and scrambling for either averaging PDL, PDG effects, or for making PMD, PDL or DOP measurements. Because the fiber within the device is continuous, all insertion losses, return losses, and PDL effects are limited only by the fiber itself. This makes it ideal for precise test and measurement applications.

The polarization controller is available in either a three or four channel configuration. The three channel system is ideal for polarization scrambling applications such as for polarization averaging, PDL or PDG measurements. The added redundancy of the four channel version opens the way to continuous polarization control, without having to occasionally reset the device when a controller reaches its limit.

The innovative design of the OZ Optics High Speed Polarization Controller can provide an integrated module that allows users easily to implement the OZ Optics High Speed Polarization Controller in their systems with both analog and digital inputs.



**Figure 1: High Speed Polarization Controller Dimensions**

## Standard Product Specifications:

Model		EPC-3000	EPC-4000
Electrical	Number of Control Channels	3	4
	Voltage Range	0 to 140 Volts	
	3dB Bandwidth	30 kHz	
	Recommended High-Speed Scrambling Frequency <sup>1</sup>	>10 kHz	
	Power Consumption	2-3 Watts per channel (Max.)	
	Electrical Interface <sup>2</sup>	8 pin board connector	
Optical	Retardation Range	2 $\pi$ Minimum	
	Insertion Loss Not Including Connectors	0.05 dB	
	Backreflection	>60dB excluding connectors	
	Wavelength Range	1260 to 1650 nm Standard — Other wavelengths available on request	
	Activation Loss <sup>3</sup>	$\pm$ 0.05 dB	
	Polarization Dependent Loss (PDL)	<0.06 dB	
	Operating Temperature	-10°C to +50°C	
	Storage Temperature	-40°C to +80°C	
	Fiber Type	Corning SMF-28 Standard — Other fiber types available on request	
Mechanical	Dimensions (LxWxH)	64x30x29 mm	
	Weight	~300 grams	

<sup>1</sup> It is recommended to set the driving frequencies to the fiber squeezer resonance frequencies.

<sup>2</sup> Other types of electrical interfaces are available upon request.

<sup>3</sup> With 0 to 140V applied to each channel.

## Ordering Information For Standard Parts:

Bar Code	Part Number	Description
56100	EPC-3000-11-1300/1550-9/125-S-XX-1-1	Three Channel Polarization Controller & Scrambler using standard Corning SMF-28 singlemode fiber. The input and output fibers are one meter long, with 900 micron diameter loose tube jacketing, terminated with no connectors.
56102	EPC-3000-11-1300/1550-9/125-S-3U3U-1-1	Three Channel Polarization Controller & Scrambler using standard Corning SMF-28 singlemode fiber. The input and output fibers are one meter long, with 900 micron diameter loose tube jacketing, terminated with Ultra FC/PC connectors.
56101	EPC-3000-11-1300/1550-9/125-S-3A3A-1-1	Three Channel Polarization Controller & Scrambler using standard Corning SMF-28 singlemode fiber. The input and output fibers are one meter long, with 900 micron diameter loose tube jacketing, terminated with angled FC/APC connectors.
56104	EPC-4000-11-1300/1550-9/125-S-XX-1-1	Four Channel Polarization Controller & Scrambler using standard Corning SMF-28 singlemode fiber. The input and output fibers are one meter long, with 900 micron diameter loose tube jacketing, terminated with no connectors.
56105	EPC-4000-11-1300/1550-9/125-S-3U3U-1-1	Four Channel Polarization Controller & Scrambler using standard Corning SMF-28 singlemode fiber. The input and output fibers are one meter long, with 900 micron diameter loose tube jacketing, terminated with Ultra FC/PC connectors.
56103	EPC-4000-11-1300/1550-9/125-S-3A3A-1-1	Four Channel Polarization Controller & Scrambler with Corning SMF-28 singlemode fiber. Input and output one meter long with 900 micron OD jacket terminated with angled FC/APC connectors.
56116	EPC-1000-DRIVER-04	Four Channel EPC Driver Card for controlling polarization controller & scrambler. DC voltage ranging from 0 to +140 V, settable rise/fall time from up to 400 microsecond, and maximum total current of 60 mA for all channels.

## Ordering Example For Standard Parts:

A customer is building a polarization scrambler circuit for PDL testing at 1550 nm. He will use a three stage system with standard singlemode fiber, and FC connectors.

Bar Code	Part Number	Description
56102	EPC-3000-11-1300/1550-9/125-S-3U3U-1-1	Three Channel Polarization Scrambler using standard Corning SMF-28 singlemode fiber. The input and output fibers are one meter long, with 900 micron diameter loose tube jacketing, terminated with Ultra FC/PC connectors.

## Ordering Information For Custom Parts:

OZ Optics provides custom designed products to meet your application needs. As with most manufacturers, customized products do take additional effort so please expect some differences in the pricing compared to our standard parts list. In particular, we will need additional time to prepare a comprehensive quotation, and lead times will be longer than normal. In most cases non-recurring engineering (NRE) charges, lot charges, and a one piece minimum order will be necessary. These points will be carefully explained in your quotation, so your decision will be as well-informed as possible. We strongly recommend buying our standard products.

### DESCRIPTION

### PART NUMBER

## Controller and Scrambling Unit **EPC-A-11-W-a/b-S-XY-JD-L**

**A** = 3000 for 3 stage high speed scrambler  
4000 for 4 stage high speed controller

**W** = Wavelength: Specify in nanometers:  
Example: 1300/1550 for standard telecom wavelength range

**a/b** = Fiber core/cladding sizes, in microns  
9/125 for Corning SMF-28 Singlemode fiber. See standard tables for other standard fiber sizes

**XY** = Connector code:  
X = No Connector  
3S = Super NTT-FC/PC  
3U = Ultra NTT-FC/PC  
3A = Angled NTT-FC/PC  
8 = AT&T-ST

SC = SC  
SCU = Ultra SC  
SCA = Angled SC  
LC = LC/PC  
See standard tables for other connectors

**L** = Fiber Length in meters, on each side of the device. If they are different lengths, specify the input and output lengths separated by a comma. Example: To order 1 meter of the fiber at the input and 7 meters at the output, replace L with 1,7.

**JD** = Fiber jacket type:  
1=900 micron OD hytrel jacket

## Questionnaire For Custom Parts:

- Are you performing polarization scrambling or polarization controlling?
- What is your operating wavelength?
- What type and size of fiber do you want?
- What type of connectors do you need?
- How long should the fibers be?
- What is the fiber jacket OD?

## Ordering Example For Custom Parts:

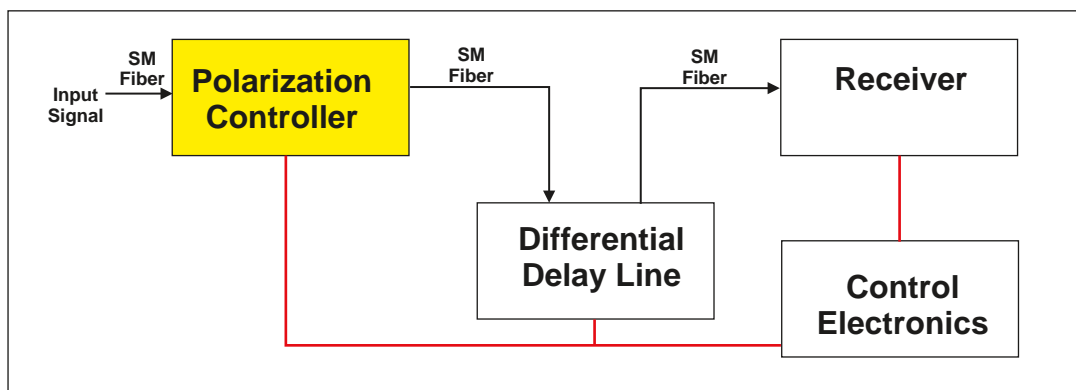
A customer wants a 4-channel polarization controller for 1310 nm wavelength. He wants singlemode fibers, 0.5 meters long, 900 micron hytrel jacketing with LC connectors. He also wants an EPC driver with built-in RS232 interface for remote control. He needs to order the following part numbers:

Bar Code	Part Number	Description
NEW	EPC-4000-11-1300/1550-9/125-S-LCLC-0.5-1	Four Channel Polarization Controller & Scrambler with Corning SMF-28 singlemode fiber. Input and output 0.5 meters long with 900 micron OD jacket terminated with LC/PC connectors.
56116	EPC-1000-DRIVER-04	Four Channel EPC Driver Card for controlling polarization controller & scrambler. DC voltage ranging from 0 to +140 V, settable rise/fall time from up to 400 microsecond, and maximum total current of 60 mA for all channels.

## Application Notes:

**Example Application:** Polarization mode dispersion (PMD) is an important issue in the quest to build high speed (10Gbs, 40Gbs, and higher) communication networks. An input signal travelling along a single mode fiber normally has some distortion, due to polarization mode dispersion. The signal effectively has been split into two arbitrary, yet orthogonal polarizations, and one polarization is leading the other. A differential delay line is a crucial element to PMD compensation.

The figure below shows how to use a polarization controller to compensate for polarization mode dispersion. The controller is installed just before a differential delay line to convert the arbitrary polarizations from the input fiber into polarizations corresponding to the orthogonal polarization controlled by the differential delay line. The faster polarization is slowed down by the delay line and the combined signals then enter the output fiber to go to the receiver. A control system monitors the quality of the signal at the receiver, and dynamically adjusts the polarization and the delay to get the two signals to match up again. Thus the PMD in the system can be corrected in real time.



## Frequently Asked Questions (FAQ):

**Q:** How does the polarization controller/scrambler work?

**A:** The polarization controller uses a unique electronically driven fiber squeezer technique to apply a high pressure on an optic fiber with a force over 25 N. This is sufficient pressure to introduce a phase change in the polarization of over 360 degrees in scale. By cascading three or four such fiber squeezers together, each at a 45 degree offset to its neighbour, one can show that one can convert any input polarization through the device into any desired output polarization.

**Q:** Why do you recommend a four squeezer system over a three squeezer system for polarization controllers?

**A:** Four squeezers are recommended for continuous polarization control. While a three squeezer system is sufficient to convert any input polarization to any output polarization, it won't allow continuous control. If you are actively controlling the squeezers to maintain a constant polarization, you can drive one of the squeezers to its voltage limit. In a three squeezer system you would have no choice but to reset that squeezer, causing a temporary loss of the polarization. In a four squeezer system we have a redundant squeezer. One can reduce the voltage applied to the squeezer currently at its limit, and compensate for the change with the other three.

**Q:** Can you make a controller with multimode fiber? How about with polarization maintaining fiber?

**A:** Building a polarization controller with multimode fiber would not make much sense. By definition, light within a multimode fiber can travel along several modes. Each mode will exhibit its own polarization state. It is impossible to control each mode individually. On the other hand, while the technique used in the polarization controller would not work on polarization maintaining fiber, one can attach a polarization maintaining fiber to the output of a polarization controller. One common application is to use the controller to take input light with changing polarization and convert it to linearly polarized light aligned to the slow or fast axis of the polarization maintaining fiber. This allows one to use sources that do not maintain polarization with polarization maintaining fiber.