FiberControl
Lightwave Polarization Solutions

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Resonant-Coil Polarization Scrambler (RCPS-600/B)

Introduction:

Polarization dependent effects in test-sets and optical transmission systems can be reduced by modulating the state-of-polarization (SOP) of the transmitted optical signal. This can be accomplished by FiberControl's Resonant-Coil Polarization Scrambler (RCPS-600/B). The RCPS-600/B converts highly polarized light into light with a scrambled polarization by rapidly modulating the SOP – by creating a time-varying birefringence in a short length of fiber.

Two models are currently available: RCPS-600 and RCPS-600B. The RCPS-600 provides scrambling at frequencies between 650-kHz and 690-kHz when driven by commercially available function generators (± 10-V_{P-P}, Z_o = 50-Ω). This frequency range can be expanded when higher amplitude sinusoidal voltages are supplied at the input modulation port. The RCPS-600B simplifies this by incorporating an internal power amplifier, which extends the modulation frequency range, when using the same above mentioned function generator. The RCPS-600B can be powered with 100, 120, 220 or 240-VAC at either 50 or 60-Hz.

This range of scrambling frequencies provide flexibility for various applications: (1) scrambling at frequencies below the low frequency response of many optical receivers (< 300-kHz), or (2) for the characterization of Erbium-doped fiber amplifiers (EDFA), scrambling at frequencies well above the saturation/recovery time (100-μs to 1-ms). Depending on the pump and signal powers within EDFAs, a reduction of the effects of inversion modulation sometimes require scrambling rates above 500-kHz.[1] For this reason, the RCPS-600/B enables scrambling rates that approach 1-MHz. As for an example of the first application, it has been found that modulating the SOP of an optical signal before being launched into a transmission fiber reduces the effects of polarization-dependent hole-burning and/or polarization-dependent loss.[2] Additional applications include the reduction of influence of PDL within optical test sets.

The figure of merit for scrambling is the degree-of-polarization (DOP). It can be reduced to less than 2%[3] over a considerable range of modulation frequencies. This product is fully licensed.

[1] Emmanuel Desurvire, Erbium-Doped Fiber Amplifiers – Principles and Applications, (New York: J. Wiley, 1994), pp. 410-420.
[2] F. Bruyère, O. Audouin, V. Letellier, G. Bassier, and P. Marmier, "Demonstration of an Optimal Polarization Scrambler for Long-Haul Optical Amplifier Systems," *IEEE Photonics Tech. Lett.*, vol. 67, no. 9, September 1994, pp. 1153-1155.
[3] $BW_e \approx$ 1-kHz.

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Specifications (Optical and Electrical):

Resonant Coil Material	Piezoelectric Ceramics (LZT)	
Fiber Type	Lucent Technologies, True Wave™	
Modulation Signal	Sine Wave	
Modulation Rate (RCPS-600/B)	≈ 650 to 690 / 105 to 900	kHz
Modulation Voltage[4]	< 10	V_{P-P}
Insertion-Loss (including connectors)	< 1.25	dB
Minimum DOP[3]	< 2 (typical)	%
Electrical Input Impedance	50	Ω
Electrical Input Connector	BNC	Amp
Optical Input Connector	FC/PC or FC/APC	Molex

Electrical Power:

Voltage	100 / 120 / 230 / 240 ± 10 %	VAC
Frequency	50 / 60	Hz
Power Receptacle	C13	

Physical Dimensions:

Length	25.1 (9.9) / 27.3 (10.75)	cm (in.)
Width	19.0 (7.5)	cm (in.)
Height	7.1 (2.8)	cm (in.)

[4] @ 600-kHz.

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Application:

In addition to its use in test-sets, the diagram in Figure 1, shows another application where the RCPS-600/B can be used. The laser on the left can be assumed to be a semiconductor laser whose output light is highly polarized and reasonably close to a single wavelength. This is the signal that's to be scrambled.

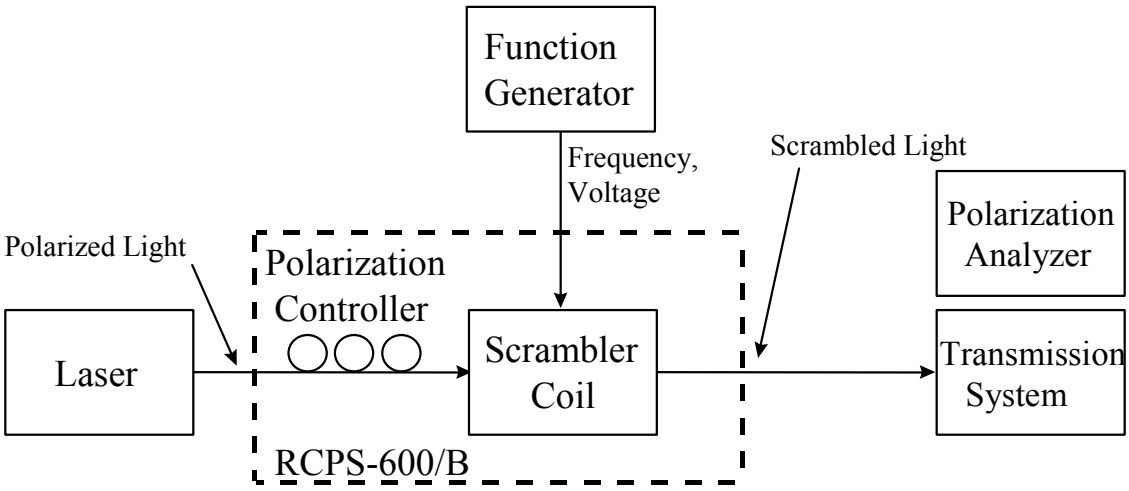

Figure 1: Equipment used for initial testing and setup of RCPS-600/B.

The function generator (FG) connects to the RCPS-600/B via a standard BNC bulkhead connector. The FG must be capable of providing 10 volts (peak-to-peak) into 50-Ω at a frequency of up to 1 MHz (e.g., HP-3245A or HP-33120A). For the RCPS-600, set up the FG's frequency between 650-kHz and 700-kHz.

Direct the output of the RCPS-600/B to the polarization analyzer (PA). Adjust the RCPS-600/B's PC for minimum degree-of-polarization (DOP). Continue to fine-tune the input modulation voltage and the input SOP to obtain low DOPs. This PC controls the SOP of the initial light and is adjusted relative to the two stress-induced birefringence axes.

The light from the laser propagating in the transmission system is now scrambled. Replace the PA with the transmission system.

The electrical response of the ceramic PZT contains anti-resonances at which the impedance of the tube rises steeply, thereby, exceeding the internal amplifier's capability at certain frequencies. This requires the modulation frequency to be slightly altered.