

***USER MANUAL
and
PROGRAMMING GUIDE***

FiberControl

**Polarization-Independent
Polarization State Scrambler
PS-700**



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Assistance and Maintenance:

Calibration, service, and maintenance agreements for the PS-700 are available from FiberControl. Assistance for proper product usage is also available.

Feel free to contact FiberControl via phone, fax, and/or email for assistance.



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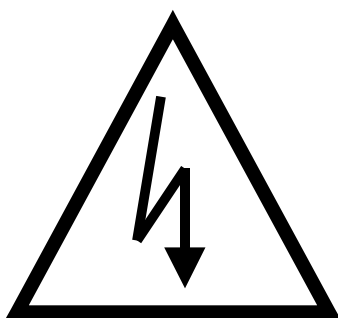
Hazard and Warning Labels/Symbols:

The following symbols have been placed at various points on the PS-700. To ensure personal safety of users and those around them, the user must be familiar with their meaning before operating the unit.

Assistance is available from FiberControl – see §**Assistance and Maintenance**, and §**Warranty and Restrictions**.

These symbols signify posted warnings where extreme caution is required, therefore, it is not recommended to proceed past them into the enclosure. These symbols do not imply that FiberControl recommends the user to proceed inside the enclosure but instead that if the user does choose to proceed, it must be with great caution. Moreover, entry into the enclosure not only incurs the risk of physical harm, but also nullifies the PS-700's warranty.

Placed on the back of the PS-700 is the following "Caution High Voltage" symbol. This symbol, shown as a lightning bolt inside an equilateral triangle, warns of the presence of "life-threatening" voltages inside of the enclosure if entered by the user.



"Caution High Voltage" symbol

On the inside of the PS-700, the locations of these "life-threatening" voltages are not specifically marked. Therefore, significant and meaningful personal physical risk is present for anyone not completely familiar with the PS-700's design. The level of risk also holds true for the measurement and test equipment of the user.



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The “Caution” symbol, shown below as the exclamation point inside a equilateral triangle, is also on the back of the PS-700 denoting the requirement of extreme caution if the enclosure is entered into or if the exterior is cleaned with liquids.



"Caution" symbol

Again, assistance is available from FiberControl – please refer to §**Assistance and Maintenance**, and §**Warranty and Restrictions**.

To insure the personal / physical safety of the operator, it is recommended that the top and / or bottom covers of the PS-700 should never be removed at any time.

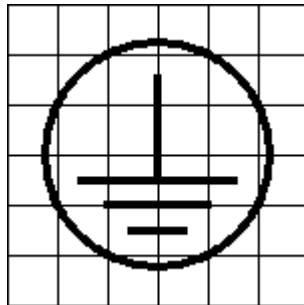
The PS-700 is only to be cleaned with a lightly damp cloth, regardless of the precautions and care undertaken by the user doing the cleaning.



Ground Label/Symbol:

Located on the inside of the PS-700, near the power supply, is the symbol for the "Protective Earth," shown below. This ground symbol is placed next to the green/yellow striped ground wire that attaches near the power supply on the side of the enclosure and the ground connection on the power entry module.

Consistent with CE marking requirements, this procedure ensures that all metal portions of the enclosure are properly grounded.



"Protective Earth" symbol

Despite the grounding design and procedure, the outside enclosure of the PS-700 is only to be cleaned with a lightly damp cloth, regardless of the precautions and care undertaken by the user doing the cleaning,



High-Level View of this User Guide:

The FiberControl PS-700's *User Manual and Programming Guide* is organized as follows:

Section 1	<i>Setup and Preparation</i>
Section 2	<i>Specifications and General Information</i>
Section 3	<i>General Concepts and Applications</i>
Section 4	<i>Front and Rear-Panel Description</i>
Section 5	<i>Remote Operation: The PS-700 Command Set</i>
Appendix A	<i>Key Operations, Quick Reference</i>



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1 Setup and Preparation

1.1 Tabletop Unit

The PS-700 was designed primarily as a tabletop unit. Four small rubber pads have been placed at the corners on the underside providing anti-skid protection and to protect the table's surface.

While the placement of these rubber pads was chosen for upright positioning on a lab-bench, the PS-700 can be oriented in any desired direction, i.e., upside down or on any of its sides, with the only caveat being the equipment's secure placement to ensure the safety of the end-user as well as others.

Plug the appropriate end of the provided power cord into the PS-700's IEC-320 receptacle and the other end into a properly grounded electrical outlet. Press the power rocker switch, located on the back panel, to the 'I' position to turn-on the power to the unit.

With the unit secured in place, the optical fibers can be attached. See §4.2.2.



1.2 Rack Mounting the Tabletop Unit

While the PS-700 polarization scrambler has been designed primarily for the tabletop, it can also be rack mounted. This section discusses details about the mounting brackets.

The rack-mounting hardware for the PS-700 consists of two brackets attached on each side near the front panel and is provided standard from the factory. Each rack-mounting bracket is attached by a pair of #10-32 by 3/8" stainless steel flat-head screws. These two mounting brackets can be easily removed using a #2 Phillips head screwdriver.

Below in Figure 1 is shown the top-down view of the unattached rack-mounting bracket and hardware (i.e., #10 flat head screws).

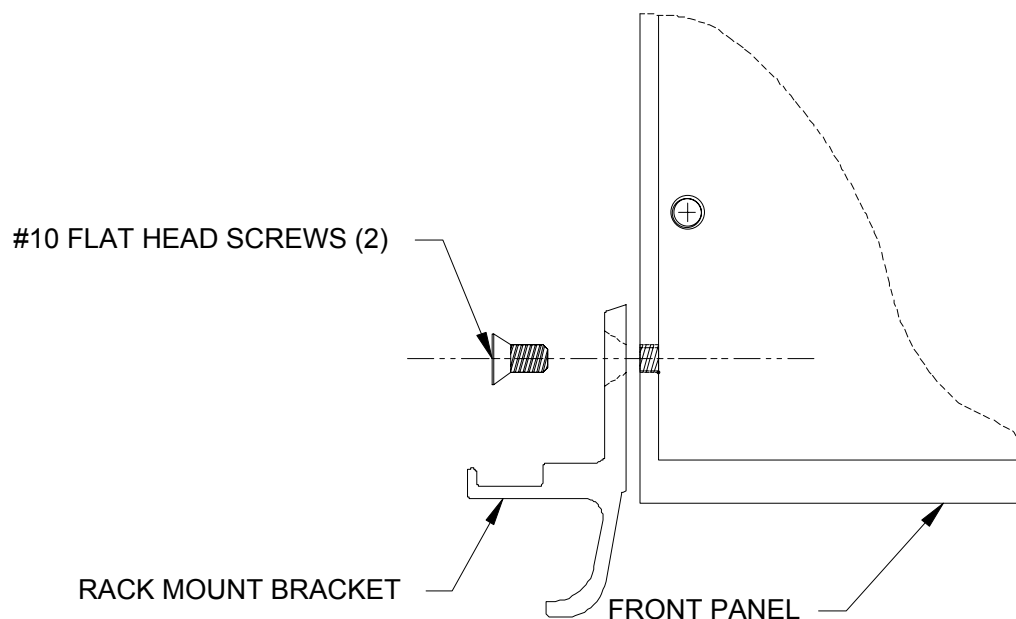


Figure 1: One of the two (left-hand side) rack-mounting brackets for the PS-700.



As shown in Figure 1, these two rack-mounting brackets are attached towards the front panel on the left and right-hand sides with #10 flat head screws.

Figure 2 and Figure 3 show the front-on and top-down views, respectively, of the PS-700 with the rack mounting brackets unattached and partially attached, respectively. The PS-700 arrives from the factory with rack-mounting brackets already attached; on delivery, the PS-700 is ready for mounting to an industry standard 19" equipment rack rails.

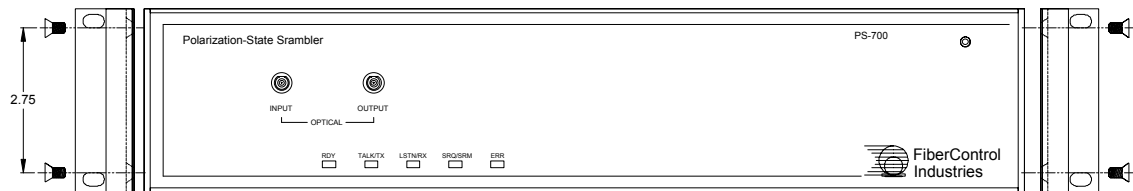


Figure 2: Front-on view detailing dimensions of the rack-mount capability of the PS-700.

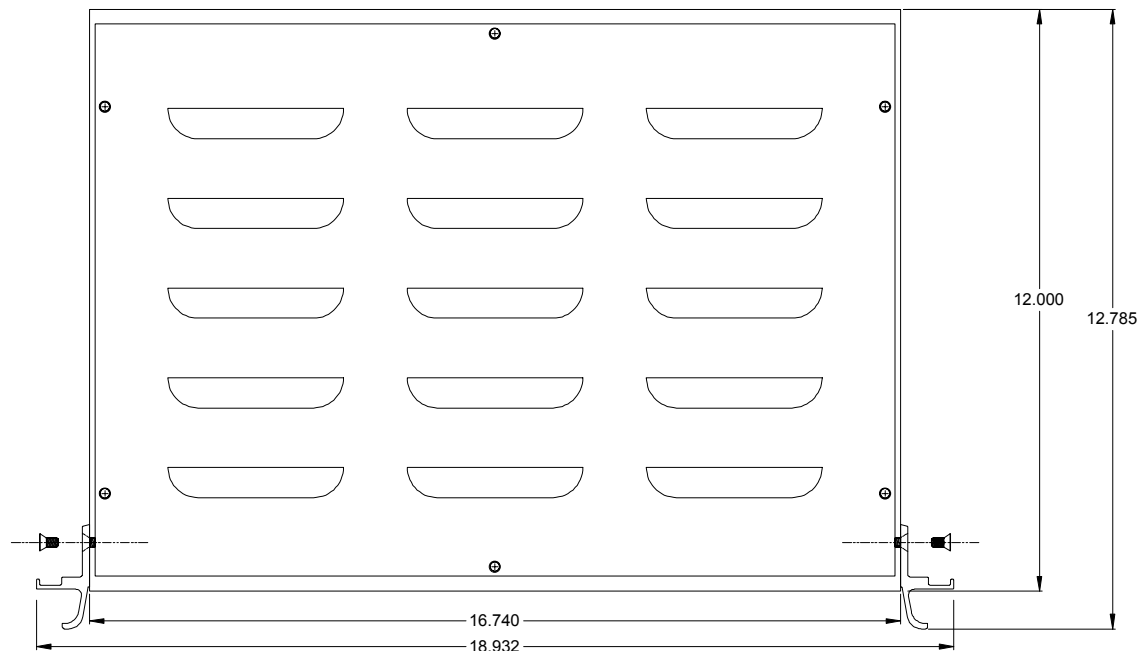


Figure 3: Top-down view of the partially assembled rack-mounting brackets.



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2 Specifications and General Information

Table 1: Optical specifications

Optical Specifications	
Insertion-Loss (typical) ¹	< 1.00 dB
Coverage of Poincaré Sphere	90% to 99% (near pseudo-random)
Degree-of-Polarization	< 5%
Polarization Dependent Loss ²	< ± 0.002 dB
Wavelength Operating Range	1300 nm to 1600 nm, or 980 nm region
Connector Types	FC, SC, or Bare Fiber
Return Loss (Connector polish)	> 50 dB (0°) > 60 dB (8°, fusion splice)
Max. Signal Power ³	+ 30 dBm
Scrambling Rate ⁴	4 MHz
Residual AM Modulation	< 0.1%

¹ 1550 nm with connectors

² 1550 nm, FC/PC connectors

³ Below SRS limit (SBS limit determined by the spectral broadening of user's source)

⁴ Measured at the -10dB point from near uniform electrical rf spectral distribution



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Table 2: Instrumentation control

INSTRUMENTATION CONTROL[‡]	
Parallel Control Interface	GPIB (IEEE 488.2), 1 port
Response Time [†]	≤ 5 msec
Software Compatibility w/ GUI interface	Labview 6.0, or any other GPIB capable development environment
System Controller	Embedded EBX w/ microcontroller, ICS Elect., Model 4864
GPIB Controller / Processor	National Instruments / μ PD7210
Make/Break Contacts	Six independent high-current relays
Host Operating Systems	Windows 95, Windows 98, Win NT 4.0, Win2000 Pro, Windows XP
Front Panel Control Interface	
Display	None
LED Indicators	
RDY	Yes
TALK	Yes
LSTN	Yes
SRQ	Yes
ERR	Yes

[‡] – refer to ICS Elect. Owner's manual

[†] – following GPIB standard (IEEE-488.2)



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Table 3: Line power and temperature

LINE POWER / TEMPERATURE	
Electrical Input Voltage	85 VAC – 264 VAC, auto-switching
Line Frequency	47 – 63 Hz
Power Dissipation (nominal)	45 W
Fusing Requirements	1 Amp
Power Receptacle	IEC 320
Power Supply Efficiency (nominal)	82 %
Operating Temperature	– 10 °C to + 35 °C

Table 4: Physical characteristics of the PS-700

PHYSICAL				
	Overall H x W x D (Metric)	Overall H x W x D (English)	Enclosure Height	Enclosure Width
Dimensions	9.2 x 48.1 x 32.5 cm	3 ⁵ / ₈ x 18.9 x 12.8 "	2U	83.7HP
Weight	34.6 N (3.53 kg)	7.79 lbs.		

Note:

- Overall heights (H) of desktop units include the presence of skid-resistant rubber pads located on the bottom panel, 0.32 cm (1/8 ") thick.
- Overall widths (W) of rack-mount units include mounting hardware.
- Enclosure height and width are related to the enclosure only – does not include the rack-mounting hardware or skid-resistant rubber pads.
- 1U = 4.44 cm (1 3/4 ")
- 1HP = 0.51 cm (0.2 ")


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**Declaration of Conformity
Declaration de Conformité
Konformitätserklärung**

**FiberControl
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Holmdel, New Jersey 07733
U.S.A.**

declares under its own responsibility, that the product:

Polarization-Independent Polarization-State Scrambler, PS-700

conforms to the following product Directives and Standards:

Safety:

73/23/EEC, 1973	Low Voltage Directive
93/68/EEC, 1993	Including amendments to above LV Directive
EN 60950: 1992	Standard, including amendments 1, 2, 3, 4, and 11

EMC:

89/336/EEC	EMC Directive
EN 50081-1, 1992	Standard, Electromagnetic Compatibility – emissions
EN 55022, 1998	Standard – Radio disturb., information technology equipment
EN 61000-3-2, 1995	Standard – Harmonic current emissions
EN 61000-3-3, 1995	Standard – Voltage fluctuation and flicker emissions
EN 50082-1, 1997	Standard, Electromagnetic Compatibility – immunity
EN 61000-4-2, 1995	Standard – Electrostatic discharge immunity
EN 61000-4-3, 1995	Standard – Radiated, r-f, e-m field immunity
EN 61000-4-4, 1995	Standard – Electrical fast transient/burst immunity
EN 61000-4-5, 1995	Standard – Surge immunity
EN 61000-4-6, 1995	Standard – Conducted immunity
EN 61000-4-11, 1995	Standard – Voltage dips and interruptions immunity

Supplementary Information:

Since this product conforms to the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC, the PS-700 carries the CE marking.

Declaration of Conformity originally conducted by F-Squared Laboratories, Damascus, MD 20872 (Report #2227-01, Issue Date: 12-21-2000). Subsequently, switcher replaced Power-One linear power supply.

Holmdel, New Jersey, USA 20, February 2002

J. D. Evankow, Jr. / MTS



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3 General Concepts and Applications

3.1 Introduction

This manual describes the operation and specifications of FiberControl's Polarization-Independent Polarization State Scrambler, PS-700.

The PS-700 rapidly alters the state-of-polarization (SOP) of light within single-mode optical fibers in a pseudo-random manner. It provides a simple user-friendly front panel interface for direct interaction, as well as remote computer control via GPIB 488.2. Moderately rapid short-term variations of output SOPs is inherent in this technique. The PS-700 is capable of altering the SOP over a wide range of wavelengths while minimally impacting the other optical parameters:

- Ultra-low insertion loss,
- Ultra-low reflection, and
- Ultra-low PDL.

Based on techniques originally developed by Hervé C. Lefèvre at Stanford University¹, the PS-700 utilizes time-varying stress-induced birefringence to alter the SOP of the polarized components of light.

With one continuous length of optical fiber secured onto six independent piezoelectric tubes, each receiving an r.f. drive voltage via a novel patented method², a time-varying birefringence is imparted into the fiber. Multiple sections of the fiber receive spatially distributed sets of stress. These provide polarization independent operation. In other words, the scrambler's capability to provide a fast and near uniform distribution of output Stokes' vectors does not depend of the input SOP.

Alternative SOPs appearing at the input of the PS-700 result only in altering the scrambling path and continues to provide near uniform, but different, coverage of Stokes' 3-space (e.g., the Poincaré sphere).

¹ USPTO #4,389,090

² USPTO #20020037127



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3.2 Applications

Many applications exist for the PS-700, a few examples are:

- PDL system and component measurements,
- Moderate/High-speed polarization scrambler,
- As a component in a PMD emulator or compensator,
- Semiconductor optical amplifiers measurements, and
- General use throughout the laboratory.

3.3 Representations of the rapidly scrambled SOPs

The control and manipulation of the SOP is fundamental within the field of optics. At the PS-700's output, a scrambled SOP is provided. For those involved in fiber-optic research, development, and manufacturing, utilizing these rapid variations in SOP is at the heart of many applications.

The displayed image of Figure 4 shows an example of scrambled experimental data. Two representations of the Stokes parameters are plotted in 3-space (i.e., Poincaré Sphere and the Observable Polarization Sphere – both of which are equivalent from the standpoint of representing the data). The Poincaré representation is quite common. For both spheres, the data points plotted in red corresponds to front surface of the sphere; blue the back surface.



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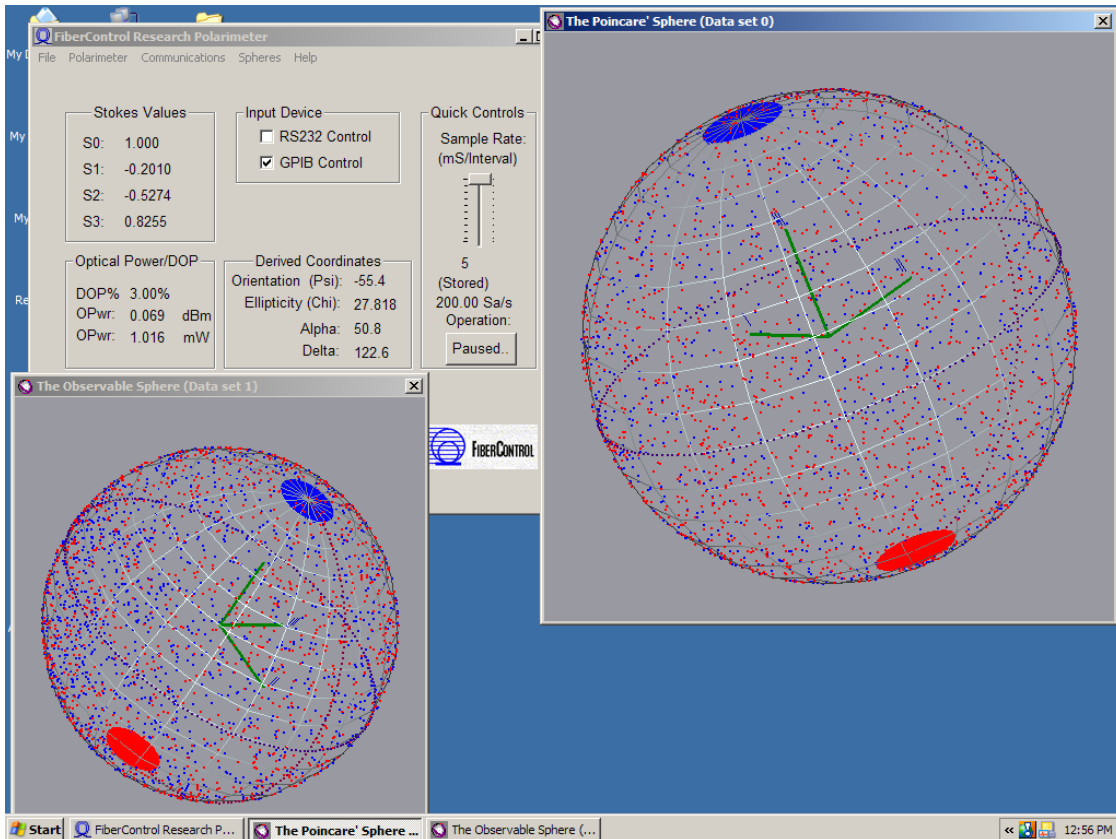


Figure 4: Experimental data of the scrambled output displayed as a polarimetric plot on the Poincaré Sphere and on the Observable Polarization Sphere.

An important scrambling figure-of-merit is the near-uniform distribution of the SOPs in Stokes' 3-space. Figure 4 shows the distribution of SOPs from the PS-700 that was obtained in fewer than 5 seconds. It's important to mention that most commercial polarimeters are not well suited for measurements at MHz scrambling rates since only a small portion of the originally generated independent SOPs is ever collected and displayed. This is especially true in this case where sampling was limited by a third-party polarimeter (2 ks/sec) and IEEE-488.2 GPIB interface (<600 ks/s).

For this reason, alternative measurement techniques were developed to better test and represent the nature of high-speed polarization scramblers, i.e., r.f.-based. Figure 5 is a typical set of plots showing the r.f.-spectral response viewed after an in-line polarizer that follows a PS-700: scrambling on (top curve) and off (lower curve).



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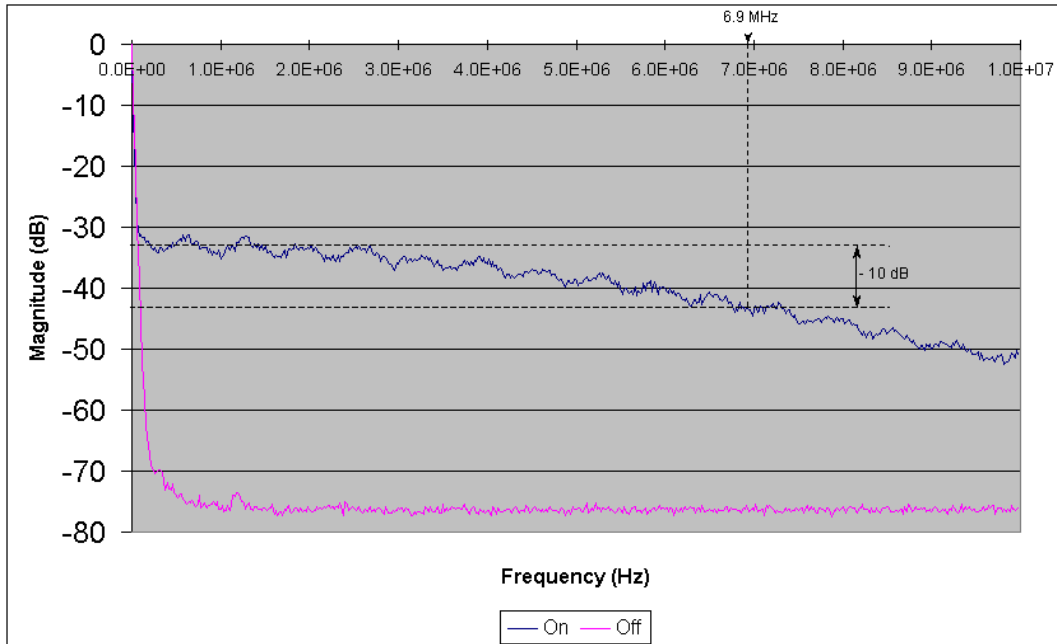


Figure 5: Experimental data showing the distribution of the frequency components of the scrambling with the scrambler on and off.

The curves show frequency-dependent intensity variations at the polarizer's output that correspond to rapid changes in the SOP resulting from the PS-700. The lower curve (scrambling off) shows that, aside from a very small peak near 1.25 MHz, the source laser is stable and well behaved.

This r.f.-spectral behavior is significantly different from other commercially available polarization-state scramblers which produce only one or two well defined peaks. Section 3.5 discusses in greater detail the inner working of the PS-700.

3.4 Design Background

Light emanating from many types of lasers is highly polarized and has a relatively constant state-of-polarization (SOP). The term SOP is a well-known defining metric which describes a relative position of electric fields that make up light and which remains unaltered unless encountering birefringence. Since there are many situations/applications where highly polarized light with a constant SOP is



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undesirable, optical scrambling was developed. Optical polarization scrambling effectively changes the SOP of light over time.

Techniques were developed that ostensibly produced polarization-dependent optical polarization scrambling utilizing a single-mode optical fiber that was wrapped around a single cylindrical piezoelectric tube (PZT) where the tube was then activated with an R.F. electrical signal.

In practice, effective optical scrambling could only be achieved if the drive frequency and drive voltage supplied to the PZT were precisely adjusted and controlled. A major drawback of this conventional technique is that an input SOP had to be maintained at a particular SOP in order to achieve effective random scrambling; therefore, this technique was actually polarization dependent. Adjusting the electrical drive voltage and frequency was problematic but having to control and maintain the input SOP was even more so and thus highly undesirable. Hence, this technique proved unworkable in practice.

Consequently, the PS-700 polarization scrambler was developed to provide optical scrambling that does not require the input SOP to be at any particular value.

3.5 Principle of Operation

Advantageously, the PS-700 overcomes the deficiencies associated with the conventional technique of providing optical polarization scrambling.

Polarization independence is achieved by wrapping a single optical fiber, under proper tension, around each tube in a cascade of separate piezoelectric tubes (PZTs), with random amounts of fixed birefringence separating each tube, where each tube is then separately excited on a time-varying basis. Geometrical, physical displacement of each tube, resulting from its excitation, imparts a time-varying birefringence to a portion of the fiber wound around that particular tube. This time-varying birefringence perturbs an initial SOP of the light from its original pseudo-stationary position on a Poincaré sphere.



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Specifically, an optical signal, upon entering the scrambler, passes through a fiber that is wound around each successive tube – grouped into two groups of three PZTs. Each of these sets of tubes is operated in a similar fashion and is excited by a two separate types of specially modulated radio-frequency (RF) electrical drive signal.

These two sets of signals when applied to each group of the PZTs, cause the tubes to exhibit a specific behavior vis-à-vis its geometric physical displacement, i.e. the tubes slightly expand and contract physically, in response to the signals. These time-varying displacements, which effectively stress the fiber wound around the tubes, induces time-varying birefringence in the fiber. This time-varying birefringence produced by each tube perturbs the initial SOP from its original pseudo-stationary position on the Poincaré sphere.

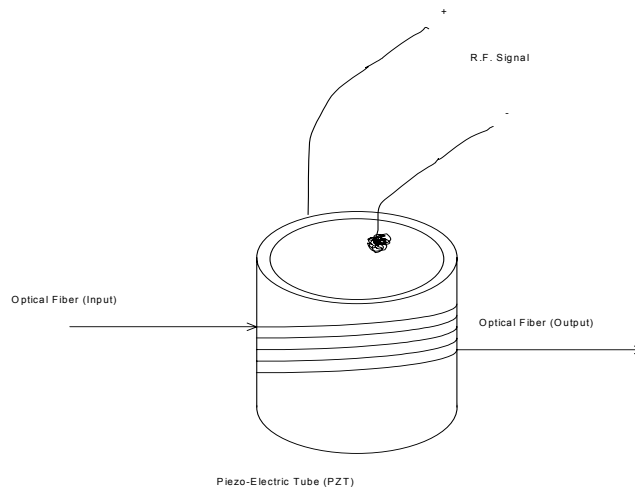


Figure 6: Basic piezo-electric (PZT) tube shown with fiber wrapping.

Figure 6 shows the basic building block of the polarization scrambler. It consists of a piezo-electric ceramic tube wrapped with a length of single-mode optical fiber. The fiber is wrapped in a special manner and secured against the outside wall of the tube to insure proper operation during the application of the r.f. electrical signal.

Figure 7 below shows the cross-sectional cut-away view of the fiber wrapped PZT tube. Also illustrated, is the mechanical displacement of the tube that results from the r.f.-electrical signal.



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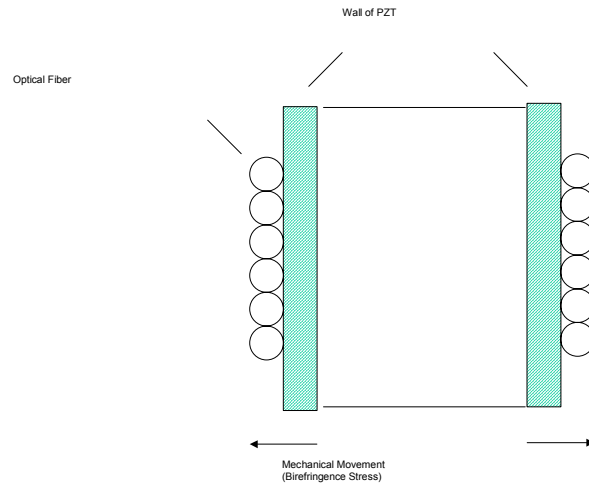


Figure 7: Cross sectional view of PZT tube with fiber wrapping.

Small mechanical movement, on the scale of microns, stresses the fiber thus causing birefringence within the fiber. Figure 8 shows the cross-sectional view of the fiber with the resulting internal stresses generating the birefringence. Also shown in Figure 8 is the angular orientation of linear electric field corresponding to the ideal interaction for scrambling.

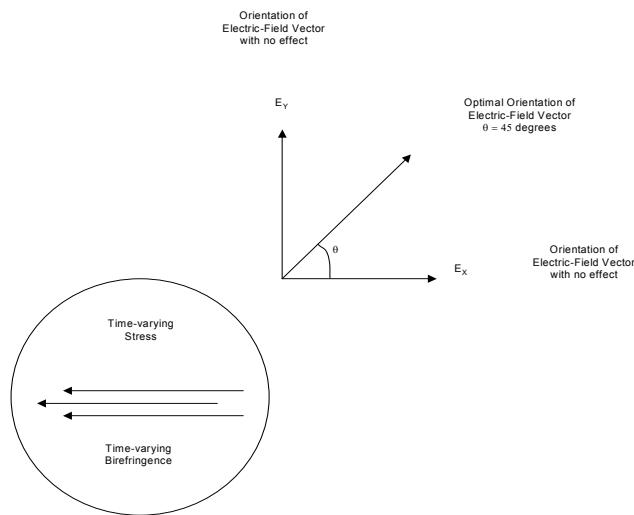


Figure 8: Details of stress induced birefringence in the fiber.



In general, the two orthogonal SOPs, shown in Figure 8 as E_x and E_y , produce a minimum interaction between linear input SOPs and the time-varying birefringence. The maximum interaction occurs when the linear input SOP is orientated 45 degrees relative to these minimums.

This time-varying birefringence enables scrambling provided the input SOP is properly aligned. It is important to note that while there is two well defined SOPs corresponding to optimal scrambling there also exists *only* two well-defined states where the converse is true (i.e., where extremely poor scrambling occurs). Understanding and making use of this detail is the basis of the polarization-independent polarization scrambler.

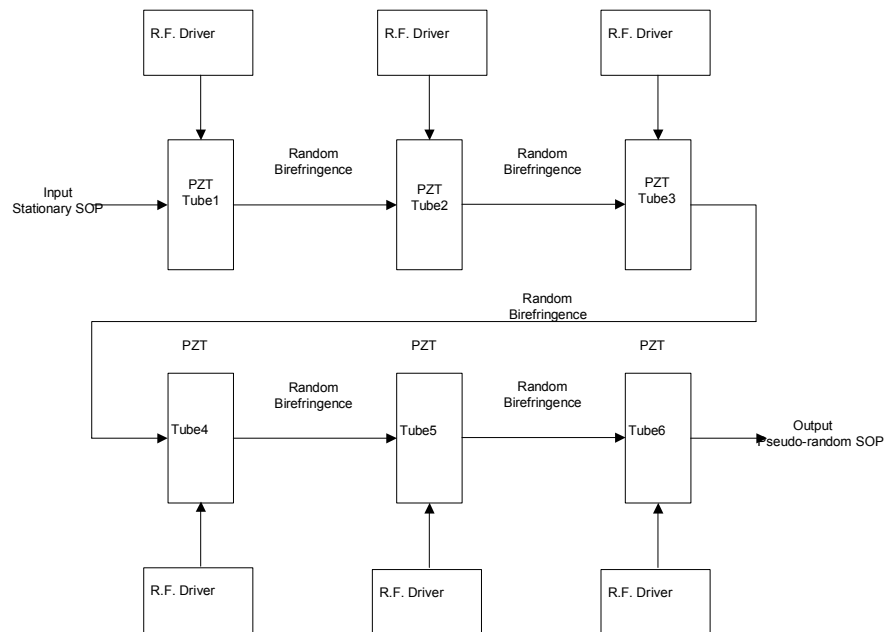


Figure 9: Block diagram showing the basic internal structure.

Shown in Figure 9 is a basic block diagram of the internal structure of the PS-700. Each PZT tube is shown in a cascade of six tubes, each with its own r.f. signal from a unique drive circuit. The separate r.f. drives provide independent modulation to each tube.



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Since there are only two well-defined SOPs where scrambling does not occur, the multiple set of tubes, with random birefringence separating each, provide opportunity for the following PZT tube to scramble those states that were ineffective in the previous.

Referring back to Figure 5, the top curve is a typical example measurement describing the behavior of the r.f. frequency components seen on a spectrum analyzer. As mentioned earlier, it represents the variation of the linear Stokes parameters at the output of the PS-700.

Other third-party scramblers produce one or two narrow peaks centered at the resonant frequency of the tube(s) (e.g., centered at 1 MHz), which is related to a simple well-defined cyclical movement about the Poincaré sphere. Their behavior has been referred to as operating in a “deterministic” manner where their single resonant behavior is a byproduct of the predictable rate that the polarization state moves around the Poincaré Sphere. By contrast, the PS-700 has an almost “white-noise” quality indicating a near pseudo-random movement in Stokes space and is a direct result of multiple independently driven PZT tubes and unique AM-FM modulation technique (refer to patent at <http://www.uspto.gov> for additional information).

Please note: to minimize the danger to the end-user, the loaded internal drive voltage to each of the PZT tubes was designed to operate well below 20 V_{p-p} and open-circuit drive voltages are less than 40 V_{p-p} .



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4 Front and Rear-Panel Description

4.1 General

The PS-700 Polarization Controller provides high-performance polarization scrambling, together with an easy-to-use interface. The front and rear-panel interfaces enable the user to perform all operations.

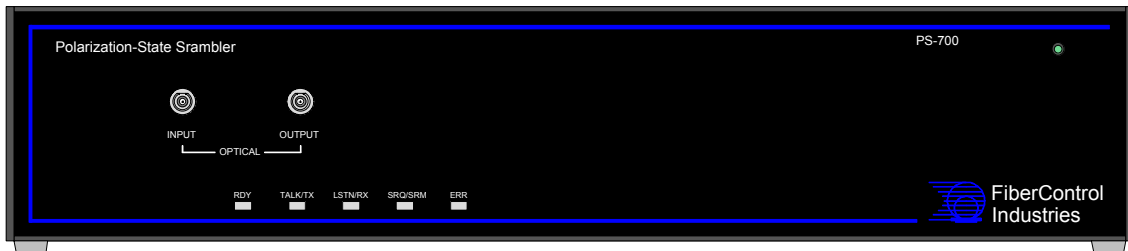


Figure 10: Front view of PS-700.

The rear-panel provides the easy access for connecting line-power (via IEC-320) and control cabling (i.e., GPIB IEEE 488.2). Next to the GPIB connector is a dipswitch that can be used to set the address. Also on the rear-panel is the on-off rocker switch, exhaust for the cooling fan, and warning labels / fusing information.

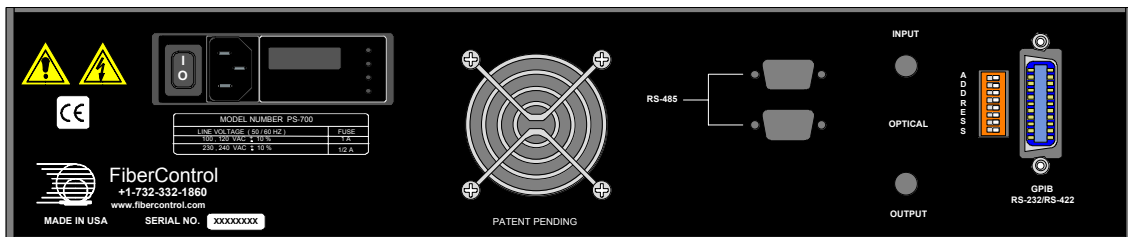


Figure 11: Rear view of PS-700.



Be certain that the vents on the top of the unit and the back fan are free of obstruction so that cooling air can properly circulate through the unit.

Please note:

Sections of text surrounded by boxes with 10% gray-level (*similar to this example*), periodically listed throughout the manual, are intended as concise summaries to aid the user. These summaries are grouped together in Appendix A.

4.2 Front-Panel Indicators, Rear-Panel Interface

4.2.1 General Usage, Powering-up and Powering-down

To power-up the PS-700, press the large dark-colored button in the upper left rear-panel marked above the power cord.

On the surface of the switch are two small labels to designate the operation of the powering (i.e., rocking the switch to the “1” corresponding to “powered on” and the rocking the button to the “0” position corresponding to “unpowered” (“0”). The oval in Figure 12 shows the location of the power switch, receptacle and fuse holder.

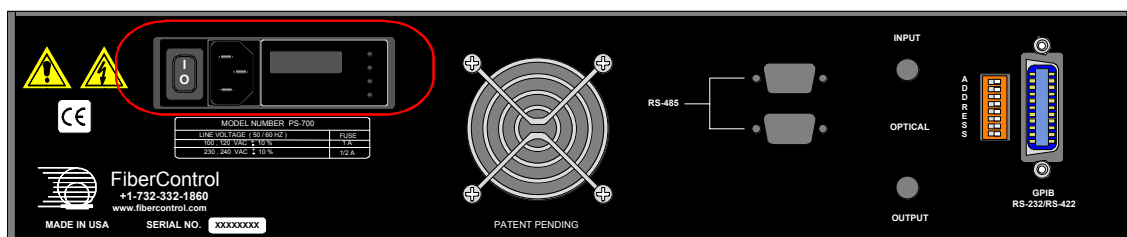


Figure 12: Rear panel depiction with an oval highlighting the location of the on-off power switch.



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With the rocker switch pressed to the “1” position, a green LED on the front panel will light indicating the unit is powered. See Figure 13.

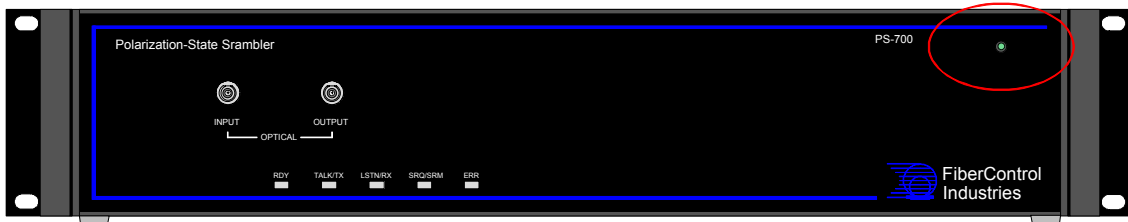


Figure 13: Depiction of front panel with an oval highlighting the location of the green LED that indicates the unit is powered up.

If the LED does not light, verify that the power cord is connected and/or that the line voltage is within the proper range (see PS-700 input power specifications in section 2).

To Power-up the PS-700:

Attach provided power cord by mating C13 plug to the PS-700’s IEC-320 receptacle, then insert plug end into line power, and push the rocker switch to the “1” position.

- Green LED on the front panel will light.
- LSTN/RX GPIB status LED flashes once (default).
- RDY GPIB status LED lights.
- Scrambler is now ready for operation.

The GPIB board within the PS-700, on power-up, runs through a self-test initialization process and momentarily blinks the LSTN/RX LED on the lower portion of the front panel. This momentary lighting of the LSTN/RX LED indicates that the GPIB address is set to 4. This is the default GPIB address – refer to



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section 4.2.3 for additional information. After the GPIB address is changed from its default setting, when the PS-700 goes through its initialization process at startup, a different LED or set of LEDs will light momentarily indicating the new GPIB address. Immediately following this, the left most LED (RDY) lights; the PS-700 is available for use. See Figure 14.

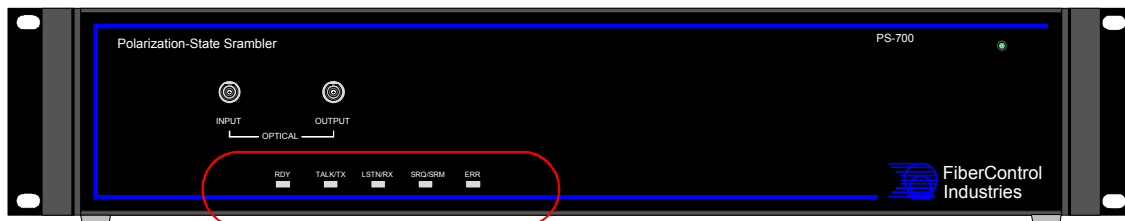


Figure 14: Front panel depiction with an oval to highlight the location of the GPIB status LEDs.

After the internal GPIB has run through its initialization process, the RDY LED will light (far left LED).

Powering down an energized PS-700 is a simple matter of rocking the switch to the “0” position. All LEDs on the PS-700, specifically those at the upper right-hand side of the front panel and associated with the GPIB will dim slowly over the course of a few seconds. If so desired, the power cord can now be removed from the back panel’s IEC-320 receptacle.

To Power-down the PS-700:

Press the rocker switch to the “0” position.

- The once lighted green LED will dim slowly over a few seconds until dark.
- The GPIB LEDs will dim slowly over a few seconds until dark.



4.2.2 Optical Interface

The highlighted oval in Figure 15 shows the location of the input and output optical connections for the PS-700. The unit is shipped with dust covers on the FC/UPC bulkhead adapters to keep dust and other contaminants away from the optical interface.

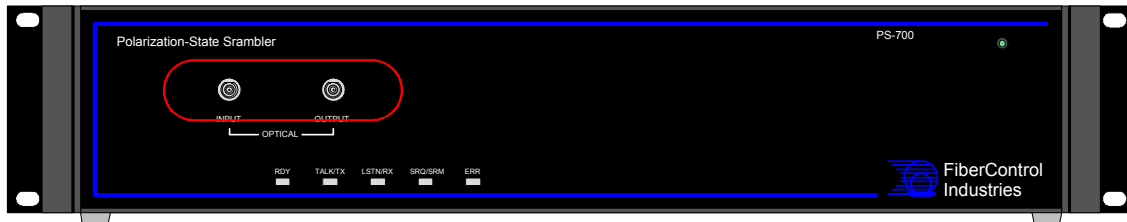


Figure 15: Depiction of PS-700's front panel with highlighted oval showing the locations of the optical input/output connectors.

Standard industry practice must be followed to insure that the connectors remain clean. Be sure to follow proper cleaning procedure for the connectors prior to inserting them into the bulkhead feedthrough (e.g., using an industry-standard cleaning tool, or compressed air to remove dust particles).

4.2.3 Remote Control and its Connections

Located on the rear panel is the GPIB connector and address switch. Following the GPIB standards, the GPIB cable can be attached as desired: directly to a controlling computer or in a festooned configuration.



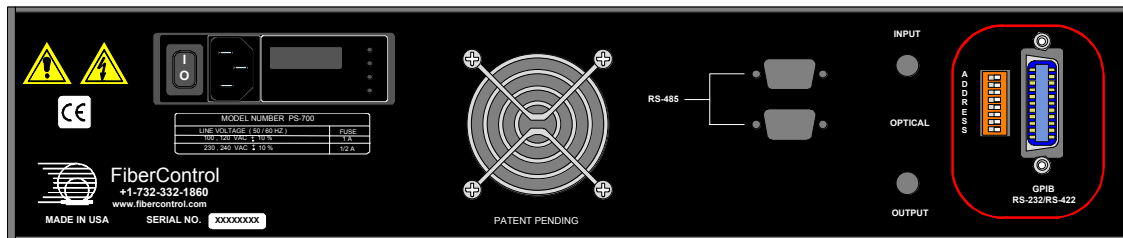


Figure 16: Rear panel depiction with an oval highlighting the location of the GPIB interface.

The usable address range is limited to the industry standard range of 0 and 30. It is not recommended that addresses 0, 7, or 21 be used for the PS-700 since industry standards customarily use these for GPIB bus controllers.

The PS-700 provides two different methods to set the GPIB address: configuring from other controllers and via the external dipswitch. The GPIB address set to 4. The default method has the external dipswitch disabled and therefore requires the GPIB address in the non-volatile flash memory to be set using another controller. Please note, as mentioned earlier, when the GPIB address is changed from its default setting, a different LED (or set of LEDs) in the highlighted portion of Figure 14 will light momentarily when the PS-700 is turned on.

To change the GPIB address to 20:

- **CALL ieOutput(4, "SYST:COM:GPIB:ADDR 20")**
- **msDelay 70**
- **CALL ieOutput(20, "SYST:COM:GPIB:ADDR?")**
- **Rdg\$== String\$(10, " ")**
- **CALL ieEnter(20, Rdg\$)**
- **PRINT Rdg\$**

Alternatively, setting the GPIB address via the external dipswitch is a four-step process. Since the switch inputs are low true signals with pullup resistors, the address signals (ADSW1 – ADSW5) are switched to ground following a binary format (i.e., the GPIB address is the sum of the binary weights of the grounded bits).

In addition, it is required that the external address switch be enable using the following SCPI command **SYST:COMM:GPIB:ADDR:EXT 1** via a personal computer in either the DOS or windows based the configuration programs



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supplied on the ICS Electronics CD (or others such as National Instruments niconf_w.exe).

Since the GPIB board reads the external address switch during the power up phase, the final steps are to save the configuration settings (***SAV 0**) and cycle the power to the PS-700 (from on to off, wait a few seconds, and back on).

For example, to set the address to 0:

- Set ADSW1 – ADSW5 to the off position
- **SYST:COMM:GPIB:ADDR:EXT 1** (in configuration program)
- ***SAV 0** (in configuration program)
- Cycle power to PS-700 to re-initialize GPIB card

Refer to the ICS Electronics instruction manual that shipped with the PS-700 for additional information: *MODEL 4864 GPIB Relay Interface MODEL 2364 Serial Relay Interface Instruction Manual*, Publication Number: 120144, October 2000 Edition Rev 3. ICS Electronics' web listing is <http://www.icselect.com>.

To change the GPIB address:

Address range is 0 to 30 (do not choose 0, 7, 21).

Method 1: (configuring from other controllers)

- Refer to ICS Elect. owner's manual, §2.7
- Default internal GPIB address is set to 4

Method 2: (activating and using external dipswitch)

- Refer to ICS Elect. owner's manual, §2.10.3
- Slide the dipswitch to desired address setting



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4.3 Rear-Panel Marking and Fusing Information

The rear-panel of the PS-700 provides the easy access for connecting line-power via the IEC-320 receptacle in the power entry module.

Also present on the overlay is a table showing the specifications and information on the fusing and line-voltage. Below, in Figure 17, is shown a likeness of the table on the label that appears directly underneath the power entry module on the back panel of the PS-700.

MODEL NUMBER: PS-700	
LINE VOLTAGE (47 – 63)Hz	FUSE
85 – 264 VAC	1 A

Figure 17: Line voltage and fusing information located on the rear-panel of the PS-700.

The line fuse is housed in right-hand side of the power-entry module, see oval highlighting this area in Figure 12. It is important to note that all power must be disconnected from the PS-700 prior to accessing the fuse-holder or fuse; the plug must be removed from the PS-700's IEC-320 receptacle. The fuse can be accessed by gently prying out the fuse-holder with a small slot-head screwdriver – a small rectangular void to the right of the power receptacle provides an aid for leverage during prying. A slow-blow, ¼" x 1 ¼", is placed under the plastic retaining strip of the fuse-holder. Only fuses from a reputable manufacturer with the proper voltage and current rating must be used.

Because the PS-700 was designed with an internal auto-switching power supply, a wide range of line voltages is acceptable (i.e., exceeding the nominal 100 VAC, 50 Hz to 240 VAC, 60 Hz range). This provides the opportunity for proper operation of the PS-700 even if the line voltage dips slightly during seasonal high demand periods.

The rear-panel also contains the warning labels – see **§Hazard and Warning Labels/Symbols**, for additional information. Read this section carefully.

A fan with integrated fan guard and serial number is also located on the rear-panel.



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5 Remote Operation: The PS-700 Command Set

5.1 General

An ICS Electronics Instruction Manual for Model 4864 GPIB control interface along with a CDROM is provided with FC's PS-700. This CDROM contains a software program that can be installed onto standalone IBM PC computers thus providing a platform for programming and control of the PS-700. In other situations, where the PS-700 is integrated into an existing GPIB programming environment, that existing IEEE-488.2 control environment can be used, so that the software on the CDROM does not need to be used due to its conformity to the IEEE-488.2 Standard.

The PS-700's GPIB accepts SCPI commands and command extensions to enable the scrambling to be turned on and off. This is accomplished by operating internal relays. The PS-700's SCPI commands conform to SCPI Standard 1994.0 and provide an industry standard, self-documenting form of code that makes it easy for the programmer to maintain.

Each command can be used as a query except where noted. The SCPI commands are *not* case sensitive. The portion of the command shown in capitals denotes the abbreviated form of the keyword. Either the abbreviated or whole keyword may be used when entering a complete command.

Optical polarization scrambling is controlled using the OPEN and CLOSE SCPI commands. It is important to note that ICS Electronics' standard product, and as such is outlined within their Instruction Manual, contains form A relays (normally open). FC replaced these with form B relays (normally closed) to reduce overall power consumption. Therefore, because the form B relays are normally closed at startup, the PS-700's default state is with scrambling enabled, see Table 6.

The IEEE 488.2 Standard mandated a list of common commands that are common to all IEEE 488.2 compatible devices. The ICS Electronics' Model 4864 within the PS-700 responds to these commands and to additional optional common commands defined in the IEEE-488.2 Standard. Within the ICS'



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Instruction Manual, Table 3-1 lists the respond to these commands and describes their effect and its status reporting structure.

The PS-700's GPIB accepts SCPI commands and command extensions to operate relays that determine the status of optical polarization scrambling. The 4864's SCPI commands conform to SCPI Standard 1994.0 and provide an industry standard, self-documenting form of code that makes it easy for the programmer to maintain. Table 2 shows the SCPI command tree.

Keyword	Parameter Form	Notes & Single Letter Commands
ROUTE :CLOSE :OPEN :ALL	channel list channel list	Relay Control Cn On A

Table 5: SCPI command tree of PS-700 with ICS Electronics Model 4864.

Note: The format for a SCPI channel list is (@1,2,n) or (@1:n)

The relays are listed in the SCPI channel list format. The channel list format is (@space 1,2,3,n) or (@space 1:n). Examples are: (@1,2) or (@1:4). The space between the @and the first number is required. In the examples, (@1,2,...n) means a list of items up to n characters long.

SCPI COMMAND	Relay Energized?	Relay Status	Optical Scrambling Status
OPEN	No	Closed	Enabled
CLOSE	Yes	Open	Disabled

Table 6: PS-700 Scrambling Control (with Form B relays).



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The following are provided as equivalent examples to *disable* optical scrambling:

ROUTe:CLOSe (@ 1:7)

ROUTe:CLOSe (@ 1,2,3,4,5,6,7)

The following is provided as an example to *enable* optical scrambling:

ROUTe:OPEN:ALL

Refer to Appendix A-1 of the ICS Electronics' Instruction Manual for more information about SCPI commands and on how to concatenate multiple commands on the same line.



Appendix A: Key Operations, Quick Reference

To Power-up the PS-700:

Attach provided power cord by mating C13 plug to the PS-700's IEC-320 receptacle, then insert plug end into line power, and push the rocker switch to the "1" position.

- Green LED on the front panel will light.
- LSTN/RX GPIB status LED flashes once.
- RDY GPIB status LED lights.
- Scrambler is now ready for operation.

To Power-down the PS-700:

Press the rocker switch to the "0" position.

- The once lighted green LED will dim slowly over a few seconds until dark.
- The GPIB LEDs will dim slowly over a few seconds until dark.

To change the GPIB address:

Address range is 0 to 30 (do not choose 0, 7, 21).

Method 1: (configuring from other controllers)

- Refer to ICS Elect. owner's manual, §2.7
- Default internal GPIB address is set to 4

Method 2: (activating and using external dipswitch)

- Refer to ICS Elect. owner's manual, §2.10.3
- Slide the dipswitch to desired address setting

