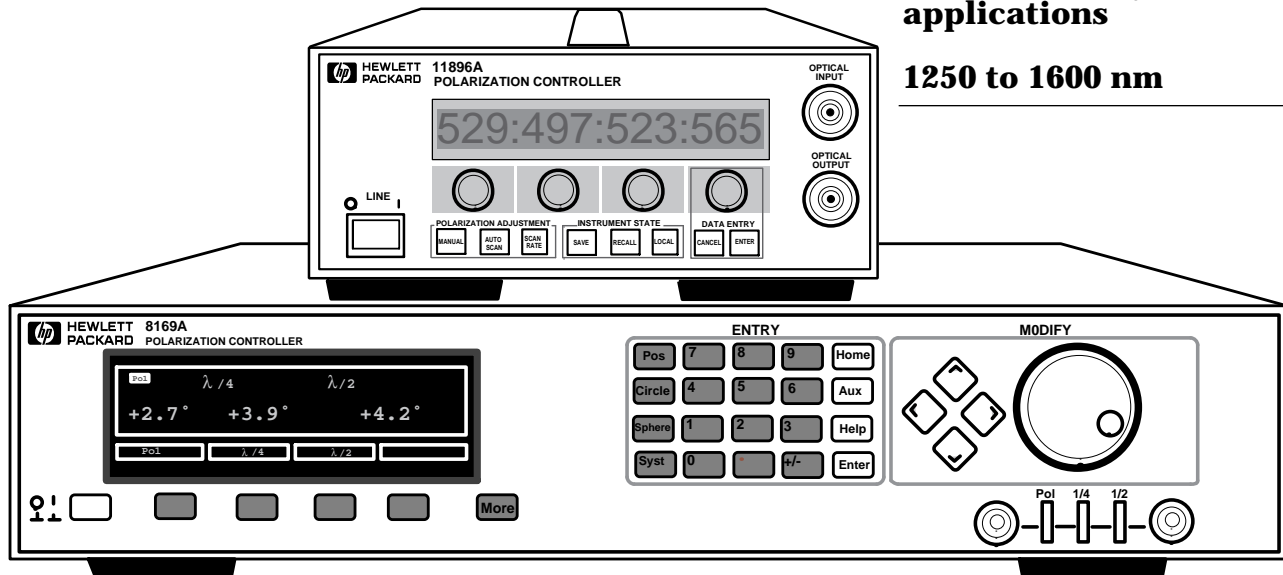


# HP 11896A and HP 8169A Polarization Controllers

## Technical Specifications

**Automatic polarization state adjustments for polarization-dependent loss measurements and polarization synthesis applications**

**1250 to 1600 nm**



### Introduction

Developing and manufacturing competitive, high-value components and systems for today's optical industries require precise attention to polarization sensitivity. The HP 11896A and 8169A Polarization Controllers can help by saving time, money and effort when measuring and working with polarization sensitive devices.

Polarization sensitive devices include EDFAs, single-mode fiber, polarization maintaining fiber, isolators, switches, lasers, couplers, modulators, interferometers, retardation plates and polarizers. Device performance will be affected by polarization-dependent efficiency, loss, gain and polarization mode dispersion.

These polarization phenomena enhance or degrade performance depending on the application area, be it communications, sensors, optical computing or material analysis.

### An Important Part of a Measurement System

A polarization controller is an important building block of an optical test system because it enables the creation of all possible states of polarization. The polarized signal stimulates the test device while the

measurement system receiver monitors the test device's responses to changing polarization. Sometimes polarization must be adjusted without changing the optical power. At other times, polarization must be precisely synthesized to one state of polarization (SOP) and then adjusted to another SOP according to a predetermined path. Each of these needs are met separately using the HP 11896A or 8169A Polarization Controllers (refer to Table 1.0 for application details).

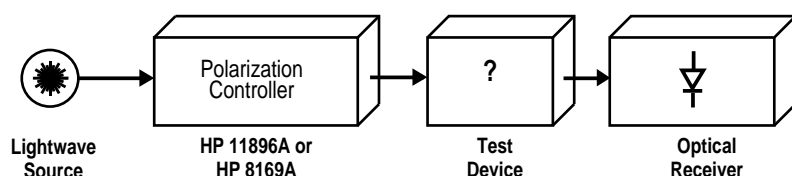


Figure 1. Conceptual block diagram of polarization controller applications.

## Two Types of Polarization Controllers...

### The HP 11896A Polarization Controllers

The HP 11896A adjusts polarization and not power. It's optical fiber loop design provides all states of polarization with extremely small optical insertion-loss variations ( $\pm 0.002$  dB) over a wide spectral range (1250 to 1600nm.) This performance combination maximizes measurement accuracy for power sensitive applications, such as polarization-dependent loss and gain, because the measurement uncertainty contributed by the polarization controller is minimized.

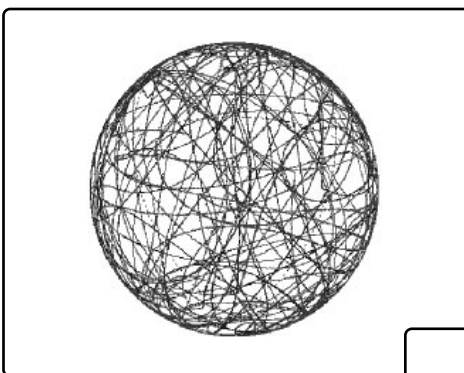
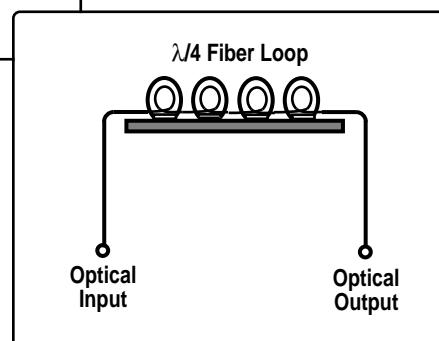


Figure 3. HP 11896A Block Diagram

Figure 2. The HP 11896A produces all states of polarization and covers the entire Poincare sphere<sup>1</sup> in a pseudo-random manner.



### The HP 8169A Polarization Controller

The HP 8169A provides polarization synthesis relative to a built-in linear polarizer. The quarter-wave plate and half-wave plate are individually adjusted to create all possible states of polarization. Predeterministic algorithms within the HP 8169A enable the transition path from one state of polarization on the Poincare sphere to another to be specified along orthogonal great circles. These features are important because device response data can be correlated to specific states of polarization input to the test device.

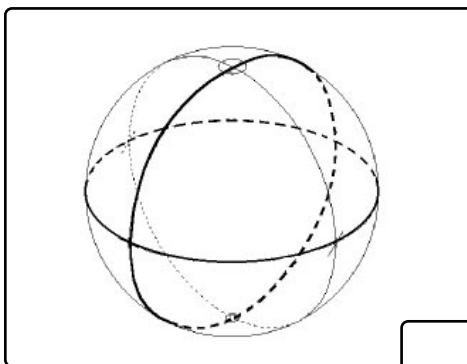
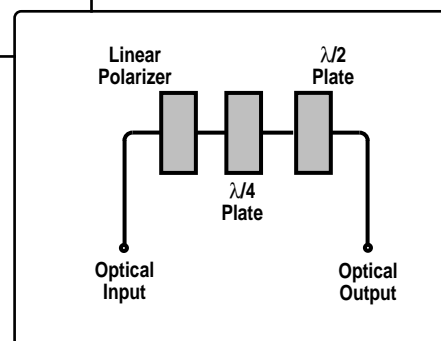


Figure 5. HP 8169A Block Diagram

Figure 4. Orthogonal great circles on the Poincare sphere<sup>1</sup> show how the HP 8169A synthesizes relative state-of-polarization points according to a specified path.



<sup>1</sup> The Poincare sphere is a three dimensional graphing system for viewing all possible states of polarization. Poincare sphere display is provided by HP 8509A/B Lightwave Polarization Analyzer.

## ...To Match Your Application Requirements

### Ease of Use, Flexibility and Speed

Four adjustment techniques enhance the ease of use, flexibility and speed of the HP 11896A and 8169A. Precise manual adjustments are made while watching the front-panel display and adjusting the front panel knobs. Nine Save/Recall registers enable random and rapid SOP hopping between nine different, user-set states of polarization. Autoscanning continuously sweeps over all states of polarization freeing the user from the tiring, mundane task of manually tuning SOP across the entire Poincare sphere.

Multiple polarization scan rates are available to match the speed of the application; be it a five-second, single-wave PDL measurement or a three-minute, wavelength-scanning PDL measurement. Autoscanning rates are also fast enough to produce polarization scrambling for some applications. Remote interrogation of all instrument settings and remote control of all adjustment procedures are provided via HP-IB.

### General-Purpose Polarization Controllers For a Wide Range of Applications

The combined capabilities of the HP 11896A and 8169A Polarization Controllers offer general-purpose performance for a variety of applications summarized in Table 1.0. Measurement systems are created by combining the HP 11896A and 8169A with other Hewlett-Packard instruments as indicated in Table 1.0; namely:

- HP 8153A Lightwave Multimeter with Optical Head
- HP 71450A or 71451A Optical Spectrum Analyzer
- HP 8509A or 8509B Lightwave Polarization Analyzer.

**Table 1.0. Application matrix for HP 11896A and 8169A Polarization Controllers**

Application Description	HP 11896A Application	HP 8169A Application
1. Polarization adjustments (manual or automatic) with extremely small power variations	Yes	No
2. Polarization synthesis	No	Yes
3. Complete, automatically stepped, adjustments of polarization over the entire Poincare sphere	Yes (pseudo-random)	Yes (deterministic)
4. Single-wavelength polarization-dependent loss measurement (2 to 10 seconds typical measurement time for PDL < 1.0 dB)	Yes <sup>1</sup> (w/ HP 8153A or 8509A/B)	Yes (w/ HP 8153A or 8509A/B)
5. Swept-wavelength polarization-dependent loss measurement	Yes <sup>1</sup> (w/ HP 71451A Opt. 002 and 003)	Yes (w/ HP 8153A and 8168B/C)
6. Polarization-dependent gain measurements of EDFA	Yes <sup>1</sup>	Yes
7. Polarization nulling for EDFA characterization	No	Yes
8. Polarization sensitivity measurements of optical coupling factor	Yes (total power delta)	Yes (power delta vs SOP)
9. Optical waveguide TE/TM mode testing	Yes	No
10. Polarized beam alignment relative to principal polarization states of the test device	Yes (w/ HP 8509A/B)	Yes (w/ HP 8153A)
11. Polarization adjustment of optical launch conditions for polarization mode dispersion measurements	Yes (w/ HP 8509A/B)	Yes
12. Simulate depolarized signals using rapid polarization scanning	Yes	Yes <sup>1</sup>

<sup>1</sup> This polarization controller is best suited for this application; however, either Hewlett-Packard polarization controller may be used.

## Specifications

**Specifications** describe the instruments' warranted performance over the 0° C to +55° C temperature range after a one-hour warm-up period. **Characteristics** provide information about non-warranted instrument performance. Specifications are given in normal type. *Characteristics are stated in italicized type.* Spliced fiber pigtail interfaces are assumed for all cases except where stated otherwise.

Description	HP 11896A	HP 8169A
<b>Operating Wavelength Range</b>	1250 to 1600 nm	1470 to 1570 nm
<b>Insertion Loss:</b> Insertion loss Variation with adjustment/rotation Variation with wavelength	< 1.5 dB ≤± 0.002 dB (Opt. 025) ≤± 0.1 dB <sup>1</sup>	<1.5 dB ≤± 0.03 dB (Opt. 020) ≤± 0.1 dB
<b>Polarization Extinction Ratio</b> <sup>2</sup>	>40 dB	>45 dB(1530 to 1560nm) >40 dB(1470 to 1570nm)
<b>Polarization Adjustment:</b> Resolution <sup>3</sup>	0.18° (180°/1000 encoder positions)	0.18° (360°/2048 encoder positions)
Fast axis alignment accuracy at home position <sup>3</sup>	± 0.18°	±0.2°
Angular adjustment accuracy <sup>3</sup> : (minimum step size) (greater than minimum step size)	± 0.18° ± 0.18°	± 0.09° <± 0.5°
<i>Settling time (characteristic)</i>	< 1 sec	< 200 ms
Memory Save/Recall registers	9	9
Angular repeatability after Save/Recall <sup>3</sup>	± 0.18°	± 0.09°
Number of scan rate settings	8	2
Maximum rotation rate <sup>3</sup>	360°/sec	3600°/sec
<b>Maximum Operating Input Power Limitation</b>	+ 23 dBm	+ 23 dBm
<b>Optical Port Return Loss (characteristic):</b> <i>Total reflection</i> <i>Individual reflections</i>	> 55 dB <sup>4</sup> > 60 dB	-- > 60 dB
<b>Power Requirements</b>	47 to 63 Hz 90 to 250 Vrms 60 VAmix	48 to 60 Hz 100/120/220/240 Vrms 45 VAmix
<b>Weight:</b>	4.5 kg (10 lb)	9 kg (20 lb)
<b>Dimensions:</b> (H x W x D)	10 x 21.3 x 36 cm 3.9 x 8.4 x 14.2 in	10 x 42.6 x 44.5 cm 3.9 x 16.8 x 17.5 in

<sup>1</sup> Specifies for any 100 nm wavelength range.

<sup>2</sup> Extinction ratio only refers to polarized portion of the optical signal.

<sup>3</sup> Angles are mechanical rotation angles of fiber loops and wave plates.

<sup>4</sup> Physical contact connector total return loss is typical > 37 dB.

## Ordering Information

### HP 11896A Lightwave Polarization Controller

Standard instrument includes front panel FC/PC connector interfaces.

**Option 011** Diamond HMS-10 connector interface

**Option 013** DIN connector interface

**Option 014** ST connector interface

**Option 017** SC connector interface

**Option 1CM** Rack mount kit

**Option 1CN** Front handles

**Option 1CP** Rack mount kit with handles

**Option 025** One meter pigtail fiber w/ FC/PC connectors

### HP 8169A Lightwave Polarization Controller

Polarization controller must be ordered with connector option.

**Option 020** Pigtailed fiber ports

**Option 021** Straight contact connectors

**Option 022** Angled contact connectors

Option 021 and 022 require two connector interfaces (see HP 81000XI series).

**For more information about Hewlett-Packard test and measurement products, applications, services, and for a current sales office listing, visit our web site, <http://www.hp.com/go/tmdir>.**

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5962-0017E**