



PAX5710VIS-T
(Cables and Laptop Included)

PAX5700 Applications

- Free Space and In-Fiber Polarimetry
- DOP Measurements
- ER Measurements on PMF
- Polarimeter Unit for the PMD5000 System
- Basic Unit for Jones and Mueller Matrix Measurements

PAX5700 Series Polarimeter Specifications

- **Input Power Range** -60dBm to +10dBm
- **Azimuth Angle Accuracy**^{1,2}: 0.2°
- **Ellipticity Angle Accuracy**¹: 0.2°
- **Normalized Stokes Accuracy**: s1, s2, s3 < 0.005
- **Degree of Polarization Accuracy**: ±0.5% Full Scale
- **Wavelength Range**:
 - VIS: 400 to 700nm
 - IR1: 700 to 1000nm
 - IR2: 1000 to 1350nm
 - IR3: 1350 to 1700nm
- **Maximum Measurement Rate**: 333 Samples/s
- **Fiber Inputs** FC/PC (other on request)
- **Free Space Input**: Ø3mm, <3mrad Beam Divergence
- **Analog Interface (via Front Panel D-Sub)**:
 - Outputs: s1, s2, s3, Power/dBm, DOP (complete Stokes Vector plus DOP);
 - Inputs: Trigger
- **Digital Interface** Outputs: s1, s2, s3, Power, DOP, azimuth and ellipticity, power split ratio and phase difference
- **Warm up Time for rated Accuracy**: 15 min
- **Operating Temperature**: 5 to 35°C

1) Azimuth angle is defined as the inclination angle of the major axis of the polarization ellipse to the horizontal axis. The ellipticity angle is given as $\arctan(b/a)$ with b the length of the minor axis and a the length of the major axis of the polarization ellipse.

2) For any SOP with $-30^\circ < \text{ellipticity} < 30^\circ$

Introduction - PAX5700 Polarimeter

The PAX5700 series polarimeter system is a flexible and powerful polarization analysis system based on our modular TXP5000 platform. This polarimeter system was designed for different applications ranging from classic polarization measurements to complex tasks like evaluating optical components with the Jones or Mueller matrix algorithm. It is also well suited for determining the Extinction Ratio (ER) of polarization maintaining fibers (PMF) and alignment of PMF to laser modules. Furthermore a complete PMD and PDL analysis system can be built by combining the PAX5700, our DPC5500 deterministic polarization controller, and our ECL5000D tunable laser source. Drawing from years of experience in the field of polarization measurement, Thorlabs is proud to introduce our newest instrument, specifically engineered for accurate measurements of polarization related effects in both fiber and free space optical systems.

How it works

The optical unit of a PAX5700 measurement sensor consists of a rotating quarter waveplate, a fixed polarizer and a photodiode (see Figure 1). The waveplate transforms the input polarization depending on the actual rotating angle. The polarizer only transmits the portion of light which is parallel to the transmission axis. So the polarization modulation is converted into an amplitude modulation. The photo detector supplies a current that is proportional to the optical power. A

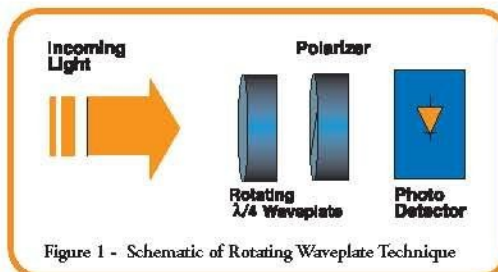


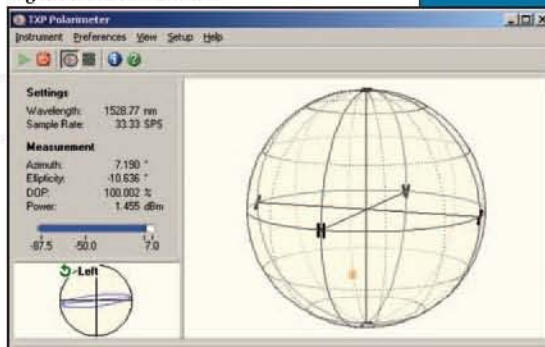
Figure 1 - Schematic of Rotating Waveplate Technique

Fourier transformation is used to accurately calculate both the state of polarization (SOP) as well as the degree of polarization (DOP).

SOP and DOP Measurements

The PAX5700 analyzes the state of polarization and the degree of polarization of optical signals in either free space or in optical fibers. The resulting data can be viewed using the Graphical User Interface which is supplied with each PAX unit. The state of the input polarization is completely characterized by different representations. As can be seen in Figure 2, the polarization data is presented in a number of forms, on the Poincaré sphere, as Stokes parameters or as a polarization ellipse with the handedness noted. Additionally, the degree of polarization and the total optical power are also provided.

Figure 2 - Polarimeter GUI



Long Term Polarization Measurements

Another standard feature is the "Scope" mode. This mode looks similar to an oscilloscope display. The polarization can be examined continuously over time or initiated with a software or hardware trigger signal. The number of data points to be acquired can be chosen by the user. Another feature is the pre-trigger function, which can be activated in each trigger mode. A user configurable number of samples are stored in a ring buffer until the trigger pulse is given. All acquired data before and after the trigger pulse are displayed in a diagram. Therefore, a real-time monitoring of the system's polarization behavior can be realized with the PAX measurement system. The measured data can be recorded in an ASCII format file (CSV). The data file contents can be viewed with any text editor and can be further processed using third party software packages such as MathCAD, Mathematica or Excel.

Software Features

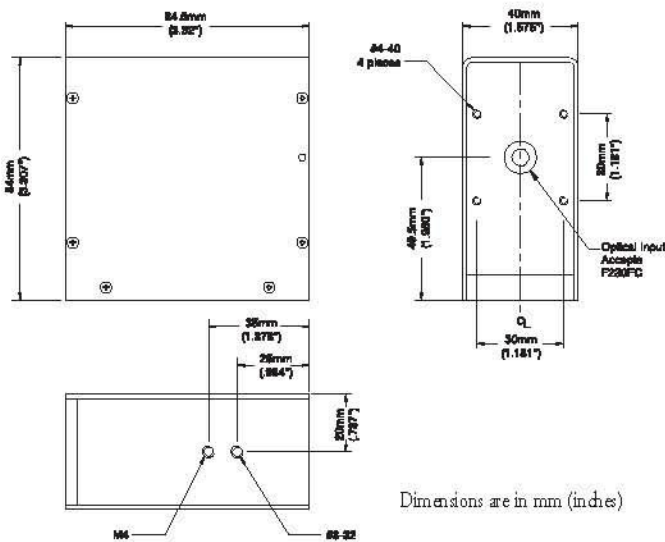
The software for the PAX system includes drivers for LabVIEW™, LabWindows™/CVI™, MSVC and Borland C. These drivers enable you to write your own applications to adapt the polarimeter into a complete optical setup. Included in the software are features specifically geared for Extinction Ratio (ER) measurements (see below).

System Configurations

The modular design combined with the variety of models makes the PAX system an ideal tool for various types of polarization related measurement tasks in R&D laboratories, as well as for final inspection in manufacturing. The PAX5700 Series can be used for free space and fiber based applications covering the wavelength range of 400nm to 1700nm. See the following page for ordering information.

The PAX5710 consists of a TXP compatible card and an external polarization measurement sensor. The PAN5710 external measurement sensor facilitates polarization analysis in free space setups. It can easily be mounted to optical benches using the M4 or #8-32 mounting holes provided in the bottom of the head. It is also compatible with our extensive line of 30mm cage system components. The optical light field to be measured should enter the aperture of the sensor nearly perpendicular to the front panel. The beam diameter should be below 3mm to guarantee that all the light reaches the detector. All sensors are supplied with a fiber collimator for FC/PC optical cables to allow polarization measurements on fiber based systems, or you may choose to use the PAX5720, which is dedicated to fiber based measurements.

External PAX – Sensor Heads



Extinction Ratio Measurement on Polarization Maintaining Fibers

Extinction ratio (ER) is a key qualifier of PM fibers and PM couplings. Using the standard features built into the PAX software, ER measurements can be made quickly and reliably in the range from 0 to 45dB.

The measured ER parameter refers to the PMF directly connected to the polarimeter input.

The easiest measurement technique is to find the maximum expansion of the polarization ellipse compared to the ideal linear state. Since this expansion is depending on the fiber stress, a lot of values have to be recorded while the fiber is "stressed" (pulled or a wavelength scan is performed).

This technique requires the highest accuracy in the measurement of the ellipticity angle. With a very high ER the setup is prone to measurement inaccuracies. To mitigate this issue the PAX5700 uses an optimized algorithm. The recorded values during fiber stressing are used to fit a circle on the Poincaré sphere.

The radius of the circle expressed in degrees is representative of the maximum expansion of the polarization ellipse.

Only the relative polarization measurement accuracy determines the ER measurement error since the shift of the circle to any position on the Poincaré sphere is irrelevant as long as the size of the circle remains unchanged. Errors resulting from poorly or angle polished fibers have no influence. Only the ER of the stressed fiber segment is measured.

The ER measurement on PMF is integrated in the PAX5700 software. All polarimeter related functions are also accessible.



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Contact Information

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PAX5710 / PAX5720 Series Polarimeter

PAX5710-T Free Space Polarimeters

The PAX5710-T versions consist of a TXP5004 chassis with USB connection, a TXP5710 Series card and one external polarimeter sensor. A pre-configured notebook computer is also included making this a complete free-space measurement system right out of the box!

This package includes all of the necessary cables to connect to the sensor and computer.



PAX5710VIS-T

Cables, External Sensor Head & Laptop Included. All Sensor Heads are Factory Calibrated.

ITEM#	DESCRIPTION
PAX5710VIS-T	TXP Polarimeter w/External Sensor 400 - 700nm
PAX5710IR1-T	TXP Polarimeter w/External Sensor 700 - 1000nm
PAX5710IR2-T	TXP Polarimeter w/External Sensor 1000 - 1350nm
PAX5710IR3-T	TXP Polarimeter w/External Sensor 1350 - 1700nm

PAX5720-T Fiber Coupled Polarimeters

The PAX5720-T versions consist of a TXP5004 chassis with USB connection and a TXP5720 Series card (with internal sensor). A pre-configured notebook computer is also included making this a complete fiber based measurement system right out of the box! This package includes all of the necessary cables to connect to the computer.

The wavelength range can be easily extended by adding additional PAX5720 cards.
Call Tech Support for pricing information and availability.



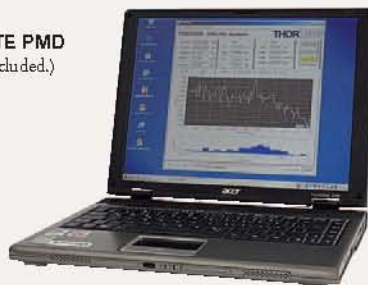
PAX5720VIS-T

Cables, Internal Sensor & Laptop Included.

ITEM#	DESCRIPTION
PAX5720VIS-T	TXP Polarimeter w/Internal Sensor 400 - 700nm
PAX5720IR1-T	TXP Polarimeter w/Internal Sensor 700 - 1000nm
PAX5720IR2-T	TXP Polarimeter w/Internal Sensor 1000 - 1350nm
PAX5720IR3-T	TXP Polarimeter w/Internal Sensor 1350 - 1700nm

Putting it all TOGETHER

PMD5000 SERIES - COMPLETE PMD ANALYSIS SYSTEM. (Laptop Included.)



Thorlabs offers a wide range of polarization measurement and control equipment as well as laser sources. These devices combine to form a versatile Polarization Mode Dispersion (PMD) and a Polarization Dependent Loss (PDL) measurement system. The PMD5000 measurement system consists of the tunable laser source ECL5000D, the deterministic polarization controller DPC5500 and either our IPM5300 or PAX5720IR3 polarimeters. This system provides extensive measurement and analysis of PMD on both broad-band and narrow-band components, optical fibers, and installed optical systems. It is capable of determining Polarization Dependent Loss (PDL) and Polarization Dependent Gain (PDG).

POLARIZATION

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