Polarization Controllers

Phoenix Photonics

***Firebird*™ Product range information**

FIREBIRD

Phoenix Fiber Polarization Controllers

Customer information note

Overview

Phoenix polarization range of controllers is all-fiber offering the following benefits over other technology approaches;

- ✓ there are no mechanical parts that may fail giving long product lifetime
- ✓ there are no free-space, bulk, optical components requiring alignment, increasing losses and affecting high power operation,
- ✓ the approach is fully solid state using the same propagation medium as the input/output fiber tails.
- ✓ Very large optical operational bandwidth

Individual waveplates are formed using standard polarization maintaining, high birefringence, fibers and the principle is to modify the birefringence of the fiber over a 2π differential phase shift giving a full circle rotation of the Poincare sphere for each waveplate. Accurately splicing three waveplates together with propagation axes at 45deg. to each other (90deg. rotation of polarization state on the Poincare sphere) gives full coverage of the sphere, i.e. any polarization state can be achieved from any starting state.

The Phoenix Firebird™ range incorporates many years of research and development to optimize, highly accurately fiber axis alignment, precision control of the waveplate birefringence with zero crosstalk between waveplates, robust packaging and full microprocessor control.

Principle of Operation

Unlike competitive approaches, Phoenix polarization controllers provide a direct relationship between waveplate phase shift and applied voltage. This means that as there is no hysteresis therefore, the polarization transfer function can be accurately set for any input wavelength and ambient temperature and the polarization evolution directly tracks the voltage control. This provides repeatability and stability of the output state of polarization.

The standard component consists of three polarization maintaining fiber waveplates, each accurately aligned at 45 deg. and fusion spliced (figure 1). The differential phase shift between the light on each of the axes is dependent on the wavelength of the light and the temperature of the fiber for a fixed length. The Phoenix approach is to accurately control the temperature of each of the waveplates thereby independently varying the birefringence of each section.

Benefits:

- ✓ Direct voltage to phase relationship (no hysteresis)
- ✓ No moving parts (no squeezers or rotators)
- ✓ Modification of the propagation parameters within the fiber therefore no break in the propagation path.
- ✓ Any wavelength range can be accommodated for which commercial PM fibers are available.
- ✓ Simple, stable, repeatable polarization control in many system applications and measurement environments.
- ✓ Cost effective

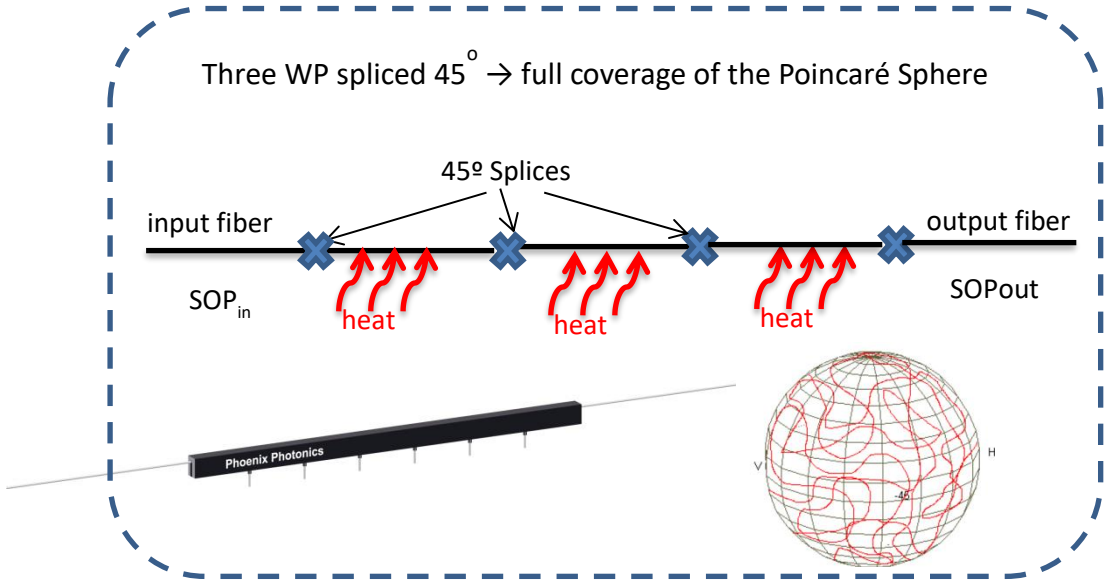

Figure 1 Principle of operation of the polarization controller. Three fiber sections are spliced to form individual controllable birefringence waveplates.

***Firebird* polarization control product family**

The concept for the product range is to provide solutions for different levels of application. The basic polarization control component (PSC) is primarily utilized in OEM applications for Test & Measurement and sensing instrumentation. The next level provided by the EPC gives the full functionality of conventional mechanical 3-loop controllers with the added benefit of electronic control targeted primarily at R&D laboratory applications where reliable, easy to use control modules are required. The full test & measurement instrument (MCPC) offers multi-channel control for production and R&D applications in PDL, PMD measurement and control. The Polarization switch (PSW) component is targeted at OEM applications where switching between two orthogonal polarization states is required.

The variable waveplate technology leads to a series of easy to use, PCB compatible components including the PSC and with the addition of an integrated polarizer the PSW. The controller (PSC) branch provides, optical bench based modules and instrumentation. The PSW branch provides products for deterministic polarization selection (figure 2).

Although primarily targeted for application in telecommunication wavelength ranges, the technology is capable of fabricating products at many different wavelengths: 630nm, 780nm, 850nm. 980nm, 1060nm, 1310nm, C-band, L-band, 2000nm.

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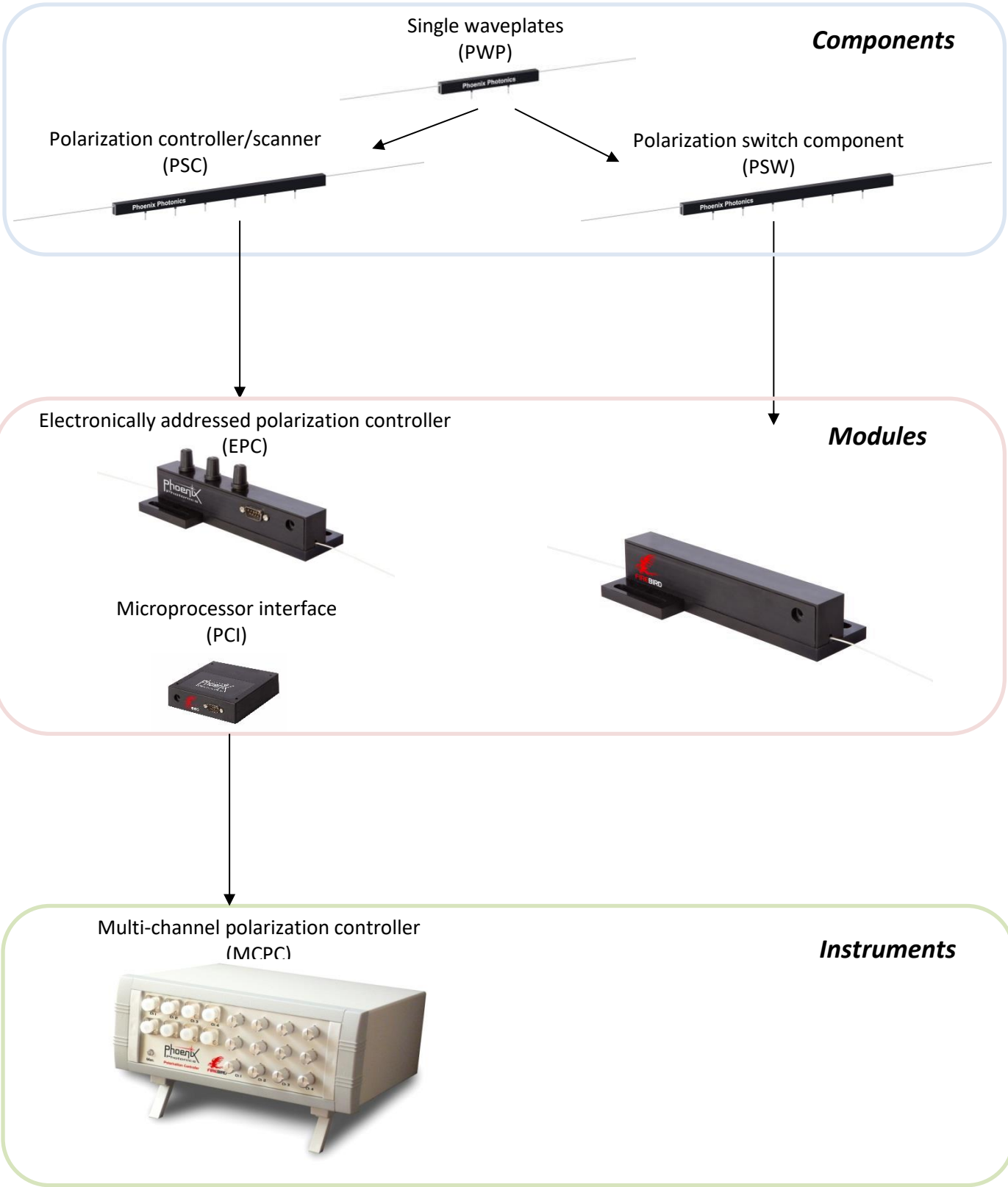

Figure 2 Phoenix polarization control product family tree

Polarization controller/scanner component (PSC)

The PSC is the basic component forming the operational heart of ***Firebird™*** instruments. The compact component has been designed to be compatible with PCB installation. This is a very popular device with test & measurement instrumentation manufacturers as a high performance, cost effective component for polarization based equipment.

Polarization switch (PSW)

The polarization switch component enables switching between the two linear states aligned along the PM fiber axes. Varying the voltage applied to the pins describes a great circle on the Poincare sphere passing through the two fiber linear states. This component provides the customer with flexibility to calibrate within the required operational range to give good PER switching.

Electronically driven polarization controller (EPC)

The EPC offers an electronic replacement for the conventional mechanical 3-loop fiber polarization controllers. The unit incorporates a PSC and driver board. The individual waveplates can be controlled manually by knobs on top of the module. This gives direct feedback 'feel' when adjusting polarization in the laboratory. It can also be controlled with three analog voltage inputs. These three buffered inputs require 0 to 10v to give >2π phase shift on each section. This enables the user to control from a variable voltage supply, or by computer via. a DAC. The packaging has been designed for use on optical benches.

Microprocessor interface (PCI)

The PCI, a microprocessor based controller designed for use with the EPC, provides a direct interface (figure 3) with a PC. Phoenix software enables full control of the EPC through a PC panel with the same functionality as the MCPC. The software will control up to 4 EPCs to set the state of polarization or provide continuous scanning/scrambling of polarization.

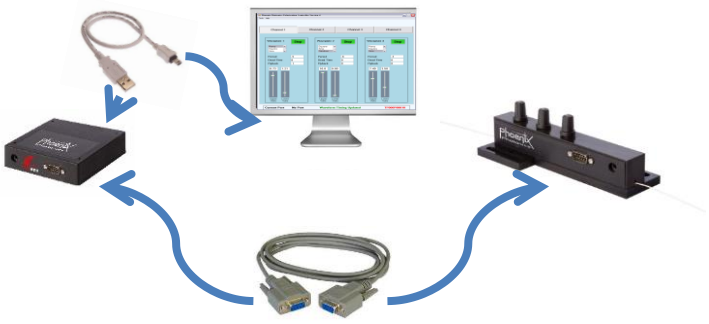

Figure 3 PCI interfaces EPC with PC for full control using Firebird software

Integrated electronically driven polarization controller (IEPC)

The IEPC provides a fully integrated solution to polarization control on the optical bench. The controller operates from the same software used by the PCI/EPC combination and all the control electronics is contained within the package. Full polarization control can be obtained with this unit and up to 4 (extendable to 8) individual controllers can be driven from one software interface.

Multi-channel polarization controller (MCPC)

The MCPC is the complete polarization control instrument. Available in compact instrument case format up to 4 channels and 19”rack format up to 8 channels. The instruments use PSCs and control each waveplate independently. The option of instrument front panel control through individual knobs has been retained, but full PC control is built into the instruments. There are several communication interface options. The PC front panel control is shown in (figure 4). There is a control option to adjust the voltage (phase shift) of each waveplate through a slider or typing in a value or a scanning option is available. The scanning option has the facility to select parameters for each waveplate;

Scanning options: sine, triangle, square, random
Period: Repetition time
Flyback time: Vary triangle asymmetrically to saw-tooth
Deadtime: Time delay before next single cycle is triggered
Voltage limits: Maximum and minimum voltage range.

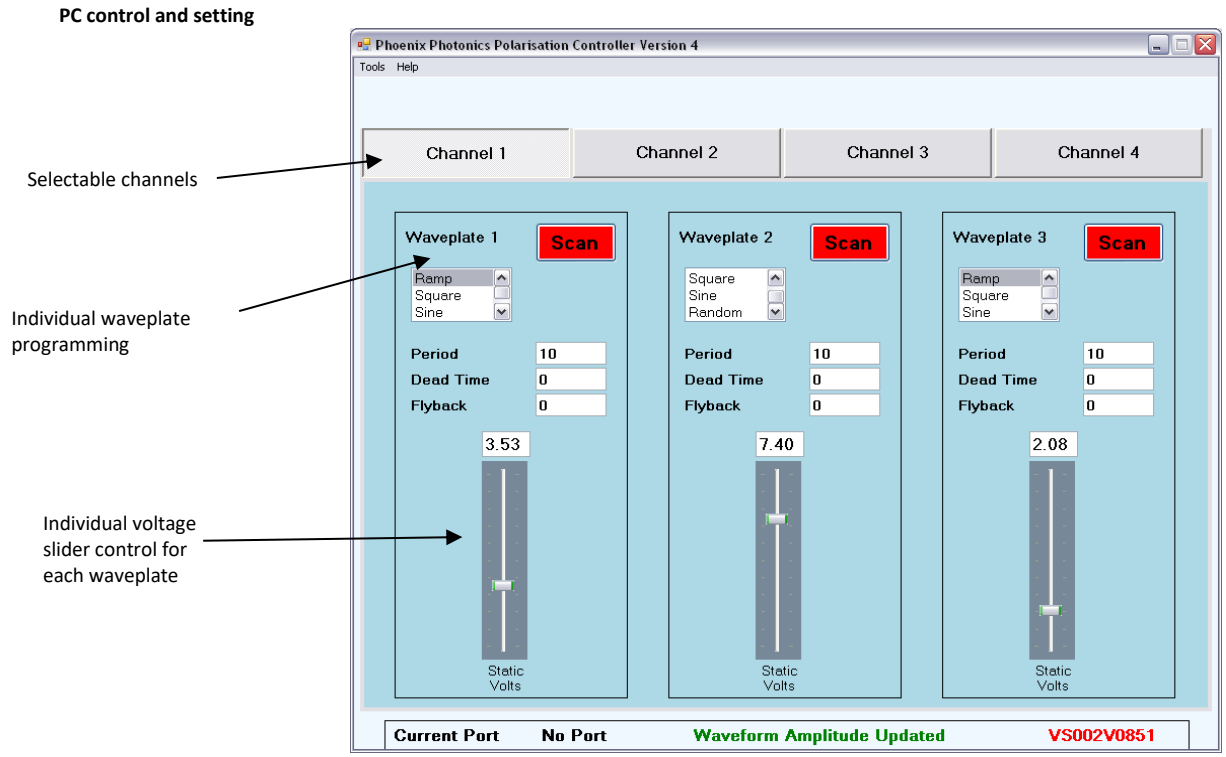

Figure 4a PC front panel control screen (manual control mode).

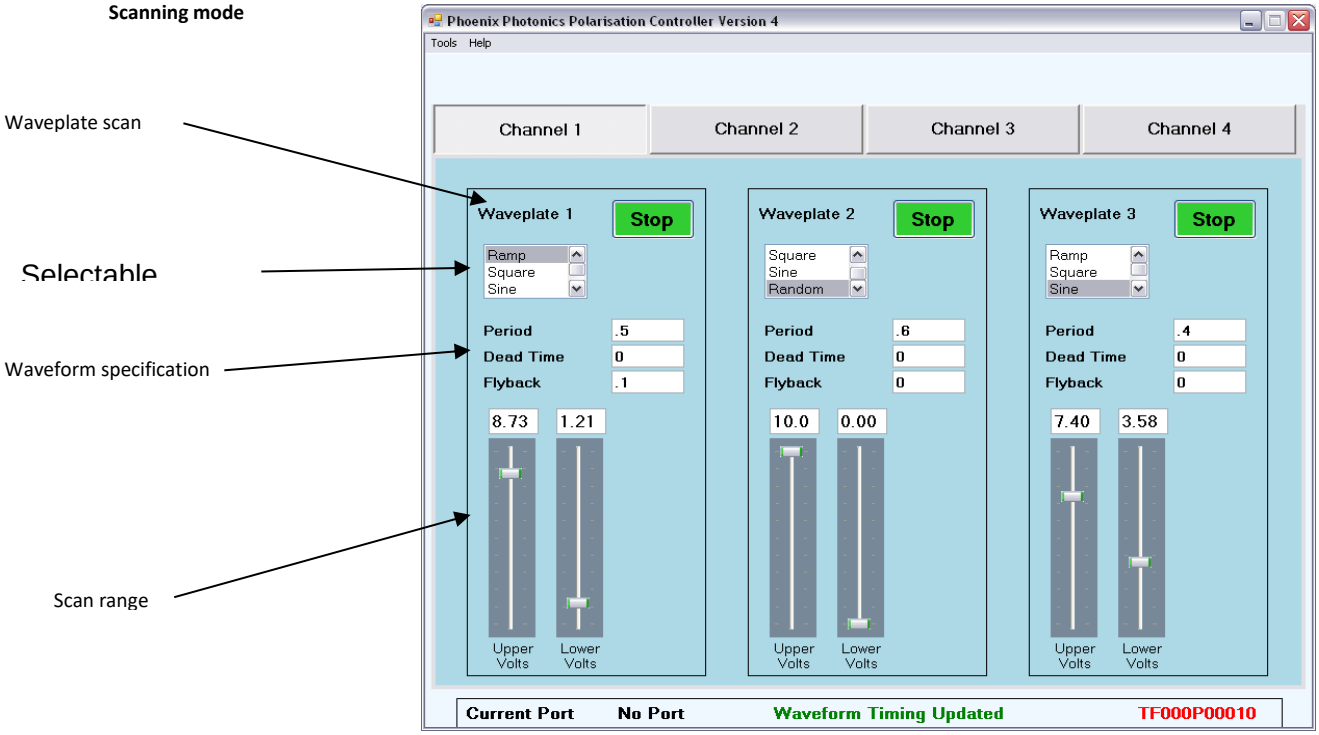

Figure 4b PC front panel control screen (auto control mode).