



iXblue Polarization Switch PSW-LN-0.1

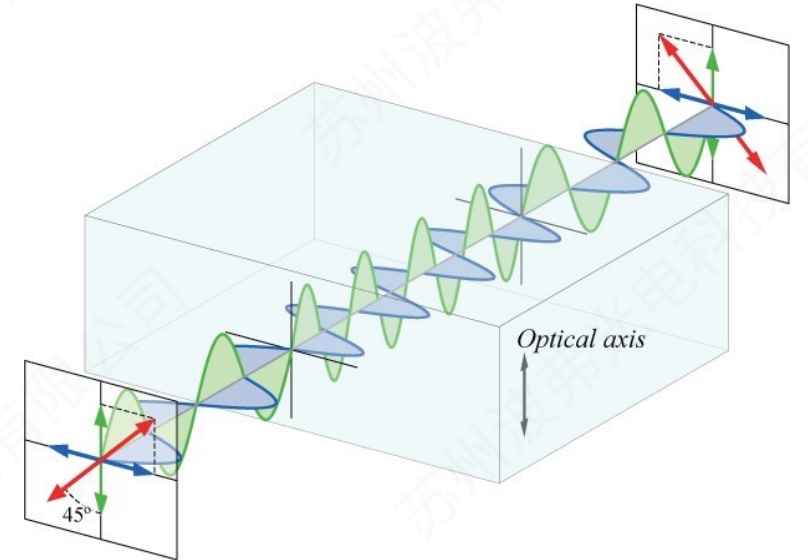
Principle

The LiNbO₃ Optical Polarization Switch PSW-LN-0.1 modulator is based on:

- A modified phase modulator.
- An optical waveguide made by titanium in-diffusion and supporting both TE- and TM-polarization states.
- A waveguide with a low PDL (Polarization dependent loss) = high extinction ratio between crossed polarization interferences.
- An input polarization maintaining (PM) fiber whose slow axis is set at 45° from the slow and fast axis of the LiNbO₃ crystal.
- An output PM fiber whose axis is set at 45° from the slow and fast axis of the LiNbO₃ crystal.
- A reliability and lumped electrodes for low frequency application (up to 200 MHz).

Principle

- The PSW-LN Rotators are based on a birefringent LiNbO_3 phase modulator whose waveguide is illuminated at 45° of its main axis. The input state of polarization (SOP) is thus equally split up in two orthogonal TE and TM polarization states.
- When a voltage is applied via the control electrodes, an optical path difference between the TE and TM components is produced, resulting in a new state of polarization (SOP) for the output light.
- The PSW-LN acts as a half-wave plate: the linearly polarized light entering the modulator at 45° of the crystal optical axis can be resolved into two waves, parallel (shown as green) and perpendicular (blue).
- In LiNbO_3 crystal, the parallel wave propagates slightly slower than the perpendicular one, and the speed is adjusted by the voltage applied to the modulator.
- At the end side of the crystal, the parallel wave is exactly half of a wavelength delayed relative to the perpendicular wave, and the resulting combination (red) is orthogonally polarized compared to the entrance state.



Principle:

Phase shift on extraordinary fast axis

$$\phi_e = \frac{2\pi}{\lambda} \left[n_e L + \frac{1}{2} n_e^3 r_{33} l \eta \frac{V_0}{g} \right]$$

Phase shift on ordinary slow axis

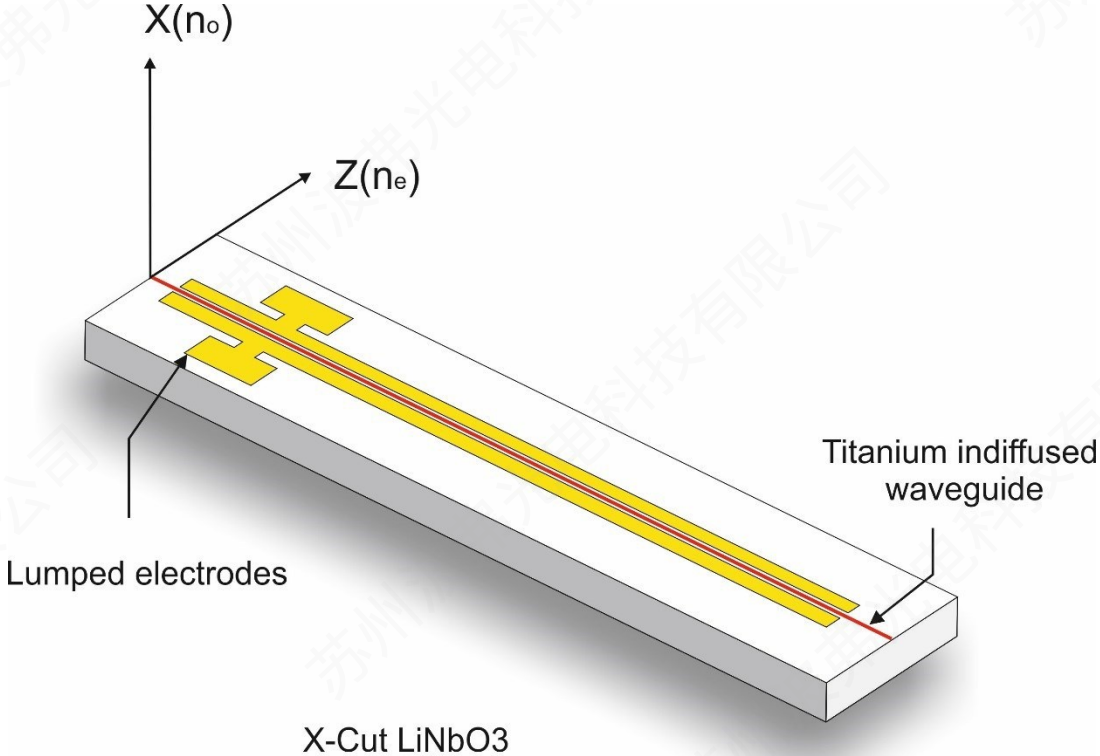
$$\phi_o = \frac{2\pi}{\lambda} \left[n_o L + \frac{1}{2} n_o^3 r_{13} l \eta \frac{V_0}{g} \right]$$

Differential phase shift

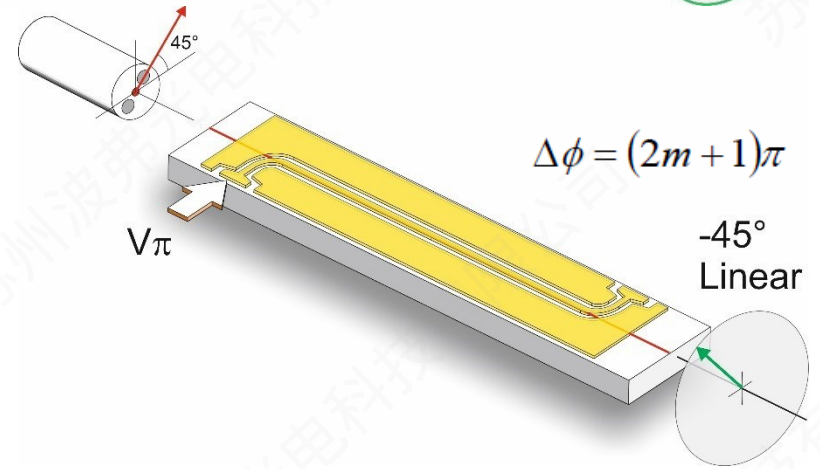
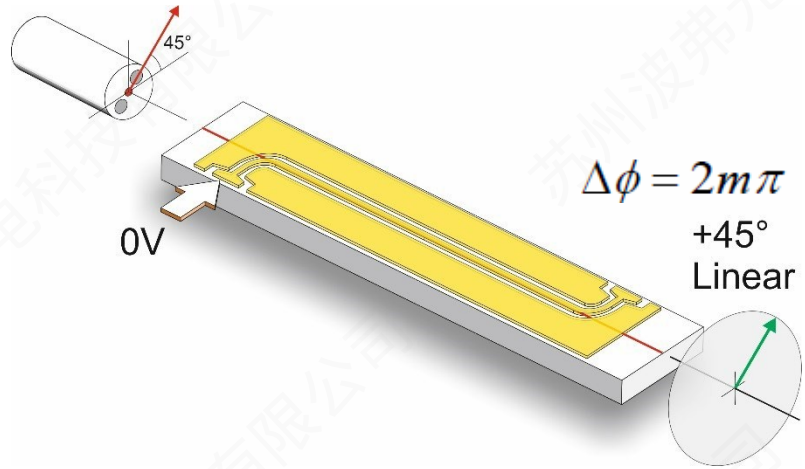
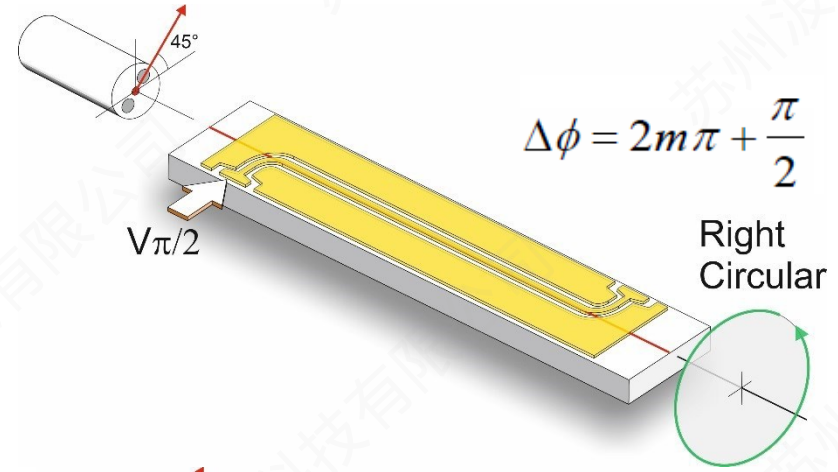
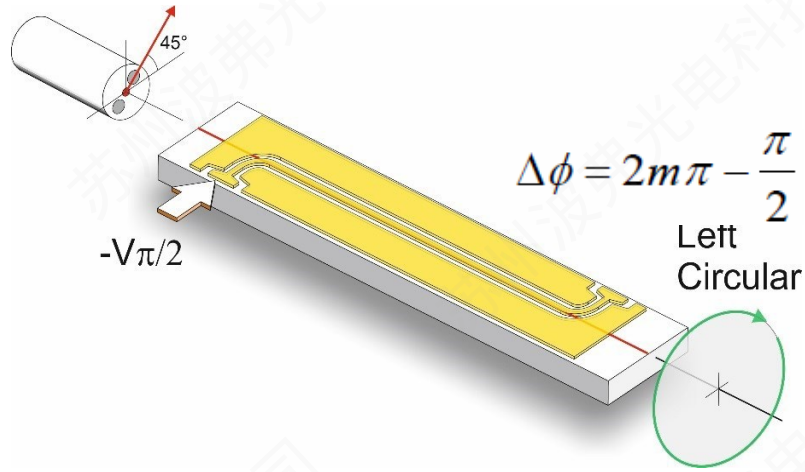
$$\Delta\phi = \frac{2\pi}{\lambda} \left[(n_e - n_o) L + \frac{1}{2} (n_e^3 r_{33} - n_o^3 r_{13}) l \eta \frac{V_0}{g} \right]$$

Symbol	Glossary
n_e	Extraordinary refractive index
n_o	Ordinary refractive index
r_{13}, r_{33}	LiNbO ₃ Electro-optic coefficients
L	Crystal length
l	Electrode length
g	Electrodes gap
λ	Optical Wavelength
V_0	Applied Voltage
η	Electro-optic overlap

Configuration: PSW-LN-0.1



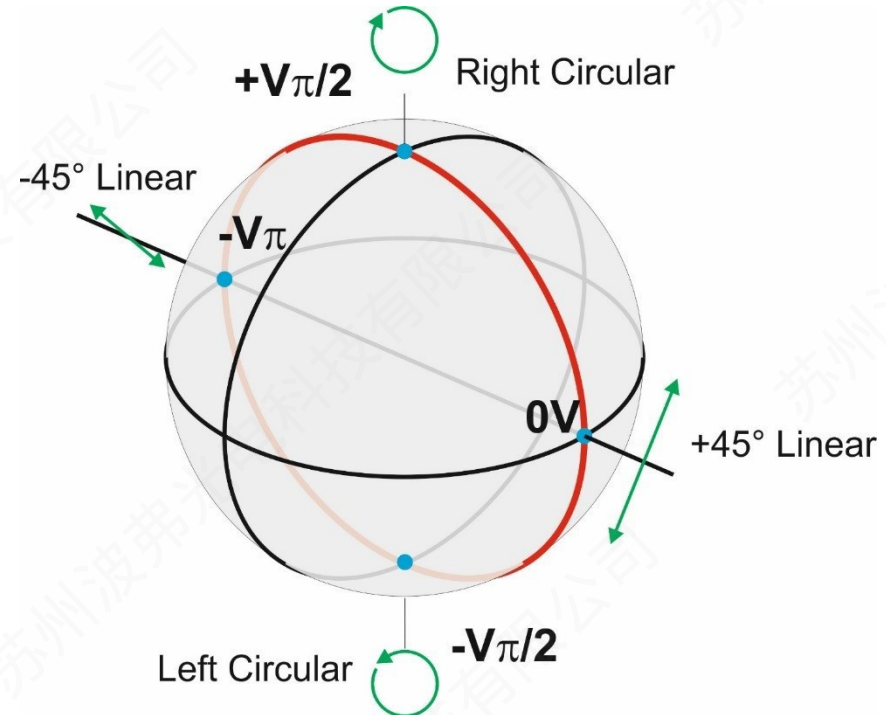
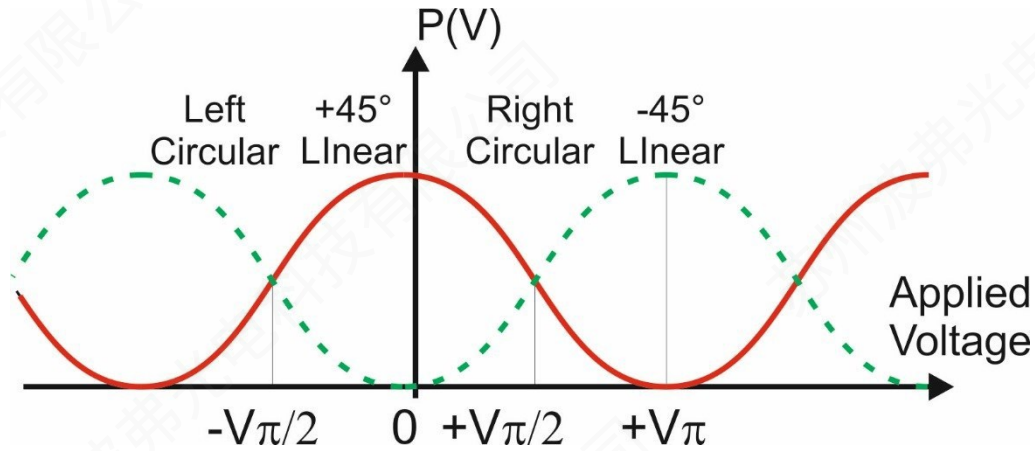
Polarization state vs Applied Voltage



Polarization switch on the Poincaré Sphere vs applied voltage

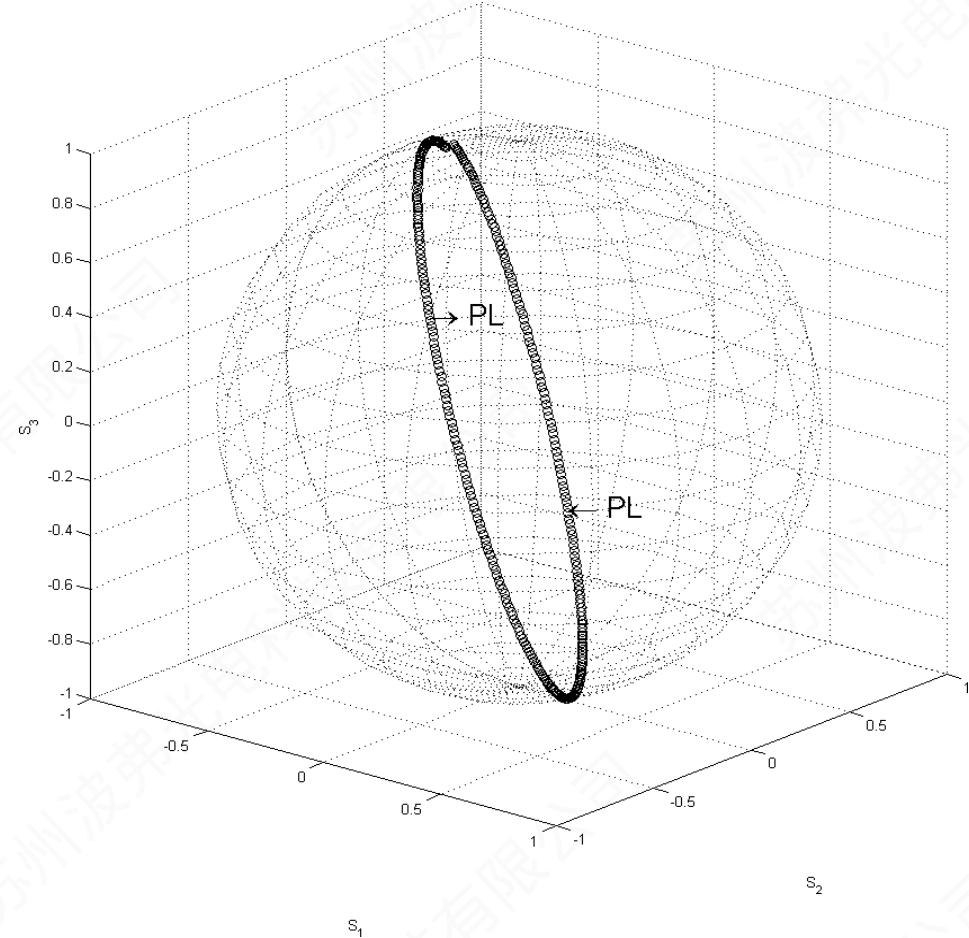
- Switching voltage : voltage needed to switch from a +/- 45° linear polarization state to a -/+ 45° linear polarization state.

$$V_{\pi} = \frac{\lambda g}{(n_e^3 r_{33} - n_o^3 r_{13}) \ell \eta}$$

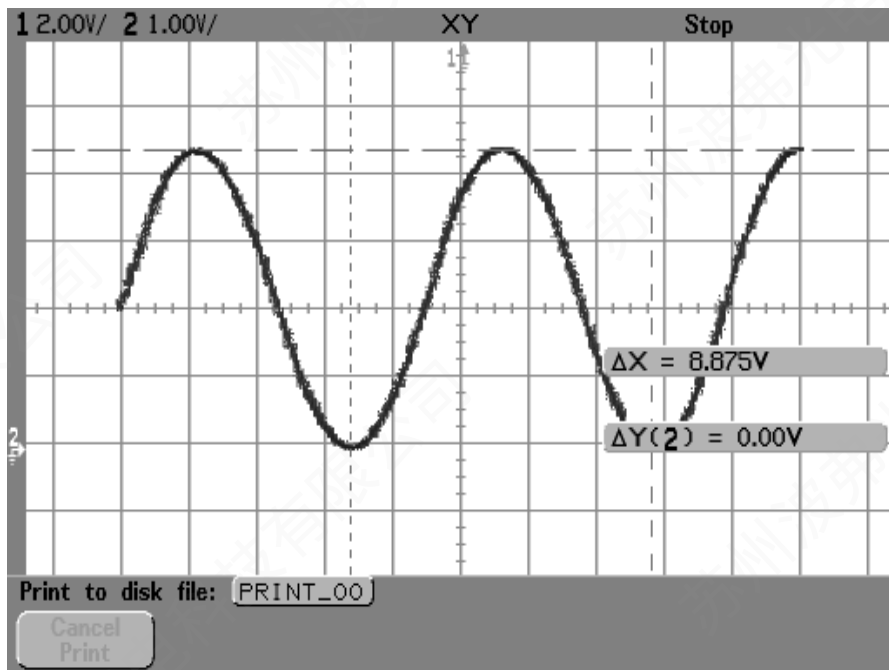


Characterization: PS-LN-0.1

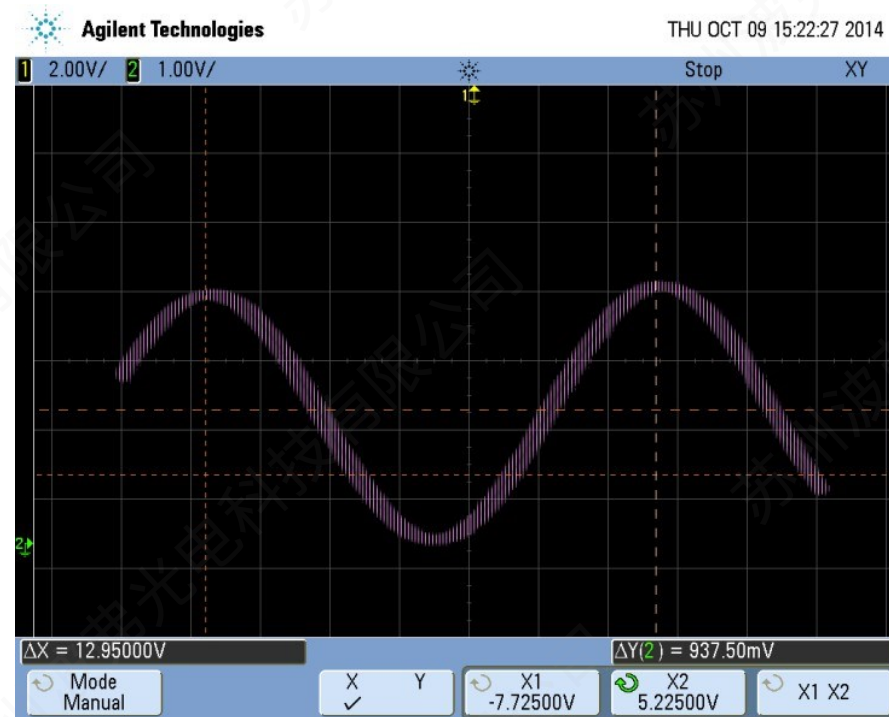
- Exemple of an experimental Poincaré sphere trace of the output SOP for a continuous voltage of $10 V_{pp}$ applied to the modulator.
- All the output SOP are located on a circle with a trajectory crossing close to the states of right and left circular polarization and two states of linear polarizations indicated by PL.



Characterization: PS-LN-0.1



Differential Half-wave
voltage measurement 4.5V
@ 1310nm (On request)



Differential Half-wave
voltage measurement 6.5V
@ 1540nm