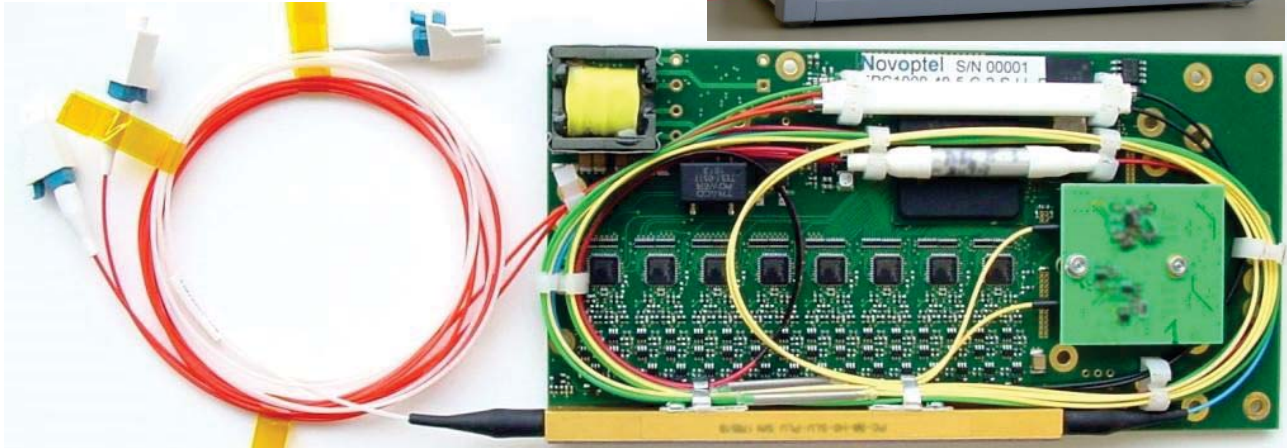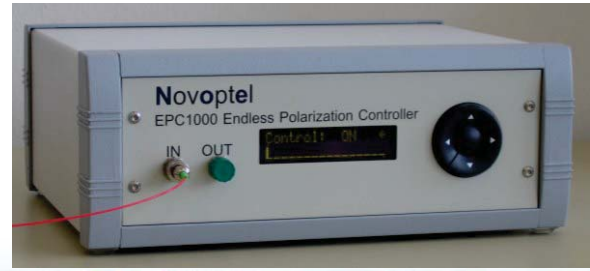# Novoptel

www.novoptel.com, www.novoptel.eu

EPC1000 Polarization Controller/Demultiplexer

- **Guaranteed endless tracking (control) speed: 40**, **60** or **100 krad/s** on Poincaré sphere
- To our knowledge, **Novoptel's endless polarization tracking speed is at least 100 times as high as that of competitor products.** If you are aware of something better then please inform us so that we can correct this statement.
- Extremely reliable: More than **350 Gigarad** were tracked in several extended tests.
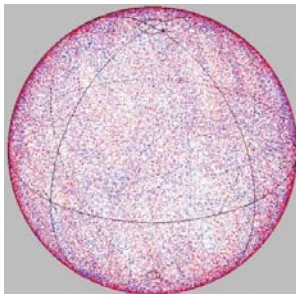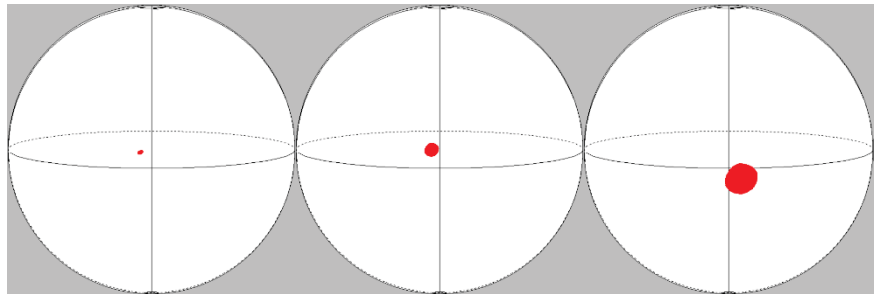

| Scrambled (example) | Controlled @ 10 krad/s | 40 krad/s | 100 krad/s |

- **Single (CW)** or **dual (DQPSK, QAM; also: DPSK, duobinary, ASK) polarization tracking**
- Wavelength range: **C band**, **extensible to L band**; also possible: S band, 1310 nm, ...
- Temperature range: **-10°C to +70°C**; extension is possible.
- Power consumption: About **5 W** from single **+5 V** source. Compatible with the needs of 40 Gb/s, 100 GbE, 2x100 GbE, 4x100 GbE and other transponders. Can be further reduced.
- Interfaces for computer (**USB**, **LAN**) or controller (**SPI**, **UART**, digital hardware lines)
- Functionality: **Channel swapping** (to exchange demultiplexed polarization channels, may for example be activated by a framer/mapper), **reset**, **control** (on/off), modification of important parameters (**control gain** and **speed**, **dither amplitude**, **delay time** of supplied error signal)
- **In-field upgradable firmware** and **remote access** possibility for diagnosis and troubleshooting
- **Desktop units (with GUI)**, **plug-in module cards**, **IP cores. Various configurations.**
- Options: User-supplied error signal, **arbitrary and endlessly variable output polarization**, ...
- APDs for smaller and variable optical input power
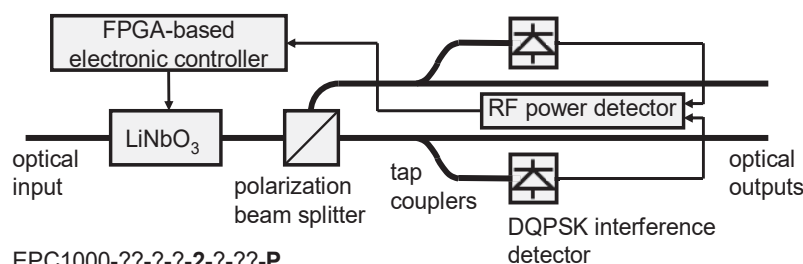
EPC1000-??-?-?-**2**-?-??-**P**

Configuration example:

EPC1000 with interference detection for **demultiplexing of polarization-multiplexed DQPSK or QAM signals**. Everything is mounted on controller card (see above).

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Results obtained with EPC1000

In 2010, world's highest symbol rate in polarization-agile realtime transmission with 4 bit/symbol: **50 Gbaud, 200 Gb/s, 430 km polarization-multiplexed DQPSK transmission with 40 krad/s polarization tracking** (IEEE PTL 22(2010)9, pp. 613-615)
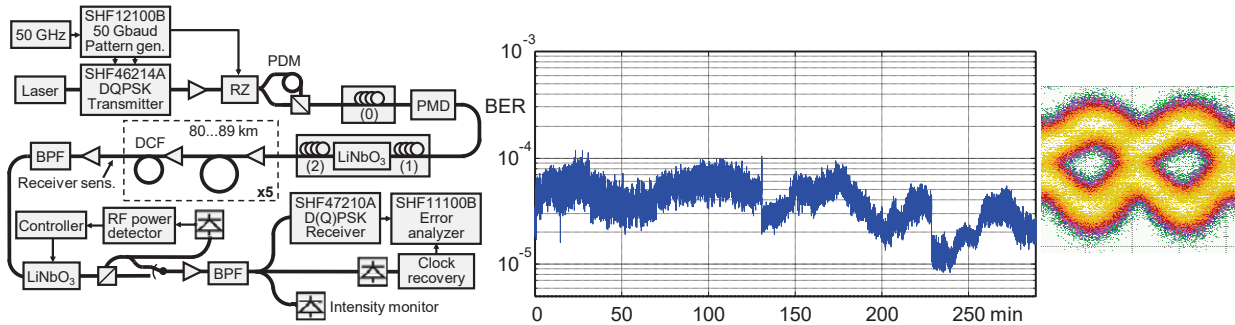
World's fastest endless optical polarization control: 100 krad/s on Poincaré sphere tracked over 64 h (Electron. Lett., Vol. 47, No. 14, 2011, pp. 813-814)
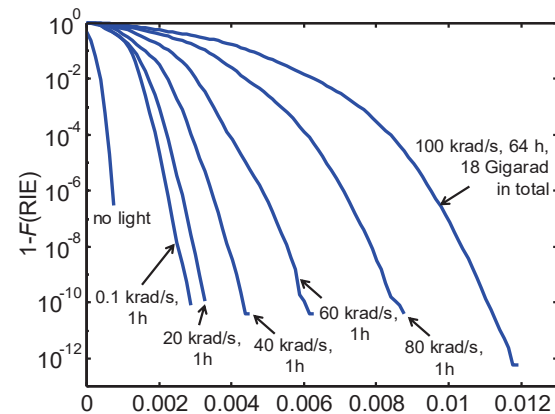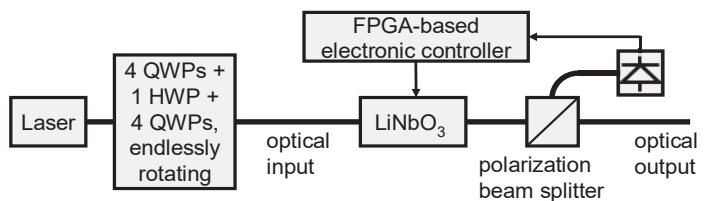
Complementary distribution function $1-F(RIE)$ of relative intensity error (RIE) for 1 hour at 0.1, 20, 40, 60, 80 krad/s, and for 64 hours at 100 krad/s scrambling speed (18 Gigarad in total). The zero point ($RIE = 0$) is determined without light.
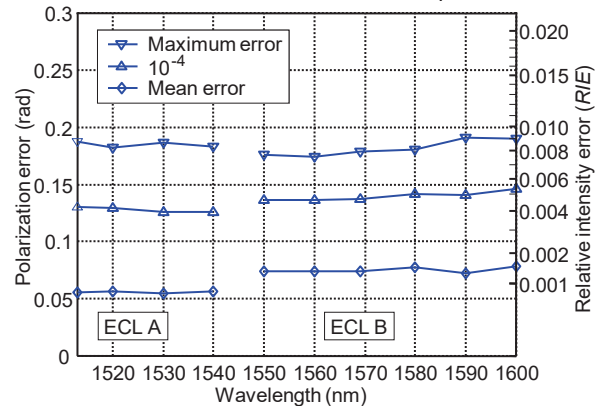
Relative intensity error (RIE) and polarization errors which are surpassed only with the given probability, as a function of wavelength for 30-minute measurements at 50 krad/s scrambling speed.

Widest endless optical polarization control bandwidth: 1 THz at 70 krad/s speed
Best extinction: 40 dB at 1 krad/s speed
Temperature-independent operation: -15°C...60°C (70°C testing if desired)
Two-sided endless polarization control: 15 krad/s at input, 200 rad/s at output

Optics Express, Vol. 22, Issue 7, pp. 8259-8276, 2014; IEEE PTL 24(2012)22, pp. 2077-2079

Customer feedback

"Novoptel's polarization tracking device EPC1000 is probably the only commercially available equipment that is capable of demultiplexing two orthogonal states of polarization with a tremendously high tracking speed (≈60 krad/s). We have evaluated extensively the EPC1000 module and have confirmed its performance to be fully satisfactory and just as claimed. Prof. Reinhold Noe and Dr.-Ing. Benjamin Koch are the well-known pioneers and leaders in this field. With their team they have achieved remarkable progress and tracking speed records over the years. I am so happy to see Novoptel offer these polarization controllers to the lightwave communication community as affordable subsystems for coherent detection."
*Dr. David Tzeng, Measurement Analysis Corporation, USA*

Polarization and phase control, usable for QKD

- **Worldwide unique product: Endless optical polarization and phase (difference) control**
- Not only an unknown variable incoming polarization is transformed into a fixed output polarization (2 degrees-of-freedom), but also the phase difference (3rd degree-of-freedom) between this polarization and its orthogonal is controlled, endlessly (without any interruption).
- **Indispensable** for any application where optical polarization and phase control are needed: General retarder with 3 and not just 2 deterministically controlled degrees-of-freedom, optical phased array, self-homodyne receiver with polarization beamsplitter for recovery of modulated signal and unmodulated LO with orthogonal polarizations and defined phase relation, coherent optical receivers with simplified electronic signal processing and ...
- **for fiberoptic quantum key distribution (QKD) based on BB84 or similar protocol implemented in the polarization domain**
- Pilot signals (0°, 45°)
    - in the frequency/wavelength domain (WDM) or
    - in the time domain (TDM), with complete pilot laser extinction and with clock recovery for QKD window timing. Very PMD-tolerant! Very advantageous.
- **Whole normalized Stokes space of the probe signal is stabilized.**
- **Endless tracking speed 20 krad/s** (typically)
- Speed scalable for TDM QKD where scattering has completely decayed
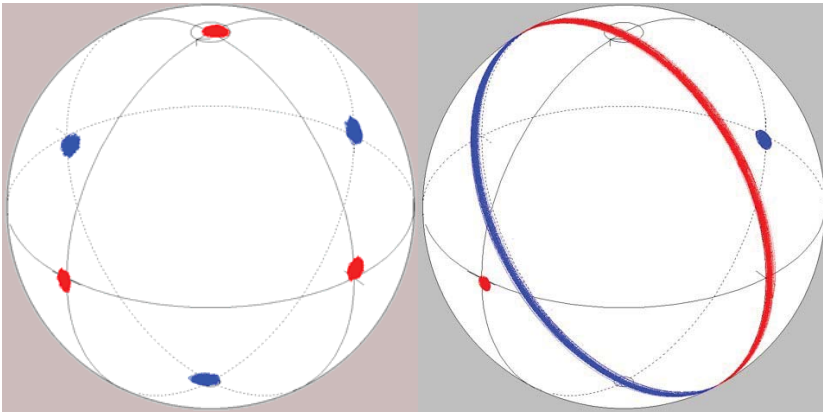
Stabilization of normalized Stokes space of the probe signal, under 20 krad/s polarization scrambling. Perfect for QKD with BB84

Traditional polarization control, does not work for QKD with BB84
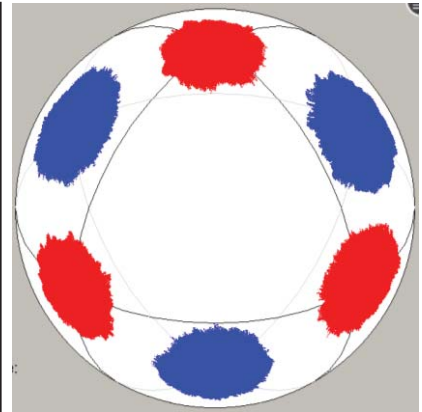
Stabilization of normalized Stokes space of the probe signal, under 20 krad/s polarization scrambling, with 35 ps of PMD. Time divsion multiplex (TDM) version.
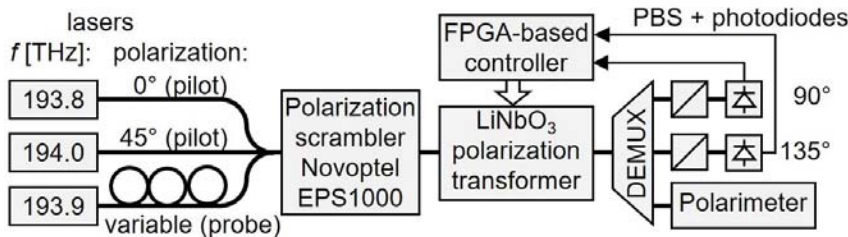
Corresponding setup for polarization and phase control with WDM pilot signals, see Electronics Letters, Vol. 49, No. 7, pp. 483-485, 2013

Below: PMD-tolerant setup with TDM pilot signals. Includes laser control PCBs for fast modulation with extreme extinction.