Distributed Polarization Crosstalk Analyzer—PolaX™

PXA-1000

Making Light Work Lighter

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C o r p o r a t i o n

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The Distributed Polarization Crosstalk (X-Talk) Analyzer (PXA-1000) is an enhanced version of a white light interferometer designed to obtain space-resolved stress information by analyzing stress-induced polarization cross-coupling along a length of polarization maintaining (PM) fiber. Its patented (US 8,599,385) optical design eliminates the strong zero-order interference and reduces the multi-coupling interference common in traditional white light interferometers, both of which can cause "ghost" peaks in the measured signal. The removal of the "ghost" peaks enables the PXA-1000 to unambiguously identify the magnitudes and locations of actual x-talk peaks, resulting in higher measurement sensitivity, higher dynamic range, and higher spatial measurement accuracy than traditional white light interferometers. The PXA-1000 also enables the use of the PM fiber itself as the sensing medium, eliminating the need to place multiple fiber gratings along the fiber. It can therefore obtain higher spatial resolution of the stress distribution than grating-based systems. Because no discrete sensing elements are required, the system is easy to install and calibrate, making it ideal for monitoring space-resolved structural changes along bridges, tunnels, dams, oil pipes, or buildings. It can also be used as an intrusion detection system, because any mechanical disturbances to the PM fiber will cause polarization coupling. Another important application is PM fiber quality inspection. The PXA-1000 easily identifies defective sections of PM fiber, enabling the manufacturers or users to remove them. Furthermore, the PXA-1000 is ideal for quality inspection and screening of PM fiber coils, since it can pinpoint the locations of imperfections or areas of local stress on the fiber coil induced during the fiber winding process. The PXA-1000 comes with a notebook computer equipped with PolaXView™ software, which displays the location and polarization coupling ratio of each stress point as a function of distance, and identifies stress points with polarization coupling above a user defined threshold level, with a list of the locations and polarization coupling strengths of all stress points. Other applications of the instrument include measuring the extremely high polarization extinction ratio of a polarizing waveguide, obtaining the autocorrelation function of a light source, measuring the birefringence of a PM fiber and the lengths of PM and SM fibers, and matching the optical path lengths of an interferometer.

Specifications:

Operation Wavelengths[1]	1310 or 1550 nm
Polarization X-Talk Measurement Sensitivity	<−75 dB (for DUT output power >5dBm) −80dB typical
Polarization X-Talk Measurement Noise Floor[2]	−95 dB
Polarization X-Talk Resolution	0.25 dB
Polarization X-Talk Repeatability[3]	±0.5 dB
Polarization X-Talk Accuracy[4]	±0.5 dB
Measurement or Sensing Range (Assuming PM Fiber Δn of 5 X10^{-4})	1.3 km or 2.6 km standard 3.1 km available
Measurement Speed[5]	8 s/ 100 m (with fiber Δn = 5 x10^{-4})
Spatial Resolution[6]	6 cm (assuming no fiber dispersion, birefringence Δn=5x10^{-4})
PER Measurement Range	> 30 dB
Spatial Accuracy[7]	±20 cm (fiber Δn =5x10^{-4})
Waveguide Polarization Dependent Attenuation	Up to 75dB (for DUT output power >5dBm)
LiNbO$_3$ Waveguide Spatial Resolution	0.75 mm
SLD Power	>7 dBm
SLD Bandwidth	>30 nm
SLD PER	>20 dB
Software	PolaXView™ data analysis/display software
Operating Temperature	10 to 50 °C
Storage Temperature	−20 to 60 °C
Power Supply	100-240VAC, 50-60 Hz
Communications Interface	USB 2.0
Display	Notebook computer with USB connection
Connector Type	PM narrow key FC/PC standard
Dimensions	2U, ¾ 19" rack width 3.5" (H) x 14" (W) x 14" (D)

Applications:

- Distributed stress sensing
- Structural change monitoring in bridges, tunnels, dams, and buildings
- PM fiber quality inspection
- PM fiber coil winding in-process monitoring
- PM fiber coil quality inspection
- Polarizing waveguide quality inspection
- Intrusion detection

Unique Features:

- High spatial resolution: 6 cm
- PM fiber as intrinsic sensing element
- −80 dB X-talk measurement sensitivity
- 30 dB PER measurement range
- Large fiber measurement range: 2.6 km
- Remote control option available for automated testing

Ordering Information:

PXA − 1000 − XX − XX− XX

Wavelength:
13 = 1310nm
15 = 1550nm

Range:
13 = 1.3 km
26 = 2.6 km

Connector Type:
FC/PC standard
FC/APC available

Notes:

1. Shorter wavelengths around 850 nm and 1060 nm available upon request.
2. Defined as the system noise displayed on the polarization X-talk curve when input light is turned off during a measurement for which the DUT output power >5dBm (See Fig. 1).
3. Defined as the standard deviation of twenty successive measurements of the amplitude of an X-talk peak between −15 and −40 dB.
4. At 23 ± 5°C. Guaranteed by design and calibration in manufacturing process.
5. Average speed for full-length scan.
6. Defined as the minimum resolvable distance between two polarization X-talk points of equal amplitude, based on Sparrow Criterion (two peaks of equal height overlap at 3dB point, resulting in a flat-top curve) and measured when the peaks are between −15 and −40 dB.
7. Defined as the standard deviation of twenty successive measurements of the distance of an X-talk peak of height between −15 and −40 dB from the X-talk peak induced by the input connector (zero position).
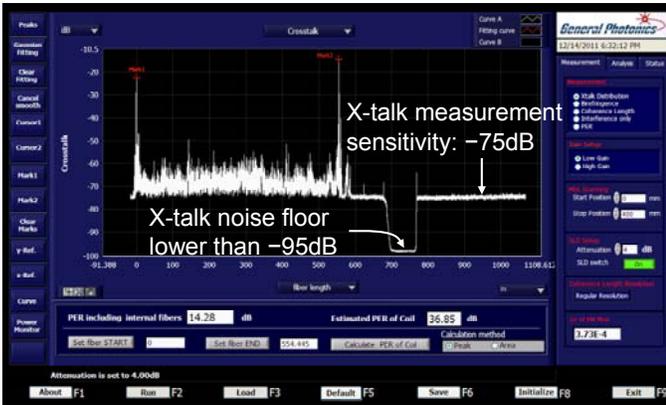
Typical Performance Data:

Figure 1: Instrument display showing the x-talk measurement sensitivity and x-talk measurement noise floor.
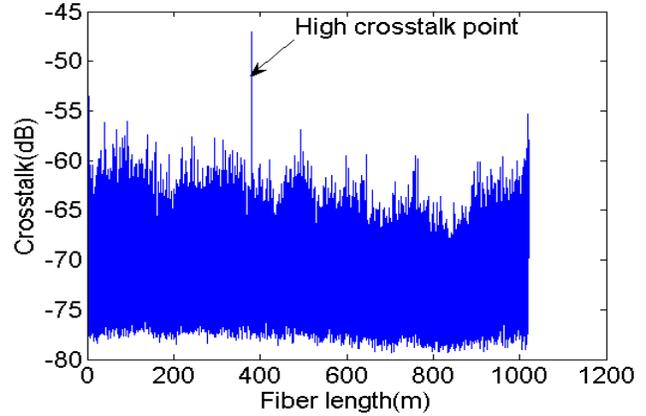

Figure 2: PM fiber quality inspection: Polarization x-talk measurement of 1000 m of raw fiber. High x-talk (−47 dB) is observed at 381 m.
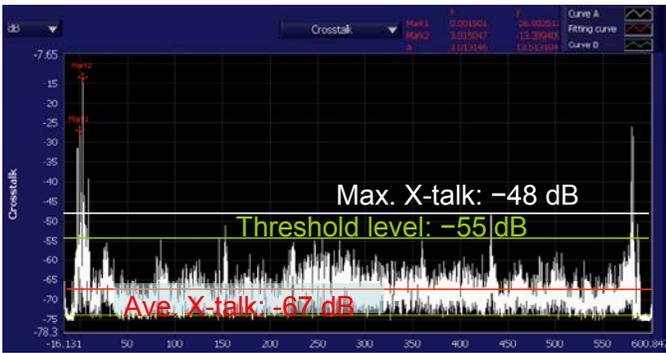

Figure 3. PM fiber coil quality inspection: Average and maximum polarization x-talk can be easily identified. In addition, the total number of x-talk peaks above a certain level (−55 dB in the graph) can be identified and their magnitudes and locations listed in a table.
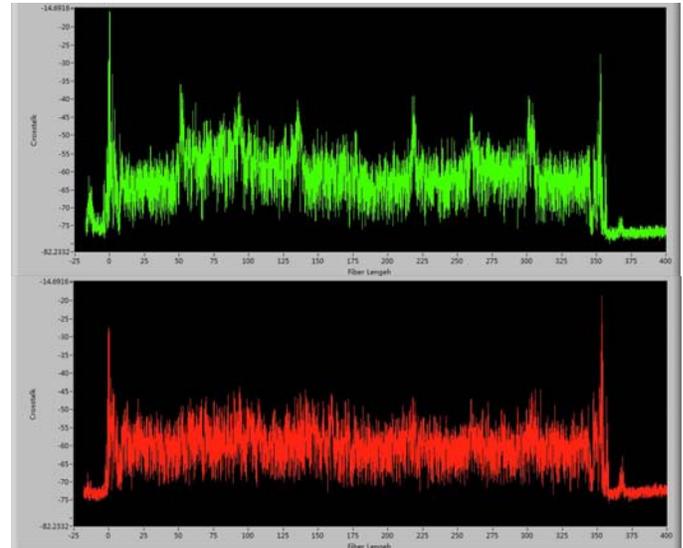

Figure 4. PM fiber coil manufacturing in-process monitoring. Green: In-line polarization x-talk measurement of a PM coil with quadrupole winding pattern from an initial winding trial. Red: In-line x-talk measurement of the same PM coil after adjusting winding procedure. The high x-talk peaks at cross-over points have been eliminated.
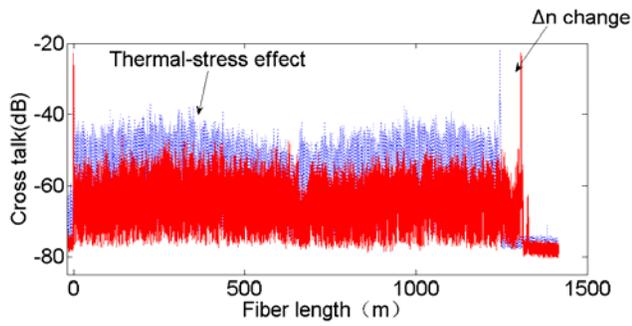
Figure 5. Measurement of thermal stress-induced polarization x-talk in PM fiber coils with quadrupole winding patterns. The temperature dependence of the fiber birefringence or beat length can also be determined from this measurement.
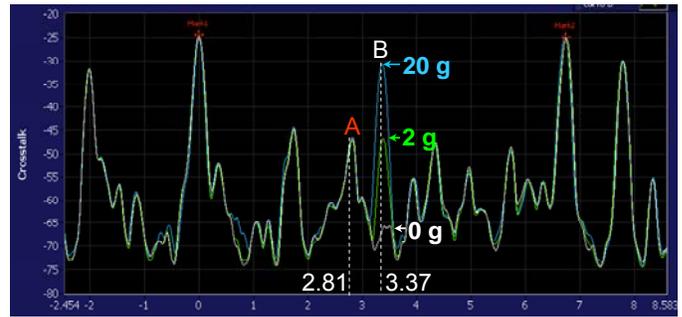

Figure 6: A 2 gram weight is placed on a straight PM fiber at position 2.81 m to induce an x-talk peak at point A. A second weight of varying mass is placed on the same PM fiber at position 3.37 m to induce an x-talk peak at point B. Three curves corresponding to 0, 2g, and 20g weights at point B are superposed in this figure to show that the instrument correctly identifies the stress induced x-talk at point B.