FIBER OPTIC TESTING

LUNA

DEFYING IMPOSSIBLE.

FIBER OPTIC TEST AND MEASUREMENT SOLUTIONS

We provide diagnostic and test instrumentation for the telecommunications industry, enabling complete characterization of optical components, assemblies, and short-haul networks. Our solutions provide substantial cost and time savings in development, production, and maintenance of next-generation optical network equipment. Our instruments provide the most comprehensive, sensitive and accurate component test available on the market today.

COMPONENT TESTING

- Arrayed Waveguide Gratings (AWGs)
- Filters
- Switches
- Wavelength Selective Switches (WSSs)
- Reconfigurable Optical Add-Drop Multiplexers (ROADMs)
- Couplers
- Planar Light-Wave Circuits (PLCs)
- Photonic Integrated Circuits (PICs)
- Tunable Dispersion Compensation Modules (TDCs)
- Fiber Bragg Gratings (FBGs)

NETWORK TESTING

- Measure transfer function of entire assembly
- Fault location and identification
- Data center length verification (skew)

PRODUCTION LINE TESTING

- Single instrument, comprehensive, fast measurement
- Pass/fail testing
- Quality inspection

OTHER TESTING

- Design verification/optimization
- Quality testing
- Accurate system modeling

TELECOMMUNICATIONS

Our test and measurement instruments make it possible for fiber-optic equipment manufacturers to diagnose and test the capabilities of optical components, assemblies, and short-haul networks. Luna's advanced solutions make it quicker and less costly to develop and produce next-generation optical network equipment that improves communications.

APPLICATIONS

The telecommunications industry relies on Luna to characterize and qualify component or assembly performance as well as to locate and identify flaws in networks and devices. Luna's equipment can also be used to monitor temperature and strain profiles inside a component or module using the in situ fiber.

Component Analyzers

Our Analyzers utilize swept wavelength interferometry to characterize any single-mode passive optical device yielding insertion loss, polarization dependent loss, optical phase, group delay, chromatic dispersion, and polarization mode dispersion; all as a function of wavelength; in a scan that takes less than 3 seconds.

Reflectometers

Our Reflectometers utilize swept wavelength interferometry to provide the industry's only zero dead-zone, high-resolution reflectometer. Our OBRs allow you to see inside your device or optical path to identify faults, measure individual insertion loss or return loss events, length, skew, group delay, and more.

Tunable Lasers

Our Phoenix™ C-band swept tunable laser is optimized for linear sweep and high wavelength accuracy. With an integrated wavemeter and two optical detectors, the Phoenix can be used for simple, accurate swept-wavelength measurements.

Optical Switches

Our optical switches can be integrated with our other test and measurement products to enable scalable testing for multiport devices or manufacturing applications.

COMPONENT ANALYZERS

The Luna Optical Vector Analyzer (OVA) 5000 is the fastest, most accurate and economical tool for loss, dispersion, and polarization measurements of modem optical networking equipment. It is the only instrument on the market providing all-parameter characterization of fiber components in a single measurement.

APPLICATIONS

- Verify optical designs in engineering
- Verify quality of components and modules in manufacturing
- Automate pass/fail testing in components and modules
- Characterize passive components
  - Wavelength tunable filters
  - Wavelength Selectable Switches (WSS)
  - Arrayed Waveguide Gratings (AWG)
  - Dispersion compensation modules
  - Reconfigurable Optical Add-Drop Multiplexers (ROADMs)
  - Integrated optical devices (PLC, resonators, etc.)

ADVANTAGES VS. ALTERNATIVE TECHNOLOGIES

- Single sweep of a tunable laser (other techniques require multiple sweeps)
- Capability to view the time domain response
- Capability to window out specific time domain artifacts to look at the spectral response of each artifact individually
- High-speed measurements, increasing throughput in testing
- Calibrates wavelength to a NIST-traceable standard on every measurement
- Measures the complete Linear Transfer function (or Jones Matrix) of the device under test

OVA 5000 — for the laboratory

KEY FEATURES

- Only instrument on the market providing all-parameter characterization of fiber components in a single measurement
- Performs full C+L band (or O band) characterization in under 3 seconds (30 ms measurement time per nm)
- Measures insertion loss (IL), polarization dependent loss (PDL), optical phase, group delay (GD), chromatic dispersion (CD), polarization mode dispersion (PMD), and more, as a function of wavelength
- Characterize devices up to 150m in length in transmission, 75m in length in reflection
- Optional software to convert OVA instrument to act as a Reflectometer

SRM 5T-50 — for the production line

KEY FEATURES

- Measures IL and GD of passive optical components up to 16 meters in length at 11.9 Hz update rate
- Full C band measurements with 1.0 pm spectral resolution and NIST-traceable 1.5 pm spectal accuracy

COMPONENT ANALYZERS COMPARISON

Specification	SRM 5T-50 (Pre-Release)	OVA-LP 5000	OVA 5000
Wavelength Range	C	C&L	O or C&L
Dynamic Range (dB)	65	80	80
Spectral Accuracy (pm)	1.5	1.5	1.5
IL	Yes	Yes	Yes
GD	Yes	No	Yes
PDL	No	Yes	Yes
PMD	No	Yes	Yes
Maximum Length Range (m)	16	150	150
Measurement Speed (sec)	0.084	3.0	3.0
*Measurement speeds vary with wavelength range. For more timing information, see product data sheets.			

SOFTWARE PACKAGES AND OPTIONS

Desktop Analysis	Provides all the benefits of OVA analysis without the instrument. Save data files from your OVA measurements and access anywhere that you have a computer.
Polarization Analysis	Combined with measurements from the OVA, this software provides a complete picture of your component's polarization dependence; allowing you to save time in calculations and measurement.
OFDR Option	Turns your OVA into a fault-finding reflectometer. With ~20 micrometer resolution, you can troubleshoot components, connections, cables & assemblies. Measures RL individually for each component down to -95 dB.

OPTICAL BACKSCATTER REFLECTOMETERS (OBRs)

Luna's ultra-high resolution Reflectometers offer backscatter-level sensitivity; providing unprecedented inspection and diagnostic capabilities for the fiber optics industry. They can pinpoint the smallest contributors to loss in fiber networks during the assembly process and well before final test; measuring insertion loss (IL), and return loss (RL) as a function of length of passive optical components and modules. They utilize swept-wavelength interferometry to measure backscattered light from within a device as a function of distance.

APPLICATIONS

- Verify quality of optical fiber cable assemblies, connectors, and short-run networks
- Troubleshoot and distinguish between macro-bends, splices, connectors, and breaks
- Verify return - and insertion - loss of multiple points in a fiber assembly or harness simultaneously
- Automate pass/fail verification of fiber assemblies
- Measure strain and temperature in optical components and networks
- Align optics in real time

ADVANTAGES VS. ALTERNATIVE TECHNOLOGIES

- High, sub-mm resolution with zero dead-zone
- High sensitivity
- Single connection IL and RL measurements with a single sweep of a tunable laser
- Capability to see the polarization state of the light as it propagates through an optical network
- Ability to use the same instrument for single mode and multimode fiber diagnostics
- Calibrates wavelength to a NIST-traceable standard on every measurement – does not require yearly factory calibration

OBR 4600 — for the laboratory

KEY FEATURES

- Industry-leading 10 micron spatial resolution with zero-dead zone
- Measure 30m of device length with 10 microns of resolution in less than 7 seconds
- Track changes in the state-of-polarization as light propagates through an optical network
- Diagnose both single mode fiber (SMF) and multimode fiber (MMF) using the same instrument

OBR 4200 — for the field

KEY FEATURES

- 500m length range with no dead-zone and millimeter resolution
- Small, rugged and easily transportable for field work
- Capability to “see” any event in a fiber assembly or network in both single mode and multimode fiber

OBR 5T-50 — for the production line

KEY FEATURES

- Industry-leading combination of measurement speed (11.9 Hz), range (8.5m), and accuracy (0.015%)
- High-sensitivity (-125 dB) and high-resolution (20 micron point-to-point)
- Streamlined software interface designed for ease of use and operation in manufacturing
- Automatically locates reflective events and yields IL, RL and event location and displays on the screen

REFLECTOMETERS COMPARISON

Specification	OBR 5T-50	OBR 4200	OBR 4600
Wavelength Range	C	1540 +/- 1nm	O or C&L
Sensitivity (dB)	-125	-125	-130
Event Resolution	0.02	1.5	0.01
IL Dynamic Range (dB)	10	16	18
RL Dynamic Range (dB)	65	50	70
Phase Measurement	No	No	Yes
Sensing	No	No	Yes
Maximum Length Range (m)	8.5	500	2000
Measurement Speed (sec)	0.084 (8.5 m)	3.8 (10.0 m)*	6.0 (30.0 m)*
*Measurement speeds vary with distance and scan mode. For more timing information, see product data sheets.			

PHOENIX TUNABLE LASERS

The Luna PHOENIX 1400 is a swept-wavelength, tunable external cavity laser designed for low noise and highly linear performance. It is perfect for a variety of fiber optic test, measurement and sensing applications, with polarization maintaining (PM) or single-mode (SM) fiber outputs available.

PHOENIX 1400

KEY FEATURES

- Full C-band tunability
- Smooth, linear sweeps
- Industry-leading wavelength accuracy and resolution
- Integrated wavelength and power monitors
- Superior noise characteristics
- Includes two optical receivers for acquisition of data

APPLICATIONS

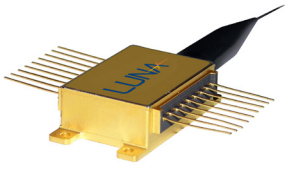
- DWDM component spectrum analysis
- Ideal source for OFDR systems
- Heterodyne measurements
- Bragg grating distributed sensing

ADVANTAGES VS. ALTERNATIVE TECHNOLOGIES

- Smooth, linear sweeps
- Integrated wavemeter with sub-picometer accuracy
- Narrow linewidth, low noise

ADDITIONAL LASERS AVAILABLE

PHOENIX 1000



MEMs-based, external cavity laser, based on the former Iolon ‘Apollo’ class of tunable lasers, offering low noise and precise tuning capability over the C-band.

PHOENIX 1200

Incorporates the PHOENIX tunable laser and driver in a compact package, with picometer accuracy and the industry’s first integrated wavemeter.

PUBLICATIONS & WHITE PAPERS

Fiber Optic Component Characterization Dispersion, PMD, Loss, Measurement

- Overview of optical vector network analyzer for single scan measurements of loss, group delay, and polarization mode dispersion
  - A white paper describing the Optical Vector Analyzer
  - May 17, 2005
- Interferometric measurement of dispersion
  - Introduction to using interferometry to measure dispersion in optical components
  - Mark E. Froggatt, Eric Moore, Matthew S. Wolfe
- Linear Systems Approach to Characterizing Components
  - Introduction to component characterization using linear systems theory
  - Mark E. Froggatt, Brian J. Soller, Eric Moore, Matthew S. Wolfe (March 20, 2002)
- Interferometric instrumentation combined with linear systems theory yields BER modeling from component measurement – SPIE magazine
  - Short introduction to how Optical Vector Analysis can be used to predict component performance based on eye-diagram and power penalty simulations
  - Brian J. Soller (September 2003)
- Optical vector network analyzer for single-scan measurements of loss, group delay, and polarization mode dispersion – Applied Optics magazine
  - Overview of method and theory behind the optical vector network analyzer's ability to complete single-scan measurements of loss, group delay, and polarization mode dispersion
  - Dawn K. Gifford, Brian J. Soller, Matthew S. Wolfe, and Mark E. Froggatt (December 2005)

Optical Frequency Domain Reflectometry High Resolution OTDR

- Optical Frequency Domain Reflectometry
  - Introduction to coherent optical frequency domain reflectometry (C-OFDR)
  - Brian J. Soller, Dawn K. Gifford, Matthew S. Wolfe, and Mark E. Froggatt (January 2005)
- Polarization resolved measurement of Rayleigh backscatter in fiber-optic components
  - Introduction to Optical Backscatter Reflectometry (OBR) with measurement examples
  - Brian J. Soller, Matthew S. Wolfe, Mark E. Froggatt (2005)
- Characterization of Polarization-Maintaining Fiber Using High Sensitivity Optical Frequency Domain Reflectometry
  - A paper by Luna Technologies staff that was published by the Journal of Lightwave Technology.
  - Mark E. Froggatt, Dawn K. Gifford, Stephen T. Kreger, Matthew S. Wolfe, and Brian J. Soller (November 2006)
- Return Loss Measurement in the Presence of Variable Insertion Loss Using Optical Frequency Domain Reflectometry
  - The high spatial resolution and high sensitivity inherent to optical frequency domain reflectometery enables precise measurements of distributed insertion loss and return loss events
  - Stephen T. Kreger, Mark E. Froggatt, Dawn K. Gifford, Matthew S. Wolfe, and Brian J. Soller
- Millimeter Resolution Reflectometry Over Two Kilometers
  - Millimeter resolution optical frequency domain reflectometry measurements are achieved over 2 km of length. This level of spatial resolution over kilometer distances enables unprecedented link characterization in emerging short-haul applications such as avionics and FTTx
  - Dawn K. Gifford, Mark E. Froggatt, Matthew S. Wolfe, Stephen T. Kreger, Brian J. Soller (September 2007)
- Mode Conditioner and Portable High-Resolution Reflectometer for Maintenance and Diagnostics of Single and Multi-mode Avionic Fiber Networks
  - Joseph J. Bos, Alex K. Sang, Mark E. Froggatt, Dawn K. Gifford (2011)

FIBER OPTIC SENSING

Our distributed sensing solutions offer high-resolution strain and temperature measurements using low-cost optical fiber as the sensor; providing unprecedented sensor density for your strain or temperature sensing application. Our systems can provide hundreds of measurement locations per meter of fiber with resolution of a few microstrain.

CHALLENGE

- Instrumenting complex parts easily
- Performing fatigue testing in composites
- Measurements that work at high strain levels
- Identifying small defects
- Mapping complex strain profiles

SOLUTION

- Fiber is extremely small and easily installed
- No drift or failure in large strain or high-cycle fatigue testing
- Provides +/- 10,000 microstrain measurement range (1%)
- ≥ 200 sensing points/m of fiber
- Fiber can be routed to map the strain in an area, not just a point

KEY FEATURES

- 5 mm or better spatial resolution
- Provides ≥ 200 sensing points per meter of fiber with a single connection
- Can measure strain profile vs. time, rather than just strain at a single point vs. time
- Excellent fatigue properties
- System identifies which sensor is connected
- Sensors are low profile
- Measurements correlate well with standard techniques

ADVANTAGES VS. FOIL GAGES

- Single connection, multiple sensors
- Inexpensive, easy to install
- Can see details foil gages would miss
- Fiber does not show fatigue like foil gages
- Can map complex strain profile
- Low cost of installation
- Chemically inert
- Immune to EMI/RFI
- Not an ignition source

APPLICATIONS

- Load, fatigue, and mechanical testing
- Composite manufacturing, engineering, and design verification
- Embedded sensing
- Structural health monitoring
- Model and simulation validation
- Temperatuare profile mapping

PRODUCTS

Distributed sensing allows customers to fully characterize their materials; offering the ability to test a structure at specific points of interest or continuously along the fiber with user-configurable sensing locations and gage lengths. In contrast to traditional discrete sensing solutions, fully distributed sensing provides a global view of the material.

Our sensing platforms provide insight into the performance, tolerances, and failure mechanisms of structures; enabling greatly reduced time, complexity, and expense of instrumentation and measurement for test applications.

ODISI A

Delivers fully distributed strain and temperature measurements with sub-cm spatial resolution, using optical fiber as the sensor

- Measurement ranges of ± 13,000 µStrain, -50 to 300 °C
- Repeatability of ± 2 µStrain, ± 0.2 °C
- Sub-cm spatial resolution
- Maximum sensing lengths of 50 meters

ODISI B

Delivers high speed, fully distributed strain and temperature measurements with 5mm spatial resolution, using optical fiber as the sensor

- 100 Hz acquisition over entire fiber
- 25 Hz active display over 1 meter
- Acquisition over 10 meter sensing range
- Measurement ranges of ± 10,000 µStrain, -50 to 300 °C
- Repeatability of ± 5 µStrain, ± 0.4 °C
- 5 mm spatial resolution

ABOUT LUNA

We are innovators, engineers, researchers and developers of technology; driving breakthroughs in fields as diverse as telecommunications, healthcare, energy, and defense.

Our innovation begins with excellence in research and develops into technologies that can be effectively commercialized. Our award-winning products provide all-parameter analysis of optical component and sub-assemblies allowing manufacturers and suppliers to reduce costs and time-to-market by improving component characterization and production schedules.

With more than 100 patents, our technologists are recognized as leaders in transforming science into solutions.

Among our innovations:

- Fiber-optic testing instrumentation for telecommunications
- Strain and temperature sensing systems that improve manufacturing and testing of composite, as well as non-composite materials, structures and systems
- Fiber-optic shape sensing for minimally-invasive surgical systems

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