Fiber Optic Sensors
Monthly Journal

August 2012

Monthly Journal by the ElectroniCast Fiber Optics Group

This is the ElectroniCast review and analysis of current market and technology trends relative to the consumption of communication-based fiber optic sensors. This monthly journal provides our clients with insights regarding the innovative applications of fiber optic sensors.

PUBLISHED ON AUGUST 3, 2012

ELECTRONICAST CONSULTANTS

4033M.0812

FOREWORD

This is the ElectroniCast review and analysis of market and technology trends relative to the consumption of communication-based fiber optic sensors, which ElectroniCast publishes an issue at the beginning of each month. The journal provides our clients with insights regarding the innovative applications of fiber optic sensors.

This month's journal has three sections:

- Selected ElectroniCast Briefs:
  - Brillouin Scattering Fiber Optic Sensors
  - Distributed Continuous Fiber Optic Sensors: Manufacturing/Factory
- Selected Highlights of Technology Presentations and Company News
- Calendar – Future Conferences

We believe you will find this journal useful for your planning of product and market development. Please contact us with any questions or comments.

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Brillouin Scattering Fiber Optic Sensors

Brillouin Scattering Brillouin scattering occurs when light in a medium (such as air, water or a crystal) interacts with time dependent optical density variations and changes its energy (frequency) and path. The density variations may be due to acoustic modes, such as phonons, magnetic modes, such as magnons, or temperature gradients. As described in classical physics, when the medium is compressed its index of refraction changes, and a fraction of the traveling light wave, interacting with the periodic refraction index variations, is deflected like in a three-dimensional diffraction grating. Since the sound wave, too, is traveling, light is also subjected to a Doppler shift, so its frequency changes.

For intense beams, such as laser light, traveling in a medium such as an optical fiber, the variations in the electric field of the beam itself may produce acoustic vibrations in the medium via electrostriction. The beam may undergo Brillouin scattering from these vibrations, usually in opposite direction to the incoming beam, a phenomenon known as stimulated Brillouin scattering (SBS). For liquids and gases, typical frequency shifts are of the order of 1–10 GHz (wavelength shifts of ~1–10 pm for visible light). Stimulated Brillouin scattering is one effect by which optical phase conjugation can take place. Brillouin scattering can also be employed to sense mechanical strain and temperature in optical fibers.

Researchers at the University of Southampton in the UK demonstrated a means of simultaneously measuring the Brillouin- and Raman-scattered radiation from a fiber; thereby as a result of those measurements, inferring both the temperature and strain with greater accuracy versus Brillouin scattering alone. The intensity of Raman-scattered radiation contains information about the temperature alone, and once the temperature is known, the strain can be computed from the frequency shift of the Brillouin signal.

The scientists used a narrow-linewidth laser at 1533.2 nm, together with a pair of erbium-doped fiber amplifiers and an acousto-optical modulator, as the probe source in their demonstration. A circulator separated the return signal from the fiber sensor and sent it to the detectors.

The sensor comprised four sections of fiber and was 1.3 km long, separated from the source/detector by 22 km of spooled fiber, demonstrating that the detector could be located a significant distance from the source/detector. The first section of the sensor (400 m) was in an oven at 60 °C. The second section (600 m) was at room temperature, was subjected to no strain and provided a reference signal. The third section (130 m) was suspended from a system of pulleys and loaded with weights to induce a known strain. The final section (200 m) served as a second reference section.

The acousto-optic modulator chopped the probe light into 100-ns pulses, enabling a spatial resolution of ~10 m in the fiber. The Raman-scattered light, shifted by approximately 100 nm, showed a clear intensity enhancement from the section of fiber inside the oven.

The Brillouin-scattered light showed a frequency shift from the section of the fiber in the oven and from the section stretched over the pulleys. From the results, the Southampton scientists calculated that the section of fiber in the oven was heated to 60 °C, consistent with the directly measured temperature. Knowing the temperature profile, they calculated the strain in the section of fiber stretched over the pulleys. As indicated by the irregular profile, the strain was not uniformly distributed because of friction in the pulley system. The resolution of the temperature measurement was ~6 °C, and the resolution of the strain measurement was ~150 με.

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Stimulated Brillouin scattering (SBS) is frequently encountered when narrow-band optical signals (e.g. from a single-frequency laser) are amplified in a fiber amplifier, or just propagated through a passive fiber. While the material nonlinearity of e.g. silica is actually not very high, the typically small effective mode area and long propagation length strongly favor nonlinear effects. For silica fibers, the Brillouin frequency shift is of the order of 10–20 GHz, and the Brillouin gain has an intrinsic bandwidth of typically 50–100 MHz, which is determined by the strong acoustic absorption (short phonon lifetime). However, the Brillouin gain spectrum may be strongly “smeared out” by various effects, such as transverse variations of the acoustic phase velocity or longitudinal temperature variations. Accordingly, the peak gain may be strongly reduced, leading to a substantially higher SBS threshold.

The Brillouin threshold of optical fibers for narrow-band continuous-wave light typically corresponds to a Brillouin gain of the order of 90 dB. (With additional laser gain in an active fiber, the threshold can be lower.) For trains of ultra-short pulses, the SBS threshold is determined not by a peak power, but rather by a power spectral density, as explained in a Spotlight article.

SBS introduces the most stringent power limit for the amplification and the passive propagation of narrow-band optical signals in fibers. In order to raise the Brillouin threshold, it is possible to increase the bandwidth of the light beyond the Brillouin gain bandwidth, reduce the fiber length, concatenate fibers with slightly different Brillouin shift, or (in high-power active fiber devices) exploit the longitudinally varying

temperature. There are also attempts to reduce the overlap of guided optical and acoustic waves, or to introduce significant propagation losses for the acoustic wave. To some extent, SBS problems can be reduced via basic amplifier design modifications, concerning e.g. the doping concentration, effective mode area and pump propagation direction.

On the other hand, the Brillouin gain can be used for operating a Brillouin fiber laser. Such devices are often made as fiber ring lasers. Due to low resonator loss, they can have a relatively low pump threshold and a very small line-width. The temperature dependence of the Brillouin shift can be used for temperature and pressure sensing (→ fiber-optic sensors).

Double Brillouin Frequency Shift Reported in Applied Optics, Vol. 49, Issue 20, pp. 3956-3959 (2010): A simple configuration for generating a double Brillouin frequency shift was demonstrated through the circulation of an odd-order Brillouin Stokes signal. It is operated based on cascaded Brillouin scattering in single-mode optical fibers that behave as the Brillouin gain media. A four-port circulator is incorporated into the setup to circulate the odd-order Brillouin Stokes signal in the fiber. It thus initiates a higher order Brillouin Stokes signal, which is double Brillouin frequency downshifted from the input signal. For the 5 km long fiber, the Brillouin pump power at 23 mW gives a clean output spectrum with 30 dB sideband suppression ratios. The output signal is 0.174 nm or ~21.7 GHz downshifted from the input signal.

Brillouin Sensors Brillouin sensors are excellent for detecting corrosion, buckling and micro cracks in large structures. The new Fiber Optic Distributed Strain and Temperature Sensor (DSTS) uses Brillouin scattering in optical fibers to measure changes simultaneously in both temperature and strain along the length of a standard, low-cost optical fiber. By wrapping or embedding a fiber inside a structure such as an oil pipeline or dam, users can detect when the structure is being strained or heated/cooled and allow the problem to be corrected before failure occurs. Such monitoring capability is invaluable in critical structures where failure could represent loss of lives or millions of dollars. The sensing fiber can also be used for telecommunications.

Progress in Distributed Fiber Optic Sensors Rayleigh, Brillouin and Raman scatterings in fibers result from the interaction of photons with local material characteristic features like density, temperature and strain. For example an acoustic/mechanical wave generates a dynamic density variation; such a variation may be affected by local temperature, strain, vibration and birefringence. By detecting changes in the amplitude, frequency and phase of light scattered along a fiber, one can realize a distributed fiber sensor for measuring localized temperature, strain, vibration and birefringence over lengths ranging from meters to one hundred kilometers.

Such a measurement can be made in the time domain or frequency domain to resolve location information. With coherent detection of the scattered light one can observe changes in birefringence and beat length for fibers and devices. The progress on state of the art technology for sensing performance, in terms of spatial resolution and limitations on sensing length is reviewed. These distributed sensors can be used for

disaster prevention in the civil structural monitoring of pipelines, bridges, dams and railroads. A sensor with centimeter spatial resolution and high precision measurement of temperature, strain, vibration and birefringence can find applications in aerospace smart structures, material processing, and the characterization of optical materials and devices.

Source:
Sensors 2012, 12, 8601-8639; doi:10.3390/s120708601; sensors ISSN 1424-8220;
www.mdpi.com/journal/sensors

Impact of ASE on Brillouin scattering of a single-frequency signal

Researchers from Laser Zentrum Hannover e.V., ant the Centre for Quantum-Engineering and Space-Time Research – QUEST, experimentally investigated the influence of amplified spontaneous emission within the Brillouin gain bandwidth on the Brillouin scattering of a single-frequency signal. The experiments were performed for the case of artificial amplified spontaneous emission (ASE) injected in backward direction into a passive fiber, as well as in forward direction of a low-power fiber amplifier.

A significant influence could be observed, when the ASE was counter-propagating to the signal. Injecting 160.6 nW of ASE within the Brillouin gain bandwidth led to a decrease of about 3 dB of the SBS-threshold of an approximately 335 m long passive fiber from about 80 mW to less than 40 mW. At a fixed signal power of 81 mW the backscattered power and the power in the Brillouin scattered Stokes maximum increased by a factor of 19.

Source: Optics Express, Vol. 20, Issue 10, pp. 10572-10582 (2012)
http://dx.doi.org/10.1364/OE.20.010572

Importance of residual stresses in the Brillouin gain spectrum of single mode optical fibers

Researchers from EDF R&D, Draka Communications, Institut Telecom/Telecom ParisTech, and the Université Paris Est, reported that residual stresses inside optical fibers could impact significantly on Brillouin spectrum properties. The researchers analyzed the importance of internal stresses on the Brillouin Gain Spectrum (BGS) for a conventional G.652 fiber and compared modeling results to measurements. Then the residual internal stresses have been investigated for a set of trench-assisted fibers: fibers are coming from a single preform with different draw tensions. Numerical modeling based on measured internal stresses profiles are compared with corresponding BGS experimental results. Clearly, Brillouin spectrum is shifted linearly versus draw tension with a coefficient of −20MHz/100g and its line-width increases.

Source: Optics Express, Vol. 20, Issue 2, pp. 1790-1797 (2012)
http://dx.doi.org/10.1364/OE.20.001790

Distributed Continuous Fiber Optic Sensors: Manufacturing/Factory

Most Factories and Process Plants Rely on Temperature and Pressure Measurements to Operate

Distributed Sensing provides measurements all the way down the line, instead of making measurements at discrete, pre-determined points. Distributed Temperature Sensing (DTS) makes continuous measurements over the full length of the optical fiber. As a result DTS is capable of detecting changes in temperature smaller than 0.01°C without prior knowledge of where that event might occur.

Distributed sensing is also real time – so you get continuous monitoring at all points along the cable at all times. Fast, frequent and accurate measurements of physical factors such as temperature, pressure or strain play a key role when it comes to ensuring the smooth operation of processes in many domestic, commercial and industrial settings. For example, most factories and process plants rely on temperature and pressure measurements to operate.

Conventional types of temperature control system are usually based on the use of point measurements: data gathered from individual sensors and gauges that measure single values at specific locations. This can limit the speed, accuracy and resolution of monitoring in many applications.

Distributed sensing, a technology that relies on analysis of light pulses reflected down optical fibers, offers a better and more efficient way to monitor changes in temperature and pressure. By using an optical fiber as the sensor, distributed sensing makes it possible to take real-time readings of temperature and strain every meter, along the fiber, which can be up to 60km long.

The Sentinel DTS is able to take temperature measurements every 1-5m along a fiber optic cable with coverage of up to 60km per unit. The Distributed Temperature Sensor illuminates the glass core of the optical fiber with a laser pulse of a 10 nano-second duration (this corresponds to a 1m pulse.)

As the optical pulse propagates down the fiber, it undergoes scattering even in the absence of impurities and structural defects. Part of this scattered radiation is known as Raman scattering. Because this vibrational energy is a well-defined function of temperature, the ratio of the signals is also. It is this ratio, in conjunction with the time of flight of an optical pulse, which is used to determine the temperature of the fiber at a given point.

According to BMP Enterprises, distributed sensing takes advantage of the fact that the reflection characteristics of laser light traveling down an optical fiber vary with the temperature and strain along its length. A distributed sensing system is made up of two basic components:

- The sensor. This consists of an optical fiber – usually a standard telecommunication optical fiber, which is normally housed inside a protective sheath to form a cable. The cable is then carefully placed to make the required measurements.

- The detector system. This includes a laser which fires light pulses down the optical fiber, and a detector, which measures the reflections from each light pulse. By analyzing these reflections it is possible to determine temperature and strain at all points along the optical fiber. With the help of more powerful lasers and more sensitive detection systems, measurements can be made using cables up to 60km long. But in a typical installation, where the fibre is looped around a building or in a process area, distances of several kilometers are more common.

The measurements themselves depend on four variables, or parameters:

- Distance, or range: the distance over which the measurements will be made

- Speed: the time required for each measurement

- Temperature resolution: the size of temperature changes that will be detected

- Spatial resolution: the smallest distance over which a change in temperature can be detected.

The trade-off between these variables determines the performance of the measuring system, and the choice of parameters usually depends on the nature of the application. Although distributed sensing systems are capable of recording a measurement every second, increasing the time intervals between measurements to minutes or hours makes it possible to achieve finer resolution results. The length of the optical fiber sensor also affects the resolution. To get the best results in each particular application, it is important to take into account the type and resolution of measurements required when deciding on the detection set-up.

The system can detect temperature changes as small as 0.01°C, but readings can take minutes to hours depending on the length of the fiber. Readings are typically presented as average readings over a meter length of fiber – e.g. the Sentinel DTS-SR obtains a 0.3°C resolution at 5km in 10 seconds with a 1m spatial resolution. Coarser resolutions – say every 10m – can be made more quickly.

Process & Plant The most common use for Distributed Temperature Sensing technology in process and plant monitoring is for cryogenic monitoring of (LNG) tanks. However, in recent years a number of other industrial uses have been identified including the monitoring of: process vessels for hotspots, production lines running temperature dependent processes, and conveyor belts. To determine if DTS technology is right for a specific industrial monitoring situation, the company (SensorTran) is developing solutions.

Advanced cryogenic plant monitoring solutions provide continuous, autonomous, on-line temperature monitoring of storage tanks and pipelines - providing tank and pipeline integrity monitoring, tank base temperature control, and pipeline cool-down monitoring. Besides LNG, DTS systems are useful in the monitoring tanks containing LPG, Ethylene, Ammonia, Oxygen, etc. Fiber optic sensing cables can be deployed:

- On Buried or Above Ground Storage Tanks
- On Single and Double-Wall Tanks
- On-Shore or On a Ship
-

Process & Plant applications often require customized fiber deployment schemes and integration of the DTS system / system data with other plant operations.

Dynamic Distributed Fiber Optic Sensing Luna Technologies is developing high performance sensing solutions. They have in development a dynamic distributed sensing system that uses optical fiber consisting of continuous Fiber Bragg Grating (FBG) sensors. With measurement rates of up to 1 kHz, cost effective fiber sensors, and significantly reduced installation time compared to equivalent foil strain gauges, this technology is ideal for obtaining dynamic strain data over a continuous object – something no other technology can achieve. This enabling technology has applications in:

- Dynamic structural health monitoring
- Model & simulation validation for mechanical structures & prototypes
- Control systems
- Process optimization for power generation
- Composite system design & engineering
- Medical systems
- Mechanical vibration

Selected Highlights of Technology Presentations and Company News

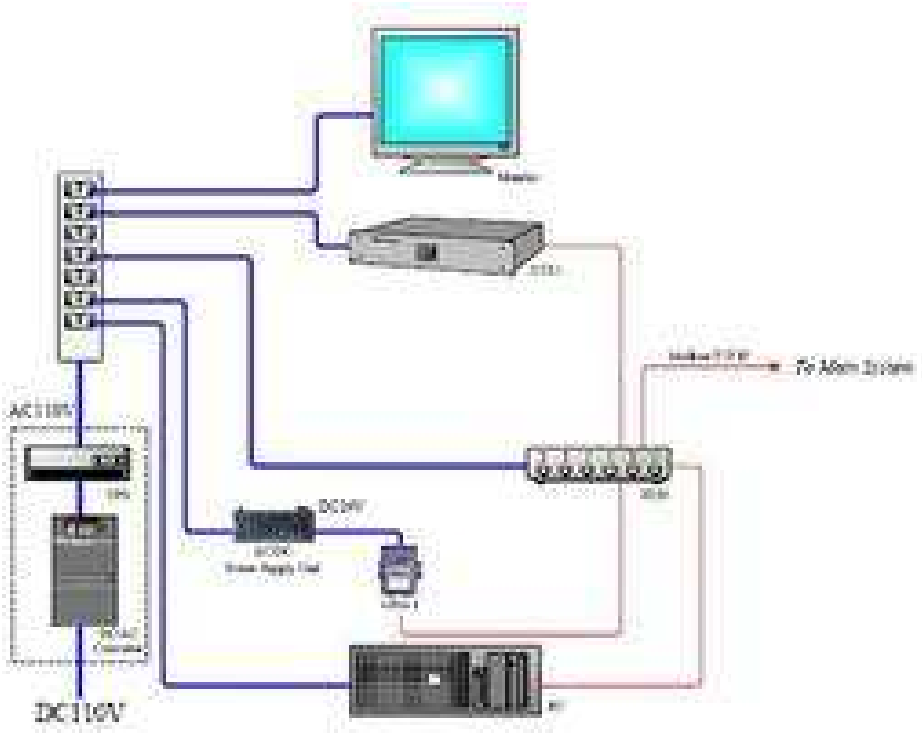
Taiwan Mass Rapid Transit Selects AP Sensing for Power Cable Monitoring

AP Sensing, together with their local partner NEC, have been selected to monitor the power cable in a brand new metro tunnel. This is the first monitoring system for a power cable to be used in the Taiwan MRT.

The Linear Power Series continuously monitors the temperature of high-voltage power cables that serve the Songsan and Xinyi metro lines. The DTS (Distributed Temperature Sensing) solution enables a stable; safe and efficient power transmission and distribution.

Together, both lines have over 80km of sensor fiber installed. They provide real-time, continuous temperature monitoring of the power cable in the tunnels, greatly enhancing the security of the underground MRT station and its passengers, as well as protecting valuable metro assets.

System Configuration Two Linear Power Series DTS units monitor the power cables in the metro lines, and each unit is equipped with one interface box to access via the Modbus protocol over RS232, RS422 and RS485, as well as over TCP/IP.



Accordinbg to AP Sensing, their solution best fulfilled the customer requirements: a very high level of overall system reliability in order to protect valuable assets and ensure passenger safety.

The Linear Power Series uses a class 1M laser, which is inherently safe and enables continuous operation even in case of a fiber break. Its open interfaces (LAN / Modbus) allow for easy integration to SCADA systems. With the lowest failure rate in the industry, AP Sensing provides a stable and virtually maintenance-free temperature monitoring solution.

Source Link: http://www.apsensing.com/not-in-menu/news-details/?tx_ttnews%5Btt_news%5D=51&cHash=ecb63c3e3e

Solid State Gyro Compass Introduced by Alphatron

Alphatron Marine adds a fiber optic heading sensor to its gyro compass product range. The small light-weight fast setting device, contains a fiber optic and 1Xblue core as sensor reference, and is fully approved by class and is MED wheel-marked.

The Fiber Gyro compass is directly connectable to a variety of ancillaries via a unique galvanically isolated docking station, among them are bearing repeaters, OSV approved interswitches, Digital repeaters repeater stands and brackets.

Due to its extreme robustness and size as well as the output of roll and pitch information as second signal, the company is targeting the high-end market of the marine industry:

- Fast crew suppliers
- Rigid inflatable (RIB)
- Dredgers
- Platform suppliers and anchor handlers
- DP classed vessels
- Various offshore applications
- Patrol vessels
- Chemical tankers
- Fast ferries
- hand carried survey tool kits

High-current-sensitivity all-fiber current sensor based on fiber loop architecture

Research Paper - In this paper, researchers demonstrate a novel all-fiber current sensor using ordinary silica fiber. The sensor employs a fiber solenoid as a current sensor head, which improves the current sensitivity by allowing optical signals to traverse the sensor head repeatedly. Theory and experiment prove that the improvement in sensitivity increases periodically with the number of repetitions of optical signals circulating round the loop.

Optical current sensors (OCSs) have been a topic of research since the 1970s because of their immunity to electromagnetic interference (EMI), safety, and low weight in comparison with traditional current sensors. Among the OCSs, all-fiber current sensors are mainly based on the Faraday magneto-optic effect and are particularly attractive because they have better optical integration than other OCSs such as bulk-glass current sensors or space coupling optical current sensors. In other words, an all-fiber current sensor consisting of passive fiber components has a relatively simple construction and can be fabricated and maintained easily.

However, one disadvantage of the all-fiber current sensor is its low current sensitivity. Compared with the sensor media of bulk-glass current sensors, the conventional silica fiber has a very low Verdet constant, and thus, a very long fiber is necessary to achieve a comparable sensitivity. However, a long fiber increases both the size and the birefringence of the system, the latter of which reduces the actual sensitivity below that predicted by theory. Another method of enhancing the sensitivity is the use of a doped fiber, which possesses a high Verdet constant, such as a terbium-doped fiber or europium-doped fiber; however, the use of a doped fiber increases cost as well as the temperature sensitivity because the Verdet constant is highly dependent on.

As a well-developed optical architecture, the fiber loop has enormous application in many areas, such as laser, sensor and optical. The main advantages of designs using the fiber loop architecture include high flexibility, low cost, and good extensibility. These characteristics can also be implemented in the optical current sensor. For example, an experiment using a fiber loop resonator to enhance sensitivity on optical current sensor has been reported since the 1980s.

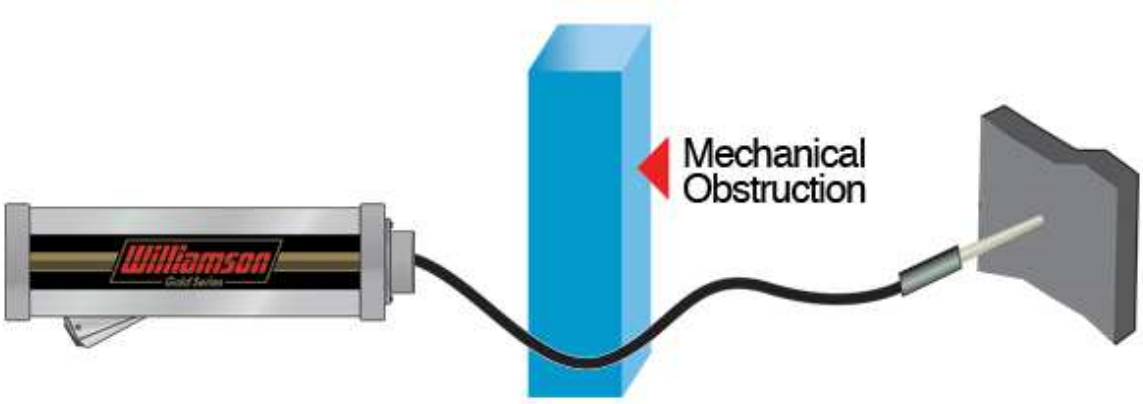
In this paper, researchers demonstrate an all-fiber current sensor based on the fiber loop architecture to improve current sensitivity. A fiber solenoid is employed as the current sensor head of a fiber loop. The optical signal can traverse the sensor head repeatedly so that the Faraday rotation angle is increased and the current sensitivity is enhanced correspondingly. This design exploits the advantages of the fiber loop and makes a minimally sized conventional silica fiber current sensor possible. Furthermore, it has a series of current sensitivities to satisfy various requirements. Experiments reveal that the sensitivity increases in an oscillatory, non-linear manner with increasing circulation of the optical signal through the fiber solenoid

Source: Optics Express, Vol. 20, Issue 17, pp. 18591-18599 (2012)
http://dx.doi.org/10.1364/OE.20.018591

Williamson Corporation
http://www.williamsonir.com/

Williamson specializes in short-wavelength single-wavelength sensors, dual-wavelength sensors, multi-wavelength sensors, fiber-optic sensors and application-specific sensors, with innovative and unique capabilities in each category of infrared thermometer.

The fiber optic sensors use a small, sealed fiber optic cable to view the target while the sensor is mounted in a remote or more convenient location. This provides greater durability and flexibility with sensor installations that involve confined spaces or severe environments. The fiber cables can range in length from 3 to 30 feet (1-9 m). In addition to standard fiber optic cables Williamson offers the following options.



ArmorGuard (AG) System - A heavy duty, flexible, stainless steel armored fiber optic cable conduit with two layers of insulation and an air purge for maximum protection against flame impingement and high ambient temperatures.

Stainless Steel Braid System (SSB) - A flexible, lightweight fiber optic cable conduit with a durable inner Teflon sleeve and an air purge for general-purpose protection in industrial installations.

Monofilament Fiber Cables (MN) - Feature a Teflon sheathing and Teflon outer jacket. They offer a smaller diameter of 0.05in 1.3m and non-conductive packaging. Ideal For applications with very confined spaces and a high potential for unwanted electromagnetic interference.

SCHOTT North America, Inc.
http://www.us.schott.com/english/index.html

A sensor measures a physical quantity and converts it into a signal, which can be read by an observer or an instrument. Fiber optics are very often an essential component of sensors in environments with high temperatures or in explosive surroundings. The company also offers custom tailored software, an additional key component for any sensor. Lighting and Imaging is your professional contact when it comes to design sensors that are easily to install and operate. They focus on fiber optical systems to determine temperature, flow or pressure.

OPTRAND, Inc.
http://www.optrand.com/

Optrand specializes in the development and manufacturing of static and dynamic Pressure Sensors for continuous monitoring and control, as well as testing and diagnostic applications.

The sealed-gauge sensors utilize one or multiple optical fibers positioned in front of a flexing metal diaphragm. The intensity of the reflected light is proportional to the pressure induced deflections of the diaphragm. The patented sensor head, diaphragm and the auto-referencing technique guarantee long-term reliability required in OEM monitoring and control systems.

The long-life (up to 1 billion cycles or 3 years), low-cost sensors are offered in various packages as small as 1.7 mm in diameter and pressure ranges from 0-100 psi (7 bar) to 0-30,000 psi (2000 bar). These sensors are designed for continuous operation in harsh conditions of high temperature up to 350°C (e.g., combustion), high Electro-Magnetic and Radio Frequency Interference fields (EMI/RFI), and chemically volatile and explosive environments. Sensors require neither water nor air-cooling.

Miniature size, dielectric nature and resistance to high temperature make Optrand sensors ideal for integration with Spark Plugs, Direct Fuel-Injectors or Glow Plugs for non-intrusive real-time cylinder pressure measurements.

AutoPSI sensors have the signal conditioner incorporated into a small metal shell permanently connected to the end of 2m (6.5') fiber-optic cable. The AutoPSI-S offers the most economical solution for dynamic pressure measurements. The temperature-compensated AutoPSI-TC sensor matches the perfomance of water-cooled transducers. The AutoPSI-HT comes with the signal conditioner rated for 125°C and a three year lifetime guarantee.

Lake Shore Cryotronics, Inc.
http://lakeshore.com/

Established in 1968, Lake Shore Cryotronics specializes in precision measurement in extreme environments. The company's scientific sensors, instruments, and metrology systems are the choice of professionals requiring dependable, accurate measurement and control. Lake Shore is the world leader in cryogenic temperature sensors and expert in high precision metrology and materials characterization applications involving extreme temperature, magnetic field, radiation, vibration, and pressure environments. An ISO 9001:2008 certified supplier providing sales and support in over 40 countries, Lake Shore is a well-respected brand in academic research, national lab, and technology industry markets.

Lake Shore offers an expanded line of terahertz and IR band-pass filters for enhancement of low signal measurement in imaging, astronomy, and spectroscopy applications. The precision, frequency-selective gold film devices are radiation hard and cryogenically stable, and have proven themselves on NASA missions and in a variety of research programs. A new wide-range fiber optic temperature sensor, suitable for use on satellites and in extremes of pressure/vacuum and temperature, is also available.

Lake Shore's systems products include cryogenic probe stations that provide convenient, repeatable platforms for characterizing performance of new electronic and photonic devices over a wide range of temperatures. Precision Hall effect measurement systems enable developers of solar cells, organic electronics, and novel semiconductor devices to measure the physical properties of promising new photonic and electronic materials — the new Model 8404 system, with its unique AC field option, enables reliable measurement of the very low mobility materials now being considered for these new devices.

These Fiber Optic Sensors provide unmatched convenience and applicability for researchers, aerospace, and industrial users that need to provide accurate temperature measurements in extreme environments. The unique packaging allows for direct sensor placement without interfering with the multiplexing and chaining capabilities of Fiber Bragg Grating based sensors. Lake Shore's Fiber Optic Sensors are ideal for advanced research, aerospace, and industrial applications due to their cryogenic operating capability and wide measurement range. An all-dielectric package is especially suited for measuring in places with high electrical noise or magnetism, such as plasma and high-energy test labs.

Lake Shore's Fiber Optic Sensors feature the following:

- Unique, compact, rugged packages
  - Single-end cabling lets you position sensors right where you want them
  - Built-in holes for convenient mounting
  - Multiple package types - all dielectric thermoplastic, copper, or stainless
  - Hermetically sealed, IP68-compliant sensor bodies allow wet operation
  - Double-ended fiber connections enable sensor chaining/multiplexing
  - Tough cable sheathing with Kevlar strength member

- Wide 450° measurement range
  - Cryogenic operation in liquid nitrogen—all packages
  - Excellent sensitivity
  - Rapid thermal response
  - ±0.5° repeatability over entire range

- Dependable measurement performance
  - High accuracy and resolution
  - High stability
  - Impervious to EMI
  - Low radiation effects
  - Vibration qualified
  - NIST-traceable calibration

Leuze electronic Expands Fiber Optic Sensors Line Leuze electronic announced the release of new fiber optic amplifiers and cables to provide an expanded range of sensing solutions. The new low cost LV461 amplifier provides a potentiometer for sensitivity adjustment, light/dark selectable switching and the ability to choose a shorter response time or a wider range.

The LV462 provides a digital display and can be easily adjusted by either the AutoSet function, or manually via +/- buttons. Various ranges and sensitivities as well as time functions can be set easily via menu selection.

The LV463 fiber optic amplifier with dual displays will be added to the product range in the third quarter of 2012. This device displays the received signal and the switching threshold simultaneously, and also provides extensive setting options through its menu interface. An optional IO-Link interface will be added in the fourth quarter that adds dual channel output and PLC configuration capability.

The new KFX series plastic fiber optic cables are available in 27 different models, and are equipped with high-quality bending protection on the optical outlet side to prevent damage in challenging applications. In addition, the existing KF series fiber optic cables offer new special head shapes for a wide range of applications to further expand their application capabilities.

Joe Panozzo, Leuze USA Product Manager for Sensors and Logistics Products says – “Leuze electronic wants to be the first choice for sensor solutions. These expanded fiber optic offerings enable us to provide an even wider range of sensing solutions than in the past”.
http://www.leuzeusa.com

Luna Innovations Launches Upgraded Version of ODiSI Sensing Platform

Advanced fiber optic technology provides quicker, more accurate testing of composite material

Luna Innovations Incorporated (NASDAQ: LUNA) launched the latest distributed fiber optic sensing platform that is 20 times faster and half the cost of its previous ODiSI (Optical Distributed Sensor Interrogator) instrument.

The ODiSI B model provides greater insight into the performance, tolerances and failure mechanisms of composite structures and vehicles. With thousands of sensing locations on a single optical fiber, the technology lets customers know what's happening inside a composite structure during manufacturing and testing.

"One of our key growth strategies is to become the leading provider of sensing systems for testing composite materials," said My Chung, CEO of Luna Innovations. "Last year we introduced our ODiSI platform to address this market. Based on customer feedback, we've developed an upgraded product that offers much faster measurement speed at half the price of our previous platform. Luna is committed to evolving our solution to respond to the needs of the composite market, particularly for new aircraft and wind turbines."

The ODiSI B introduction comes as total demand for composites is growing; with global composite material shipments projected to reach $29.9 billion by 2017.

First introduced in August 2011, the ODiSI product line supports the exacting standards of the aerospace, automotive, energy and other composites industries where high-density strain or temperature measurements are required for structural or mechanical testing.

Luna's ODiSI platform provides a number of advantages over traditional strain gages. It uses low-cost optical fiber to provide unprecedented sensor density, with hundreds of measurement locations per meter of fiber. The fiber is small, rugged and easy to install, while the glass structure of the fiber makes it ideal for fatigue testing under high strain as needed with composite materials.

While a normal strain gage has one sensing point per channel and requires multiple connections per sensed location, Luna's sensing solution provides thousands of measurement points per fiber with one connection for all of these sensors. Luna's ODiSI B provides these benefits with a per-sensor cost well below that of traditional foil gages.

"Luna Innovations is improving the way composite materials are tested and validated for peak performance and safety, and customers are starting to embrace our technology," Chung said.

About Luna Innovations

Luna Innovations Incorporated (www.lunainnovations.com) focuses on sensing and instrumentation. Luna develops and manufactures new-generation products for the healthcare, telecommunications, energy and defense markets. The company's products are used to measure, monitor, protect and improve critical processes in the markets it serves. Through its disciplined commercialization business model, Luna has become a recognized leader in transitioning science to solutions.

Micron Optics, Inc. to Share Significant Cost Savings with its Customers

Micron Optics, the leading provider of innovative equipment for fiber optic sensing and laser imaging, announced significantly reduced pricing for its dynamic line of optical sensing interrogators. Effective immediately, dynamic interrogator list prices are reduced up to 50%, and a full-featured interrogator model is now available for under US $10,000.

All optical sensing interrogator models continue to include Micron Optics' ENLIGHT Sensing Analysis software. The software package combines traditionally useful features of conventional sensor software with the specific needs of the optical sensing system.

While optical sensing systems have long provided the means to make measurements in applications where conventional sensors cannot, the high cost of the field-proven, reliable optical sensor systems have limited the scope and practicality of some deployments. Micron Optics' new optical sensing interrogator price structure means that civil engineers and other optical system integrators do not have to choose between price and performance when selecting a sensor system for buildings, bridges and other structures monitored for public safety.

"The steady maturation of fiber optic sensing applications has manifested in strong and steady growth of world demand for our interrogators. Our company's proactive response manufacturing strategies include volume purchases of select raw materials and new manufacturing technology processes that increase production enable Micron Optics the opportunity to enthusiastically share the savings we have gained with our customers though our new breakthrough prices" said Andrei Csipkes, Chief Operating Officer, Micron Optics, Inc.

Micron Optics is committed to increasing the accessibility of its industry leading optical sensing equipment to the widest audience of commercial and industrial applications, engineering centers, science organizations and other users. These dramatic product price reductions will enable more users to realize the inherent benefits of fiber optic sensing technology in a broad array of applications without having to compromise reliability or performance.

About Micron Optics, Inc.

Micron Optics' optical sensing and imaging products make impossible measurements possible, revealing new, critical information for Infrastructure, Energy, Transportation, Medical and Industrial sectors. Since 1990, Micron Optics has been expanding its core capabilities from tunable optical components and leading-edge instrumentation and software, to complete optical sensing systems. Based in Atlanta, Georgia, USA, Micron Optics is a privately held company. For more information, visit http://www.micronoptics.com

Acorn Energy Companies DSIT and US Seismic Collaborate to Win $900,000 BIRD Development Grant

Acorn Energy, Inc. (NASDAQ:ACFN), announced that two of the Acorn Energy portfolio companies, DSIT Solutions Ltd. and US Seismic Systems Inc., were awarded a $900,000 grant from the BIRD Israel/U.S. Bi-national Industrial Research and Development Foundation.

The grant is being awarded for the joint development of the next generation integrated passive/active threat detection system for underwater site protection. The BIRD Foundation provides funding money for projects involving joint innovation and development between American and Israeli companies.

John Moore, CEO of Acorn commented, "We encourage all of the Acorn portfolio companies to take advantage of synergies within the Group in order to reach company goals faster and better. In this case we are very pleased to see that USSI and DSIT are cooperating on a very exciting project that has generated serious interest and funding from the BIRD Foundation. USSI, a company with vast experience in the field of fiber optic seismic sensors, has developed revolutionary, state-of-the-art fiber optic underwater passive sensors. DSIT is a world leader in active Diver Detection Sonar systems. Both companies bring to the project their unique expertise and experience, in order to develop and integrate a very comprehensive passive/active underwater security system that will meet the needs of water bound energy facilities, offshore platforms, ports and harbors."

The integrated passive/active underwater security system that is the subject of this grant is potentially the most comprehensive system of its kind available. The advantages of combining the world's best passive and active sensors will lead to an underwater system that provides extremely efficient and effective coverage of all areas of a site. The combined system will be designed to provide a much greater probability of threat detection with a lower rate of false alarms for all types of threats.

The BIRD Foundation grant is designated to cover 50% of the development costs of the project over a period of two years. The grant calls for the signing of a Cooperation and

Project Funding Agreement between the companies and the BIRD Foundation within 3 months to enable commencement of the funding. Dr. Eitan Yudilevich, the Executive Director of the BIRD Foundation: "BIRD's support of U.S./Israel partnerships has led to very significant successes during its 35 years of existence. These partnerships have contributed to both the U.S. and Israel, by promoting innovation and reducing the risks of joint projects. This project is a great example of the special U.S./Israeli synergy in the area of Homeland Security".

About the BIRD Foundation

The BIRD (Binational Industrial Research and Development) Foundation works to encourage cooperation between Israeli and American companies in the various areas of technology, and provides assistance in locating strategic partners from both countries for developing joint products. Approaching its 35th birthday, the BIRD Foundation has invested in close to 830 projects, which have yielded revenues of about $8 billion. The BIRD Foundation supports projects without receiving any rights in the participating companies or in the project itself. The financial assistance is repaid as royalties from sales. The Foundation provides support of up to 50% of a project's budget, beginning with R&D and ending with the initial stages of sales and marketing. The Foundation shares the risk and does not demand that the investment be repaid if the project fails to reach the sales stage. The BIRD Foundation works in full cooperation with the Chief Scientist's Office at the Ministry of Industry, Trade, and Labor in Israel, and with the U.S. Commerce Department's National Institute of Standards and Technology (NIST).

About US Seismic Systems, Inc.

US Seismic Systems, Inc. designs, integrates, manufactures and sells fiber optic sensing systems and solutions for the Energy and Defense markets. USSI utilizes all-optical fiber sensing technology for its state-of-the-art sensors. USSI's proprietary optical fiber and electronics combine to form the sensor system, which is designed to replace the legacy electronic-based sensor systems at a lower cost and with improved performance and reliability. www.ussensorsystems.com

About DSIT

DSIT develops sonar and acoustic solutions and acts as a system integrator for advanced Security Command and Control systems. The Company's offerings are designed to provide the latest in technology and its intelligent application for the energy, commercial, defense and homeland security markets. The Company's offerings include: AquaShield - Diver Detection Sonar (DDS), PointShield - Portable DDS, Sonar Simulators and Trainers, MAR - Portable Acoustic Ranges, Underwater Acoustic Signal Analysis (UASA) systems, and Sonar Upgrade Programs (SUP). www.dsit.co.il

About Acorn Energy, Inc.

Acorn Energy, Inc. (NASDAQ: ACFN) is a holding company focused on making energy better by providing digital solutions for energy infrastructure asset management. The four businesses in which it has controlling interests improve the world's energy infrastructure by making it: more secure - providing security solutions for underwater energy infrastructure (DSIT); more reliable - providing condition-based monitoring to critical assets on the electric grid (GridSense, OmniMetrix) and more productive and efficient/increasing oil and gas production while lowering costs through use of permanent ultra-high sensitive seismic tools that allow for a more precise picture of reservoirs (US Seismic). www.acornenergy.com

Long-distance fiber-optic point-sensing systems based on random fiber lasers

Researchers reported that the random fiber laser (RFL) without point-reflectors is a temperature-insensitive distributed lasing system for the first time. Inspired by such thermal stability, they propose the novel concept of utilizing the RFL to achieve long-distance fiber-optic remote sensing, in which the RFL offers high-fidelity and long-distance transmission for the sensing signal.

Two 100km fiber Bragg grating (FBG) point-sensing schemes based on RFLs are experimentally demonstrated using the first-order and the second-order random lasing, respectively, to verify the concept. Each sensing scheme can achieve >20dB optical signal-to-noise ratio (OSNR) over 100km distance. It is found that the second-order random lasing scheme has much better OSNR than that of the first-order random lasing scheme due to enhanced lasing efficiency, by incorporating a 1455nm FBG into the lasing cavity.

Source: Optics Express, Vol. 20, Issue 16, pp. 17695-17700 (2012)
http://dx.doi.org/10.1364/OE.20.017695

Calendar – Future Conferences:

12 - 16 August 2012
SPIE Optics + Photonics Exhibition
San Diego Convention Center
San Diego, California, United States
http://spie.org/x30535.xml

See more than 230 companies displaying the latest in optical components, devices, and materials for a variety of important technologies (such as biomedical optics, organic photonics, nanotechnology, and solar energy).

September 4-7, 2012
25th International Conference:
Shipbuilding, Machinery and Marine Technology (SMM)
Hamburg, Germany
http://smm-hamburg.de/en/

SMM is the leading international forum of the maritime industry. Every two years, the representatives of the shipbuilding and marine equipment industries from all parts of the world meet in Hamburg, present innovations and forward looking technologies, and set the course for future success of the industry.

Oct 14-19, 2012
2012 - 22nd International Conference on Optical Fiber Sensors (OFS-22)
Beijing, China
Website: http://www.ofs-22.org

Venue: China Hall of Science and Technology, Beijing, China

The International Conference on 'Optical Fiber Sensors' is acknowledged as the world's leading conference on all topics related to fiber-optic, guided-wave and optical sensing devices, systems, theories and techniques for research and applications. The first OFS was held in London, in 1983. Since then it has become established as the leading forum. The conference is held approximately every eighteen months, rotating between the Americas, Europe and Asia/Pacific. OFS-22 will be held in Beijing from 15-19 October 2012. It will be the first time that China hosts the OFS conference. OFS-22 will offer invited and contributed paper presentations both in oral sessions and poster sessions, special workshops, and an exhibition of commercial products, as well as social and cultural events.
Main topics:
• Physical, Mechanical, and Electromagnetic Sensors
• Chemical and Environmental Sensors

• Biological and Medical Sensors
• Fiber Optic Gyroscopes
• Fiber Grating Sensors
• Photonic Crystal Fibers and Sensors
• Micro- and Nano-structured Fiber Sensors
• Distributed Sensing
• Multiplexing and Sensor Networking
• Smart Structures and Sensors
• Passive and Active Devices for Photonic Sensing
• New Fibers and Coating Materials for Sensing
• Sensor Application, Field Tests and Standardization
• Slow and Fast Light, and Other Emerging Technologies for Sensing

Special Workshops:
• Fiber Optic Gyroscopes
• Industrial Progress, Commercial Systems and Field Tests.

PACK EXPO International
October 28-31 2012
McCormick Place
Chicago, IL (USA)
http://www.packexpo.com/pei2012/public/MainHall.aspx?ID=1266

With an expanded focus on processing and integrated processing-packaging systems, PACK EXPO International 2012 is the one and only place to find the total solutions to help your business stay ahead of the curve. No other show in the industry can match the impact or promise PACK EXPO International holds for your business.

November 6-8, 2012 Berlin, Germany
2012 4th Civil Structural Health Monitoring Workshop (CSHM-4)
For additional information contact Wolfgang.habel@bam.de

Wolfgang R. Habel, Ph.D., the organizer, will announce details of the workshop in December 2011. The 2012 Civil Structural Health Monitoring Workshop will be held at the Bundesanstalt für Materialforschung und-prüfung (BAM), the Federal Institute for Materials Research and Testing.
2013 -- 6th International Conference on Structural Health Monitoring of Intelligent Infrastructure (SHMII-6)
SHMII-6 Hong Kong, China 2013

The 6th International Conference on Structural Health Monitoring of Intelligent Infrastructure, SHMII-6 2013, will provide a forum for international scientists, engineers, enterprises and researchers to discuss recent advances in smart sensors, wireless sensor networks, signal acquisition and processing, real-time data transferring and management, structural health diagnosis and prognosis, life-cycle performance

assessment, and to explore the potential for international cooperation. Participants will be able to share innovative ideas on the state-of-the-art, state-of-the-practice and future trends of smart sensors, advanced sensor networks and integrated systems for structural health monitoring of intelligent infrastructures.

SHMII-6 2013 is the official conference of the International Society for Structural Health Monitoring of Intelligent Infrastructure (ISHMII) and is organized by the Department of Civil and Structural Engineering, The Hong Kong Polytechnic University.

TOPICS
- Smart sensing materials
- Wireless sensors, fiber optical sensors, GPS and other advanced sensors
- Remote monitoring system
- Data transmission, acquisition and processing
- Data mining and data management
- Field applications
- System identification and damage detection
- Condition monitoring and safety evaluation
- Structural health diagnosis and prognosis
- SHM-aided life-cycle performance assessment
- Damage control, repair and strengthening
- Integrated systems and implementations of SHM
- Design guidelines and codes of SHM
- Standardization of SHM systems
- Non-destructive evaluation/testing
- Self-powered sensors, energy harvesting for sensor networks

For further information, please contact Prof. Y.L. Xu, Department of Civil and Structural Engineering, The Hong Kong Polytechnic University, at shmii6.2013@polyu.edu.hkThis e-mail address is being protected from spambots. You need JavaScript enabled to view it or Phone: +852 2766 6050.

Hong Kong is a Special Administrative Region of the People's Republic of China. It is a world's leading financial capital with the greatest number of skyscrapers and long span bridges. Hong Kong is also recognized as a cosmopolitan centre where East Meets West, reflected in its cuisine, education, culture and traditions. It is an ideal place for shopping, dining and sight-seeing. Hong Kong's cuisine is renowned for its exotic fusion of eastern and western flavors along with a wide variety of culinary delights. Most

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See ADDITIONAL Listings at:
http://www.sensorsportal.com/HTML/Links.html

http://spie.org/x306.xml