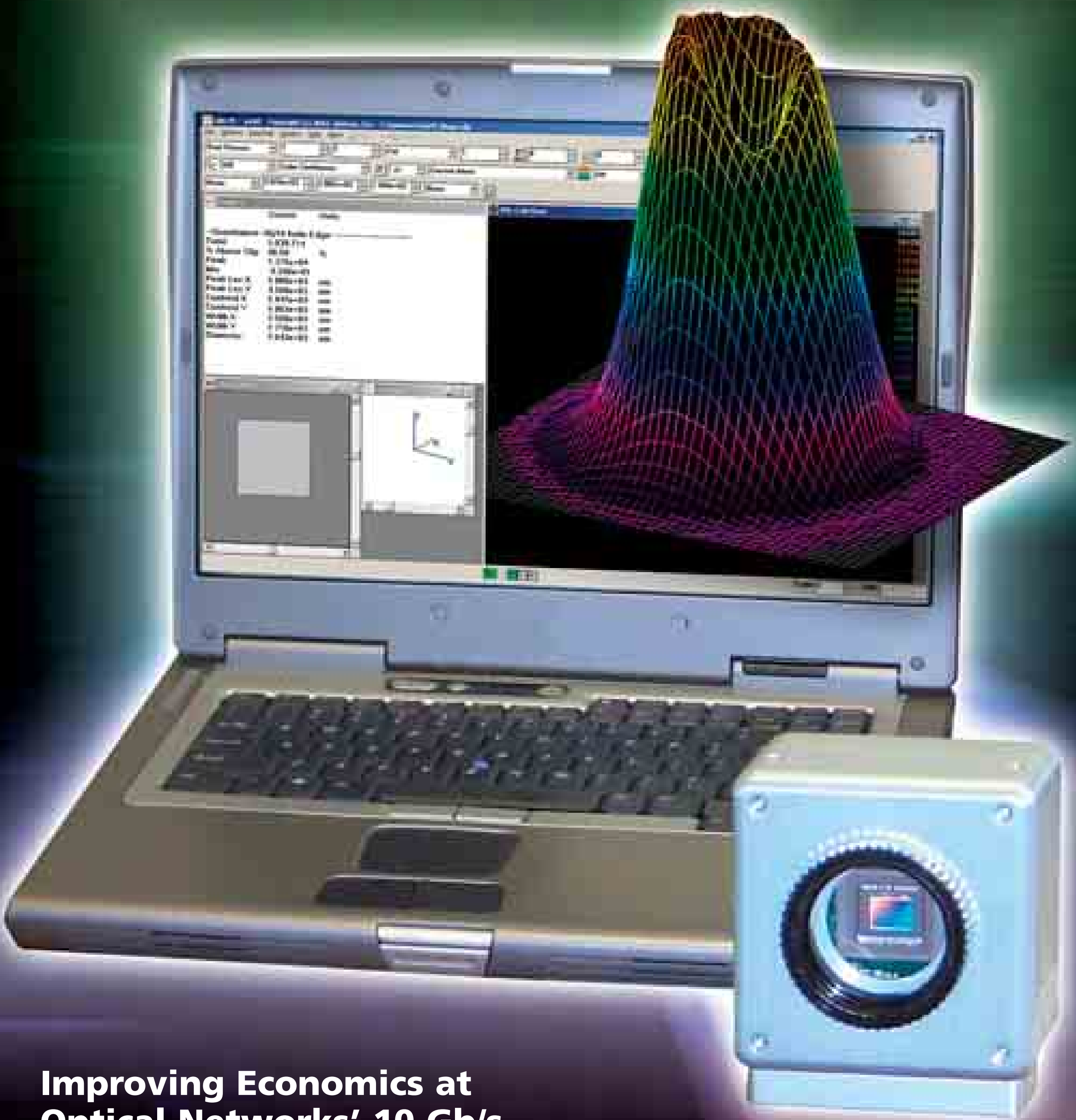
March 2005

PTB

Photonics Solutions for the Design Engineer



Improving Economics at Optical Networks' 10 Gb/s Sweet Spot

Product of the Month

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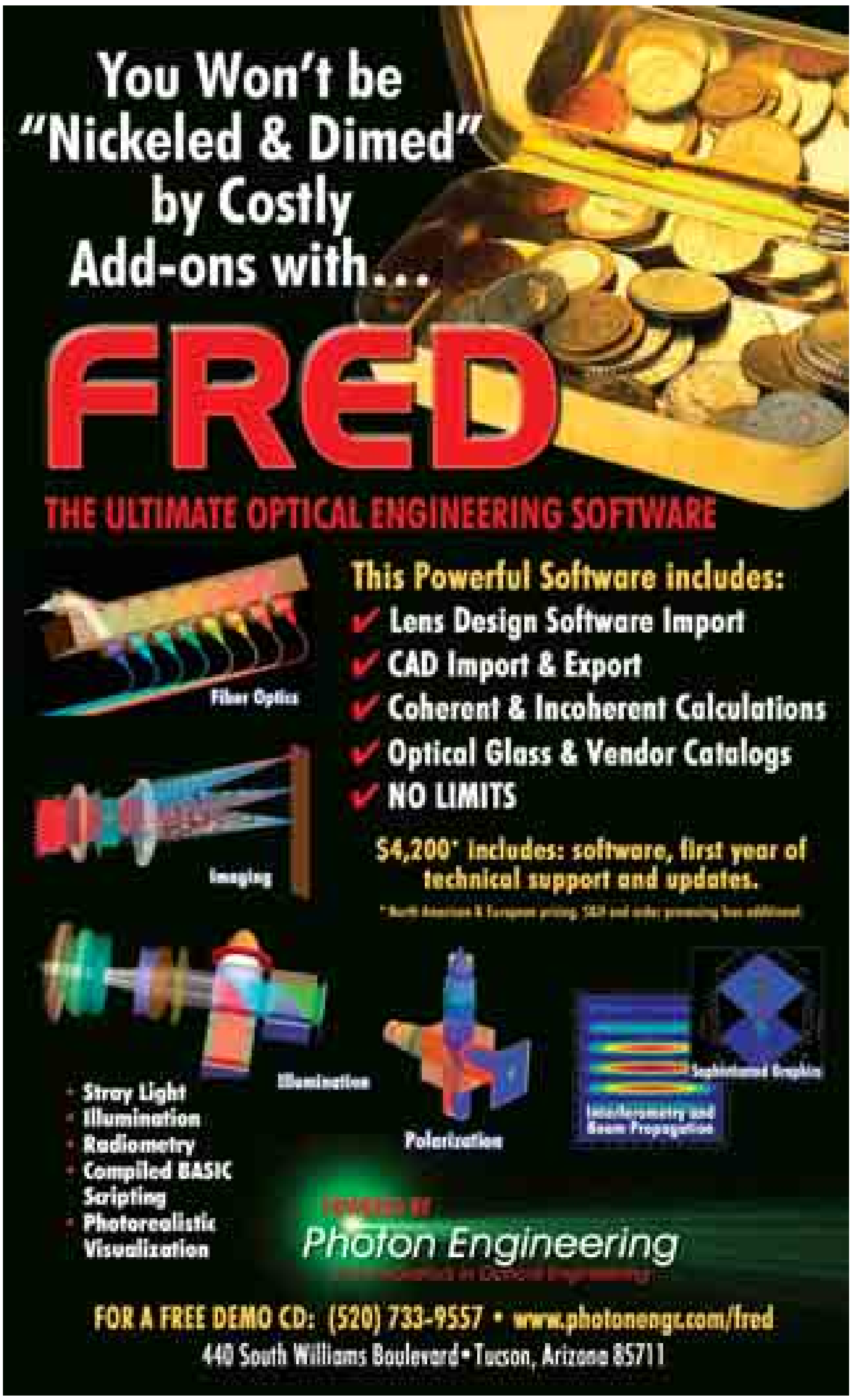
Supplement to *NASA Tech Briefs'* March Issue. Published by Associated Business Publications Intl.

FEATURES

DEPARTMENTS



SOLUTIONS

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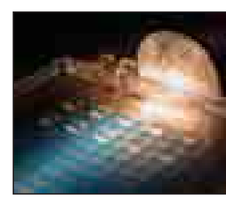

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ON THE COVER

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PTB Insights

Radu Barsan
President and CEO
Redfern Integrated Optics (RIO)

Improving Economics at Optical Networks' 10 Gb/s Sweet Spot

The communications industry is currently facing a critical juncture as increasing bandwidth demands and convergence opportunities create a "sweet spot" at 10 Gb/s. However, significant challenges are still hampering the widespread deployment of 10 Gb/s optical networks. One critical hurdle is the difficulty of creating economically viable modulated-light sources that can reliably deliver 10 Gb/s transmission for distances of 40 km, 80 km, and beyond.

Until now, externally modulated lasers were the only viable solution for transmission in the 1550-nm band, which is used for extended reach and DWDM optical networks at 10 Gb/s. External modulation dissipates more power than direct modulation because the laser is turned on to full power at all times and the external modulator attenuates this to create the modulated signal. Externally modulated lasers using a distributed feedback (DFB) laser with a Lithium Niobate modulator, for example, are large, expensive, and require a high power driver. Monolithic or hybrid integrated electroabsorption modulated lasers (EMLs) are also expensive, especially for distances up to 80 km, and prohibitively expensive for narrow grid DWDM. In addition, EMLs have limited output power, which can increase the need for additional erbium-doped fiber amplifiers (EDFAs) or more expensive EDFAs.

Figure 1. Small form factor TOSA based on PLANEX technology.

Projected volumes for 10 Gb/s transceivers are insufficient to support the development required to overcome the low production yields associated with monolithic EMLs. This means that EMLs will be only marginally capable of meeting volume and cost requirements for SONET and DWDM performance at 80 km, a key requirement for telecom.

The use of a new Planar External Cavity (PLANEX) approach overcomes these obstacles through innovative design and manufacturing techniques that economically produce directly modulated External Cavity Lasers (ECLs). The approach combines a Planar Lightwave Circuit (PLC) containing an integrated Bragg grating and a high-performance, low-cost gain chip. Optimizing the low-cost integration of ECLs on silicon wafers using proven high-yield processes and standard CMOS fabrication tools enables a dramatic reduction in the cost of implementing 10 Gb/s links for 40 km, 80 km, and DWDM.

The PLANEX approach offers three key advantages: a low-cost, highly scalable volume-oriented production environment; reduced cost-of-ownership and migration from TDM to DWDM; and higher performance over longer distances.

Production Environment

A key tenet of the production model is to eliminate the low-yield constraints of complex fabrication processes in the early part of the production chain and to leverage high-yield low cost components in the final assembly. The use of pre-tested components that are readily outsourced allows for improved yields and lower costs, along with the ability to scale-up production volumes efficiently.

By using low cost, outsourced gain chips, the PLANEX approach eliminates the need for expensive and underutilized internal InP fabrication facilities, which are a major cost in conventional EML production. The gain chip is integrated with a low-cost PLC containing a Bragg grating, which is fabricated on a silicon wafer using well-established, volume-oriented processes.

The gain chip functions as an optical amplifier and the Bragg grating acts as both a partially reflecting mirror and a wavelength locker. This enables the laser to output a controlled chirp waveform at a very well defined wavelength. The large cavity size of the ECL provides a device that exhibits low reflection sensitivity, and, in some applications, can operate without an optical isolator. In contrast, EML implementations require an isolator to overcome their inherent high-reflection sensitivity.

The flexibility of the PLANEX ECL design makes it possible to further automate assembly using Silicon "Optical Bench" technology, allowing for efficient integration of the optical laser driver, gain chip, ball lens, and other components on a single silicon platform containing the gain chip and waveguide grating.

As shown in Figure 1, the miniature size and high degree of integration inherent to the PLANEX approach allows implementation of complete optical transmitter modules that are compatible with the smallest TOSA form factor specified by the XFP and XMD MSA for 40 km and 80 km. At the 40 km distance, the ECL approach offers a better than 30% cost advantage over comparable EML devices. Scalability of the high-yield model provides even greater cost benefits for 80 km and DWDM applications.

Deployment & Ownership

PLANEX technology offers a high degree of manufacturing flexibility for producing wavelength-specific DWDM devices, which enables carrier and network administrators to more efficiently migrate from TDM to DWDM, using the same basic component design and

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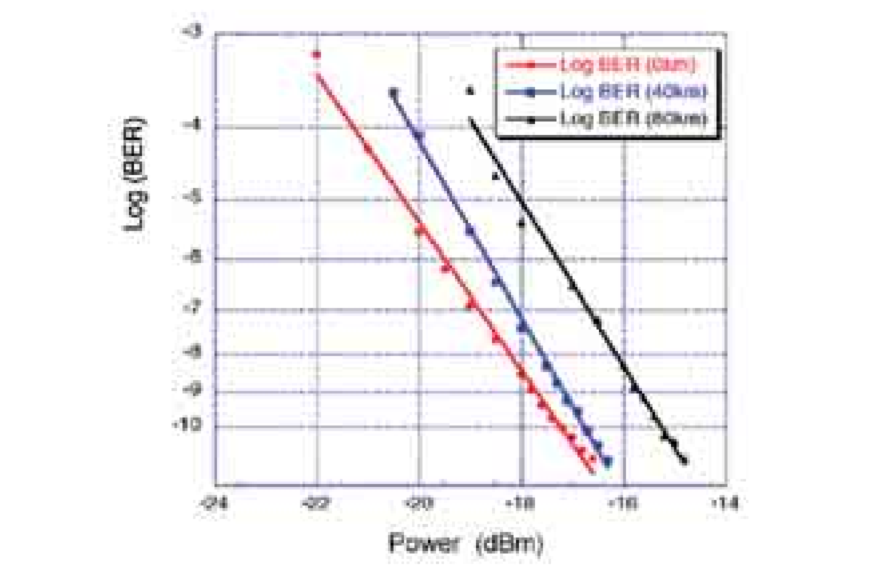

Figure 2. Consistent Bit Error Rate (BER) performance at extended distances.

TOSA form factor. Unlike DFB and EML manufacturing, where the wavelength decision must be made at the early stage of wafer processing, the ECL wavelength is set during the packaging process using pretested components. This also helps to reduce the lead-time for DWDM ECLs and simplifies the carriers' inventory management.

Since the gain chip used in the ECL has a broad bandwidth (with a single gain chip covering almost the entire C-band), all DWDM channels in the C-band can be supplied by using a high-volume gain chip and different (low-cost) PLCs. This mitigates the need to test and qualify additional modules and also eliminates the cost of adding a separate wavelength-locker component. In contrast, EML devices typically need a wavelength locker because of their higher sensitivity of wavelength to temperature variations, which is typically ~100 pm/°C, or 10X the sensitivity of the ECL.

Performance

The PLANEX approach improves performance by tightly controlling chirp, maintaining consistent eye and Bit-Error-Rate (BER) characteristics.

EML chirp is transient by nature; however, monolithic EML devices exhibit undesirable additional "adiabatic chirp" due to internal reflections, which limit transmission distances. Hybrid EML devices address this issue through the addition of an optical isolator between the DFB and modulator to eliminate chirp, but pay the penalty of added complexity and cost. In comparison, planar ECLs exhibit low, reproducible chirp characteristics that have no adverse impact at 40 km. The same basic devices can be manufactured to provide reproducible "negative chirp" for reliable transmission at 80 km, with costs comparable to 40 km.

Planar ECL product implementation has demonstrated performance characteristics that consistently meet or exceed the specified performance of industry standards such as Telcordia GR235 OC192 and 10 Gigabit Ethernet. BER measurements taken back-to-back (40 km and 80 km) with the ECL setup for the same operating conditions and an extinction ratio of 8.2 dB are shown in Figure 2. The results are within target performance specification, showing a small dispersion penalty of 0.2 dB at 40 km and 2 dB at 80 km at 10-10 BER.

These results represent the industry's first demonstration of a directly modulated ECL that can transmit 10 Gb/s through 80 km of SMF; thus, confirming the viability of this approach for TDM and DWDM optical transmission systems. In addition, continued development of PLANEX-based hybrid ECLs and Silicon Optical Bench integration provides the technology platform and building blocks for more advanced and more integrated next generation products.

This article was written by Radu Barsan, President and CEO of Redfern Integrated Optics (RIO) based in Santa Clara, CA.

Dr. Barsan has 25 years of commercial experience in semiconductor and optical components development, operations, and general management — Phaethon Communications, Cirrus Logic, AMD, and Cypress Semiconductor — and a Ph.D. in Applied Sciences from the Catholic University of Louvain, Belgium. For more information, call (408) 970-3500 or visit www.rio1.com.

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Bare Fiber Holder Eases Positioning for Optical Measurements

Measurements are accurate and repeatable from device to device and user to user.

ILX Lightwave Corporation, Bozeman, Montana

Bare fiber measurements are common in optical component manufacturing before the device under test (DUT) is connectorized and final tested. Insertion loss and polarization dependent loss are typical measurements on passive components before they are connectorized. The precision of these measurements is high, on the order of ±0.01 dB, and repeatability of the measurements is critical in determining the ultimate throughput of the process and devices. With small fiber cores, 8 to 62.5 µm, handling bare fiber for measurements is difficult because the fiber core is easily susceptible to breakage.

A patented bare fiber holder design has been developed to ease the difficulty of making accurate and repeatable bare fiber measurements. This unique design incorporates a clamshell style holder consisting of left and right injection-molded, interlocking halves with an internal, opposing V-groove. There are eight and nine V-grooves in each half, respectively. In the closed position, the tolerance between opposing V-grooves is 0.003 inches. The two halves are connected with a locating pin and torsional spring to maintain a normally closed position.

When the clamshell is closed, V-grooves gather the bare fiber into an accurate, repeatable placement while preventing damage to the fiber through bending or breaking. The opposing V-groove design also ensures there is no excess pressure on the fiber, thereby avoiding polarization changes in the light due to fiber distortion.

Figure 1. **Bare Fiber Holder** incorporates clamshell style holder with an internal, opposing V-groove.

A ten percent glass-filled polycarbonate was chosen for the bare fiber holder's material for its light weight, strength, high impact resistance, and high heat deflection temperature. The glass fill reduced the thermal expansion and increased the tensile strength and stiffness. Injection molding was chosen as the most cost effective way to maintain the tight dimensional tolerances on the interlocking V-grooves.

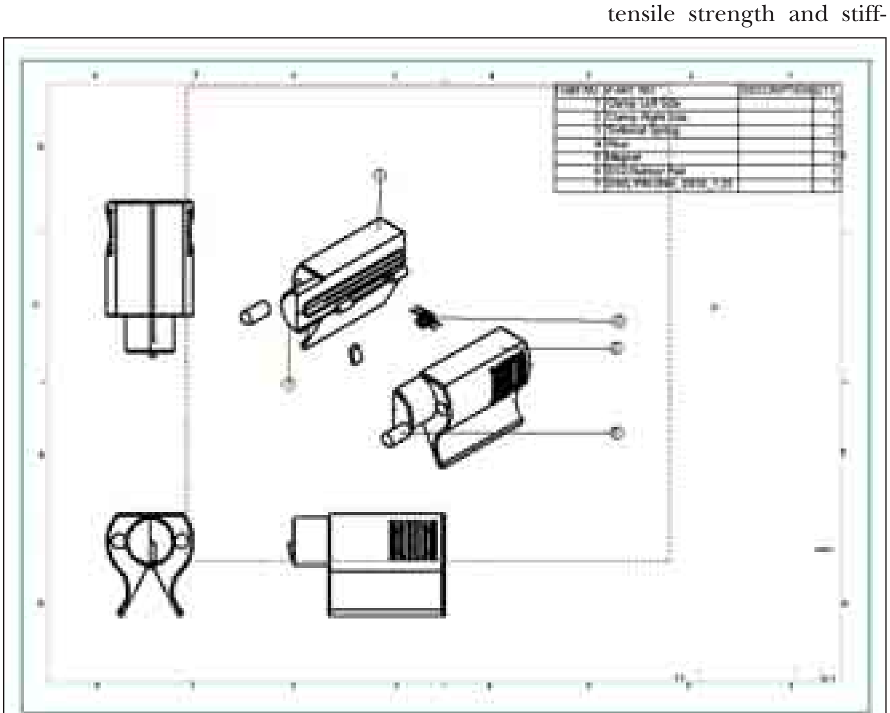

Figure 2. **Design Schematic** of clam shell style bare fiber holder.

Other considerations in the design include completely encapsulating the bare fiber, blocking any ambient light that would affect the measurement. Finger grips are integrated into the design so that single-handed positioning and placement of the holder into the power meter are possible. Nickel-plated neodymium magnets on both the inside and fiber exit tip ensure that the holder closes completely and is held in place once inserted into the power meter, drawing it into the adapter and holding it flush. Electrically conductive compression pads are included to eliminate static build-up on the holder, which eliminates electrostatic movement of the fiber upon insertion or removal.

The result is a very lightweight bare fiber holder that requires minimal thumb and finger pressure to hold open while positioning the bare fiber. Releasing the pressure on the thumb and finger tabs gently encloses the bare fiber, positioning it between the halves and locating it at the center of the holder.

This type of device can be used in any production or R&D environment requiring accurate and repeatable bare fiber measurements. A new precision fiber optic power meter, the FPM-8210, was developed in conjunction with the bare fiber holder. The FPM-8210 has a patented integrating sphere design that reduces polarization-dependent response of the meter as well as the sensitivity of measurement accuracy to axial placement of the bare fiber end, with respect to the integrating sphere.

Bare fiber testing with the holder and several ILX FPM-8210 power meters exhibited excellent repeatability in power measurements against rotational changes in the fiber and linear extension of the fiber from the tip of the holder. These factors, both of which are important in production testing of optical components, reduce the effort of an operator to position the bare fiber correctly to minimize measurement errors. This ultimately reduces the uncertainty in the measurement system. As shown in Figure 3, rotational repeatability ranged

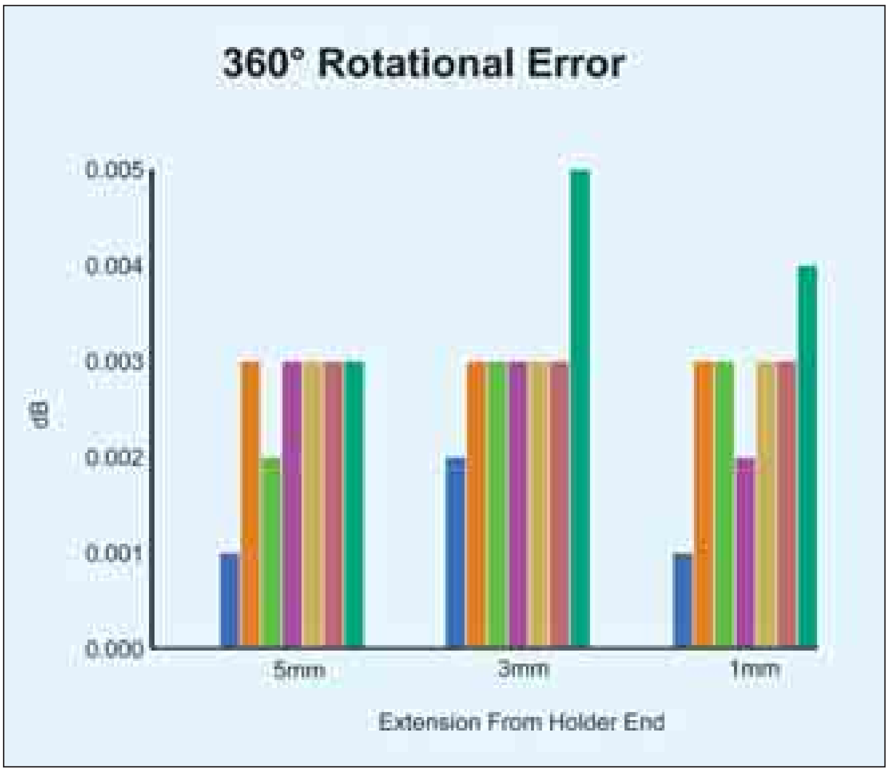

Figure 3. **Power Measurement Error** in dB by rotating the fiber 360∞ at 5, 3, and 1mm extension from the holder tip.

from 0.001 to 0.004 dB, while linear extension, 1 to 5 mm from the tip of the holder, exhibited a measurement repeatability of 0.001 to 0.003 dB. A statistical analysis for rotational and linear extension led to a three sigma specification of 0.003 dB power measurement repeatability. These errors are on the order of 0.0007% in the measurement.

This article was written by Thaddeus Orosz, Instrumentation Product Manager at **ILX Lightwave**. *For more information, call Thaddeus at (406)556-2559 or email him at torosz@ilxlightwave.com. ILX is online at www.ilxlightwave.com.*

Miniature Dual-Wavelength Camera Using InGaAs Focal Plane Arrays

Camera simultaneously images visible and shortwave infrared light.

Sensors Unlimited Inc., Princeton, New Jersey

The recent development of indium gallium arsenide (InGaAs) focal plane arrays (FPAs) capable of imaging visible and shortwave infrared (SWIR) wavelengths has yielded a miniature dual-wavelength camera with no moving parts that weighs only 11 ounces, consumes less than 1.6 W of power, and operates at room temperature.

Capable of simultaneously imaging the visible and SWIR spectrum, the all solid-state camera can replace complex systems that previously required two cameras. Having a dual wavelength FPA in one camera decreases payload weight and size and simplifies image-fusion systems. The on-board non-uniformity corrections (NUCs) help make this compact imager simple to use and suitable for many applications in industrial machine vision, laser-beam profiling, and military imaging. Additionally, this camera outputs 12-bit digital RS-422 signals and EIA-170 analog video; the latter can be displayed on commercial TV monitors.

The camera's key element is a 320x240-pixel, backside-illuminated, substrate-removed, InGaAs photodiode array. In the traditional epitaxial structure for InGaAs PIN photodiodes, the absorption region is topped off with an InP cap. Unlike a frontside-illuminated format where light

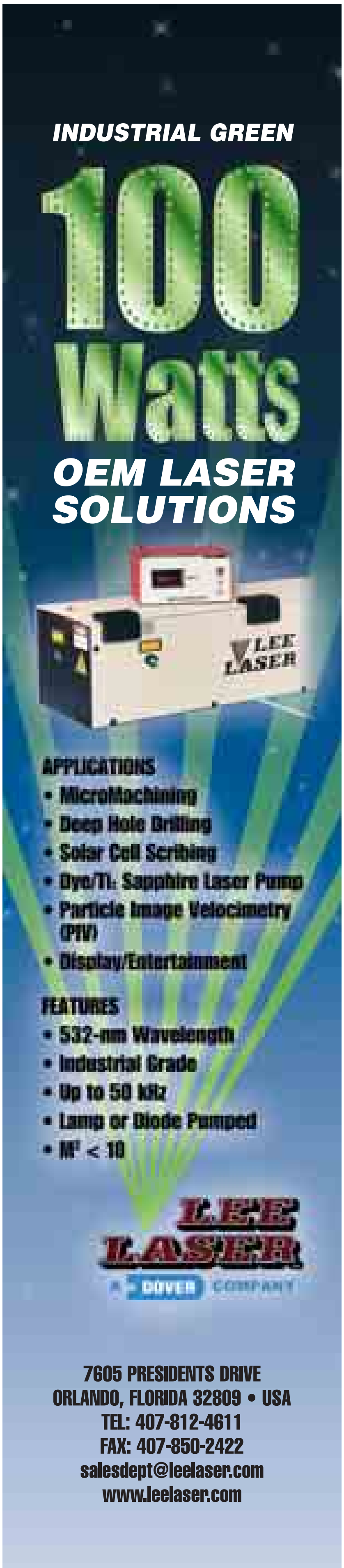

Figure 1. **InGaAs-Based MiniCamera** can perform tasks that previously required two cameras and complex system integration.

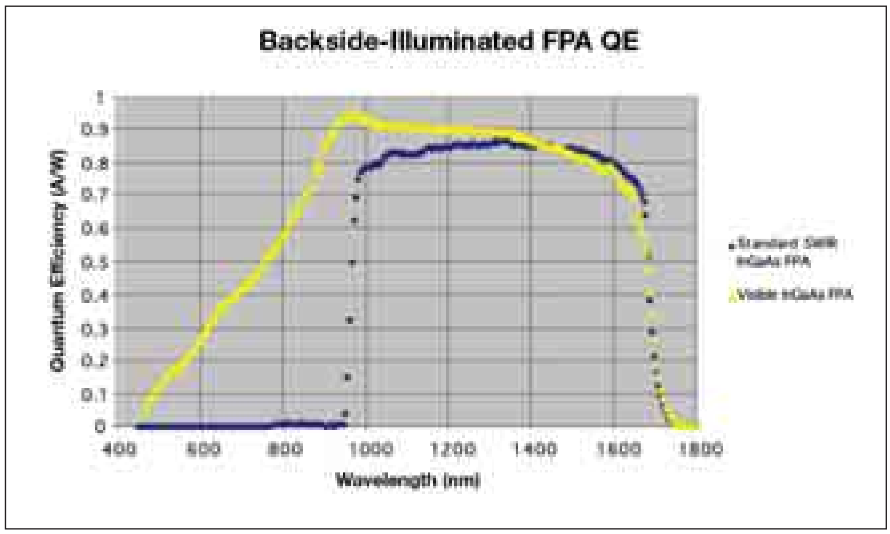

Figure 2. **Backside-Illuminated FPA** QE Graph

passes through the InP cap to reach the InGaAs absorption region, light in a backside-illuminated format must pass through the InP substrate to reach the pixel's active region — the InGaAs layer. Thinning or removing the InP substrate achieves increased quantum efficiency in the visible band because more visible light reaches the InGaAs absorption layer. Normally, visible light would be absorbed by the InP substrate because of its 920-nm cutoff. It is the absorption of wavelengths below 920 nm in the InP, not the capabilities of InGaAs itself, that has limited InGaAs FPAs' wavelength range to only the SWIR. The backside-illuminated, dual-wavelength FPA used here has just enough InP from the epitaxial growth process remaining to passivate the InGaAs surface and provide a contact layer for the frontside common-cathode contact to the ROIC. The result of the substrate removal process is an FPA consisting of just the epitaxial layers bump-bonded to a CMOS ROIC.

Using both wet etching and mechanical thinning produces a thinner InP contact layer than that which can be achieved using mechanical thinning alone. A thicker layer of InP can lead to imaging artifacts, such as image retention and high-pixel crosstalk from InP fluorescence. Combining the two methods also improves production capacity and uniformity between chips, which is critical for applications in both industry and defense where cameras must be reliable, delivered on time, and have consistent performance. Mechanical thinning on its own can lead to variations in a single device as well as differences between devices. Utilizing the epitaxial layers also contributes to a consistent and reproducible manufacturing process where the visible response can be successfully repeated from device to device.

The quantum efficiency of the FPAs used in the Visible-InGaAs MiniCamera exceeds 70% in the 1000 nm to 1600 nm portion of the spectrum. Efficiency tops 50% at 800 nm and 10% at 500 nm (see Figure 2). The FPA's high-responsivity in both the visible and SWIR wavelength bands allows the camera to assist in hyperspectral imaging, semiconductor wafer inspection, astronomy, and imaging of most laser pointers, designators, and range finders.

This article was written by Tara Martin, a research engineer focusing on InGaAs/InP process development at **Sensors Unlimited Inc.**, *3490 US Route 1 Bldg. 12, Princeton, NJ 08540. For more information, contact Tara Martin at tmartin@sensorsinc.com or (609) 520-0610.*

Two-Photon Fluorescence Microscope for Microgravity Research

The benefits of two-photon fluorescence microscopy are realized at reduced cost.

John H. Glenn Research Center, Cleveland, Ohio

A two-photon fluorescence microscope has been developed for the study of biophysical phenomena. Two-photon microscopy is a novel form of laser-based scanning microscopy that enables three-dimensional imaging without many of the problems inherent in confocal microscopy. Unlike one-photon optical microscopy, two-photon microscopy utilizes the simultaneous nonlinear absorption of two near-infrared photons. However, the efficiency of two-photon absorption is much lower than that of one-photon absorption, so an ultra-fast pulsed laser source is typically employed.

On the other hand, the critical energy threshold for two-photon absorption leads to fluorophore excitation that is intrinsically localized to the focal volume. Consequently, two-photon microscopy enables optical sectioning and confocal performance without the need for a signal-limiting pinhole. In addition, there is a reduction (relative to one-photon optical microscopy) in photon-induced damage because of the longer excitation wavelength. This reduction is especially advantageous for *in vivo* studies. Relative to confocal microscopy, there is also a reduction in background fluorescence, and, because of a reduction in Rayleigh scattering, there is a 4× increase of penetration depth.

The prohibitive cost of a commercial two-photon fluorescence-microscope system, as well as a need for modularity, has led to the construction of a custom-built system (see Figure 1). This system includes a coherent mode-locked titanium: sapphire laser emitting 120-fs-duration pulses at a repetition rate of 80 MHz. The pulsed laser has an average output power of 800 mW and a wavelength tuning range of 700 to 980 nm, enabling the excitation of a variety of targeted fluorophores. The output from the laser is attenuated, spatially filtered, and then directed into a confocal scanning head that has been modified to provide for side

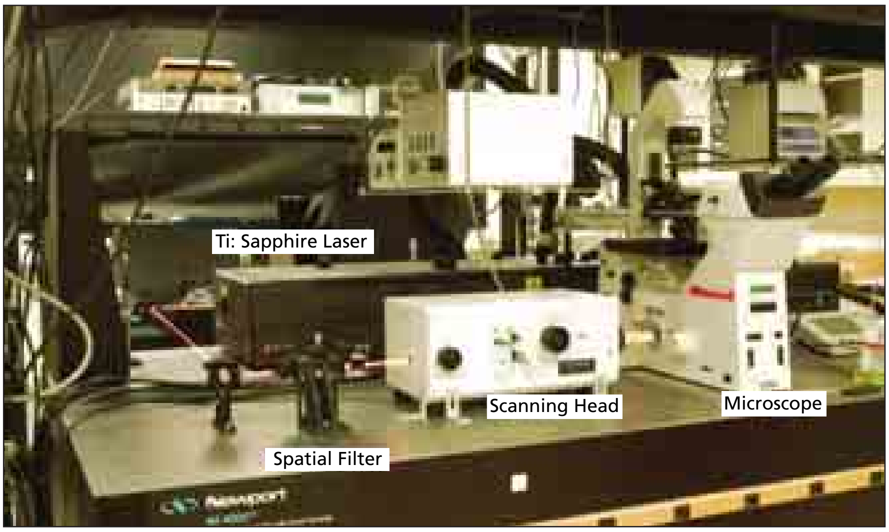

Figure 1. This **Optoelectronic System** is a custom-built system for two-photon fluorescence microscopy.

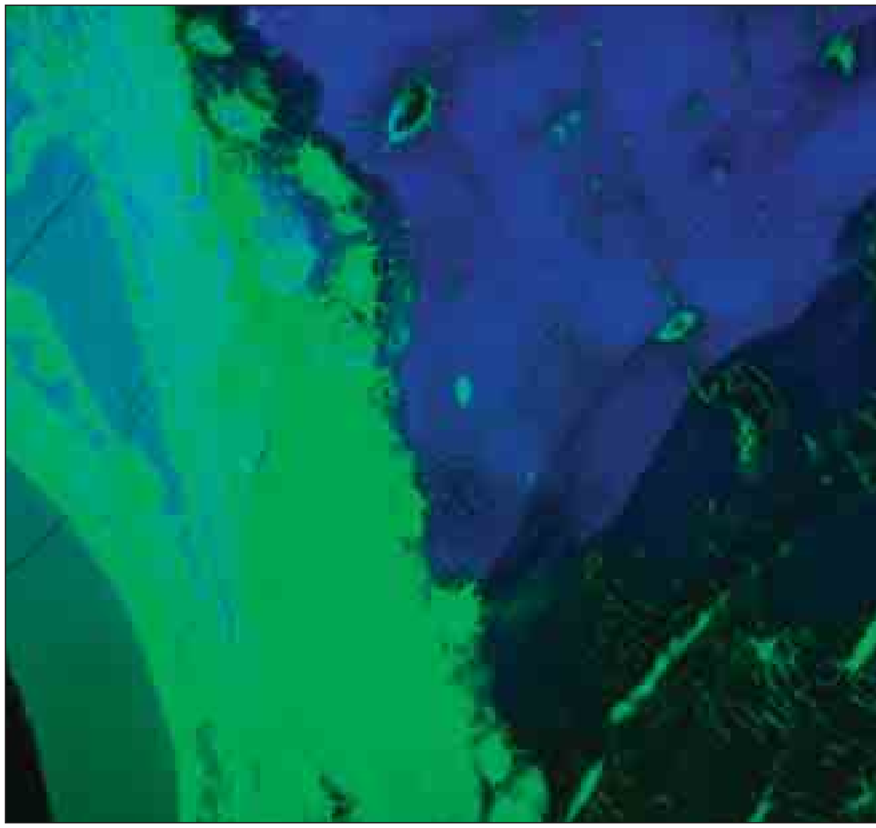

Figure 2. **This Two-Photon Image** of a human femur section shows several areas of remodeled bone. The field of view is 200 µm. The specimen in this image was provided by the Cleveland Clinic Foundation.

entry of the laser beam. The laser output coupler has been replaced with a dichroic filter that reflects the longer-wavelength excitation light and passes the shorter-wavelength fluorescence light. Also, the confocal pinhole has been removed to increase the signal strength.

The laser beam is scanned by a two-perpendicular-axis pair of galvanometer mirrors through a pupil transfer lens into the side port of an inverted microscope. Finally, the beam is focused by a 63-magnification, 1.3-numerical-aperture oil-immersion objective lens onto a specimen. The pupil transfer lens serves to match the intermediate image planes of the scanning head and the microscope, and its location is critical.

In order to maximize the quality of the image, (that is, the point spread function of the objective lens for all scan positions), the entire system was modeled in optical-design software, and the various free design parameters (the parameters of the spatial-filter components as well as the separations of all of the system components) were determined through an iterative optimization process. A modular design was chosen to facilitate access to the optical train for future fluorescence correlation spectroscopy and fluorescence-lifetime experiments.

The spatial resolution of the microscope at an excitation wavelength of 780 nm was measured by scanning a 170-nm-diameter fluorescent bead throughout the focal region and found to be 320 nm in the transverse direction and 740 nm in the longitudinal direction. The sectioning capability of two-photon microscopy is demonstrated in Figure 2, which depicts a human bone specimen as imaged by use of two-channel spectral detection.

The two-photon microscope is now being employed to study osteoblast and osteoclast bone cells in cultures, including the effects of fluid flow and other environmental stimuli. Ultimately, these studies will be used to investigate and develop effective countermeasures to the bone loss experienced in a reduced-gravity environment. In addition, a variant of this instrument is being considered as an add-on module to the Light Microscopy Module, which will be deployed on the International Space Station.

This work was done by David G. Fischer and Gregory A. Zimmerli of **Glenn Research Center** *and Marius Asipauskas of the National Center for Microgravity Research.*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17573-1.

New Products

Product of the Month

Wideband Achromatic Waveplate

NanoOpto Corp. (Somerset, NJ) offers a novel wideband achromatic waveplate, the SubWave AQWP650+, using a proprietary nano-structure-based design to provide true zero order performance across a broad wavelength range. An achromatic quarter waveplate for high-performance DVD/CD read/write combination drives used in entertainment, mobile systems, and computing, the SubWave AQWP650+ provides 90° (i.e., quarter wave) ± 4° of phase retardance uniformly across a 630 nm to 805 nm wavelength range.

This device is constructed using only dielectric materials, which reduces the likelihood of optical drive failure under both repeated use and in mobile applications. It also exhibits stable optical performance and physical robustness over a broad operating temperature range. The SubWave AQWP650+ is available diced to customer specific sizes, from 1 mm to 10 mm on a side.

For Free Info Visit http://info.ims.ca/4746-200

Five-Axis Laser System

The Laserdyne Model 450 five-axis (three linear and two rotary) laser system from Prima North America (Champlin, MN) is designed specifically for precision percussion and trepan

drilling of turbine engine blades, nozzle guide vanes, shrouds, and similar size components. It is equipped with a fully CNC controlled Convergent Lasers P50L pulsed Nd:YAG laser mounted outside the work area. Linear accuracy in the X, Y, Z axes is ±0.013 mm/300 mm (±0.0005 in/ft).

Accuracy in the rotary A, B axes is ±20 arc-second and ±6 arc-second respectively. The system has a part weight capacity of 18.2 kg (40 lb) for workpiece and fixturing. Overall machine footprint is 3.2 m^2 (34.4 ft^2). Unique features include Optical Focus Control (OFC), BreakThrough Detection™, and Active Optical Sensing (AOS).

For Free Info Visit http://info.ims.ca/4746-205

Electro-Absorption Modulators

A range of electro-absorption modulators (EAMs) fabricated using indium-phosphide are available from the Centre for Integrated Photonics (CIP, Ipswich, UK) in 40-Gb/s and 10-Gb/s versions for either single wavelength or DWDM communications applications. The devices offer compelling advantages as building blocks for next-generation optical networks including very small size, high bandwidth, and low drive voltages. The use of novel structures (e.g., a buried heterostructure geometry) results in low insertion loss (4.5 dB or 4 dB typical).

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Laser Beam Profiler

The FireWire® cameras used in Spiricon's (Logan, UT) LBA-FW Laser Beam Profilers connect directly to laptop computers without a frame grabber card, providing a very portable beam analysis instrument. Both CCD and pyroelectric cameras are provided to cover the complete spectral range from UV to far IR. Cameras are either 12-bit or 14-bit digital and can easily capture CW and pulsed lasers beams.

Multiple FireWire® cameras can operate on one FireWire® bus, enabling simultaneous laser beam profilers. This is especially useful for single shot, high power lasers, wherein a user wants to capture a single event in multiple locations in the optical train.

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Optical Spectrum Analyzer

Apex Technologies (Newbury Park, CA) offers its Next Generation Optical Spectrum Analyzer, the AP2040 series, based on an interferometer principle that enables ultra high resolution of 0.16 pm or 20 MHz. Other features include wavelength accuracy of ±3 pm, an optical measurement level range of -75 dBm to +20 dBm, a built-in tunable laser output of >-5 dBm, and a multicolor touch screen. Applications include WDM, optical amplifier, and modulated signal analysis; optical passive device and optical multiplexer device characterization; and tunable laser source side modes.

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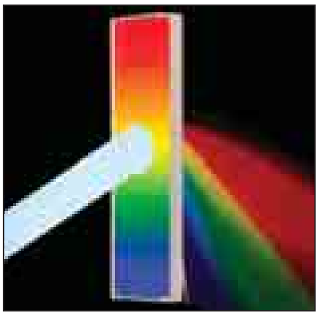
Holographic Gratings



Wasatch Photonics' (Walnut Creek, CA) product line of true volume phase holographic diffraction gratings provide superior performance through high dispersion capability, high efficiencies for polarization modes, wide bandwidth, low losses, and rugged design and packaging, including hermetic sealing and small form factor. They are unique because they operate in transmission. Applications that will benefit from enhanced spectral and optical signal separation and measurement include spectroscopy, laser tuning and pulse compression, hyperspectral imaging, fiber optics, and image acquisition.

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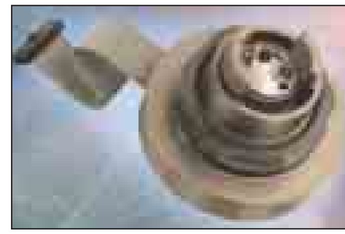
Bulkhead Media Converters



A new family of Bulkhead Media Converters (BMCs) from Stratos Lightwave (Chicago, IL) accepts standard optical signals and converts them to an industry standard signal. The devices handle optical-to-electrical and full physical layer (PHY) conversion. Standard options include Gigabit Ethernet and Fast Ethernet media conversion using the standard RJ-45 interface connection. Other variations include Ethernet MII or GMII ribbon cable interfaces, and 1x/2x Fiber channel transceivers with a ribbon cable interface on the electrical side.

Field-proven Expanded Beam optics allow for a reliable, easy-to-clean, easy-to-mate optical interface designed to resist water, mud, dust, oil, and high levels of shock and vibration. Maximum optical link distance is 2 km for Fast Ethernet and 550 m for Gigabit Ethernet. Units are available for 62.5/125 or 50/125-µm multi-mode fiber, and can be equipped with one to four optical channels in various combinations of simplex and duplex configurations. Operation is via a single +3.3 V power source.

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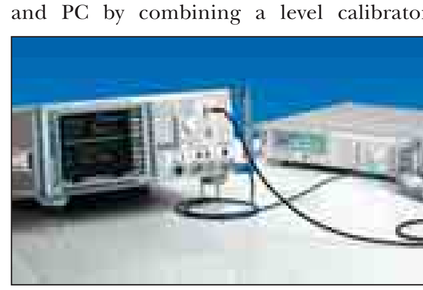
LED Lamps

Para Light Corp. (Walnut, CA) introduces an extensive line of high-power LED lamps that can handle forward current as high as 70 mA to produce exceptional brightness. The L-5T3XX series lamps come in a popular T-1 3/4 package (5 mm in diameter) and are especially suitable for traffic and outdoor signage and a variety of automotive applications. Available in blue, yellow and orange, they have a water clear lens, a viewing angle of 30°, and operate in a temperature range of -25°C to +85°C.

For Free Info Visit http://info.ims.ca/4746-212

Measuring Receiver

Rohde & Schwarz (Columbia, MD) has introduced the FSMR Measuring Receiver, a single-instrument solution for calibrating all key parameters of signal generators and fixed and variable attenuators. It eliminates the need to cable together multiple, single-function instruments or a spectrum analyzer, power meter, and PC by combining a level calibrator,



AM/FM/PM modulation analyzer, audio analyzer with THD and SINAD capability, RF power meter, and comprehensive spectrum analyzer. It is available in frequency ranges from 20 Hz to 3.5 GHz, 26.5 GHz, and 50 GHz.

Measurements include output level accuracy, carrier frequency accuracy, setting accuracy of modulation depth and deviation, weighted and unweighted spurious modulation, and modulation frequency response, distortion, and frequency. Key parameters are traceable to NIST and other national standards organizations.

For Free Info Visit http://info.ims.ca/4746-207

New Products

Aspherical Lenses

A range of Panasonic aspherical glass lenses is now available from Photonic Products (Hertfordshire, UK). The equal optical characteristics achieved by Panasonic's "One-Shot" precision moulding method include a short focal length (0.69 - 14.91 mm) and a high numerical aperture (0.097 - 0.65), ensuring a compact and lightweight lens for smaller, lighter devices with high performance.

Mechanical diameters range from 1.7 mm to 8.2 mm. Applications include optical drive devices, laser diodes, optical communication systems, and sensors.

For Free Info Visit http://info.ims.ca/4746-209

Multi-Spectral Raman Spectrometer

Headwall Photonics' (Fitchburg, MA) multi-channel, multi-spectral Raman spectrometer meets industry requirements for high spectral performance in a very small form factor. Based on Headwall's patented retro-reflective, concentric design for Raman analysis, customers can apply high-performance analytical Raman techniques in both traditional laboratory environments as well as in commercial application areas, such as industrial process monitoring and control where the multi-channel, multi-sensor design is well-suited. Standard and custom configurations are available. For 785 nm Raman excitation laser, the spectral range is 779 nm-1144 nm, spectral resolution is 0.4 nm FWHM, and the effective f/# is f/2.4.

For Free Info Visit http://info.ims.ca/4746-210

Glassy Liquid Crystals

CRG Industries (Dayton, OH) introduces Glassy Liquid Crystals, an advanced form of liquid crystals that combine the properties of liquid crystals with the characteristics of polymers, such as the ability to form films. As a unique type of liquid crystals, the crystals offer nearly perfect circular polarization and selective wavelength reflection, can be processed like current liquid crystals, and maintain molecular alignment when formed into solid, stable films. Applications include flat screen displays, filters, optical storage, and other electro-optic devices.

For Free Info Visit http://info.ims.ca/4746-206

Laser Measurement System

NanoModeScan, a new tool from Photon (San Jose, CA), measures M-squared and other beam propagation characteristics of a broad range of lasers with different wavelengths, beam powers, and laser pulse frequencies. A complete M-squared measurement can be generated in seconds. The system includes a Photon NanoScan profiling tool mounted on a motorized, computer controlled stage and a software package that simplifies the process and displays the data for production environments. The NanoModeScan process is compliant with ISO Standard 11146.

For Free Info Visit http://info.ims.ca/4746-214