Top Products Of 2009

Even in a down year, this mix of devices, components, and test equipment demonstrates that new solutions are possible through design creativity and application of innovative technologies.

Launching a new product can be thrilling as well as stressful. Introducing a new product to the RF/microwave industry, after all, is the "moment of truth" in which all that market research, technology, and engineering comes together to be judged by the industry at large. Having a product reviewed in the pages of magazines such as this is one form of recognition of a product's worth; being named to the list of Top Products of The Year is one indication that a product is making its mark in this industry. This year's list includes an assortment of different products, from components to test instruments, selected by the editors of Microwaves & RF for their combinations of performance, value, and uniqueness.

The year was marked by two significant vector-network-analyzer (VNA) product introductions from Anritsu Co. and Agilent Technologies. Gracing the cover of the year's first issue, the VectorStar line of VNAs from Anritsu Co. included the flagship model MS4647A with standard frequency coverage from 10 MHz to 70 GHz and available with optional low-frequency extension for coverage of 70 kHz to 70 GHz. To cover such a wide range, the VectorStar analyzers employed an innovative architecture using two VNA systems in parallel, one for frequencies from 2.5 GHz and below and one for frequencies above 2.5 GHz. Both RF/microwave sections rely on a common local oscillator (LO) frequency synthesizer and a common intermediate-frequency (IF) subsystem.

The broadband VNA offers sensitivity of -103 dBm at 70 GHz and 0.1-dB compression with a +10-dBm signal at 70 GHz. Across their impressive 103-dB dynamic range, the VNAs acquire data quickly, with measurement speed of 20 s/point. All of the VectorStar analyzers present information and controls by means of a 26-cm touch-screen liquid-crystal-display (LCD) screen and employ the familiar Microsoft Windows XP Pro operating system.

The PNA-X series VNAs from Agilent Technologies, including the flagship model N5245A with frequency range of 10 MHz to 50 GHz, provide nonlinear vector network analysis through the use of "X-parameters." These are mathematical extensions of S-parameters that can be used in the firm's Advanced Design System (ADS) suite of software simulation tools for nonlinear modeling and circuit analysis. All VNA models offer as many as 32 measurement channels with 32,001 measurement points, with 10 markers per trace. All VNAs provide frequency resolution of 1 Hz with 1 PPM frequency accuracy and 0.05 PPM frequency stability at temperatures from -10 to +70C. The typical phase stability of the analyzers is an impressive 0.4 deg. to 26.5 GHz, 0.75 deg. to 43.5 GHz, and 0.80 deg. to 50 GHz.

For the model N5245A VNA, the typical leveled power is +16 dBm to 26.5 GHz, +13 dBm to 43.5 GHz, and -1 dBm to 50 GHz. The specified power level accuracy is 2 dB to 26.5 GHz, 2 dB to 43.5 dBm, and 3 dB to 50 GHz, with typical power level accuracy of 0.47 dB to 26.5 GHz, 0.97 dB to 43.5 dBm, and 0.93 dB to 50 GHz. The analyzer can typically sweep across power ranges of 42 dB to 26.5 GHz, 40 dB to 43.5 GHz, and 26 dB to 50 GHz, and the power can be set with resolution of 0.01 dB. The analyzers perform a variety of different swept measurements, including linear, logarithmic, power, CW, and segment sweeps. The noise floor of the 50-GHz model is specified at -107 dBm measured in a 10-Hz intermediate-frequency (IF) bandwidth at 50 GHz, with typical performance of -113 dBm under the same measurement conditions. The 50-GHz VNA's receiver features a dynamic range of 129 dB while the overall system achieves a dynamic range of 126 dB. The receiver boasts a 0.1-dB compression point for an input level of +13 dBm to contribute to the wide dynamic range.

A number of other test instruments earned spots on the Top Products list for 2009, including the 2500B series of synthesizers from Gigatronics. These test sources offer bandwidths as wide as 100 kHz to 50 GHz in a single unit with frequency switching speed of typically better than 500 s for a 1-GHz step and as fast as 100 s for smaller frequency steps. The signal generators have an internal oven-controlled crystal oscillator (OCXO) as a reference source or can be operated with an external frequency reference at 5 or 10 MHz. The internal reference yields phase noise of -77 dBc/Hz offset 100 Hz from a 10-GHz carrier, -109 dBc/Hz offset 10 kHz from the same carrier, and -138 dBc/Hz offset 1 MHz from a 10-GHz carrier.

On the signal analysis side, the WaveMaster 8 Zi series of digital oscilloscopes from LeCroy Corp. boasts eight models with bandwidths ranging from 4 to 30 GHz. The scopes have standard vertical resolution of 8 b, with an enhanced-resolution feature providing as much as 11 b vertical resolution. The scopes deliver sampling rates of 80 GSamples/s across two channels and 40 GSamples/s across all four channels. The rise time for the 30-GHz model is 17 ps at the full-bandwidth (two-channel) setting. The input sensitivity can be set from 10 to 500 mV/div for the three highest-frequency models (20, 25, and 30 GHz).

In a smaller package, the PowerSensor+ power meters/sensors LadyBug Technologies take advantage of a Universal Serial Bus (USB) interface with a laptop or personal computer to use the computer's capabilities for control and signal processing. As a result, the combination sensors and power meters measure only 1.60 x 2.25 in., not including the length of the coaxial connector, yet can provide power measurements over a frequency range of 10 MHz to 26.5 GHz in a single unit.

The power meters/sensors can measure the power levels of CW and pulsed signals over a dynamic range of -60 to +20 dBm. They can perform CW and average power measurements as well as time-gated pulsed and peak measurements, including measurements of pulse repetition frequency (PRF), rise and fall time, pulse width, duty cycle, and peak-to-average power ratio (crest factor). The miniature

test instruments are supplied with software drivers, provide a video bandwidth of 10 MHz, effective sampling rate of 48 MSamples/s, and measurement speed of 2000 settled readings per second.

As part of a trend in the increasing use of USB-based instrumentation, the Lab Brick family of USB signal generators from Vaunix Technology Corp. deserve special mention for their ease of use and performance levels from 50 MHz to 6 GHz. The signal sources weigh less than 1 lb. but can control output levels from -40 to +10 dBm through a simple graphical user interface (GUI) on a personal computer (PC).

FOCUS Microwaves introduced a measurement solution for characterizing wide-bandgap transistors, such as silicon-carbide (SiC) and gallium-nitride (GaN) devices, under different load and bias conditions. The firm's pulsed load-pull (PLP) and pulsed-I-V (PIV) systems can be configured for on-wafer S-parameter measurements when used with commercial test equipment, such as oscilloscopes, power meters, and microwave VNAs.

On a somewhat smaller scale, TriQuint Semiconductor introduced its PowerBand line of discrete power transistors for CW and pulsed signals over a total frequency range of 500 MHz to 3 GHz. The power transistors, which are based on both silicon LDMOS and GaAs pseudomorphic high-electron-mobility-transistor (pHEMT) technologies, deliver as much as 50 W output power at 1-dB compression at 2 GHz. As an example, model T12003028-SP is an LDMOS device for use with a +28-VDC supply. It operates from 500 MHz to 2 GHz with 10-dB typical gain with 30 W output power at 1-dB compression. For narrowband applications, it can generate 45 W output power at 2 GHz with 14-dB gain and 59-percent drain efficiency.

Also miniature in size, the VVA series of voltage-variable attenuators from Mini-Circuits offer precise control of signal levels from 10 MHz to 7 GHz. Using control voltages of 0 to 6 V, the attenuators provide 30 dB or more attenuation at the maximum attenuation setting, with low insertion loss at the minimal attenuation setting (0 V). For example, model VVA-13662/3 operates from 5500 to 7000 MHz with 27 dB maximum attenuation and 1.6 dB typical insertion loss at the minimum attenuation setting.

One of the more significant advances in integrated circuits (ICs) for wireless base station applications came from Analog Devices with the firm's introduction of integrated phase-locked-loop (PLL) circuits that also incorporate in-phase/quadrature (I/Q) modulators, local oscillators (LOs), amplifiers, dividers, and supporting components housed in a 6 x 6 mm package. The company's ADRF60x and ADRF670x series of devices provide RF outputs from 300 to 3600 MHz. In these circuits, an on-board voltage-controlled oscillator (VCO) is locked to an external reference oscillator by means of integrated fractional-N PLL circuitry. The combination delivers excellent close-in phase-noise characteristics. For example, for the model ADRF6702, which operates with an internal LO range of 1550 to 2150 MHz and produces RF output signals from 1550 to 2200 MHz that are flat within a 2-dB window, the phase noise is better than -108 dBc/Hz offset 100 kHz from a 2-GHz carrier.

Two other highly integrated source products deserve mention: a line of packaged PLLs with integrated VCOs from Hittite Microwave Corp. and a series of hybrid VCOs based on printed

circuit resonators from Synergy Microwave Corp. The former, with integrated fractional-N synthesizers and VCOs in a 6 x 6 mm QFN package, cover 665 MHz to 13.4 GHz. The latter, employing compact coupled planar resonators (CCPRs), measure just 0.3 x 0.3 in. and operate to 12 GHz.

In terms of low phase noise, the opto-electronic oscillator (OEO) developed by OEwaves relies on optical techniques to achieve stable output frequencies even with vibration and changes in temperature. The OEO achieves phase noise of -145 dBc/Hz offset 10 kHz from the carrier for output frequencies from 10 to 12 GHz and a phase noise floor of -174 dBc/Hz. It employs a high-power light source, such as a laser, to drive an optical modulator and a fiber-optic delay line or storage device. The 1550-nm light source is detected at the fiber output and amplified, phase corrected, and filtered before being applied back to the modulator in electrical form.

Spinnaker Microwave developed its model SMS-ACX RF converter/exciter module for electronic warfare (EW) and electronic-countermeasures (ECM) applications. It accepts IF input signals from DC to 1 GHz and upconverts them to low-noise output signals from 10 MHz to 14 GHz (and optionally 40 GHz). It can work with an external IF source, or internal IF signals can be provided by a direct-digital-synthesizer (DDS) source capable of frequency steps as small as 1 Hz. The converter/exciter can switch to any frequency within 50 s (and optionally to 10 s).

Using a modular format, the QuickSyn frequency synthesizers from Phase Matrix provide signals from 100 MHz to 10 GHz with resolution as fine as 0.001 Hz and output levels from -25 to +15 dBm. They also switch frequencies in 100 s or less while maintaining phase noise of -150 dBc/Hz offset 10 kHz from the carrier.

Finally, for those wanting to fabricate their own prototype circuits, the ProtoLaser S system from LPKF Laser & Electronics North America works with ceramic, FR-4, and PTFE laminate materials using a focused laser to etch fine circuit lines and features on a substrate's conductive metal. The system operates with a high-power laser at 1064 nm with 20 W CW power. The laser can operate in pulsed mode at rates from 10 to 100 kHz. The minimum track width is 50 m, the minimum gap width is 25 m, and the minimum corner radius is 12.4 m. The ProtoLaser S system achieves repeatability of 2 m and can produce complex circuits as large as 229 x 305 mm in less than 20 minutes. It is shipped with integrated software that can import a wide range of layout file formats, including Gerber and DXF files.