CHRIS DEMARTINO | Technology Editor

Satcom Trends Span Higher Frequencies, GaN, and Integrated Solutions

Today's satcom applications benefit from the latest cutting-edge technology offered by the RF/microwave industry.

No question, the RF/microwave industry continues to provide innovative solutions to the satellite-communications (satcom) industry. This is demonstrated by the number of Ka-band products being introduced, as satcom applications are utilizing these higher frequencies. Moreover, performance enhancements being realized include power amplifiers (PAs) with improved efficiency, low-noise amplifiers (LNAs) with very low noise figures at millimeter-wave frequencies, and more compact solutions. Smaller sizes are due partly to the utilization of highly integrated products.

This wideband synthesizer covers a frequency range of 54 MHz to 13.6 GHz. (Courtesy of Analog Devices)

In addition, while the benefits of gallium-nitride (GaN) technology have been well documented, it is worth noting how the technology is specifically enabling satcom applications. Gallium-arsenide (GaAs) technology previously dominated the satcom realm, and although GaAs has by no means disappeared, GaN has now clearly assumed a prominent role. Taking all of this into account, one should be aware of the latest technology developments that are impacting the satcom arena.

ONE COMPANY'S PERSPECTIVE

BAE Systems (www.baesystems.com) is heavily involved in developing RF/microwave technology solutions to support today's satcom requirements. "The two major trends we see—more capability/throughput from traditional large satellites and small satellites with low target cost—call for optimal use of available resources in an extremely power-constrained environment,"says Phillip Smith, the company's chief engineer of advanced microwave products. "This includes moving to higher frequencies like Ka-band and beyond for available bandwidth, coupled with bandwidth-efficient modulation (BEM) techniques that maximize spectrum use—but dictate enhanced linearity.

"Other developments include increased solid-state power amplifier (SSPA) output power levels with the highest possible efficiency to minimize required prime power," adds Smith. "And robust high-sensitivity receivers are enhancing link margin and easing requirements for transmitted power from crosslinks or ground terminals. Reconfigurability and multi-functionality are also in high demand, with phased-array implementations becoming more attractive as microwave integrated circuits (MICs) become ubiquitous."

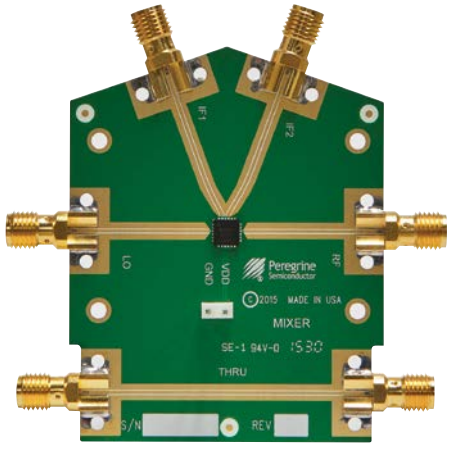
To support satcom applications, BAE Systems is developing solutions based on both GaAs and GaN technologies. GaAs technology is being utilized to build low-noise amplifiers (LNAs) with sub-2-dB noise figures at millimeter-wave frequencies. And the company is taking advantage of GaN technology to offer high-power solutions.

"We provide GaAs- and GaN-based monolithic-microwave-integrated-circuit (MMIC) technologies that are well-suited for satcom requirements," explains Smith. "Our space-qualified GaAs technologies include pseudomorphic-high-electron-mobility-transistor (pHEMT) and metamorphic-high-electron-mobility-transistor (mHEMT) technologies.

"Extremely low noise figures at frequencies from 10 to 200 GHz (e.g., under 2 dB at 80 GHz) are being achieved by 50-nm gate-length mHEMT LNAs," he continues. "Current four-inch GaN wafers have produced MMIC PAs with 10 to 15 W of output power and 30% power-added efficiency (PAE) at

Ka-band."

GaN technology can help to meet space-lifetime requirements. Smith notes, "GaN reliability meets demanding space-lifetime requirements—the process exhibits a mean time to failure (MTTF) of 10 million hours at channel temperatures of +200°C when operating at a V_{ds} of 30 V. GaN is currently being scaled to six-inch wafer sizes (with planned release to production in 2017) to enhance chip affordability, repeatability, and foundry capacity."



This image-reject mixer operates to 19 GHz. (Courtesy of Peregrine Semiconductor)

One point Smith brought up is the move to Ka-band frequencies. A number of companies are developing products that operate at this frequency band. For example, MACOM (www.macom.com) recently launched the MAAP-011289, which is a 3-W PA that covers a frequency range of 28.0 to 30.5 GHz.

In addition, Anokiwave (www.anokiwave.com) unveiled the AWMF-0109 and AWMF-0113 models earlier this year. The AWMF-0109 and AWMF-0113 are Ka-band integrated solutions that should find their way into satcom transmit applications. The intent of both devices is that they can be easily installed in planar phased-array antennas. The AWMF-0109 supports four dual polarization radiating elements, while the AWMF-0113 supports eight single polarization radiating elements. Both devices operate from 27.5 to 30.0 GHz.

MORE ON GAN TECHNOLOGY

GaN technology offers other benefits, too, such as allowing for smaller packages. David Schnaufer, technical marketing manager at Qorvo (www.qorvo.com), elaborates: "The demand for high-performance semiconductor products in small package styles is increasing. Small-packaged devices are particularly important in satellite communications and must be able to withstand harsh environments on land, in the air, and at sea."GaAs technology has long been the norm for RF devices in these spaces," says Schnaufer. "But with the demand for smaller form factors, and the extreme heat, cold, and damp conditions of satcom systems, GaN is the new best choice. GaN is more reliable, fits in a smaller package, and operates at higher temperatures than GaAs. Our recent breakthroughs in GaN device and packaging technology allow for smaller packages while offering environmental protection."

Qorvo currently offers a number of GaN products in support of satcom applications. One example is the TGM2635-CP PA, which was announced earlier this year. This 100-W PA covers a frequency range of 7.9 to 11 GHz, and is well-suited for X-band satcom systems.

Several other suppliers are also providing GaN-based solutions for satcom applications. Among them is Mitsubishi Electric, which recently expanded its lineup of Ku-band GaN devices with two new models. The MGFK50G3745 and MGFK48G3745 deliver output power levels of 100 and 70 W, respectively.

INTEGRATED SOLUTIONS

Today's satcom requirements are also prompting suppliers to develop highly integrated solutions. "A nearly insatiable demand for bandwidth and the desire to get more value from current levels of investment are two trends driving significant growth in the satellite market," says Greg Henderson, vice president, RF/microwave business at Analog Devices (www.analog.com). "Continuing success in the industry will come through developing high-performance, highly integrated silicon solutions.

"We are replacing large multi-technology signal chains with monolithic, fully integrated, silicon direct-conversion transmit (Tx) and receive (Rx) solutions," continues Henderson. "We're using an antenna-to-bits portfolio for applications up to 100 GHz. We believe customers want complete signal-chain capability, including complementary functions such as clocks and phase-locked loops (PLLs). Looking ahead, by leveraging design and millimeter-wave integration IP, significant improvements in performance (as much as 10× greater throughput than current solutions)—with 30% lower power consumption and a reduced footprint of more than 10×—are possible."

One product from Analog Devices that fits this description is the ADF5355, which is a wideband synthesizer with an integrated voltage-controlled oscillator (VCO) *(Fig. 1)*. The company says this product is being designed into Ka-band receivers. The frequency range of the ADF5355 spans 54 MHz to 13.6 GHz.

Additional suppliers of integrated solutions include Peregrine Semiconductor (www.psemi.com). Earlier this year, the company introduced the PE41901 image-reject mixer, which is suitable for Ku-band satcom applications *(Fig. 2)*. The PE41901 contains two mixers, a local-oscillator (LO) path 90-deg. coupler, and RF port baluns on a single die. The integration of this functionality allows the required board space to be minimized. The PE41901 covers an RF frequency range of 10 to 19 GHz.

This article discussed some of the latest developments in the satcom space. Clearly, Ka-band solutions are one focal point, as this frequency band is highly crucial for today's satcom applications. Of course, high-power GaN products will continue to power the next-generation of satcom. Furthermore, suppliers are reaching new levels of innovation with highly integrated products, leading to a number of performance enhancements.