Harnessing Smaller Wavelengths to Capture Growing Opportunities

By Eravant

Opportunities abound in the realm of microwave and millimeter wave electronic systems.

With ever-growing demand for wireless bandwidth, opportunities abound in the realm of microwave and millimeter wave electronic systems. But at these wavelengths the technical and business landscapes have often been difficult to navigate. Many applications that are destined for widespread market acceptance are still in their infancy.

For those involved in the development of leading-edge wireless products, some of the more difficult challenges include surveying and selecting component suppliers. This is especially true in systems where one electronic component can impact the performance of several others. Moreover, the depth and breadth of a supplier's understanding of these dependencies must be plumbed as soon as possible to ensure that system integrators can consistently achieve the best possible performance over the long term.

For many years Eravant, formerly SAGE Millimeter, (Torrance, CA) has been investing heavily to build up its expertise and inventories, encompassing a wide expanse of coaxial and waveguide components that span frequencies from DC to over 300 GHz. Their product categories run the gamut to ensure that almost everything needed to harness high-end wireless spectrum is available through Eravant's comprehensive catalog of stocked items. Several product categories are worth highlighting as examples.

Figure 1 • SOL-30312-28-G1.

Figure 2 • SOT-02220313003-SF-B6.

Figure 3 • STE-SF415-04-S1.

Signal Sources

Almost all wireless applications need clean signal sources. Since its beginning, Eravant has been a leader in the production of low-noise Gunn oscillators (Fig. 1 SOL-30312-28-G1). The economy and performance of these components make them ideal sources of RF power in many applications. With output frequencies available from 9 to 110 GHz, mechanical tuning ranges are as high as +/-12 percent. Voltage-tuned Gunn oscillators, widely used in range/speed radar sensors and frequency-agile systems, achieve industry-leading value and performance across the 9 to 96 GHz spectrum.

Sources from Eravant also include mechanically tuned dielectric resonator oscillators (DROs) spanning 3 to 37 GHz, and phase locked DROs that blanket 1 to 94 GHz. Additionally, frequency synthesizer modules tune continuously from 0.2 to 20 GHz (Fig. 2 SOT-02220313003-SF-B6). They achieve hopping speeds of 3 microseconds with 10-kHz frequency resolution.

Eravant's frequency multipliers and frequency converters occupy additional territory in wireless systems.

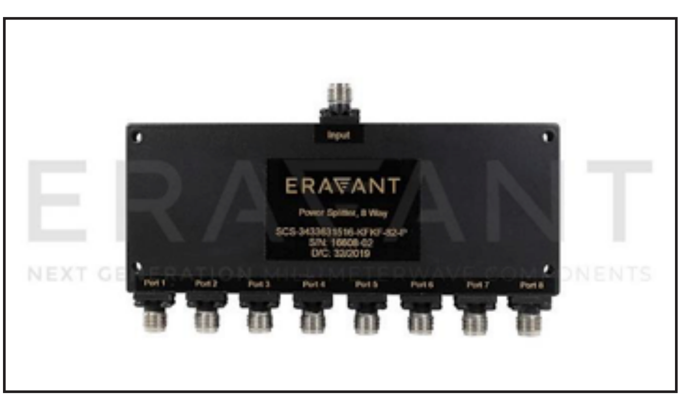

Figure 4 • SCS-2734032516-KFKF-82.

Active multipliers generate low-noise and fast-tuning signals that cover 20 to 113 GHz, with multiplication factors ranging from 2 to 8. Passive multipliers reach 220 GHz with multiplication factors of 2, 3, or 4. Frequency converters (mixers) support IF signals from DC to 40 GHz using LO and RF frequencies spanning 18 to 170 GHz.

Eravant's frequency extenders are a family of integrated assemblies that combine successive stages of multipliers, amplifiers, and filters to yield multiplication factors from 2 to 16. Over full waveguide bandwidths, they produce signals from 50 to 320 GHz (Fig. 3 STE-SF415-04-S1). Because multiplied signals generally inherit the amplitude and phase characteristics of the source signal, they can be used to extend the frequency range of many scalar and vector network analyzers.

When signals are spread out across an array of antennas elements, or teamed up to deliver higher power, Eravant's power dividers can join up to 16 channels at frequencies reaching from 1 to 170 GHz. A typical 8-way divider operating from 26.5 to 40 GHz features 2.5-dB total insertion loss, +/- 8 degree phase imbalance, and +/- 0.8 dB amplitude variation between ports (Fig. 4 SCS-2734032516-KFKF-82).

Antenna Performance Gains

For any wireless system, antennas are where the rubber meets the road. Eravant offers a wide variety of antennas that support applications from radar and communication systems to advanced instrumentation. Planar antenna arrays are available as stand-alone components or integrated with radar sensor assemblies (Fig. 5 SSS-24307-27M-DW). A new modular antenna system facilitates the construction of custom arrays for

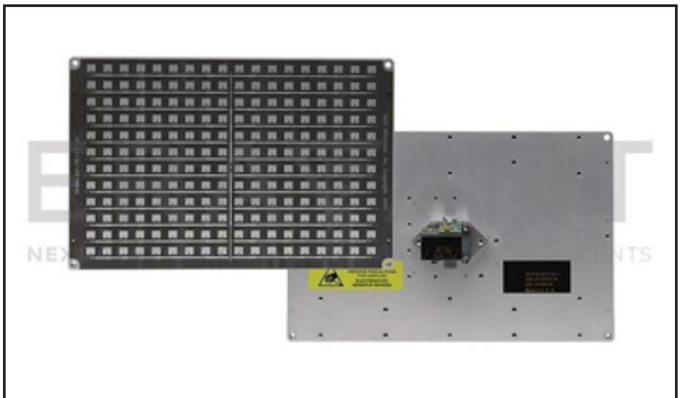

Figure 5 • SSS-24307-27M-DW

Figure 6 • SAM-2832830695-DM-L1-64C.

Multiple-Input Multiple-Output antennas that exploit multi-path propagation routes to increase channel capacity and improve system reliability (Fig. 6 SAM-2832830695-DM-L1-64C).

Omnidirectional antennas are often found where the landscape requires uniform signal coverage. Offering gains from 2 to 7.5 dBi, Eravant's passive omnidirectional antennas cover full waveguide bands between 26.5 and 110 GHz (Fig.7 SAO-2734030810-KF-S1). Models with integrated low-noise amplifiers boost antenna gain to 18 or 30 dBi across the Ka band (26.5 to 40 GHz).

Horn antennas are another product category where Eravant commands a wide domain. Units without lenses have gains in the range of 15 to 26 dBi at frequencies from 12.4 to 325 GHz. Many selections include dual feeds to support polarization diversity. Still higher levels of performance are achieved by Cassegrain and lens-corrected antennas, with gains as high as 51 dBi at frequencies from 17.5 to 160 GHz (Fig. 8 SAG-1441644501-06-S1). For Ultra-Wide Bandwidth and other broadband applications, a collection of ridged horn antennas occupies ground from 1 to 110 GHz with either single or dual polarization available (Fig.9 SAV-0131831040-NF-U2). Eravant also carries a range of other antenna products such as waveguide probes that are typically used for near-field measurements. They bridge an expanse from 8.2 to 325 GHz.

Figure 7 • SAO-2734030810-KF-S1.

Eravant's lineup of choke-flange and scalar antennas achieve well-controlled azimuth and elevation responses for systems such as antenna measurement ranges, instrumentation radar, and 5G applications employing polarization diversity. For example, a dual-polarized choke flange feed horn antenna operating from 24 to 42 GHz boasts 35 dB cross-polarization rejection and 25 dB sidelobe suppression with gain of 10 dbi (Fig. 10 SAH-2434231060-328-S1-280-DP). Over the same frequency range, a dual polarized scalar feed horn antenna delivers 17 dBi gain, also with 35 dB cross-pol rejection and 25 dB sidelobe suppression (Fig. 11 SAF-2434231725-328-S1-280-DP).

Non-Reciprocals

Ferrite devices including isolators and circulators can serve as barriers to, or off-ramps for, reflected signals. Isolators can stabilize an oscillator by absorbing reflections from a variable load such as an antenna in the presence of nearby moving objects. Isolators are also used to ensure the stability of high-gain amplifiers, or flatten the frequency response of other devices. Circulators are often employed as diplexers to transmit and receive signals flowing through a single antenna. For most applications, performance milestones include isolation, insertion loss, and bandwidth. A Faraday rotation isolator operating from 170 to 220 GHz typically yields 4 dB insertion loss and 30 dB isolation (Fig. 12 STF-04-S1). A waveguide junction circulator directs signals from 22 to 33 GHz with 0.5 dB insertion loss and 18 dB isolation (Fig. 13 SNF-34-C5).

Orthomode transducers (OMTs) provide another way to diplex to transmit and receive signals. Orthogonally positioned waveguide ports are merged into a single

Figure 8 • SAG-1441644501-06-S1

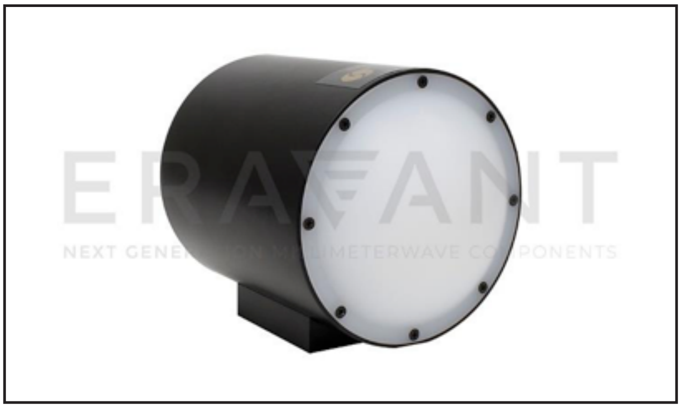

Figure 9 • SAV-0131831040-NF-U2.

antenna feed (Fig. 14 SAT-333-28028-S1). Cross-polarized transmitted and received signals enable full-duplex communication through a single antenna with very low coupling between channels. Other diplex devices include Transmit/Receive switches and circulators, but OMTs often result in the best performance overall. Recognizing this potential, Eravant supplies OMTs with some of the best performance metrics available, including 50 dB port isolation and 30 dB cross-polarization suppression.

Eravant also carries a variety of high-performance coaxial-to-waveguide adapters. Low-VSWR transitions ensure that signal loss and distortion are minimized. This is no small feat when different electromagnetic field patterns in each transmission medium must be coupled within a compact structure without generating spurious modes of wave propagation. A wide variety of end-launch and right-angle adapters transport signals from 7 to 125 GHz. Nine coaxial connector options are offered, ranging from Type N to 1.0 mm.

A newer family of devices offers more direct signal pathways for both electronic packaging and system integration. Engineers at Eravant recently developed Uni-Guide connectors that provide an exceptionally compact and versatile method of transitioning from a coaxial bead soldered into the wall of an electronic enclosure (Fig. 15 SUF-2812-480-S1). Uni-Guide connectors conform to the mounting profiles of standard coaxial connectors and function as drop-in waveguide-port replacements. Component manufacturers can now reduce both the size and number of stocked enclosures by eliminating the waveguide transitions that would otherwise be included. Uni-Guide connectors can also improve the compactness of subassemblies and reduce their cost by eliminating coaxial-to-waveguide adapters. Further, a simple 90-degree rotation of Uni-Guide connectors changes the orientation of the waveguide flange, often eliminating the need for a twisted waveguide adapter.

Measurement Certainty

Another realm where Eravant excels is millimeter wave instrumentation. Extenders for scalar and vector network analyzers employ carefully matched combinations of high-performance components. Each extender for scalar network analyzers includes a frequency extender, a direct-reading attenuator, a directional cou-

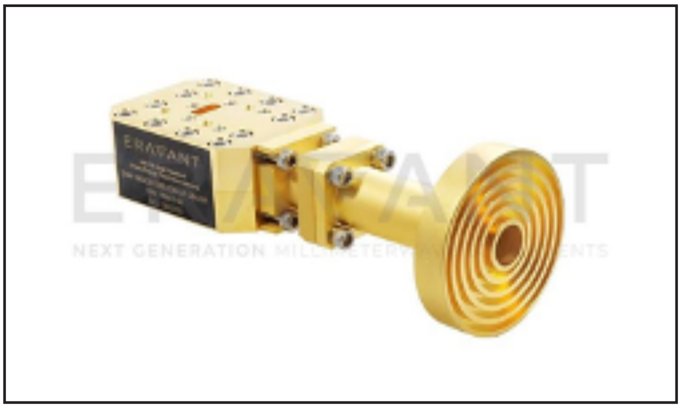

Figure 10 • SAH-2434231060-328-S1-280-DP

Figure 11 • SAH-2434231060-328-S1-280-DP.

Figure 12 • STF-04-S1, Figure 12 • SNF-34-C5

Figure 13 • SNF-34-C5.

pler, and a pair of amplitude detectors (Fig. 16 STN-SF415-04-D2). Typical dynamic range for scalar measurements is 30 dB for insertion loss and 20 dB for return loss. Although the dynamic range is modest, such capabilities are often adequate for design optimization.

Extenders for vector network analyzers are much more complex but vastly more capable, offering dynamic range as high as 100 dB over waveguide bands from 50 to 220 GHz. Compatible network analyzers must have dual phase-locked sources with a frequency-offset option that enables coherent down-conversion of detected signals. Test systems such as these require a hefty investment but they are indispensable for successfully producing and assembling components in applications where phase and amplitude responses are critical, such as filters, phased array antennas, and RF imaging systems.

Another family of extenders works with industry-standard noise figure test sets. Each extender combines an integrated down-converter with a calibrated noise source and isolator (Fig. 17 STG-15-S1). The components interface directly with the host test system for easy setup and operation.

Venturing further into Eravant's panorama of test equipment, one can find a comprehensive line of corner reflectors and radar target simulators. Trihedral corner reflectors vary in size from 0.7 to 30 inches (18 to 760 mm). They provide consistent radar cross-sections for testing Doppler, FMCW, and other types of radar sensors. Doppler target simulators use a single-sideband mixer to generate a frequency-shifted signal that is fed back to the sensor. The returned signal approximates a signal received from a moving target. Multiple target signals can be generated simultaneously. A variable attenuator adjusts the effective radar cross-section of the simulated target. The simulators are typically used to calibrate sensors in a production or laboratory environment.

Radar Headings

Engineers and technicians at Eravant have been designing and building radar sensor heads for more than 30 years. Most of their high-volume sensor heads operate at either 24.125 GHz or from 34 to 36 GHz. Doppler sensor heads combine a low-noise oscillator with a diplexer,

Figure 14 • SAT-333-28028-S1.

Figure 15 • SUF-2812-480-S1.

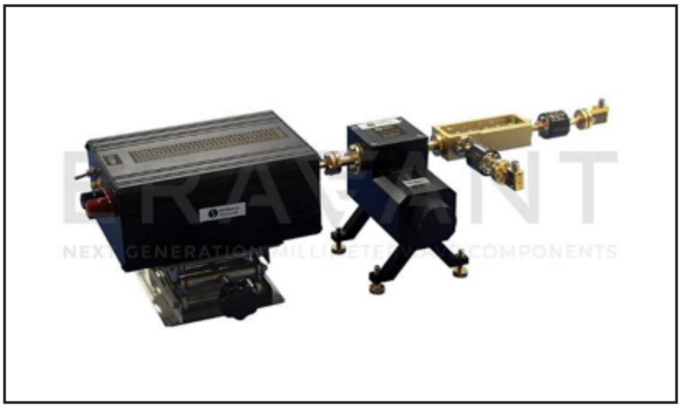

Figure 16 • STN-SF415-04-D2.

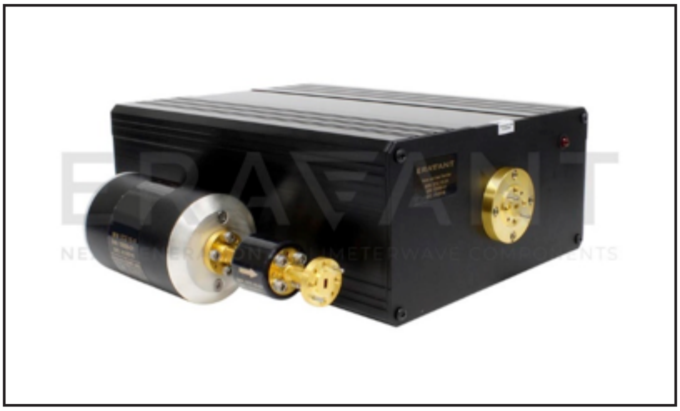

Figure 17 • STG-15-S1.

mixer, and one of several antenna options. Units with planar antennas are suitable for short- and medium-range applications. Doppler sensor heads with lens antennas are typically used for long-range speed detection (Fig. 18 SSS-35315-22L-D1). Most are available with dual receive channels that provide quadrature-shifted Doppler signals. By examining the phase difference between the two channels one can determine whether a target is moving toward or away from the sensor.

Ranging sensor heads employ an electronically tuned signal source. Otherwise, they are similar to their Doppler brethren. Sweeping or otherwise modulating the transmit frequency produces baseband signals that indicate the distance to various objects in the sensor's field of view. Received and down-converted signals are typically captured and analyzed with digital signal processors. Range resolution is determined by several factors including tuning bandwidth, oscillator calibration, signal-to-noise ratio, modulation rate, target velocity, and the signal-processing algorithm employed.

Separately integrated transmit and receive modules can serve as building blocks for a variety of applications. A typical transmit module covering 21 to 27 GHz includes a harmonic mixer that operates with an LO frequency centered at 12 GHz (Fig. 19 SST-2430630005-42-S1). Modulation bandwidth is 0.01 to 4.0 GHz with output power of +8 dBm. A receiver module covering the same spectrum also uses a harmonic mixer and a 12-GHz LO signal (Fig. 20 SSR-2430630060-42-S1). The receiver achieves a noise figure of 4.0 dB with 3 dB conversion gain and a 1 dB compression point of -5 dBm at the input. The transmit and receive modules can be combined with OMT model SAT-FK-42042-S1, waveguide transition SWT-420470-SA-C-QC, and an antenna such as SAC-2012-470-S2. Such an assembly could serve as the higher-frequency portion of a short-haul full-duplex 5G transceiver offering 4 GHz modulation bandwidth.

Eravant's mission is to guide customers from early concepts to working systems that are as economical and reliable as possible. Their engineering and manufacturing personnel can help integrate prototype systems into compact subassemblies. Recent successes include a

Figure 18 • SSS-35315-22L-D1.

Figure 19 • SST-2430630005-42-S1

Figure 20 • SSR-2430630060-42-S1.

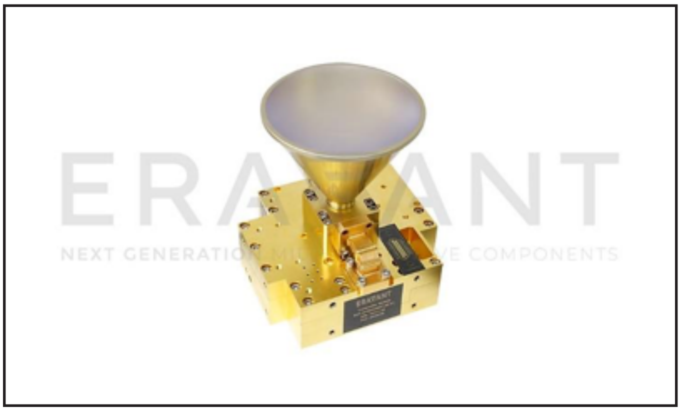

Figure 21 • SSK-ST2730253027-28-C1.

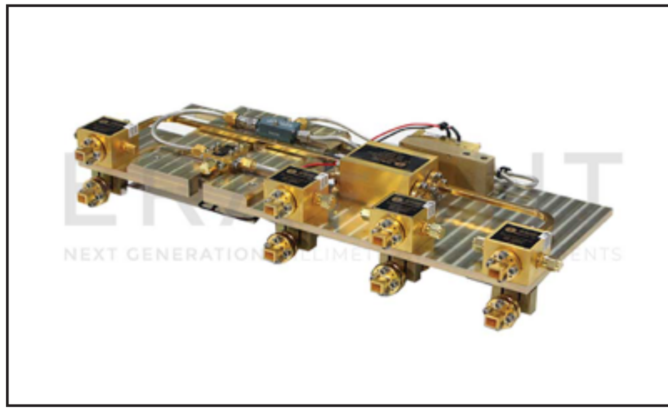

Figure 22 • SSC-7337331202-1212-B1.

space-qualified transmitter module (Fig. 21 SSK-ST2730253027-28-C1). Working at 26.8 GHz, the assembly transmits +29 dBm through a lens-corrected, circularly polarized horn antenna to yield Equivalent Isotropic Radiated Power of +52 dBm.

Another example is an eight-channel FMCW radar transceiver that operates from 70 to 75 GHz (Fig. 22 SSC-7337331202-1212-B1). This subassembly includes a direct-digital synthesized RF source, a single-sideband modulator, and four transmit channels that are excited through a SP4T RF switch. Four receive channels employ I/Q mixers with horn antennas having 10 dBi gain. The system tunes across a 5 GHz swath in less than 100 us, delivering sub-mm range resolution for rapidly moving objects.

Whether the application is a high-bandwidth communication link, high-resolution radar, or advanced instrumentation in a medical, industrial, or scientific setting, Eravant has probably seen something like it. As a dedicated partner they are eager to apply their rich range of knowledge to help lift new ideas off the ground and set them in motion toward successful and timely results.