KA-BAND ANTENNAS LINK MOBILE SATCOM USERS

SATELLITE COMMUNICATIONS (SATCOM) technology is moving far beyond the simple reception of video from orbiting geosynchronous satellites and into full bidirectional mobile satcom services. To accomplish this at Ka-band frequencies, efficient antenna designs are needed for mobile satcom terminals. Researchers from the RF and Microwave Research Laboratory at the Technische Universitat Ilmenau (Ilmenau, Germany) and the Fraunhofer Institute for Integrated Circuits IIS, Design Automation Division EAS (Dresden, Germany) attempted to compare two different Ka-band antenna terminal setups for mobile satcom applications. The two antennas traded size for performance: one was a larger, high-gain antenna, the other a lower-gain, lower-profile antenna.

The researchers point out the growing interest in Ka-band frequencies at 29.5 to 30.0 GHz for uplinks and 19.7 to 20.2 GHz for downlinks because of their healthy capacity and compact terminal antennas. In emergency situations where terrestrial communications systems may not be available or reliable, the use of geosynchronous satellites can provide a means of communications. The two antenna designs explore the classic tradeoff of size for performance.

The larger of the two designs is a Cassegrain double-reflector antenna mounted on a mechanically adjusted, two-axis positioner on a carrier vehicle. The reflector diameter is 60 cm, but it provides large gain of about 40 dBi in support of high data rates for bidirectional satcom links. While moving, the antenna tracks satellite direction by means of multimode monopulse tracking. It can be mounted on large vehicles, such as pickup trucks.

The smaller antenna is designed for greater mobility, with a maximum height of only 15 cm. The smaller profile and size yields less gain, at about 20 dBi, and a correspondingly broader beamwidth. The low profile of the antenna design makes possible a compact satellite terminal outdoor unit (ODU) with a mechanical azimuth positioned that operates effectively while maintaining the aforementioned height, even when the vehicle is in motion.

The design was evaluated by means of an antenna ODU demonstrator capable of adjusting azimuth for both uplink and downlink operations. In contrast to the larger, high-gain antenna, this low-profile satcom antenna is suitable for mounting on smaller vehicles, including standard automobiles. See “Ka-Band User Terminal Antennas for Satellite Communications,” *IEEE Antennas & Propagation Magazine*, February 2016, p. 76.

TRANSCEIVER ARRAY AIDS SUBMILLIMETER-WAVE RADAR

SUBMILLIMETER-WAVE RADAR SYSTEMS operating at beyond 300 GHz are effective solutions for imaging concealed weapons at security checkpoints. These fine wavelengths can detect metal objects through most clothing without the health risks posed by x-ray imaging systems.

In pursuit of a practical submillimeter-wave front end, researchers at the California Institute of Technology’s Jet Propulsion Laboratory (JPL; Pasadena, Calif.), under contract with the National Aeronautics and Space Administration (NASA), developed an eight-pixel transceiver array for use in a 340-GHz imaging radar. The array was fabricated by silicon micromachining for relatively low cost and with high circuit density, with 12-mm pixel spacing in a vertically integrated waveguide configuration.

This work builds on active imaging techniques developed at JPL in the development of a frequency-modulated, continuous-wave (FMCW) radar that measures the time of flight between the system and a target by transmitting chirped tones, then demodulating received signals for determining the range to the point of focus on a target. Because the scanning speed of JPL’s radar system was limited by a mechanical scanning mechanism, the authors sought an eight-pixel transceiver array capable of faster scanning frame rates.

The researchers’ experiments produced a transceiver array capable of operating from 324 to 354 GHz. The transceiver provides 0.5-mW transmit power per pixel with conversion loss of 8 dB. Performance is ultimately limited by combining the receiver and transmitter paths in a 3-dB waveguide hybrid coupler with about 28-dB isolation. High isolation is required of the hybrid coupler to achieve good system sensitivity because of transmitter phase noise leakage that degrades receiver performance. The High Frequency Structure Simulator (HFSS) electromagnetic (EM) simulation software from ANSYS (www.ansys.com) was used to simulate and optimize the hybrid coupler.

Silicon waveguide structures for the transceiver array were fabricated at JPL’s Micro-Devices Lab using a multi-etch-depth, deep-reactive-ion-etching (DRIE) silicon micromachining process. A tiered hard mask was employed to define all of the circuit patterns prior to silicon etching, thus avoiding spinning photoresist across a silicon wafer, as well as minimizing pits and over-etched channels in the wafer. Deep waveguide trenches were formed in an 800-μm-thick silicon wafer, with through-wafer waveguides etched from both sides of the wafer to minimize surface roughness and loss.

Experiments using a single pixel of the array have provided effective imaging of concealed weapons, even when concealed beneath thick leather jackets. See “A Silicon Micromachined Eight-Pixel Transceiver Array for Submillimeter-Wave Radar,” *IEEE Transactions on Terahertz Science and Technology*, Vol. 5, No. 2, March, 2015, p. 197.