Planar Submillimeter-Wave Mixer Technology With Integrated Antenna

This technology can be used for terahertz radar imagers and in testing of quantum cascade lasers.

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High-performance mixers at terahertz frequencies require good matching between the coupling circuits such as antennas and local oscillators and the diode embedding impedance. With the availability of amplifiers at submillimeter wavelengths and the need to have multi-pixel imagers and cameras, planar mixer architecture is required to have an integrated system. An integrated mixer with planar antenna provides a compact and optimized design at terahertz frequencies. Moreover, it leads to a planar architecture that enables efficient interconnect with submillimeter-wave amplifiers.

In this architecture, a planar slot antenna is designed on a thin gallium arsenide (GaAs) membrane in such a way that the beam on either side of the membrane is symmetric and has good beam profile with high coupling efficiency. A coplanar waveguide (CPW) coupled Schottky diode mixer is designed and integrated with the antenna. In this architecture, the local oscillator (LO) is coupled through one side of the antenna and the RF from the other side, without requiring any beam splitters or diplexers. The intermediate frequency (IF) comes out on a 50-ohm CPW line at the edge of the mixer chip, which can be wire-bonded to external circuits. This unique terahertz mixer has integrated single planar antenna for coupling both the radio frequency (RF) input and LO injection without any diplexer or beam splitters. The design utilizes novel planar slot antenna architecture on a 3-μm-thick GaAs membrane.

This work is required to enable future multi-pixel terahertz receivers for astrophysics missions, and lightweight and compact receivers for planetary missions to the outer planets in our solar system. Also, this technology can be used in terahertz radar imaging applications as well as for testing of quantum cascade lasers (QCLs).

This work was done by Gautam Chattopadhyay, Imran Mehdi, John J. Gill, Choonsup Lee, and Nuria Llombart of Caltech for NASA's Jet Propulsion Laboratory and Bertrand Thomas of Oak Ridge Associated Universities. Further information is contained in a TSP (see page 1), NPO-46880