Abstracts

Compact single-chip W-band FMCW radar modules for commercial high-resolution sensor applications

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Two compact single-chip 94-GHz frequency-modulated continuous-wave (FMCW) radar modules have been developed for high-resolution sensing under adverse conditions and environments. The first module contains a monolithic microwave integrated circuit (MMIC) consisting of a mechanically and electrically tunable voltage-controlled oscillator (VCO) with a buffer amplifier, 10-dB coupler, medium-power and a low-noise amplifier, balanced rat-race high electron-mobility transistor (HEMT) diode mixer, and a driver amplifier to increase the local-oscillator signal level. The overall chip-size of the FMCW radar MMIC is 2/spl times/3.5 mm/sup 2/. For use with a single transmit-receive antenna, a 94-GHz microstrip hexaferrite circulator was implemented in the module. The radar sensor achieved a tuning range of 1 GHz, an output signal power of 1.5 mW, and a conversion loss of 2 dB. The second FMCW radar sensor uses an MMIC consisting of a varactor-tuned VCO with injection port, very compact transmit and receive amplifiers, and a single-ended resistive mixer. To enable single-antenna operation, the external circulator was replaced by a combination of a Wilkinson divider and a Lange coupler integrated on the MMIC. The circuit features coplanar technology and cascode HEMTs for compact size and low cost. These techniques result in a particularly small overall chip-size of only 2/spl times/3 mm/sup 2/. The packaged 94-GHz FMCW radar module achieved a tuning range of 6 GHz, an output signal power of 1.5 mW, and a conversion loss of 5 dB. The RF performance of the radar module was successfully verified by real-time monitoring the time flow of a gas-assisted injection molding process.

❑ Return to main document.