A Low Noise Integrated Sub-Harmonic Mixer at 183GHz

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Abstract

Low-loss, heterodyne detection systems operating at terahertz frequencies are essential for applications in atmospheric remote sensing. Such applications need good quality air-bridged Schottky diodes for use in heterodyne mixers and multipliers. Sub-harmonic Schottky diode mixers are key components of these receivers since they provide high spectral resolution and good sensitivity at room temperature.

Conventional technology relies on the ability to flip-chip solder a diced diode chip onto a quartz wafer carrying filter metallisation. Successful flip-chip bonding requires highly specialised skills, is difficult to do well and inevitably introduces additional parasitic losses into the circuit.

This paper describes the development of integrated devices, whereby an anti-parallel pair of planar Schottky diodes is integrated with the associated filter metallisation, monolithically fabricated on a 50μm-thick GaAs substrate. The Schottky diodes are air-bridged to reduce the parasitic capacitance of the diode structure. Diodes with anode diameters of approximately 1 μm have been fabricated, resulting in idealities, $\eta \sim 1.15$ and series resistances, $R_S \sim 15\Omega$.

The diode structure has been designed to operate in a fixed-tuned, reduced-height, crossed-waveguide mixer block. The mixer layout has been optimised using a combination of three dimensional electromagnetic and circuit simulations. The MMIC circuit is about 4 mm long, 0.28 mm wide and will be mounted in a waveguide block that includes matching elements inside the Local Oscillator (LO) and RF waveguides. The mixer is expected to operate in the band 160-190 GHz with a double side band (DSB) conversion gain greater than -6 dB when pumped with 2 mW of Local Oscillator (LO) power. A minimum DSB gain of -5.2 dB and a DSB noise temperature of 500 K are expected at 183 GHz.

The precision mixer block has been machined in the machine shop of RAL. The testing of the 183 GHz mixer is currently taking place.