670 GHz Schottky Diode Based Subharmonic Mixer with CPW Circuits and 70 GHz IF

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***Abstract*—Gallium Arsenide (GaAs) based sub-harmonically pumped Schottky diode mixers offer a number of advantages for array implementation in a heterodyne receiver system. Since the radio frequency (RF) and local oscillator (LO) signals are far apart, system design becomes much simpler. JPL has developed a planar GaAs Schottky diode process that results in very low parasitic anodes that have cutoff frequencies in the tens of terahertz. This technology enables robust implementation of monolithic mixer and frequency multiplier circuits well into the terahertz frequency range. Using optical and e-beam lithography and conventional epitaxial layer design with innovative GaAs membrane topologies and metal beam leads JPL is able to design high performance terahertz circuits with high fidelity.**

However, all these mixers use metal waveguide structures for housing. Mixers in metal machined waveguides are difficult to incorporate in integrated multi-pixel heterodyne array receivers for spectroscopic and imaging applications at terahertz frequencies. Moreover, the recent developments of terahertz transistors with sufficient gain provide an opportunity, for the first time, to have integrated amplifiers followed by Schottky diode mixers in a heterodyne receiver at these frequencies. Since the amplifiers are developed on a planar coplanar waveguide (CPW) coupled architecture, it is useful to design the mixers on similar CPW coupled transmission lines to facilitate integrated multi-pixel array implementation.

We have designed and developed a coplanar waveguide (CPW) based subharmonically-pumped mixer working at 670 GHz using GaAs Schottky diodes. The specific system design required an IF frequency of 70 GHz, posing a substantial design challenge. To the best of our knowledge, this is the first time CPW-based Schottky diode mixers have been designed at these frequencies. In this design, shown in Fig. 1, RF and LO signals are coupled to a anti-parallel diode pair using grounded CPW lines on a 25-micron thick GasAs substrate with air-bridges and vias to cancel substrate modes. In this design we used LO and RF matching networks as well as appropriate CPW stubs to short out LO and RF frequencies at appropriate locations. Fig. 2 shows a SEM micrograph of a fabricated device. We measured 16-18 dB of conversion loss for these mixers at 670 GHz RF and 70 GHz IF. Compared to waveguide mixers, these results are inferior. However, we believe that the performance can be improved if we use a low frequency IF output frequency.

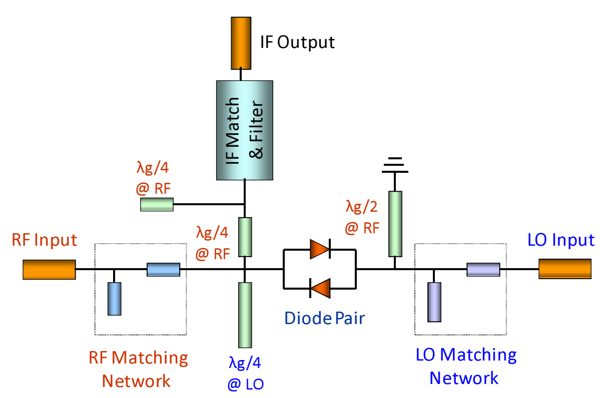

Fig. 1: Schematic diagram of the 670 GHz subharmonic mixer with 70 GHz IF.

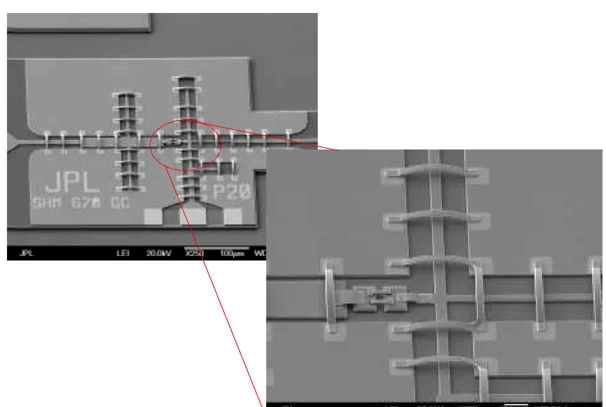

Fig. 2: SEM micrograph of the fabricated 670 GHz subharmonically-pumped mixer with CPW coupling structures and 70 GHz IF output frequency.

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