

A Design Methodology for Planar Triplers in Coplanar Waveguide on Thick Membranes

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The local oscillator is a key element of any Terahertz receiver. A typical Schottky mixer requires a drive of ~ 1 mW to achieve good conversion gains and noise figures. In many currently operating systems this power is provided by a chain of frequency doublers and/or triplers driven by a Gunn diode oscillator. This chain is implemented by a sequence of waveguide blocks in which both non-linear elements and filter structures are mounted on thin quartz membranes. These structures have a number of advantages for space applications including ruggedness (with the possible exception of the membranes) and good handling of the inevitable heat dissipation. On the other hand the weight of the waveguide elements would become an issue if a large number of local oscillators were required, as would be the case in a focal plane array.

We report research into methods of designing planar frequency triplers on GaAs substrates using coplanar lines to provide the impedance matching and frequency filtering elements for GaAs Schottky diodes. A methodology has been evolved that enables optimised tripler designs to be achieved without the exceptional computing times that would be needed for the unguided optimisation of a particular design topology. This methodology will be presented in this paper.

This research has identified a number of issues that are significant in determining the efficiency of coplanar waveguide structures in tripler circuits. The most significant of these is the excitation of substrate modes which can be minimised by using thick (20 μm) GaAs membranes for the substrate. These provide greater ruggedness and lateral thermal transport than the more commonly used thin membranes (~ 1 μm). Mode conversion is an inevitable problem with coplanar waveguide junctions, but can be controlled by the use of bridges between grounds at appropriate places. A further problem, which is unique to frequency triplers is the very short distance between the fundamental feedpoint and the 50 Ω third harmonic output point on the circuit. The methodology is based on recognising this as a major issue and deals directly with this problem. A final issue is the incorporation of a good representation of the Schottky diode with its parasitic elements within the electromagnetic software model. This issue will be specifically addressed within this paper.

The conclusions of the design study, supported by experimental work, is that coplanar waveguide triplers are feasible and can have useful efficiencies, but cannot achieve the efficiencies of the best waveguide structures. They are therefore good candidates for implementing local oscillators up to 500 GHz, but are unsuitable for applications where a chain of multipliers is required.