Tuned Zero-Bias Schottky Diode Detectors for Microwave Radiometers

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At Boulder Environmental Sciences and Technology, we are developing the next generation of microwave radiometers that are small, lightweight, and consume very little power. The zero-bias detector is a transducer of microwave power to a voltage that can be recorded, visualized in plots, and stored in memory for post processing. It is the final piece in the microwave chain of the microwave radiometer and its sensitivity effects the system in many significant ways. It determines how much total gain is needed in the microwave chain, and thus also effects how much power is required and the overall size of the system. These parameters are extremely important for our design because our systems are intended to operate on small and remote platforms that have limited power and cannot carry large bulky instruments. These platforms include UAVs, small satellites, and buoys.

A typical zero-bias Schottky diode detector, on its own, is a reflective circuit and thus requires an isolator at its input to provide a good impedance match to the device it is connected to. These are also typically wideband detectors that cover single mode waveguide bandwidths, e.g. 60 to 90 GHz for a WR-12 device, 140 to 220 GHz for WR-5.1, etc. In addition, our microwave radiometers cover many frequency channels in a single unit, achieved using a waveguide manifold multiplexer with cavity resonator channel filters. These filters require their outputs to be matched with no more than -10 dB reflection from their respective loads. Since the detectors are placed at the outputs of these filters, each detector must be matched within the bandwidth of their respective filter. Furthermore, the system is required to be highly integrated to reduce the overall size and weight of the system. Thus, we have chosen to use a tuned circuit for the zero-bias Schottky diode detector. These detector circuits are much smaller than the wideband detectors and provide a good match to the filters at the output of the multiplexer.

The presentation will begin with a discussion of layout of the detector circuit leading into the method used for simulating the various pieces of the circuit. The full diode analysis requires a combination of full wave finite-difference time-domain and harmonic balance simulations. Next, techniques for handling and placing the very tiny (90 µm by 50 µm by 20 µm) diodes onto their thin film circuits will be discussed. Lastly, measurement and simulation data will be compared.