A Programmable Waveguide Calibration Load

Jacob W. Kooi[1*], Rodrigo A. Reeves[2], Arthur W. Lichtenberger[3], Theodore J. Reck[1], Andy K. Fung[1], Sander Weinreb[4], James. W. Lamb[4], Rohit S. Gawande[1], Kieran. A. Cleary[4], and Goutam Chattopadhyay[1].

[1]*NASA Jet Propulsion Laboratory, Pasadena, CA 91109, USA*
[2]*CePIA, Astronomy Department, Universidad de Concepcion, Chile.*
[3]*University of Virginia, Charlottesville, VA 22904-4743, USA*
[4]*California Institute of Technology, Pasadena, CA 91125, USA*
[*]Contact: Jacob.W.Kooi@jpl.nasa.gov

***Abstract*—**

We have developed a programmable, accurate, and miniaturized calibration load for use in millimeter and submillimeter low-noise amplifier characterization. The proposed solution uses a thermally conductive vane attenuator with a small thermal mass, integrated heater, and silicon thermometer. In the present design we utilize a 125 μm thick z-cut crystal quartz vane due to its relatively low dielectric constant, high cryogenic thermal conductivity, chemical robustness, and small thermal contraction. To provide adequate attenuation, the bottom side of the quartz fabrication wafer has an nm thick resistive Ti metal layer deposited.

On the top of the quartz wafer a pattern of Au is deposited to allow adhesion of the heater resistor, thermometer, and internal heat strap. The z-cut quartz vane is mounted on three low thermally conductive Torlon posts, centered on the maximum E-field, and positioned across the waveguide.

With this approach the quartz vane, protruding all the way into the waveguide, approximates a blackbody with a physical temperature T. When operated in a PID loop, these properties combine to facilitate a programmable calibration load with a switching speed of $<$ 10 s between 25 - 75 K.

Measurement verification, including linearity, will be provided. In addition, it will be shown that the W-band design operates overmoded to ~230 GHz at which point the TE30 mode begins to effectively bypass the vane attenuator. The concept is in principle scalable to terahertz frequencies.