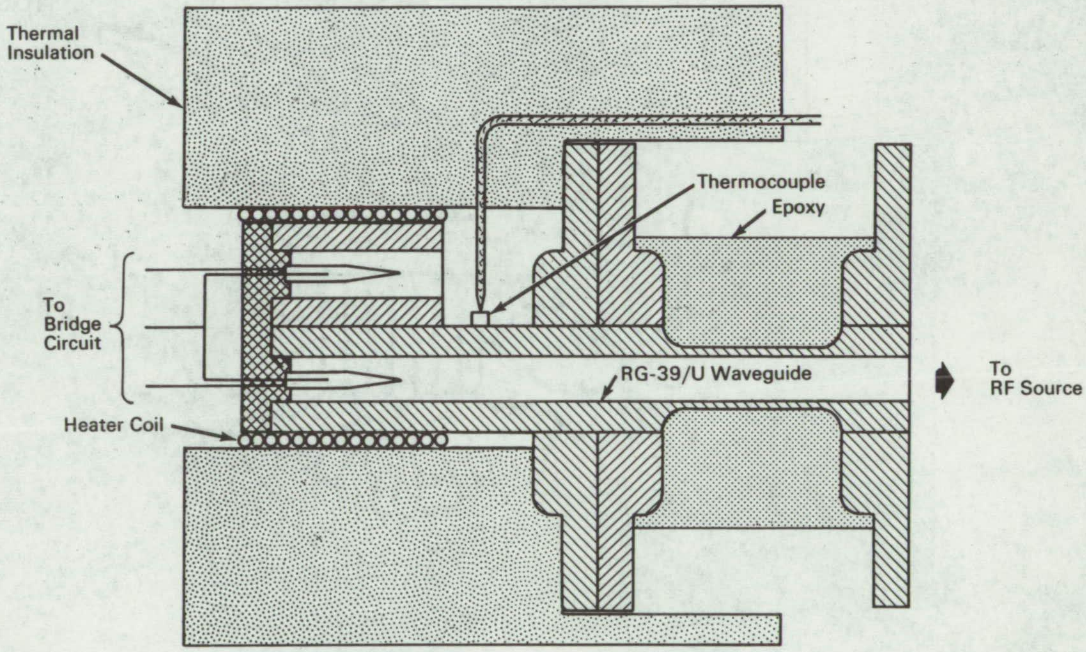
NASA TECH BRIEF

Ferroelectric Bolometer Measures RF Absolute Power at Submillimeter Wavelengths



The problem:

Measuring low intensity rf absolute power at millimeter and submillimeter wavelengths. Such measurements are necessary to determine the operating parameters of certain electronic devices. Standard bolometer elements and calorimeters are frequency dependent and have limited sensitivity at frequencies above approximately 100 gigacycles.

The solution:

Two ferroelectric bolometer sensing elements mounted in sections of waveguide and connected in series in a standard temperature compensating bridge circuit.

How it's done:

Two precisely identical ferroelectric bolometer elements are mounted in RG-99/U waveguide sections with one of the sections connected to the rf system. The other waveguide section is in intimate contact with the first but is not illuminated with rf power. A heating coil is wound directly around the two waveguide sections and the whole assembly is wrapped with thermal insulation. A thermocouple is mounted

(continued overleaf)

in a cavity that contacts the two waveguide sections and is used to monitor the temperature in the vicinity of the ferroelectric elements. The heater coil is used to control the temperature because the dielectric constant of the ferroelectric material is most temperature sensitive at a point near its Curie temperature. The two ferroelectric elements are series connected in a temperature compensating capacitance bridge circuit that is powered by a constant 1 kc audio source. RF power absorbed by the ferroelectric bolometer produces a small temperature change which causes a large change in the permittivity and unbalances the bridge circuit. The capacitance required to rebalance the bridge is a direct measure of the absolute power applied to the ferroelectric bolometer.

Notes:

1. Power changes of less than 0.002 milliwatt have been measured at frequencies of up to 308 gigacycles.
2. Maximum sensitivity results when the ambient mount temperature is held at 94° to 96°C for a ferroelectric material consisting of a ceramic mixture of 45% lead titanate ($PbTiO_3$) and 55% strontium titanate ($SrTiO_3$) with a Curie temperature of 105°C.
3. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland, 20771
   Reference: B66-10051

Patent status:

No patent action is contemplated by NASA.

Source: Marvin Cohn and James Donald Rodgers of
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