June 1975 B75-10102

NASA TECH BRIEF

Marshall Space Flight Center

Integrated-Circuit Balanced Parametric Amplifier

A new balanced parametric amplifier has been fabricated on a single dielectric substrate. The amplifier has a pair of Shottky barrier varactor diodes mounted on a single semiconductor chip. The circuit includes a microstrip transmission line and a slot line section to conduct the signals. The main features of the amplifier are reduced noise output and low production cost.

As shown in Figure 1, the amplifier circuit is built on a dielectric substrate which supports the microstrip line on one side and the slot line section on the other side. The microstrip line extends from the edge of the substrate to the slot line section. They are joined by a metallization feedthrough element penetrating through the substrate.

A single semiconductor chip, as shown in the enlarged view in Figure 2, contains a pair of Schottky barrier varactor diodes. One terminal of each diode is attached to the feedthrough element. The remaining terminal of each diode forms an inductive connection attached to a metallized film. The film covers one side of the substrate. Lengths L of the slot line sections are chosen to resonate the varactor diodes at idler frequency. Lengths of inductive connections are also selected to series-resonate the diodes at pump frequency.

The pump frequency is supplied by a waveguide (not shown) which transmits through a filter element to a reduced waveguide section. This section is dimensioned so that its length corresponds to $\lambda_i/4$ and $\lambda_p/2$ simultaneously (λ_i = idler signal wavelength, and λ_p = pump signal wavelength). The filter element is parallel-resonant at the pump frequency but represents a very low impedance at the idler frequency. This low impedance at the idler frequency is transformed through the reduced waveguide section to a very high impedance at the slot line section, which effectively isolates the idler circuit from the pump circuit.

The microstrip line includes three sections. The first section is adapted to be coupled to an external circuit such as a circulator (not shown). The section

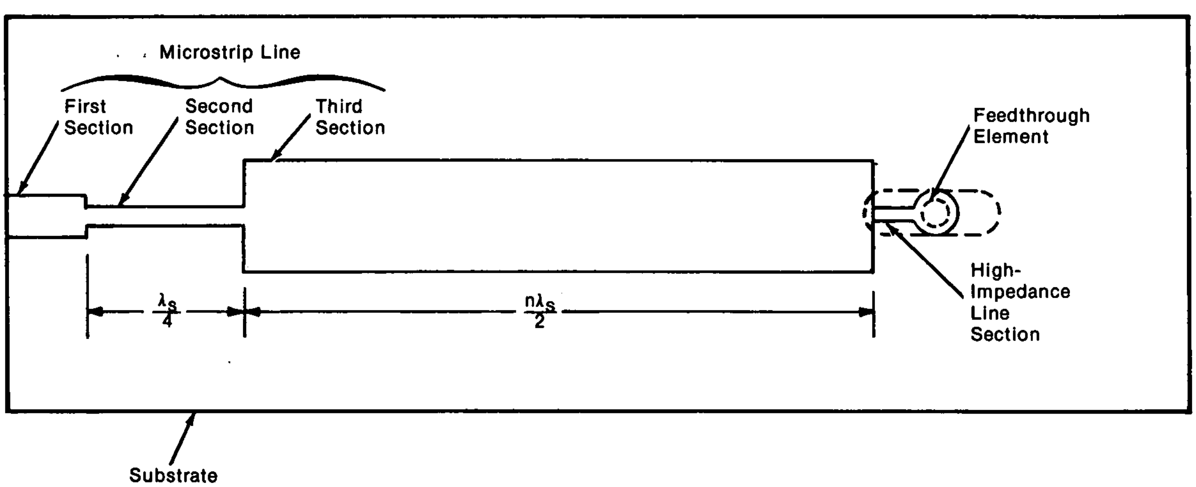

Figure 1. Amplifier Mounted on Substrate

(continued overleaf)

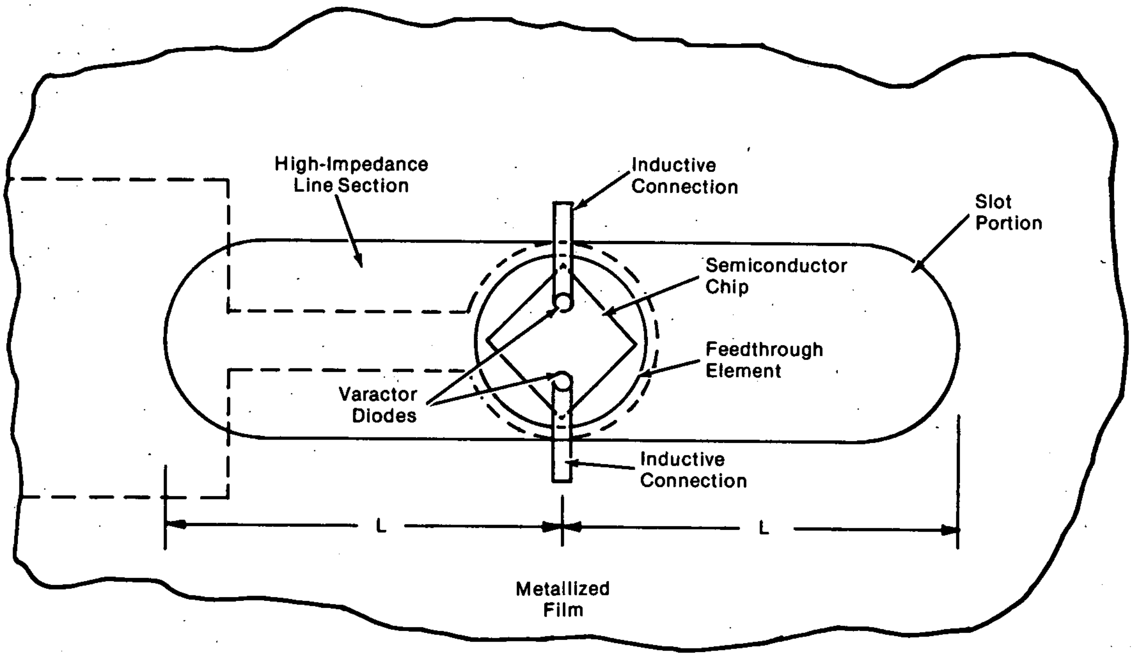

Figure 2. Slot Line Section (Opposite Side of Figure 1)

couples into a second line section of a length substantially equal to a quarter wavelength of the input and output signals ($\lambda_S/4$). Following the second section is a wide third line section of a relatively longer length equal to multiple half wavelengths of the input and output signals, i.e., $n\lambda_S/2$, where n is an integer.

In operation, the RF signal to be amplified is fed through the microstrip circuitry to the varactor diodes. Pump power is supplied by the waveguide as described, which causes a flow of electrical charge within the varactor diodes at the pump frequency. The interaction of the input signal current and the pump current, coupled by the voltage-dependent capacitance of the varactor diodes, causes the varactors to exhibit a negative resistive impedance to the input signal. This amplifies the input signal which is reflected back through the microstrip line for transmittal to an external circuit. The balanced diode connection prevents the transmission of pump or idler energy into the microstrip circuitry.

Note:

Requests for further information may be directed to:

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Reference: B75-10102

Patent status:

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Source: L. E. Dickens of
Westinghouse Electric Corp.
under contract to
Marshall Space Flight Center
(MFS-23193)

Categories: 01 (Electronics - Components and Circuitry)
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