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A STABLE BROADBAND IMPATT AMPLIFIER

C. S. Ward, R. W. Laton, J. A. Spada

Raytheon Company, Missile Systems Division
Bedford, Massachusetts 01730

ABSTRACT

A single diode IMPATT amplifier has been demonstrated at X-band which amplifies a 200mw average power input signal by 9 dB over a 1 dB locking bandwidth of 3.7%. This result is believed to be the largest gain-bandwidth product yet achieved with a single IMPATT diode for this power level.

SUMMARY

A ridged waveguide resonant microwave circuit with a double tuned input/output port was developed in order to improve the instantaneous gain bandwidth capability of single IMPATT diode amplifiers, operating as either stable amplifiers or injection locked oscillators. Earlier designs at Raytheon based upon circulator-coupled coaxial circuits were found to be extremely troublesome, narrowband, and difficult to tune. Subsequent missile active seeker transmitter developments continue to require single diode stages, and these have been identified as bandwidth limiting components of such transmitters.

The circuit shown in cross section in Figure 1 employs two bandwidth enhancing unique features which are combined with conventional cavity-loaded, off-resonance-terminated coaxial diode structures frequently referred to in the literature as either the "Kenyon" or "Kurokawa" waveguide circuits. These unique features are a double ridged dominant mode rectangular waveguide cavity and an asymmetrical compound input/output coupling iris. The double ridged waveguide cavity configuration enhances bandwidth by lowering the "Q" factor of the resonant structure, while the compound iris provides for double-tuning the transition between the cavity and the input/output waveguide. (Since the diode is a negative resistance one-port device, the amplifier operates in a reflection gain configuration where a single cavity port serves both input and output functions.) The two cascaded apertures in the compound iris are dissimilar and spaced closer than one-eighth wavelength at the center frequency, in an empirically determined design, because of the

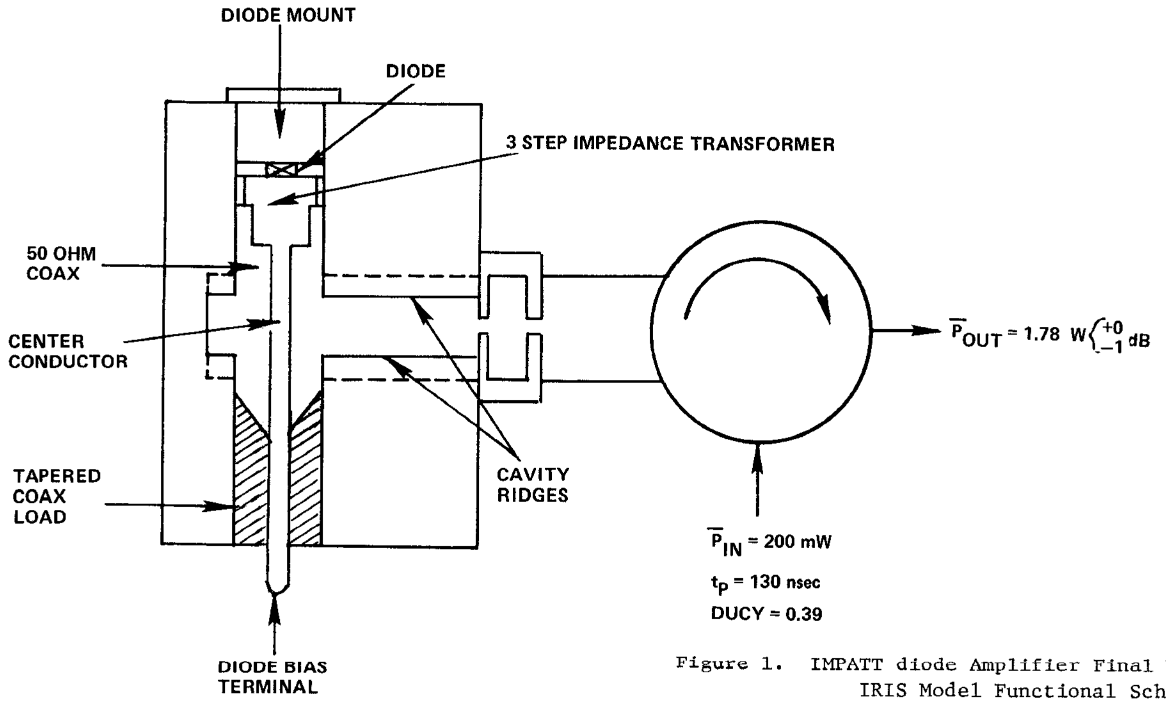

Figure 1. IMPATT diode Amplifier Final Waveguide IRIS Model Functional Schematic

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asymmetric nature of the coupling from standard waveguide outside the cavity to a double ridged configuration within.

The amplifier shown in Figure 1 has been built and experimentally optimized. Figure 2 shows the performance which has been measured. the 9 ± 0.5dB gain bandwidth value of 3.5% at the 1.8 watt average output power level significantly exceeds the performance achieved with earlier designs, namely 5dB and 1% at the -1dB points. It also exceeds any other published performance known to the authors. A further advantage of the broadband matched nature of the amplifier is the duty cycle accommodation displayed by the amplifier. Figure 3 shows measured performance for duty cycles of 30, 20, and 10%, respectively. These were obtained ay operating the amplifier at a fixed PRI of 1 μsecond and varying the pulsewidth from 333 to 100 nanoseconds, with no tuning or bias current adjustments of the amplifier allowed.

This concept is immediately applicable to solid state transmitters for missile seeker as well as communications applications.

REFERENCES

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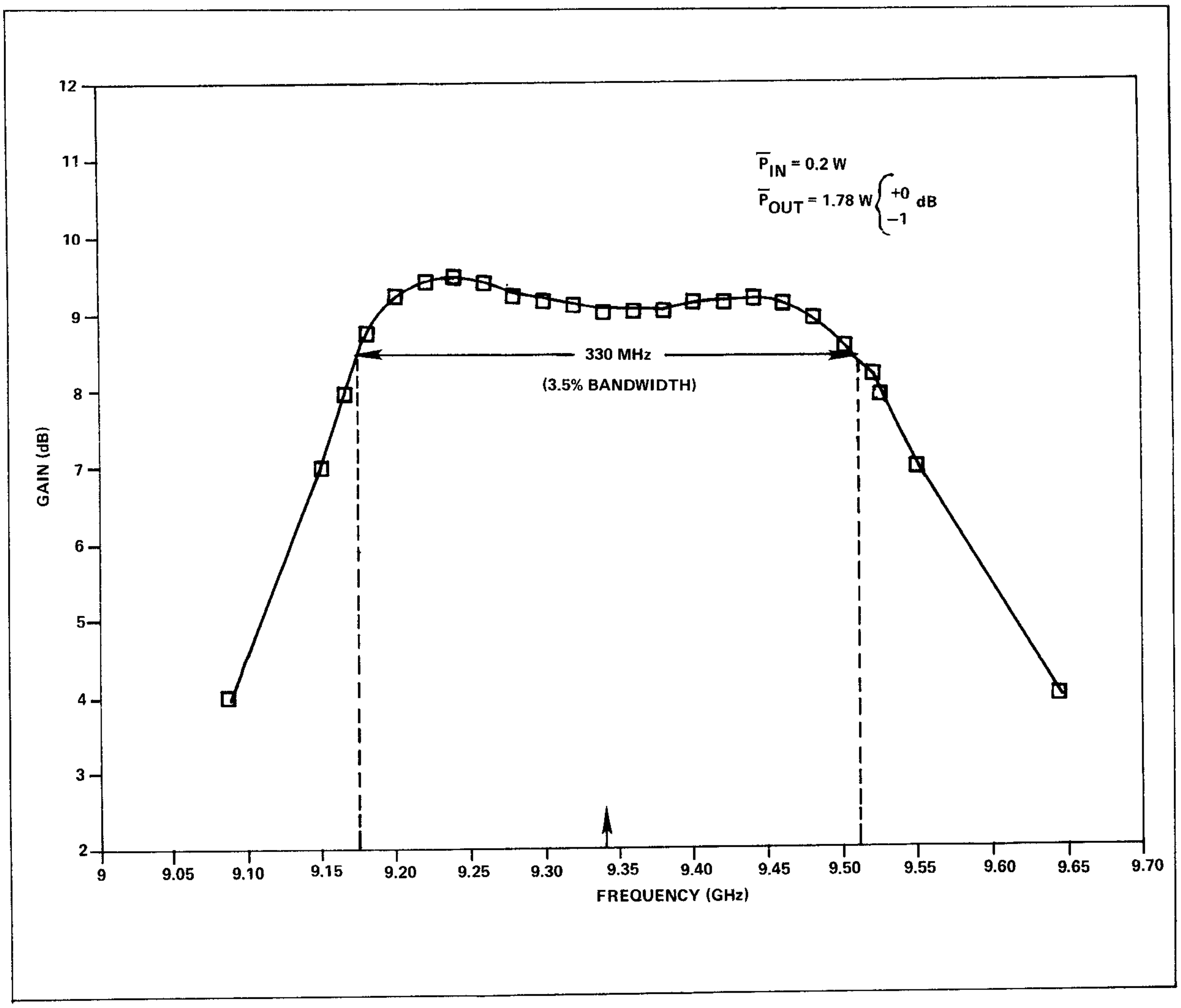

Figure 2. Single Diode Amplifier Module
Final Gain-Bandwidth Results
Compound IRIS

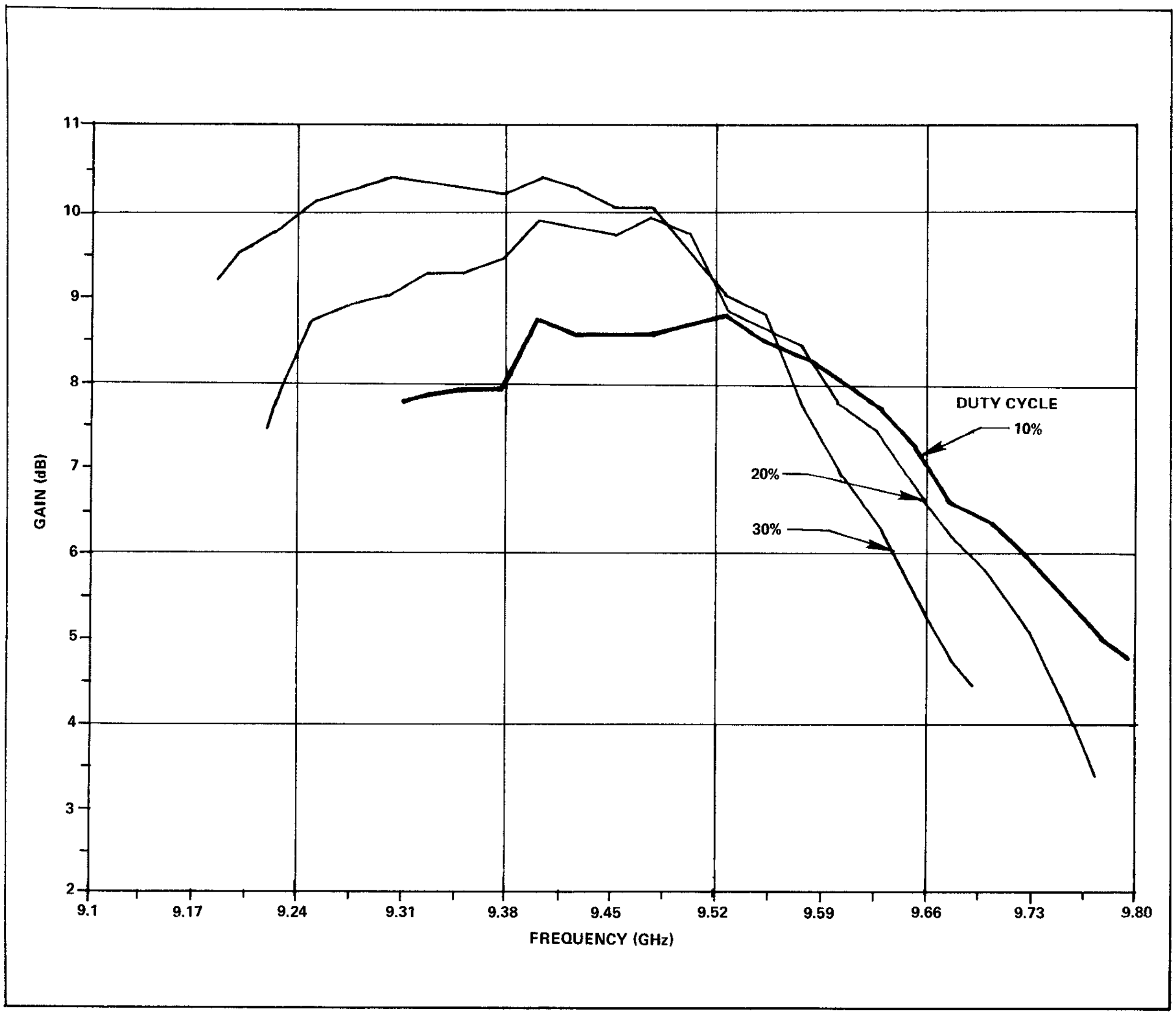

Figure 3. Single Diode Amplifier Gain vs Frequency for Different Duty Cycles