X AND KU-BAND FERRITE-DIODE LIMITERS

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Abstract

X and Ku-Band subsidiary resonance[1-4] type of ferrite limiters have been developed for a solid state replacement for the gas tube portions of TR-limiters. When used in conjunction with PIN and varactor diode limiters, completely passive receiver protection is obtained.

Introduction

Carter et al[4] have reported a design consisting of five single crystal and six polycrystalline YIG laminations sandwiched between dielectric laminations. Single crystal YIG was used to lower threshold limiting to 2.8 watts. At X-band 3 dB of spike limiting and 30 dB of flat limiting was obtained for peak powers of 10 kW and average powers of 10 W.

In the present work ferrite limiting was achieved with a series of polycrystalline YIG rods mounted parallel to the E field. This circular rod design is a modification of the laminar design. It is felt that the rod design provides a structure in which the critical physical parameters can be readily varied to obtain optimum coupling between the RF field and the ferrite. With improved coupling, device length can be minimized for a given degree of limiting.

The complete limiter with its permanent magnet is shown in Figure 1. Both varactor and PIN diodes were used as limiter diodes. A video diode is used to sample the RF current and provide self biasing of the limiter diodes. The diode limiters alone were capable of handling spikes of about 5 kW at 50 nanoseconds and flat leakage pulses of about 1 kW at 1.0 microseconds. With this diode power handling capability, it is not necessary that extremely expensive single crystal YIG be used to obtain low ferrite limiting thresholds.

Experimental Results

For the ferrite portion of an X-band limiter operating at a relatively high duty cycle of 0.012, the limiting threshold was less than 50 W and flat leakage power was less than 25 W. Spike limiting was 6-9 dB and flat leakage limiting was about 20 dB. At peak incident powers of 2.5 kW nearly 30 W of average power was absorbed in the ferrite rods. Results for a complete ferrite-diode limiter operated under comparable conditions are given in Figure 2. For power levels up to 2.5 kW the spike leakage did not exceed 30 mW. When the ferrite-diode limiter was operated at a lower duty cycle of 0.001 but at higher incident power levels of up to 20 kW, the spike leakage was less than 2 W and the flat leakage was less than 50 mW. Insertion loss of the package was less than 0.9 dB over a 9.3 - 10.0 GHz bandwidth.

As shown in Table I comparable results were obtained with a Ku-band ferrite-diode limiter. Spike leakage power was less than 4 W for peak powers up to 10 kW and insertion loss was less than 1.3 dB.

Extremely fast recovery times were observed. The recovery time was less than 50 nanoseconds for the ferrite section and less than 100 nanoseconds for the complete ferrite-diode limiter at both X and Ku-band. Recovery time was controlled primarily by the diode section of the limiter and not by the ferrite section.

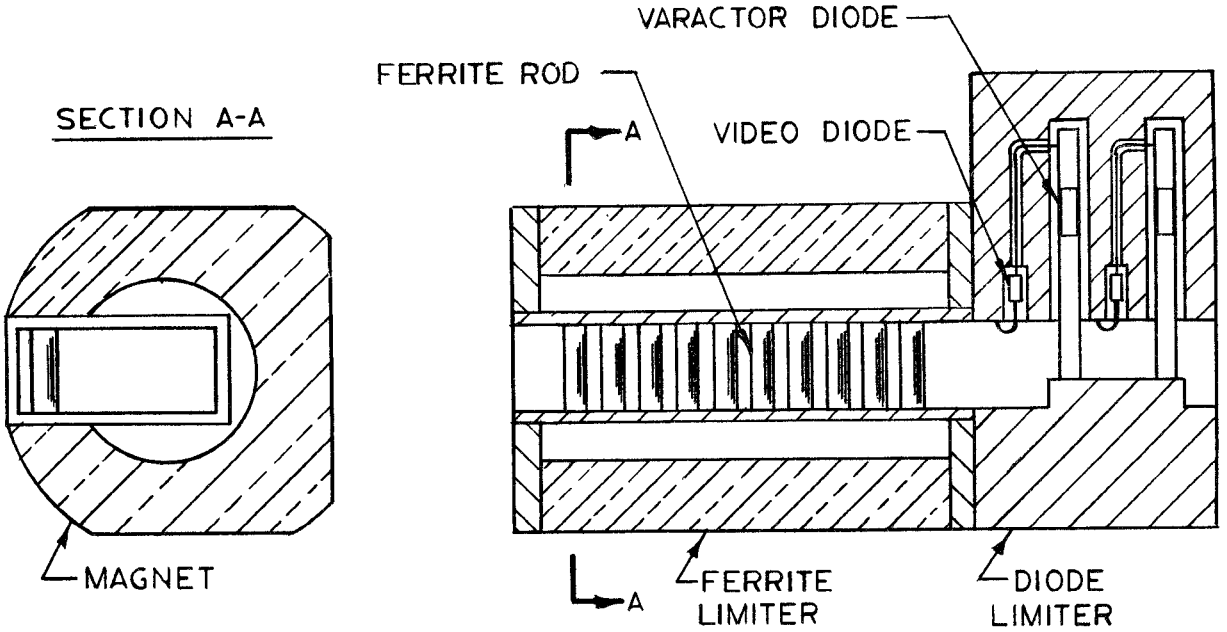
Table I

Ferrite-Diode Limiter Characteristics

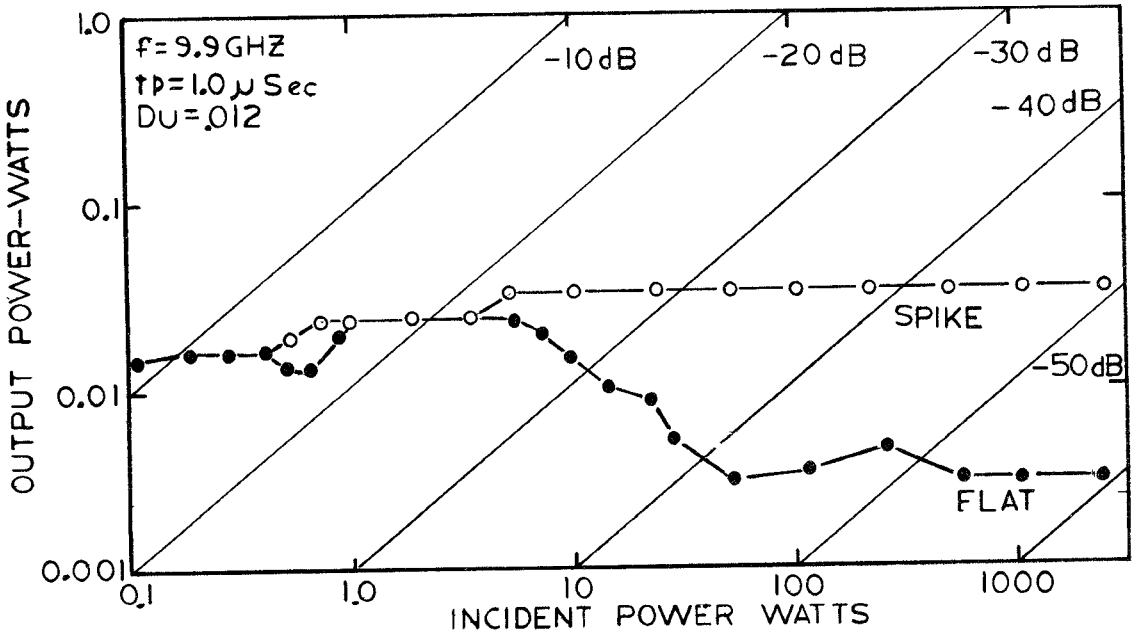
Characteristic	X-Band	Ku-Band
Frequency - GHz	9.3-10.0	15.8-16.1
Insertion Loss - dB	0.9	1.3
VSWR	1.4	1.4
Peak Power - kW	20	10
Average Power - W	30	10
Spike Leakage - W	2	4
Flat Leakage - mW	50	50
Recovery Time (3 dB) - ns	100	100
Device Length - inches	3.0	2.5
Device Weight - ounces	15	10

References

1. Uebele, G. S., "Characteristics of Ferrite Microwave Limiters", IEEE Trans. M.T.T., pp. 18-23, January 1959.
2. Krupke, Hartwick & Weiss, "Solid State X-Band Power Limiter", IEEE, Trans. M.T.T., pp. 472-480, November 1961.
3. J. Carter and J. McGowan, "X-Band Ferrite-Varactor Limiter", IEEE Trans. M.T.T., pp. 231-232, April 1969.
4. J. Carter, J. McGowan, & S. Dixon, "A Laminary Subsidiary Resonance Limiter", Research & Development Tech. Report ECOM-3114, USAEC, May 1969.



FERRITE-DIODE LIMITER
FIGURE-1



X-BAND FERRITE DIODE LIMITER
FIGURE-2

Notes