8.4: A COINCIDENCE REGION POWER LIMITER USING MONOCRYSTAL LITHIUM FERRITE AT 6500 Mc/s*

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Passive Microwave power limiters that use narrow linewidth ferrimagnetic materials such as YIG and gallium-substituted YIG operating in the coincidence region have been previously reported[1,2,3]. However, these limiters have been restricted to operating in the L- and S-band ranges because of the low ferrite saturation magnetization ($4\pi M_s$).[+] Recently, monocrystal lithium ferrite having a $4\pi M_s$ of 3900 and exhibiting relatively narrow line-width properties[4] has become available. We have used this material in the development of a coincidence power limiter that operates in the 6500-Mc/s frequency range. (Independent work on coincidence limiting using lithium at 5200 Mc/s, has recently been reported by Rossol[5].

A photograph of the limiter with an adjustable permanent magnet is shown in Figure 1. The circuit arrangement consists of the decoupled

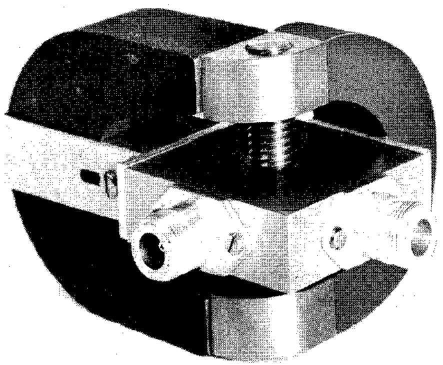

Fig. 1a. Lithium ferrite limiter (with adjustable permanent magnet).

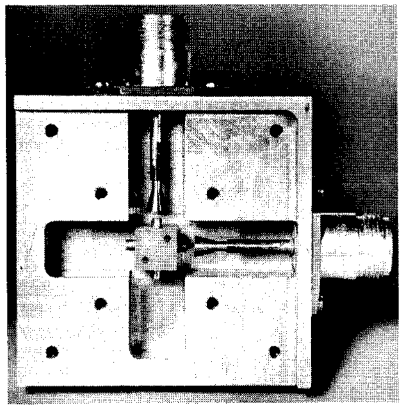

Fig. 1b. Limiter with top cover removed.

orthogonal resonator configuration introduced by De Grasse[1]. The lithium ferrite, which is highly anisotropic (see the measured data in Figure 2),

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+Coincidence limiting is restricted to approximately an octave region, which for a sphere is given by; $1/3\ (4\pi M_s) < \omega/\gamma \leq 2/3\ (4\pi M_s)$
where ω = angular frequency and
γ = gyromagnetic ratio

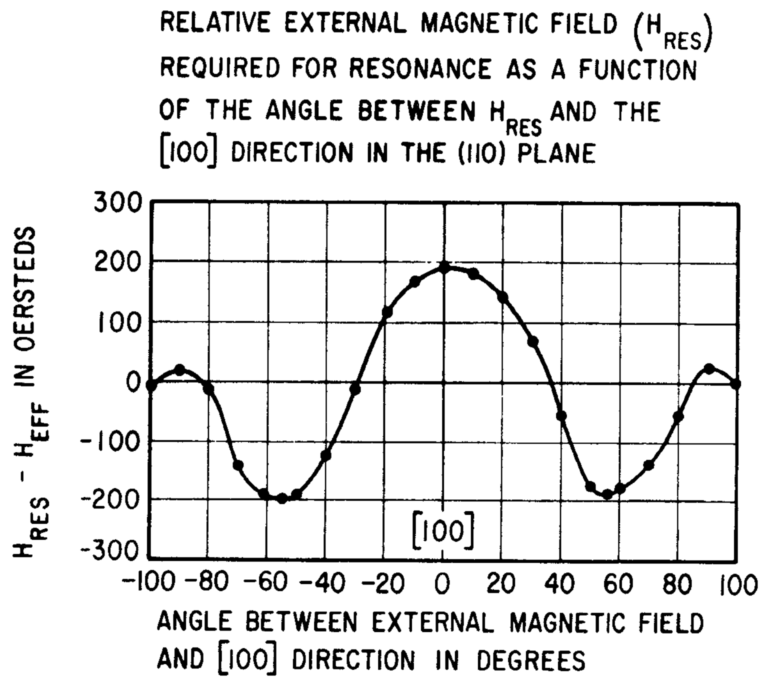

Fig. 2. Monocrystal lithium ferrite anisotrophy (measured at 6500 Mc/s).

yielded limiting threshold levels that varied from -9 dbm to 0 dbm, depending upon the crystal orientation with respect to the external magnetic field (H_{DC}). The higher limiting level was obtained when the H_{DC} was oriented along the [111] (easy) axis. In this orientation, the measured linewidths are largest[6], being about 5 oersteds and 2.5 oersteds for ΔH and ΔH_k, respectively.

A typical input power vs. output power characteristic is shown in Figure 3. To date, the operating band over which limiting was obtained extended from 5000 Mc/s to 6800 Mc/s. However, low-level limiting should be obtainable from about 4400 Mc/s to 7100 Mc/s, as shown by the P_{crit} (threshold power) vs frequency measurement plotted in Figure 4.

The insertion loss of the device was as low as 1.1 db with an instantaneous bandwidth of 60 Mc/s and a dynamic range in excess of 30 db. Further decreases in the insertion loss can be obtained with the application of larger ferrite spheres. (The sphere diameter used in the described limiter was 0.037 inch.)

The phase-shift characteristics of the device as a function of input power are shown in Figure 3. It is seen to have phase-distortionless qualities similar to those of the varactor limiter. This is to be expected since both types of limiters use similar mechanisms.

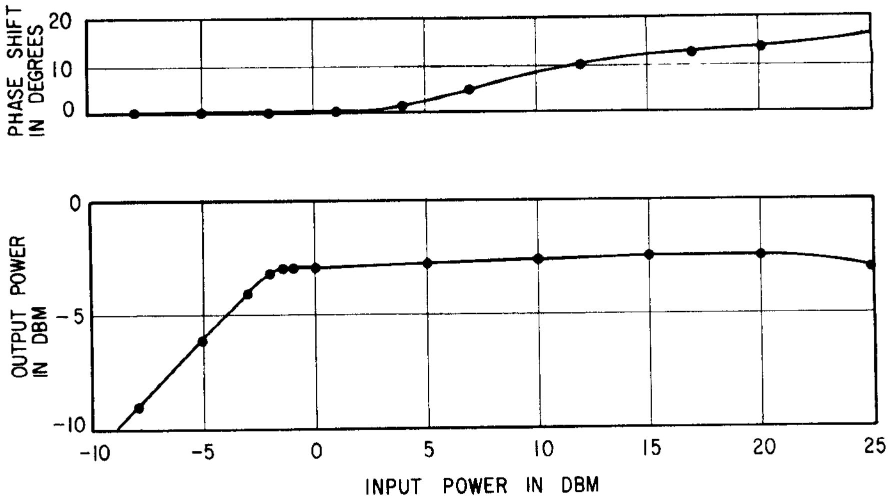

Fig. 3. Typical phase and limiting characteristics of lithium ferrite limiter (measured at 6500 Mc/s).

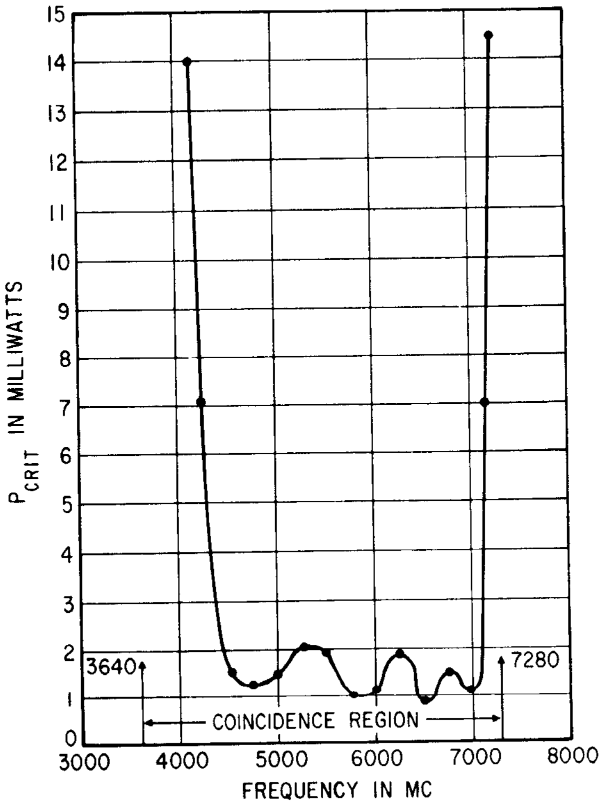

Fig. 4. Critical threshold power as a function of frequency (measured in a TEM cavity).

The response of the limiter to pulsed RF signals exhibited the expected spike characteristic at the leading edge, which is caused by the time required to excite the appropriate spin wave from the uniform precision. The width of the spike was found to be inversely proportional to the amplitude of the incident pulse, and its height was approximately equal to the incident pulse amplitude. In addition, the spike energy (area under the spike) appeared to be independent of the incident pulse. (This is similar to the results observed on YIG in reference 3).

A detailed measurement of the decline of the lithium magnetic susceptibility as a function of input power is shown in Figure 5. It is seen that the sharp break, which is the predicted characteristic, is replaced by a gradual decline. This is believed to be a result of some inhomogenity broadening[7]. Thus, still narrower linewidth lithium ferrite should be obtainable, which would yield lower threshold limiters.

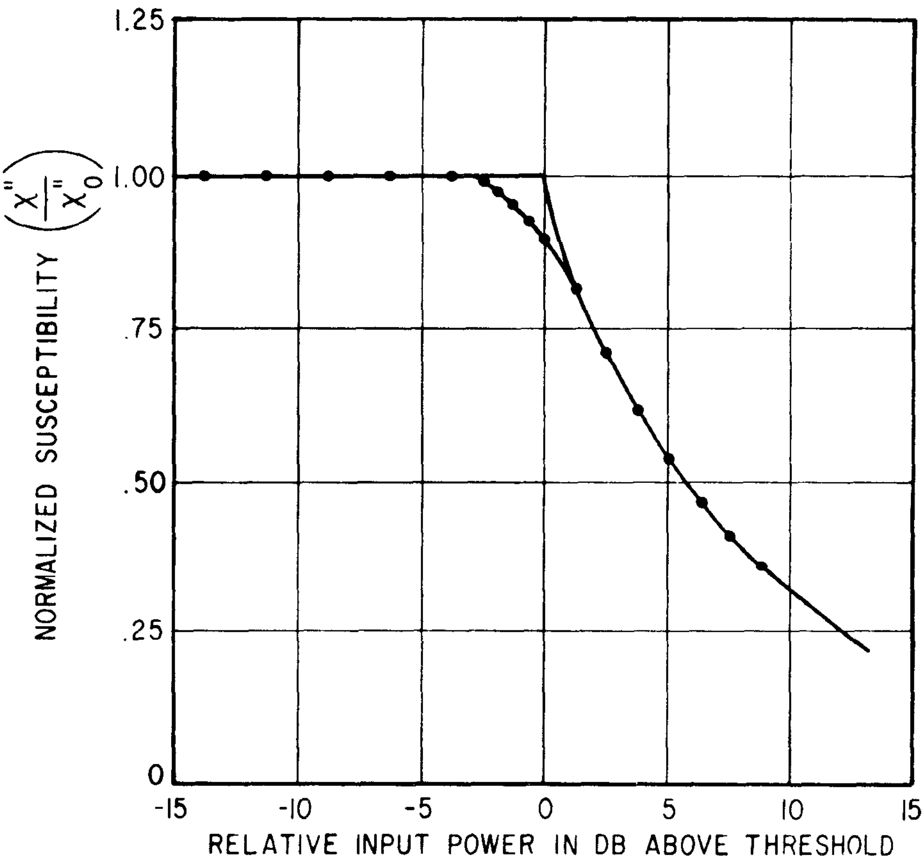

Fig. 5. Magnetic susceptibility of single crystal lithium ferrite as a function of input power (measured in a TEM cavity).

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