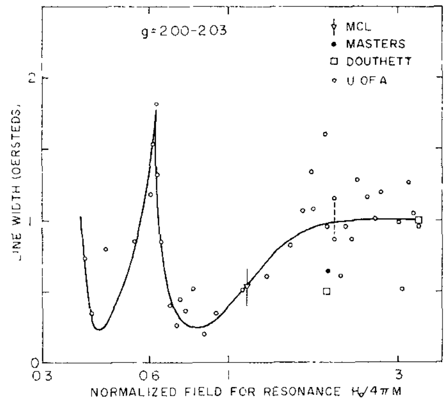

Fig. 1—Linewidth vs normalized field for resonance for 0.020 inch diameter sphere of Microwave Chemicals Lab. polished single-crystal YIG. Multiply the abscissa by 5 to convert to frequency in Gc.

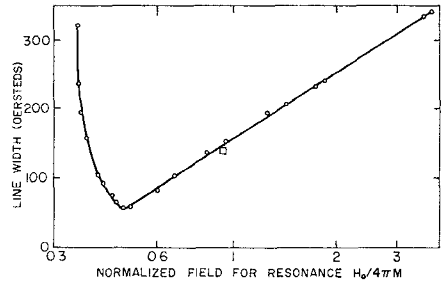

Fig. 2—Linewidth vs normalized field for resonance for sphere of Motorola M-052 polycrystalline spinel. Multiply the abscissa by 10 to convert to frequency in Gc.

other commercial polycrystal and single crystal YIG and substituted YIG materials. However, magnetostatic modes were noticed only in the single crystal materials. One notable feature of the curves for these materials is the fact that the linewidth remains fairly constant after the frequency becomes larger than 2.8 ($4\pi M$) Mc. These results are in disagreement with Douthett and Kaufman[6] who find a linear increase in linewidth with frequency. We have also determined experimentally that the sample size does not have an appreciable effect as frequency is changed, *i.e.*, it is not necessary to keep the ratio of sphere diameter to wavelength constant. However, the linewidth is very dependent upon the surface finish, especially with narrow linewidth materials. Consequently, it is important to improve the surface finish as the frequency increases.

The linewidth behavior of a polycrystal spinel is shown in Fig. 2 as a function of the normalized field for resonance. The material is M-052, a Motorola nickel cobalt ferrite, for which the manufacturer reports a saturation magnetization of 3150 gauss, a linewidth of 140 Oe (at 9.3 Gc), and a g factor of 2.27. The manufacturer's linewidth value is shown on Fig. 2 by a square. The abscissa in Fig. 2 may be converted to frequency in Gc by multiplying by 10. It is interesting to note that the linewidth drops to less than half of its X-band value when $H_0/4\pi M$ is equal to about one half and that the linewidth continually increases with frequency after the uniform mode enters the spin wave manifold. This behavior is typical of spinels and is considerably different from that displayed by the garnets.

A more recent material that is of considerable interest possesses a hexagonal crystal structure[8] and is designated $Z_{n1.5}M_{n0.5}Y$ ($B_{a2}Z_{n1.5}M_{n0.5}F_{e12}O_{22}$). The linewidth of a single crystal sphere of this material was measured at X-band and its linewidth increased from 16–20 Oe as the frequency increased from 8.2–12.4 Gc. The sample was 0.055 inch in diameter and had a 600 grit (40 micron) finish. These measurements were performed with a magnetostatic field and the microwave magnetic field in the easy plane and perpendicular to each other. The linewidth is slightly larger when the microwave magnetic field is perpendicular to the easy plane but is considerably larger when the magnetostatic field approaches a direction perpendicular to the easy plane.

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[8] Supplied through the courtesy of A. Tauber, U. S. Army Signal Res. and Dev. Lab., Ft. Monmouth, N. J.

A High Isolation/High Speed Microwave Modulator

The modulation technique shown in this communication is capable of converting a continuous wave X-band signal into nanosecond carrier pulses with measured (on to off state) isolation greater than 50 db. Fig. 1 illustrates the basic block diagram of the system.

The theory of operation of this modulator is quite simple. Essentially, the CW signal from the X-band generator is circulated from port 1 to port 2 of the circulator; in the off state, the network formed by the E-H tuner, varactor switch and variable short form a nonreflecting load. Under these conditions no signal is circulated to 3. In the transmission state, a pulse is applied to the varactor switch which unbalances the network and allows a proportional pulse of microwave power to circulate to port 3.

It is interesting to note that a minimum balanced condition occurs if three of the four degrees of tuning freedom of the network are adjustable. This indicates that the network forms a pseudo microwave bridge. Two degrees of tuning freedom may be used if the reverse bias on the varactor diode is adjustable.

Under ideal conditions, *i.e.*, employing the use of a circulator of infinite isolation, it is felt that extremely high orders of transmission to off state isolation can be obtained by this technique. Since in these experiments the circulator isolation (port 1 to 3) was 35 db, some signal from the inadvertent detuning of the network at port 2 is used to cancel the leakage from port 1. This effect results in an increase in the normal insertion loss and a decrease in the measured isolation. The main contributions to the insertion loss are: 1) the incomplete unbalance of the network, 2) power dissipated in the diode, and 3) losses due to high VSWR in the network.

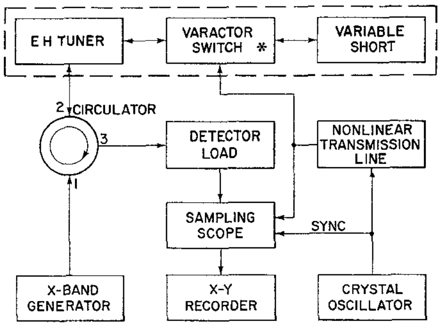

Fig. 1—Modulator block diagram. *Varactor diode mounted in an "in line" or tunable detector mount.

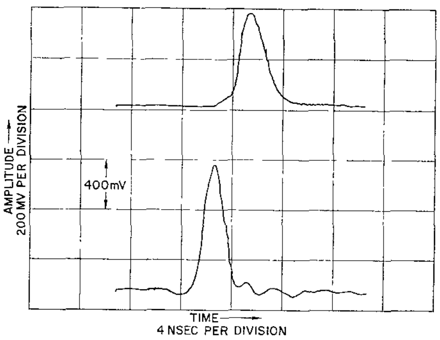

Fig. 2—Waveforms of modulating and detected pulse.

In the experiments, a 1 kc square wave and a 2 nsec pulse were used to trigger the diode. In the first case the trigger magnitude was sufficient to saturate the varactor diode, *i.e.*, no further significant increase in output for a change in magnitude could be obtained, whereupon the isolation was greater than 70 db and the insertion loss was 4.5 db. In the latter case the trigger magnitude was insufficient to saturate the diode; however, the isolation was greater than 50 db and the insertion loss was 10.6 db. Fig. 2 shows oscillographs of the 2 nsec trigger pulse (lower trace) and detected output video pulse (upper trace). Some smoothing of the pulse due to the finite bandwidth of the system is noted. The time delay between the trigger pulse and detected pulse is the delay time of the waveguide components.

The X-band power level used in these experiments was 263 milliwatts. The pulse repetition rate of the 2 nsec pulses was 97 nsec. An AEL 1033D (40 Gc cutoff) varactor diode was used as the switch and a 1N23B detector was used. The detector tangential sensitivity in the narrow pulse experiment was −43.5 dbm where in the 1 kc case the tangential sensitivity was −50 dbm both for a signal pulse noise-to-noise ratio of 1 db. In both cases the varactor diode was switched from zero volts to some reverse bias potential.

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