Letters

A New Type of Isolator Using the Edge-Guided Mode

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***Abstract*—Experiments on a new edge-guided mode isolator are reported. In this isolator, one edge of a wide strip is shorted to the ground, and no lossy electrical materials are used. Large isolation and small insertion losses were obtained.**

Hines has shown that an edge-guided (EG) mode of propagation occurs in a wide microstrip transmission line using a ferrite slab magnetized perpendicular to the ground plane. He applied this principle of nonreciprocal wave propagation to isolators, mutiport circulators, and phase shifters [1].

In the isolators proposed by Hines, a lossy electrical material is used as a reverse-wave absorber. The isolator has a very wide band of about two octaves, but the ratio between backward and forward losses is not as large as desired.

Since then, several authors have discussed the characteristics of this mode and have improved the EG mode devices [2]–[4].

We have been engaged in improving the EG mode isolator. Here, we would like to propose a new type of isolator. Fig. 1 shows the structure of the new isolator. One edge of a wide strip is shorted to the ground, and there are no lossy electrical materials in this circuit. In Fig. 1, tapered line sections are inserted between the input and output connectors and the wide stripline section in order to suppress the reflection due to the change in characteristic impedance of this transmission line.

One might expect that the reverse waves will be mostly reflected due to the shorted edge, but this does not occur. The mechanism of the reverse loss has not been explained.

It is very difficult to analyze the characteristics of this circuit, so we made the experiments about S_{11}, S_{12}, S_{21}, and S_{22} with much care.

One of the results is shown in Fig. 2. S_{11} and S_{22} are less than about -15 dB. One might consider that the reverse loss could be due to radiation. We carefully shielded the circuit and measured the characteristics, but there was no change. Therefore, it was concluded that most of the reverse waves must be absorbed by the ferrite slab.

It is well known that there are three types of isolators: a) the Faraday rotation type; b) the field displacement type; c) the gyromagnetic resonance type. Hines' edge-guided mode isolator is classified as a field displacement type. On the other hand, this isolator seems to be similar to a gyromagnetic resonance type, but has a much wider frequency band than a typical gyromagnetic resonance type.

This isolator has some desirable characteristics: a) a large isolation of about 60 dB and small insertion losses of about 1 dB; b) a simple structure without lossy materials; c) a wide band of about 1–2 GHz.

Further theoretical and experimental investigations on this type of isolator and circulator are now being done.

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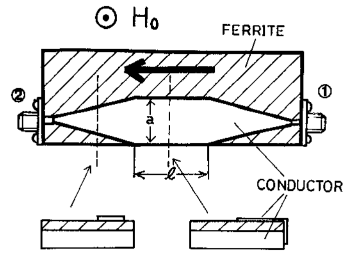
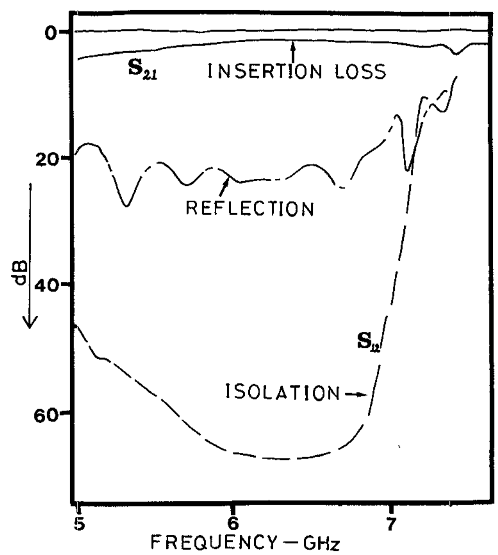
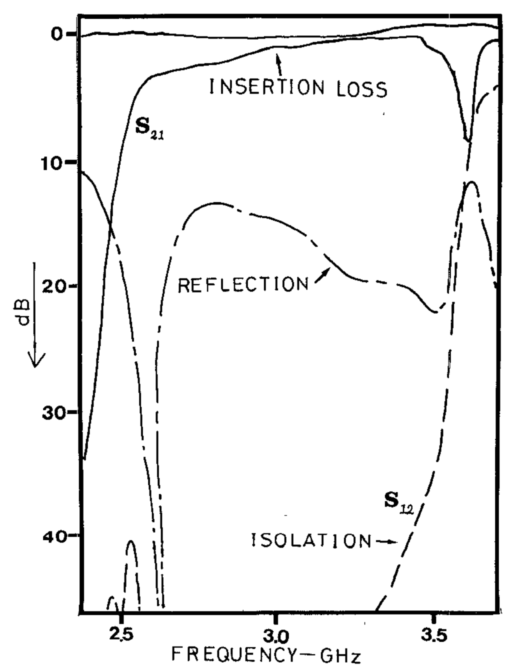


Fig. 1. The isolator structure. An arrow shows the forward direction.



(a)



(b)

Fig. 2. Experimental results. Ferrite slabs are YIG. (a) $4\pi Ms = 1750$ [G]: $Hi = 800$ [Oe]: $\Delta H = 84$ [Oe]: $l = 20$ [mm]: $a = 10$ [mm], when all are at 10 GHz. (b) $4\pi Ms = 580$ [G]: $Hi = 1300$ [Oe]: $\Delta H = 49$ [Oe]: $l = 38$ [mm]: $a = 16$ [mm], when all are at 10 GHz.