

TUESDAY, MAY 16, 1961

SESSION 3: FERRITES

9:00 AM - 12 NOON

CHAIRMAN: FRANK REGGIA

DIAMOND ORDNANCE FUZE LAB

WASHINGTON, D. C.

3.6 A NEW BALANCED TYPE FERRITE SWITCH

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This paper will describe a new type of ferrite switch that was invented by the author. Generally, a microwave ferrite switch has unstable characteristics because of the unstable characteristics with temperature of the ferrite material used. A stable ferrite switch can be made using two hybrids and two new wave guide elements with ferrites, and making the best of balancing characteristics obtained by combining the wave guides.

Switching Element. The waveguide assembly shown in Fig. 1 acts as a short-circuit or a loss-less waveguide, depending on whether a current is passed or not passed in a wire which is wound into a coil around the wave guide. Studies of this waveguide assembly show that there is a characteristic portion where the isolation remains nearly constant and only the phase shift varies to a large extent with the variation in magnetic field applied to a ferrite rod as shown in Fig. 2. The equivalent plane of the short remains invariable and the isolation remains nearly maximum when a current is passed through the coil as shown in Fig. 3.

Balanced Type Ferrite Switch. On the basis of the circuitry as shown in Fig. 4-1, that is, by connecting two hybrid circuits by two parallel lines with equal length and placing the two elements mentioned above, A and B, one in each of these two lines, with an interval of $\lambda_g/4$, a ferrite switch of constant impedance type can be obtained. In the case of magnetic field being zero, input power from input terminal 1 appears at the output terminal 2. On the other

hand, if A and B are applied with the respective magnetic fields which result in π difference in phase shift, the input from terminal 1 is, for the most part, fed to dummy load 3, and the part leaking past A and B is absorbed in the dummy load 4, as a result of which isolations between 1 and 2 can be made very large. Resorting to such circuitry, we can maintain a good decoupling ratio between 1 and 2 at all times if a design is made so that the balance is retained irrespective of the possible degradation of the characteristics of A and B due to change in ambient temperature, applied magnetic field, etc.

Result of Experiment. Measurements were made with the circuitry mentioned above in the 7000 MC band with the results that under the condition of ambient temperature in the range of 5-55°C and the power source voltage variation of $\pm 5\%$, it was possible to obtain isolations of more than 40db for the CW microwave input of about 7W and moreover, to obtain the switching time of 0.3 m sec for a field coil of about 500 T. Figure 5 shows an example of these characteristics. The insertion loss was about 0.3db.

This balanced type ferrite switch can be used for switching two signals, with the circuitry as shown in Fig. 4-2. The most significant feature is that because balance is utilized, the stabilized characteristics are obtainable against change in ambient temperature and applied magnetic field. Moreover, high isolations are obtained with a small insertion loss.

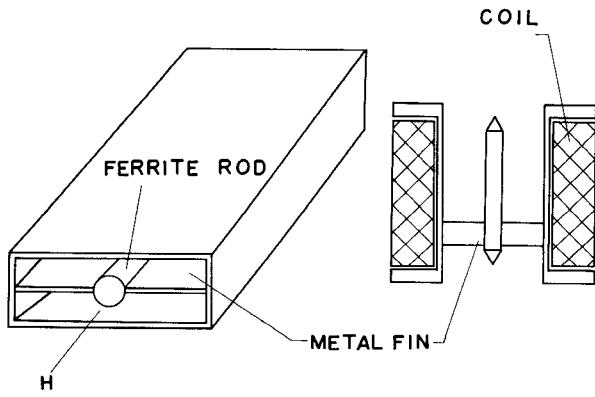


Figure 1 - The Switching Element, with Ferrite Rod, Has Been Employed In A New Balanced Type Ferrite Switch.

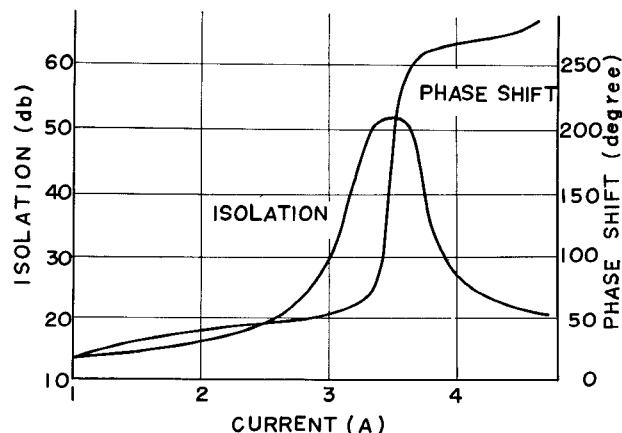


Figure 2 - Isolation and Phase Shift As a Function of Coil Current.

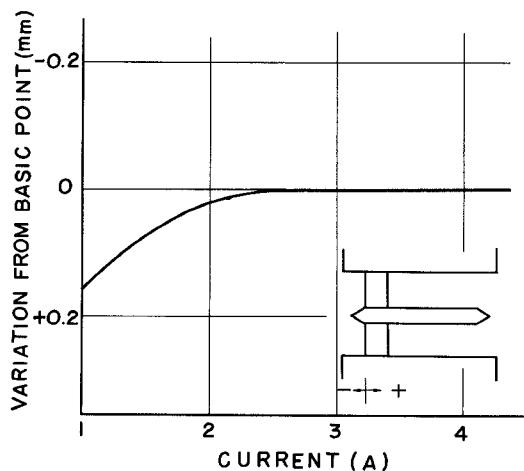


Figure 3 - Variation of the Position of the Equivalent Short Plane from Basic Point as a Function of Coil Current.

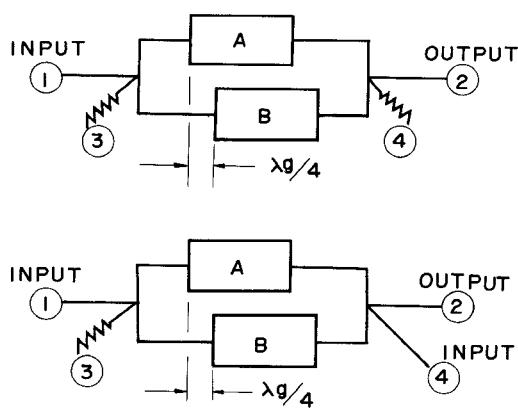


Figure 4 - (Above) Configuration of the Balanced Type Ferrite Switch with One Input Terminal.
(Below) With Two Input Terminals.

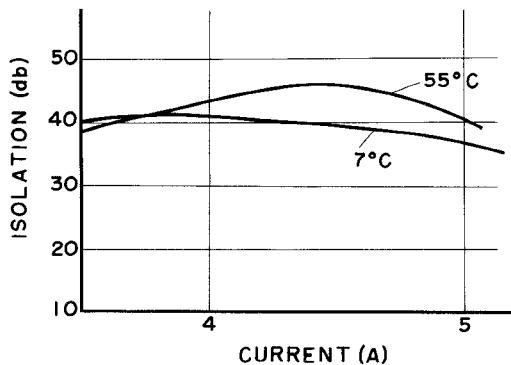


Figure 5 - Isolation Characteristics of Ferrite Switch as a Function of Coil Current.