Correspondence

"Double-Ridge Waveguide"

Dr. Seymour Cohn has pointed out that the equation for attenuation as shown on page four of the article "Double-Ridge Waveguide for Commercial Airlines Weather Radar Installation"[1] by the undersigned should be corrected to read as follows:

$$\alpha = 6.01 \times 10^{-7} k\sqrt{f} \left\{ \frac{\frac{1}{b_1} + \frac{2}{a_1}\left(\frac{f_c}{f}\right)^2}{\sqrt{1 - \left(\frac{f_c}{f}\right)^2}} \right\} \cdot \frac{60\pi^2\left(\frac{b_1}{a_1}\right)}{Z_{0\infty}}.$$

Using a value for K of 1.2 which seems reasonable for this geometry, Dr. Cohn has computed the attenuation for the double ridge guide and obtained numbers of 0.0407 decibel per foot at 5,400 mc and 0.028 decibel per foot at 9,375 mc, which agrees rather well with measured data.

I would like to call your attention to the fact that the b_1 in the attenuation formula represents the total height of the ridge waveguide rather than as shown in Fig. 2 of the above article.

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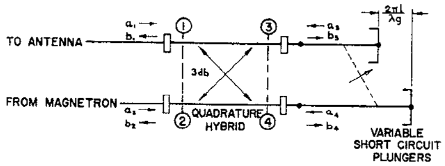
[1] Trans. IRE, vol. MTT-3, pp. 2–9; July, 1955.

On a Variable Impedance Termination for Testing High Power Components

In testing microwave components for electrical breakdown under high power it is generally desirable to simulate conditions encountered in a system. For proper evaluation it is necessary, therefore, to employ a termination, the reflection coefficient of which is variable and which will handle high powers. Our attempt to manufacture a variable mismatch device similar to those described in the literature[1] were unsuccessful, since we could not obtain sufficiently high insertion vswr without electrical breakdown of the tuner.

One can introduce a variable reflection coefficient by using a short slot hybrid junction with two of the arms short circuited by movable plungers which are displaced from each other by an angle θ as shown in Fig. 1.



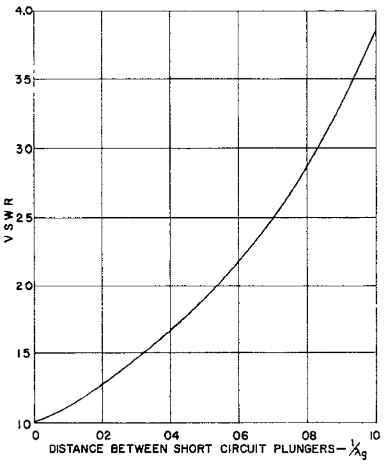


Fig. 1—Insertion vswr of high power phase shifter.

The vswr introduced into the line as a function of $l/\lambda g = \theta/2\pi$ is also shown. A device of this type has been built and used successfully at 250-kw peak power with an insertion vswr of 2:1 without any signs of breakdown.

An analysis of this device can be made employing the scattering matrix $|S|$. If a_1, a_2, a_3, and a_4, are the incident waves on terminals 1, 2, 3 and 4, and b_1, b_2, b_3, and b_4 are the waves scattered from these terminals, then the relationship

$$|S|\ |a| = |b| \tag{1}$$

describes the junction performance.

The scattering matrix is easily written as

$$|S| = \begin{vmatrix} 0 & 0 & -j & e^{-j\theta} \\ 0 & 0 & 1 & -je^{-j\theta} \\ -j & 1 & 0 & 0 \\ e^{-j\theta} & -je^{-j\theta} & 0 & 0 \end{vmatrix}, \tag{2}$$

which includes the displacement of terminal 4 by the angle θ.

From (1) is obtained 4 simultaneous equations:

$$-ja_3 + a_4e^{-j\theta} = b_1\sqrt{2} \tag{3}$$

$$a_3 - ja_4e^{-j\theta} = b_2\sqrt{2} \tag{4}$$

$$-ja_1 + a_2 = b_3\sqrt{2} \tag{5}$$

$$a_1e^{-j\theta} - ja_2e^{-j\theta} = b_4\sqrt{2}. \tag{6}$$

These equations are subjected to the following boundary conditions:

$$a_1 = 1 \text{ (Normalization)} \tag{7}$$

$$a_2 = 0 \text{ (Matched termination)} \tag{8}$$

$$a_3 + b_3 = 0 \text{ (Short circuit on terminal 3)} \tag{9}$$

$$a_4 + b_4 = 0 \text{ (Short circuit on terminal 4)}. \tag{10}$$

The reflection coefficient on the input arm is

$$\frac{b_1}{a_1} = \Gamma_1. \tag{11}$$

From the above equations one obtains

$$\Gamma_1 = \frac{1 - e^{-2j\theta}}{2} = je^{-j\theta}\sin\theta. \tag{12}$$

The voltage standing wave ratio in terms of the magnitude of the reflection coefficient is

$$\text{vswr} = \frac{1 + |\Gamma_1|}{1 - |\Gamma_1|} = \frac{1 + \sin\theta}{1 - \sin\theta}.$$

Similar results may be obtained by using a "folded magic tee" or other hybrid junction.

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[1] Ragan, M.I.T., vol. 9, p. 489.