Letters

Comments on "Errors in S_{11} Measurements due to the Residual Standing-Wave Ratio of the Measuring Equipment"

R. W. BEATTY AND G. E. SCHAFER

In the above paper,[1] we are concerned that an unsuspecting reader might conclude from the wording in its acknowledgment that we endorse the analysis and conclusions of the authors. This is not the case.

Although our suggestions after reading an early version of the paper did result in some improvements in clarity and rigor, we feel that the paper which was published still is not sufficiently clear to enable one to assess its rigor. In addition, we believe that the authors' criticisms of the work of previous researchers, including our own, are not necessarily valid.

We therefore wish to make it clear that we do not endorse any aspects of the above paper.

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[1] R. V. Garver, D. E. Bergfried, S. J. Raff, and B. O. Weinschel, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-20, pp. 61–69, Jan. 1972.

Correction to "A Transmission Line Taper of Improved Design"

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Abstract—**The optimum tapered transition formulated by Klopfenstein fails to meet the end values of impedance when the transformation ratio is large. A minor correction of Klopfenstein's formula corrects the inconvenience.**

In the above paper,[1] a transmission-line taper of improved design, which found numerous applications in microwave circuits was formulated. The performance of Klopfenstein's taper is superior to the stepped quarter-wave transformer. It is also easy to build the taper in microstrip and stripline techniques so that one may expect to see its use also in future designs. Therefore, it seems worthwhile to point out a slight error in Klopfenstein's formula, which leads to inconsistent designs when the transformation ratios are considerably larger than unity.

In the process of deriving the formula for the optimum taper, two arbitrary constants are introduced. The first constant, denoted ρ_0, is introduced through Klopfenstein's formula (10) which makes the reflection coefficient behave in an optimum way. The second constant, here denoted by P, is introduced by solving Klopfenstein's equation (4). The solution of that differential equation may be written in the following form

$$\ln Z_0(x) = 2\int_0^x F(\xi)\, d\xi + P. \tag{1}$$

The solution must be a function $Z_0(x)$ which satisfies the following two boundary conditions

$$Z_0\left(-\frac{l}{2} - \epsilon\right) = Z_1 \tag{2}$$

$$Z_0\left(\frac{l}{2} + \epsilon\right) = Z_2 \tag{3}$$

where ϵ is a small number, approaching zero. When the two constants ρ_0 and P are selected to fit the two previous conditions, the expression for computing the characteristic impedance takes the following form:

$$\ln Z_0(x) = \frac{1}{2}\ln (Z_1Z_2) + \frac{1}{2}\,\frac{\ln (Z_2/Z_1)}{\cosh A}\left[A^2\phi\left(\frac{2x}{l}\ A\right) + U\left(x - \frac{l}{2}\right) + U\left(x + \frac{l}{2}\right) - 1\right]. \tag{4}$$

The last term in the bracket, -1, is missing in Klopfenstein's formula (12). When the ratio Z_2/Z_1 is a small number, this omission causes negligible errors, but for large transformation ratios, the error may become appreciable.

For the transition from $Z_1 = 10\ \Omega$ to $Z_2 = 50\ \Omega$ with standing-wave ratio 1.2 we have computed the values of $Z_0(x)$ by Klopfenstein's formula (12) and by the corrected formula (4) above. As can be seen from Fig. 1, the original Klopfenstein formula gives an asymmetric distribution of impedance while our formula (4) corrects this inconvenience.

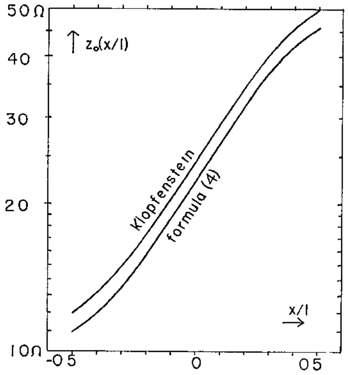

Fig. 1. Impedance taper.

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[1] R. W. Klopfenstein, *Proc. IRE*, vol. 44, pp. 31–35, Jan. 1956.