Letters

Comments on "Full-Band Low-Loss Continuous Tracking Circulation in *K* Band"

Y. AYASLI

In a recent paper [1], Konig *et al.* report the design of a wide-band *Y*-junction stripline circulator for the 18–26.5-GHz frequency band. In this paper, among the design constraints and assumptions, it is stated, "Adjust the ground plane spacing such that the first transformer step physically subtends an angle at the edge of the ferrite resonator equal to the coupling angle ψ."

It is difficult to understand this statement because ψ is the "stripline width, in radians" [2]. Therefore, once it is determined from the circulation conditions, the stripline width at the edge of the ferrite resonator is also defined, independent of ground plane spacing or any other parameter.

The dielectric constants of the surrounding medium and the ferrite are taken into consideration in choosing ψ for "continuous tracking" [3]. Once ψ is properly chosen, the input wave impedance of the ferrite and the wave impedance of the surrounding medium are equal around the center frequency and this result is independent of the ground plane spacing [4].

Therefore, around the center frequency, the first transformer section adjacent to the disk simply has an impedance equal to the junction input impedance and, hence, it cannot be considered as the first section of a 3-section impedance matching transformer. It must be for this reason that adjustments for the matching section were required and less than the expected octave bandwidth was obtained.

References

[1] J. G. de Konig, R. J. Hamilton, and T. L. Hierl, "Full-band low-loss continuous tracking circulation in *K* band," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-25, pp. 152–155, Feb. 1977.
[2] H. Bosma, "On the principle of stripline circulation," *Proc. Inst. Elec. Eng.* (Part B Suppl.), vol. 109, pp. 137–146, Jan. 1962.
[3] Y. S. Wu and F. J. Rosenbaum, "Wide-band operation of microstrip circulators," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-22, pp. 849–856, Oct. 1974.
[4] S. Ayter and Y. Ayaslı, "The frequency behavior of stripline circulator junctions," *IEEE Trans. Microwave Theory Tech.*, MTT-26, Mar. 1978.

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On the Smith Chart

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The Smith Chart *is* the complex plane of the reflection coefficient.

The unique contribution of P. H. Smith was the superposed grid for identifying impedance or admittance values; however, students, when being introduced to the Chart, can often be caught up in the superposed grid. Mastery of the use of the Chart requires a clear understanding of its underlying essence.

Since we are all taught to portray complex numbers by a magnitude and a phase angle, where the angle is measured from a horizontal line to the *right* of an origin, it would be helpful if this angle convention were always maintained. The common forms of the Chart show the angle of the reflection coefficient when measured in degrees according to this complex number convention; however, when expressed in fractions of a wavelength the direction to the left of the origin is used as a reference.

A short circuit is generally a better reference than an open circuit, but the Chart is, after all, as much of an admittance chart as an impedance chart. In the interests of those learning to use the Chart, it would be helpful if those individuals responsible for its printing would rotate by 180° their scales of angular measure expressed in fractions of a wavelength.

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Comments on "Measurement of Microwave Loss Tangent by Means of Microwave Resonator Bridge"

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In the above paper[1], Kneppo and Weis claim that the microwave resonator bridge (MRB) is a new and highly sensitive method for measuring dielectric losses of materials. Contrary to their belief, the principles of measurement are not new but have already been reported in [1] and [2]. Especially, the system arrangement described in [2] is the same as that of MRB, except that the former uses a shutter in tandem with a matched termination as a reference load of the bridge, while the latter uses a reference resonator. Thus the point in question is whether or not this replacement of the reference load improves the sensitivity of the bridge.

For a given perturbation brought about by inserting the sample into a measured resonator, MRB produces larger change in relative output power, $(|b_4'|/|b_4|)_0$ in (A8), than the bridge in [2]. It should be emphasized, however, that the signal output $|b_4'|_0-|b_4|_0$ is the same for both bridges, and the enhanced relative change is brought about by reducing $|b_4|_0$. When measuring the signal by the substitution technique, as in the present case, this enhancement in relative change does not lead to the improvement of sensitivity. This will be easily admitted by noting that changing $|b_4|_0$ while keeping $|b_4'|_0-|b_4|_0$ invariant is only to shift the position on an attenuator dial where a small difference $|b_4'|_0-|b_4|_0$ is to be read out. In general, those portions of an attenuator dial are finely graduated where attenuations are small. It follows, therefore, that the larger $|b_4|_0$ corresponding to the smaller attenuation permits the better accuracy for measuring a small difference.

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[1] I. Kneppo and M. Weis, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-25, pp. 418–423, May 1977.

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In addition, MRB requires an additional adjustment of tuning the measured resonator for its resonant frequency to coincide with that of the reference one. This adjustment seems difficult because, as shown in Fig. 5, tuning broadens the output response of MRB. Therefore, there is a possible error source due to detuning. The discussion of errors lacks for this amount.

In conclusion, it is doubtful whether MRB provides better sensitivity than the bridge in [2]. The only advantage of MRB is that, as pointed out in the concluding section, it may compensate for the temperature drift of the parameters of the measured resonator.

References

[1] K. Watanabe and I. Takao, "A bridge method for simultaneous measurements of coupling coefficient and loaded Q of a single-ended cavity," *Rev. Sci. Instrum.*, vol. 44, pp. 1625–1627, Nov. 1973.

[2] K. Watanabe, M. Ashiki, S. Mizushina, and I. Takao, "Accurate determination of microwave conductivity by means of cavity coupling coefficient measurement," *Japan. J. Appl. Phys.*, vol. 14, pp. 909–910, June 1975.

Reply[2] *by Ivan Kneppo and Michal Weis*[3]

The replacement of the reference load consisting of a shutter and matched termination by a reference resonator has these advantages:

1) The change in relative output power ($|b_4'|/|b_4|$) produced by the MRB is larger than the change of the original bridge. This relative sensitivity increases as the difference between the coupling coefficients of the reference and measured resonators decreases. As for the MRB output signal measurement it is true that the RF substitution technique is not optimal from the standpoint of full exploitation of the sensitivity provided by the MRB. It appears more convenient to use a calibrated detector followed by a differential amplifier which allow us to compensate the zero signal of the MRB or to use a measuring microwave receiver, respectively.

2) The response of the MRB: the output power versus frequency, contains also some additional information about another parameter of the measured resonator namely, about the loaded quality factor. For example, from integral of the MRB response it is possible to obtain the relation for calculation of the loaded Q and the change of Q due to the sample inserted into the measured resonator. It is matter of fact, that such measuring of the quality factor is a comparative one, and also has an advantage of high sensitivity.

3) MRB gives also the information about the difference in tuning of the measured and reference resonators and allows us to tune the resonators exactly to the same resonance frequency. Then, the measuring method permits measurement of all three parameters of the measured resonator without any circuit rearrangement. Of course, the detuning represents an error source that can be diminished, e.g., by the use of the electrically tuned reference (or measured) resonator connected in the control loop, which automatically tunes the resonator to the minimal output power of MRB.

[2]Manuscript received October 3, 1977.

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Correction to "Input Impedance of Coaxial Line to Circular Waveguide Feed"

N. D. DESHPANDE AND B. N. DAS

In the above paper[1] the expression (8) in Section IV should read as

$$|\Gamma| = \frac{\sqrt{[(\gamma_{in}-1)^2 + x_{in}^2]}}{\sqrt{[(\gamma_{in}+1)^2 + x_{in}^2]}}. \tag{8}$$

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[1]M. D. Deshpande and B. N. Das, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-25, pp. 954–957, Nov. 1977.

Correction to "Optimization of the Matching Network for a Hybrid Coupler Phase Shifter"

J. PIOTR STARSKI

In the above paper,[1] the manuscript received date was printed incorrectly. The date should have read, Manuscript received August 16, 1976.

Manuscript received September 21, 1977.

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[1]J. P. Starski, *IEEE Trans. Microwave Theory Tech.*, vol. MTT-25, pp. 662–666, Aug. 1977.