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Letters

Comments on "Error in Impedance Measurement When the Signal is Introduced Across the Slotted-Line Probe"

ROBERT V. GARVER

In the above short paper,[1] an attempt was made to calculate the errors in VSWR and phase caused by detector mismatch in a backwards-connected (power into the probe) slotted line. The short paper is wrong. There will be no first-order errors as predicted theoretically in the referenced short paper. The errors encountered in measuring nonlinear devices (diodes) are more complex than those encountered in measuring linear devices. It is very important that the harmonics generated by the diode being measured be absorbed in a matched load and kept out of the detector (especially for high-VSWR diodes). A low-pass filter is commonly used in front of the detector, but (unless it is padded) this filter reflects the harmonic power back into the diode. When the diode being measured does not see a match at the harmonic frequencies, then the harmonic mismatch will interact with the diode to make more efficient or less efficient the conversion to harmonics, depending on the phase relationship between diode and harmonic mismatch. The variable conversion to harmonics will change the impedance of the diode being measured (at the fundamental frequency) as the phase between diode and harmonic mismatch (unpadded low-pass filter) is varied. Therefore, when using a backwards-connected slotted line, it is important to have in front of the detector a low-pass filter that is padded or otherwise matched at the harmonic frequencies as seen from the diode. It is not important for the detector to be matched at the fundamental frequency in a backwards-connected slotted line, as proven in the following discussion.

Generator mismatch causes no first-order errors when the generator is connected to a slotted line in the normal manner. Given a generator and detector with identical output (input) impedances, one can interchange them and there will be no change in energy transfer through the slotted-line network for a linear passive network. Therefore, detector mismatch causes no first-order errors in measurements using a backwards-connected slotted line when linear passive impedances are being measured.

The error made in the subject short paper is that the maximum and minimum of the standing wave between detector and unknown are calculated instead of the maximum and minimum voltage transfer from the generator to the real part of the detector impedance.

A simple experiment with a backwards-connected slotted line will prove the point. With the probe decoupled 30 dB and a good impedance match for an unknown, connect a detector with a 2:1 VSWR to the slotted-line input with a phase shifter between it and the slotted line. The VSWR of the good match will be measured for all settings of the phase shifter and not the VSWR of the detector.

As a mental experiment, take the case of a perfectly matched load for an unknown. In this case, the distance between detector and unknown will give no change in error. According to the subject

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[1] J. Barbero, *IEEE Trans. Microwave Theory Tech.* (Short Papers), vol. MTT-22, pp. 887–889, Oct. 1974.

short paper this experiment will simultaneously satisfy worst case and best case phase conditions and a VSWR of 2:1 (the assumed detector mismatch) will be measured. But as the probe is moved back and forth, the only interaction will be between the finite capacitance of the 30-dB decoupled probe and the 2:1 detector mismatch to provide a VSWR indication of 1.005:1, much less than the 2:1 first-order error incorrectly predicted in the short paper.

In summary, the detector mismatch in a backwards-connected (power into the probe) slotted line contributes no more error to the measured VSWR than is contributed by the generator mismatch when the slotted line is connected in the normal manner. Careful attention must be given to the harmonic impedances a nonlinear device sees when it is being measured, no matter which way the slotted line or other measuring system is used.

Author's Reply[2]

J. BARBERO

Mr. Garver's comment is correct. In my short paper the standing wave in the line is calculated as in the normal measurement (detection across the probe) should be done, but this is not the case in the backwards-connected slotted line.

Nevertheless, Mr. Garver says that it is necessary to pay attention to the harmonics generated in the measurement of nonlinear devices. The measurement method under discussion is usual when the signal in the unknown must be kept very low, and in this case, the device is practically linear, so the harmonics generated are negligible.

Correction to "A Class of Waveguide Filters for Over-Moded Applications"

CHUNG-LI REN AND HAN-CHIU WANG

In the above paper,[1] two typographical errors should be noted.

1) On page 1203, the second line above (5), $\beta_e \simeq (k\epsilon)^{1/2}$ should read $\beta_e \simeq k(\epsilon)^{1/2}$.

2) On page 1205, in the footnote to Table I, $Z_{Ii}/Z_0 = (Z_I/Z_0)m_i$ should read $Z_{Ii}/Z_0 = (Z_I/Z_0)^{m_i}$.

[2] Manuscript received January 23, 1975.
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[1] C.-L. Ren and H.-C. Wang, *IEEE Trans. Microwave Theory Tech. (Part II) (1974 Symposium Issue)*, vol. 22, pp. 1202–1209, Dec. 1974.