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Further Comments on "Integration Method of Measuring Q of the Microwave Resonators"

P. L. OVERFELT AND D. J. WHITE

In reply to our comments [1] concerning his paper,[1] I. Kneppo showed an exact integration of the expression

$$P(\omega) = P_0\left[1+Q_L^2(\omega/\omega_0 - \omega_0/\omega)^2\right]^{-1} \quad (1)$$

between the limits ω_1 and ω_2 by the substitution of variables, $x = \omega/\omega_0 - \omega_0/\omega$, and a simplifying choice of limits symmetrical in x

$$I = \int_{\omega_1}^{\omega_2} P(\omega)\, d\omega = P_0\omega_0 Q_L^{-1} \tan^{-1}\left(Q_L\omega_2\omega_0^{-1}\right). \quad (2)$$

Limits symmetrical about $x = 0$ amount to the condition

$$\omega_1\omega_2 = \omega_0^2 \quad (3)$$

and when this relation holds, (2) is exact as may be verified by substituting (3) into the general expression for I, regardless of integration limits

$$I = \frac{P_0\omega_0}{2Q_L}\left\{\tan^{-1}\left[\omega_0 Q_L \frac{\omega_2(\omega_0^2-\omega_1^2)-\omega_1(\omega_0^2-\omega_2^2)}{(\omega_0^2-\omega_1^2)(\omega_0^2-\omega_2^2)Q_L^2+\omega_1\omega_2\omega_0^2}\right]\right.$$
$$-2\frac{1}{\sqrt{4Q^2-1}}\ln\left[\frac{(\omega_0^2+\omega_2^2)Q_L+\omega_2\omega_0\sqrt{4Q_L^2-1}}{(\omega_0^2+\omega_2^2)Q_L-\omega_2\omega_0\sqrt{4Q_L^2-1}}\right.$$
$$\left.\left.\cdot\frac{(\omega_0^2+\omega_1^2)Q_L-\omega_1\omega_0\sqrt{4Q_L^2-1}}{(\omega_2^2+\omega_1^2)Q_L+\omega_1\omega_0\sqrt{4Q_L^2-1}}\right]\right\} \quad (4)$$

and using the identity

$$2\tan^{-1} a = \tan^{-1}\frac{2a}{1-a^2}. \quad (5)$$

We had assumed [1] integration limits symmetrical in ω_0

$$\omega_1 = \omega_0 - \omega_s/2$$
$$\omega_2 = \omega_0 + \omega_s/2 \quad (6)$$

rather than x, but this does not account for the difference between our results and Kneppo's for typical microwave cavities.

Unfortunately, (7) in [1] omitted the square on Q_L in the denominator of the $\tan^{-1}$ term, this equation being otherwise identical to (4) of this note. Thus, our approximations for the case $Q_L \gg 1$, $\omega_0 \gg \omega_s$ were in error. When (6) is substituted in (4), given these conditions, Kneppo's (2) results.

It follows that (8) and (9) in our comments [1] are in error and that (10) should read

$$I = 2\pi P_0 \Delta f \tan^{-1} k. \quad (7)$$

In any case, the method of integrating (1) between general limits is of much interest, and (4) does allow asymmetrical limits for experimental integration. For example, integrating between the 3-dB and the resonant frequencies (setting ω_1 or ω_2 equal to ω_0) gives

$$\frac{I}{P_0} = \frac{\pi^2\Delta f}{4} \quad (8)$$

where Δf is the 3-dB bandwidth. This expression should allow a check on the symmetry of the resonance curve and, hence, show how good a description of the cavity resonance (1) actually is.

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Comments on "New Narrow-Band Dual-Mode Bandstop Waveguide Filters"

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I have read the above paper[1] with interest, but find some possible discrepancies between the data presented in Fig. 4 and the data presented in Fig. 6. It seems to me that the data in Fig. 4 is probably accurate, reflecting as it does the rejection obtainable through a single pair of ports coupling to a dominant mode propagating waveguide. No matter how the multiple pole filter is synthesized in the concept discussed by the authors, the shunt coupled bandpass filter is coupled only by a pair of couplings to the main line. Thus, the limitation on the depth of the obtainable rejection is determined by two factors: 1) orthogonality of the two coupling irises, and 2) return loss of the two coupling irises.

The data of Fig. 6 implies an input return loss for the bandpass filter and a value for the coupling iris isolation of over 50 dB, values which do not seem very likely. The data of Fig. 4 shows

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[1] J.-R. Qian and W.-C. Zhuang, *IEEE Trans Microwave Theory Tech.*, vol. MTT-31, pp. 1045–1050, Dec. 1983

values of approximately 18 dB, a rather reasonable number. I would ask the authors to comment on the method used to avoid direct crosstalk from the input to the output, (crosstalk would bypass the complementary bandpass filter) in the data of Fig. 6.

To achieve rejection values of 50 to 60 dB normally requires coupling of each resonant section to a different point along the main line with the distance between the coupling points being selected for proper phase cancellation. Such a technique was presented in [2].

Reply[2] *by J.-R. Qian and W.-C. Zhuang*[3]

The object of our paper [1] is to achieve high rejection values (over 40 dB) in the stopband for a bandstop waveguide filter without requiring many coupling irises along the main waveguide. It is just the distinguished feature against others.

We agree with Mr. Snyder that the obtainable rejection for our filters is determined by the return loss and the orthogonality of the two coupling irises.

The return loss or the reflection from the bandstop filters can be divided into two parts according to the following substitution. When the first and last equations of (3) in [1] are inserted into (8) in [1], it is easy to find that the transmission and reflection coefficients for the bandstop filters shown in Fig. 2(b) in [1] are

$$t' = 1 - \left(jM'_{01}/e_0\right) i'_1 - \left(M'_{n\,n+1}/e_0\right) i'_n$$

$$r' = \left(jM'_{01}/e_0\right) i'_1 - \left(M'_{n\,n+1}/e_0\right) i'_n. \qquad (1)$$

In the case of $\omega = \omega'_p$, the vector diagram for t' and r' is shown in Fig. 1. In order to make the resultant of the two components of r' in (1) equal to a unit vector and $t' = 0$, these two components must be 90° out of phase with each other; therefore i'_1 and i'_n are in phase at frequencies $\omega = \omega'_p$. At the frequencies other than poles in the stopband, i'_1 and i'_n are almost in phase, so that $t' \simeq 0$ and $r' \simeq 1$. At the frequencies in the passbands of the filters, i'_1 and i'_n are almost 90° out of phase with each other, so that the two components of r' cancel out, and then the resultant r' is restricted below a prescribed level.

This is the physical reason why there are poles and zeros in the frequency bands. So the return loss or the reflections of the two coupling irises is not a problem in our filters.

As Mr. Snyder mentioned, the crosstalk may have happened because of imperfections in orthogonality of the two irises. The imperfections cause direct coupling from the input of the bandstop filter to the output. This coupling effect can be taken into account by a bypassing reactance jX_b, which, in parallel to the mutual inductance M'_{01}, directly connects the source e_0 to the load R_0.

Taking account of introducing X_b into Fig. 2(b) in [1], the loop equations for the bandstop filters can be rewritten as (3) in [1],[4] but the element Z in the second column should be in place of $(Z - jM'^2_{01}/X_b)$. This means that the i'_1 loop is detuned and can be easily compensated by adjusting the tuning screw of the first cavity.

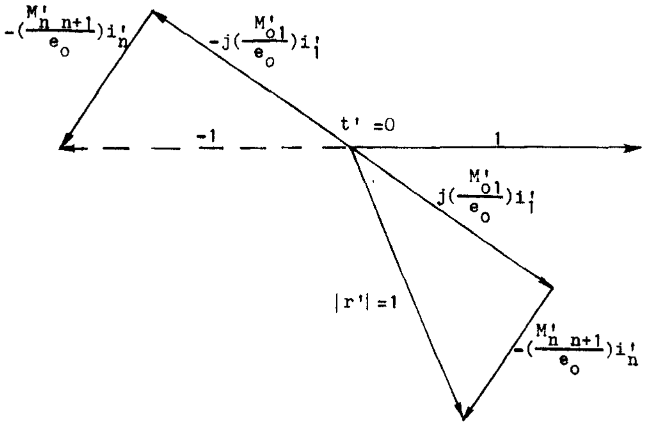

Fig. 1. Vector diagram for t' and r'.

Therefore, as long as $X_b \gg M'_{01}$, the insertion of the X_b has no effect on the accuracy of the theory described in [1], and this has been confirmed by the experiment mentioned before [1].

Even though the high rejection values in the stopbands are obtainable theoretically, the experimental results shown in Fig. 6 in [1] could not be obtained without making the auxiliary experiments with several steps, which ensure the expected values of the parameters R, M's to be carried out and the resonant frequencies of each cavity to be identical.

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[4]By the way, in [1, eq. (3)], the element $(jM_{1n} - jM'_{01}/2m)$ was misprinted as $(jM_{1n}jM'_{01}/2m)$ and the columns were misaligned

Comment on "Fast-Fourier-Transform Method for Calculation of SAR Distributions in Finely Discretized Inhomogeneous Models of Biological Bodies"

ALLEN TAFLOVE, SENIOR MEMBER, IEEE, AND KORADA R. UMASHANKAR, SENIOR MEMBER, IEEE

In the above paper,[1] Borup and Gandhi state in their Section IV that, in addition to their FFT method, "Thus far, the only technique available to compute SAR distributions for models of man is the method of moments (MOM)." In this letter, we would like to point out that there exists a *viable alternative numerical approach* which has been the subject of intense research and numerous publications over the past ten years. In fact, some *nine years ago*, an article in the same MTT TRANSACTIONS [1] discussed the application of this approach to a three-dimensional tissue geometry having 14 079 space cells for purposes of computing the SAR distribution as well as the induced temperatures.

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