Comments on "Analysis and Realization of L-Band Dielectric Resonator Microwave Filters"

Slawomir Bialas and Adam Abramowicz

The application of a 2-D and 3-D finite element method to estimate the parameters of the structures with dielectric resonators deserves special attention. However, working through the above paper[1], one can find that some parts of it have been carelessly written.

In the paper two filters employing dielectric resonators are called "elliptic filters," though they cannot be classified into this category. To explain why, let us briefly present the classification of the elliptic filters. Such filters exhibit the Czebyshev (equiripple) behavior in both pass- and stop-bands. The even order elliptic filters have been called hypothetical, since they cannot be realized as reactive networks with resistive termination and without ideal transformers, because their discrimination loss is finite at both zero and at infinite frequency (a lowpass filter case). However, it is possible to transform them so that, while they retain their order, they become realizable and still exhibit Czebyshev behavior in both pass- and attenuation-bands [1]. This can be achieved by using appropriate frequency transformations that lead to two types of the even order filters called "wiggle" and "bar" [1]. The bar-type and wiggle-type elliptic filters differ in the number of the ripples in the pass-band. The odd order elliptic filters along with the even order wiggle-type and bar-type filters are sometimes called the true elliptic filters. Equations (1) and (2) give the number of the transmission zeros ν of the realizable (true) elliptic filters for lowpass filters (transmission zeros at the infinite frequency is not included). The number of transmission zeros for the bandpass filters must be doubled:

$$\nu = \frac{n-1}{2} \qquad n\ odd \tag{1}$$

$$\nu = \frac{n}{2} - 1 \qquad n\ even \tag{2}$$

where: n is the filter order. Any other types of filters that do not exhibit the equiripple properties or the number of their transmission zeros is not equal to that given by (1) or (2) cannot be called "elliptic". Their similarity with elliptic filters is often expressed by using the word "elliptic" in the names like quasi-elliptic and pseudo-elliptic filters.

The most popular structure in which the microwave elliptic bandpass filters are realized is the multiple-coupled cavities structure. In this structure only even order elliptic filters can be realized [2].

Now let us consider filters shown in Fig. 3 and Fig. 16, 17 of the paper. The Fig. 3 is labelled "5th degree elliptic filter…". As it is explained above, the odd order elliptic filters cannot be realized in the multiple-coupled cavities structure. The authors of the subject paper have given such a label after [3] ([5] in their paper) where the influence of the Siu's paper [4] is clear. Siu has presented the realization of "an 5th order elliptic filter" [4] but has used resonant couplings, and although he has applied 5 cavities physically (a triple-mode plus a dual-mode cavity), from the point of view of the filter synthesis his filter had more than five cavities. Moreover, the structure presented in Fig. 5 seems to be free from resonant couplings.

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The authors are with the *Institute of Radioelectronics and Institute of Electronics Fundamentals, Warsaw University of Technology, Nowowiejska 15/19, 00-665 Warsaw, Poland

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[1] V. Mandrangeas *et al., IEEE Trans. Microwave Theory Tech.,* vol. 40, no. 1, pp. 120–127, January 1992

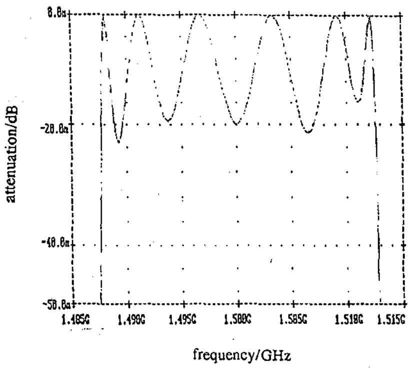

Fig. 1. Frequency response of the filter realizing the normalized coupling matrix (Table II) in the passband.

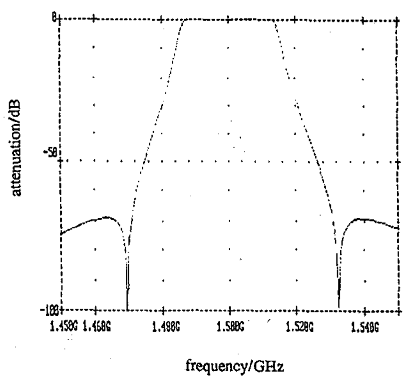

Fig. 2. Wide band frequency response of the filter realizing the normalized coupling matrix (Table II).

According to presented classification, sixth order elliptic bandpass filters should have four transmission zeros. Whereas, the Fig. 16 clearly shows one pair of the transmission zeros only, which would denote the quasi-elliptic filter. Furthermore, close scrutiny of the Fig. 16 and Fig. 17 reveals that, probably by author's mistake, figures present two different filters. The resonant frequencies of the filters differ considerably: 1.4635 MHz in Fig. 16 and 1.336 MHz in Fig. 17. The midband insertion losses are also different: 0.3 dB in Fig. 16 and 2 (?) dB in Fig. 17. It would be interesting to know if the filter in Fig. 16 has similar wide band response as that in Fig. 17. What is more, we have found a striking discrepancy between a matrix of normalized couplings and obtained filter characteristics. The matrix of normalized couplings is presented in the Table II, while the Figs. 15 and 16 display a scheme representation of the filter structure and the results of the experiment respectively. The values of the couplings included in the Table II have little in common with the characteristics presented in Fig. 16. After conducting the simulation of the couplings matrix specified in the Table II, we have found characteristics presented in the Fig. 1 and Fig. 2. It is easy to notice that the main differences as regards the Fig. 16 consist in the values of the ripple level in the passband and in the stopband. The passband ripple level presented in Fig. 16 is equal to 0.035 dB (computed from reflexion losses), while from the normalized couplings matrix we have found it equal to 0.02 dB as can be seen in Fig. 1. The stopband

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attenuation level presented in Fig. 16 is equal to 50 dB, whereas we have found it equal to 68 dB! (Fig. 2).

Nevertheless, a method of the synthesis of filters with the reduced number of transmission zeros is very interesting. The procedure of tuning such filters may turn out to be easier in relation to the filters realizing elliptic characteristics especially for the high number of cavities.

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Reply to Comments on "Analysis and Realization of *L* -Band Dielectric Resonator Microwave Filters"

V. Madrangeas, M. Aubourg, P. Guillon, S. Vigneron, and B. Theron

In the above paper [1], we applied the 3-D finite element method to design and to realize an *L*-band dielectric resonator filter.

The authors comments concerning the elliptic filters is correct but in microwave, most people use the word "elliptic" instead of "quasi elliptic" or "pseudo elliptic," see for example [2]–[6], ...

The Fig. 16 in our paper [1], shows the transmission and reflection responses for the 6 pole filter. In Fig. 17 [1], we present the result of the wideband frequency sweep for this filter. The measurements have been realized using a Hewlett-Packard 8510 Network Analyzer.

We first notify that the curve of the Fig. 16 [1] has been drawn after a calibration procedure. This calibration is indicated by the notation "C" at the left of the screen. In this case, the marker 1 gives an in band insertion losses equal to 0,3 dB and a return loss equal to 25 dB. The resonant frequency of the filter is 1.4635 GHz (and not 1.4635 MHz).

On the other hand, no calibration has been realized before measuring S_{21} parameter on the Fig. 17 [1]. There is not "*C*" at the left of the screen. In this case, the interconnecting cables and adaptors (as well as the instrument itself) introduce variations in magnitude and phase that can mask the actual performances of the device under test. So, it isn't possible to calculate the midband insertion losses. Furthermore, it is better to determinate the resonant frequency and the insertion losses on a narrow-band because there are the same number of measurement points in the sweep on a narrow-band as on a wide-band.

We must also note that Marker 2-1 (1,336 GHz) on Fig. 17 [1] indicates the difference of frequency between the Marker 1 (resonant frequency of the filter) and the Marker 2 (resonant frequency of the first spurious mode). We would only show here the position of the nearest spurious mode. So Figs. 16 and 17 [1] represent the responses of the same filter but on a different band width.

It is fair to find a difference between the matrix of normalized coupling and obtained filter characteristics for many reasons.

At first, the calculation of the matrix of normalized coupling are realized without taking into account the losses.

On top of that, in theory, we have only considered a coupling between the resonant elements 1 and 2, 2 and 3, 3 and 4, 4 and 5, 5 and 6, 1 and 4, 3 and 6 (Fig. 15 [1]).

In fact, in practice, there is a coupling between the dielectric resonator (DR) 1 and the DR 2, and between the DR 3 and the DR 5 for this type of dielectric resonator microwave filters. This unknown couplings can modify the stop band attenuation level.

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V. Madrangeas, M. Aubourg, and P. Guillon are with I.R.C.O.M., U.R.A. 356 CNRS, University of Limoges, 123 Avenue Albert Thomas, 87060 LIMOGES C'edex, France.

S. Vigneron and B. Theron are with ALCATEL ESPACE—26 Avenue J. F. Champollion, 31037 Toulouse C'edex, France.

IEEE Log Number 9208355.

Comments on "Authors' Response"

Slawomir Bialas and Adam Abramowicz

However, the resonant frequency of the filter presented in Fig. 17 is clearly higher than 1.56 GHz we must agree that the Figs. 16 and 17 in the paper[2] represent the responses of the same filter and it is better to determine the resonant frequency and the insertion losses in the narrow-band.

It quite often happens that microwave people use the word "elliptic" instead of "quasi-elliptic" or "pseudo-elliptic" but this should not be accepted as the norm. Besides, among suggested papers [2]–[5] (in the authors' reply) only in the paper [2] and [3] the word "elliptic" denotes "quasi-elliptic" or "pseudo-elliptic" filters. In the

The authors are with the Institute of Radioelectronics and Institute of Electronics Fundamentals, Warsaw University of Technology, Nowowiejska 15/19, 00-665 Warsaw, Poland.

V. Mandrangeas

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