A MINIATURIZED MONOLITHIC DUAL BAND FILTER USING CERAMIC LAMINATION TECHNIQUE FOR DUAL MODE PORTABLE TELEPHONES

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ABSTRACT

A miniaturized monolithic dual band filter is developed for dual mode portable telephones. By using ceramic lamination technique, 1mm-thick 900MHz filter and 1.9GHz filter are fabricated and stacked to be co-fired. The performance degradation due to the thickness and the dual band matching network are discussed. Experimental filter is constructed. It shows very good performance.

I. INTRODUCTION

Recently, portable telephones become very popular and various new systems, such as 900MHz digital cellular and 1.9GHz personal communication system, have been introduced. Each system has merit and demerit respectively. Thus we should select a system which meets our purpose. Another better solution is a dual mode telephone. This is very attractive for us to use it in various situations.

However, dual mode telephone requires new miniaturized components, because the volume of the hand set becomes two times as large as a single mode one by making in a conventional structure. A miniaturized monolithic dual band filter is one of key components to reduce the size of the hand set. A ceramic lamination technique[1, 2] is very important in this case, because very thin dielectric filter can be constructed successfully by using this technology.

The authors fabricated very small and 1mm-thick stripline filters for 900MHz band and 1.9GHz band. They are stacked to build up a 2mm-thick monolithic dual band filter. These two filters are co-fired simultaneously by ceramic lamination technique with ceramic green sheets and silver conductive paste.

So far, some stripline filters, diplexers and LC chip filters have been reported[3]-[10]. However, such a monolithic structure is quite unique. It is necessary to overcome the difficulties to construct a low-insertion-loss filter of 1mm-thick triplate structure. Usually insertion loss might be increased, due to a narrow gap between two shield electrode layers. This paper describes the discussion for the insertion loss of the 1mm-thick planar filters and impedance matching network to create a dual pass band. Experimental filter is constructed and the performance will be demonstrated.

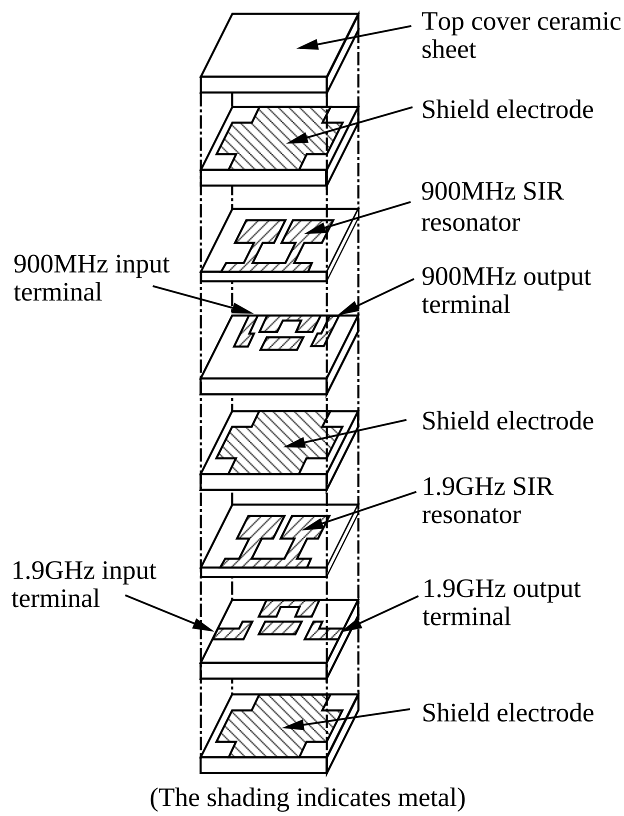

Fig. 1. Filter configuration of monolithic dual band filter

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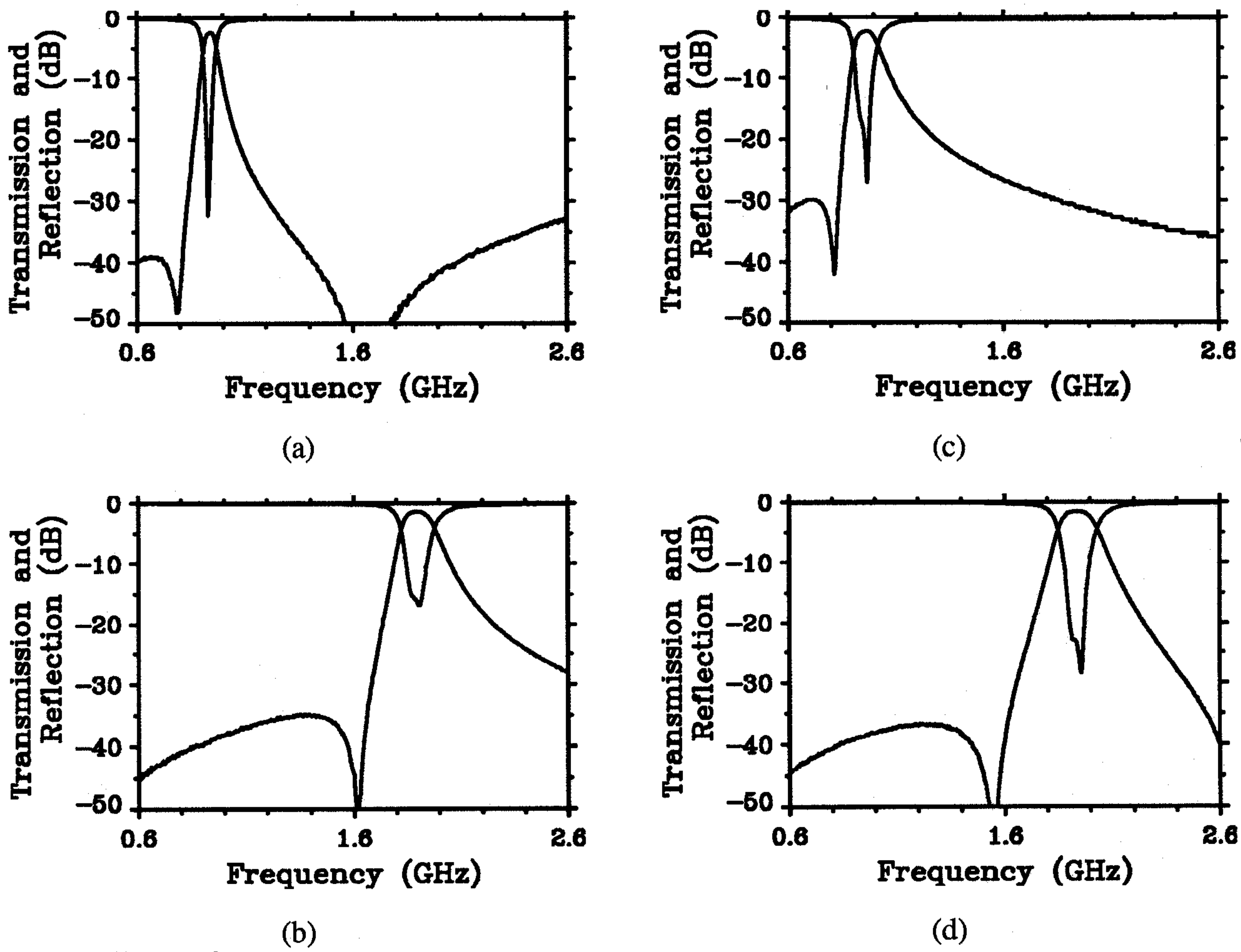

Fig. 2. Filter performance
(a)2mm-thick 900MHz
(b)2mm-thick 1.9GHz
(c)1mm-thick 900MHz
(d)1mm-thick 1.9GHz

II. FILTER CONFIGURATION

Figure 1 shows the filter configuration. This filter has two input terminals and two output terminals. The each filter presented here has basically a same filter equivalent circuit of [3]-[7]. The major difference is the thickness of 1mm. Here the insertion losses are compared with 2mm-thick conventional ones. Figure 2(a)-(d) show the performances. In fact, the insertion losses are slightly increased. But differences are not so significant owing to the optimization of the structure and the stripline patterns. Figure 3 shows the effect of SIR(Stepped Impedance Resonator) impedance stepping ratio versus unloaded Q' s and resonance frequencies. Figure 4 shows the effect of a loaded capacitance on unloaded Q. The ceramic lamination technique could make it easy to change them, while it is very difficult for conventional coaxial approach. Therefore the authors could advantageously developed such a miniaturized filter in a short time first in the world.

III. IMPEDANCE MATCHING NETWORK

The filter is a two-in and two-out structure as mentioned. Thus some impedance matching network is required to create a dual pass band. Each filter has to be open at the pass band of its counterpart. Figure 5(a),(b) show the phase characteristics of each filter. The conventional technique requires LPF and HPF for each side. As a result, the total volume of the filter circuit could not be small. The matching circuit developed here is shown in Figure 6. The circuit is simplified by studying the phase characteristics of each filter intensively. Only one chip capacitor and one inductor are used in each side for phase shifting.

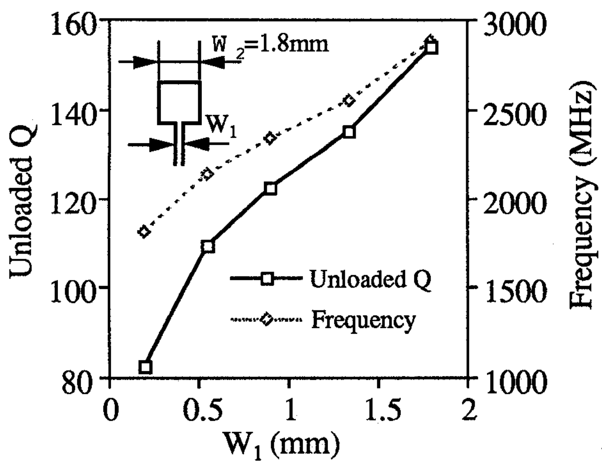

Fig. 3. SIR stepping ratio versus Q's and resonance frequencies

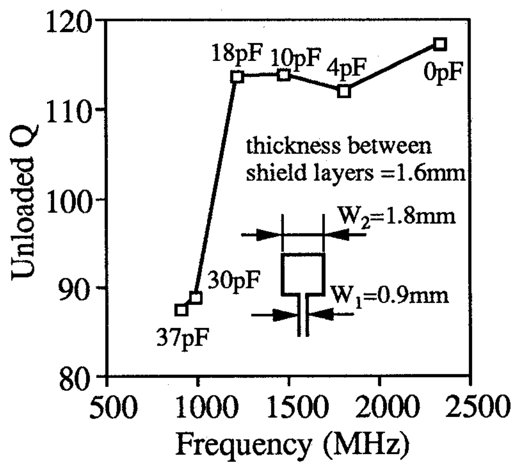

Fig. 4. Effect of loaded Capacitance on unloaded Q

IV. EXPERIMENTAL RESULTS AND CONCLUSIONS

An experimental dual band filter is constructed in a monolithic structure. Two 1mm-thick planar filters are stacked and co-fired. The total dimensions are 3.2mm x 4.5mm x 2.0mm which is same as the conventional planar filter. Figure 7 shows the photograph of the dual band filter. The performance including matching network is shown in Figure 8. It exhibits an excellent performance for various dual mode portable telephones in 900MHz band and 1.9GHz band. Therefore very compact dual mode portable telephones will be developed in foreseeable future.

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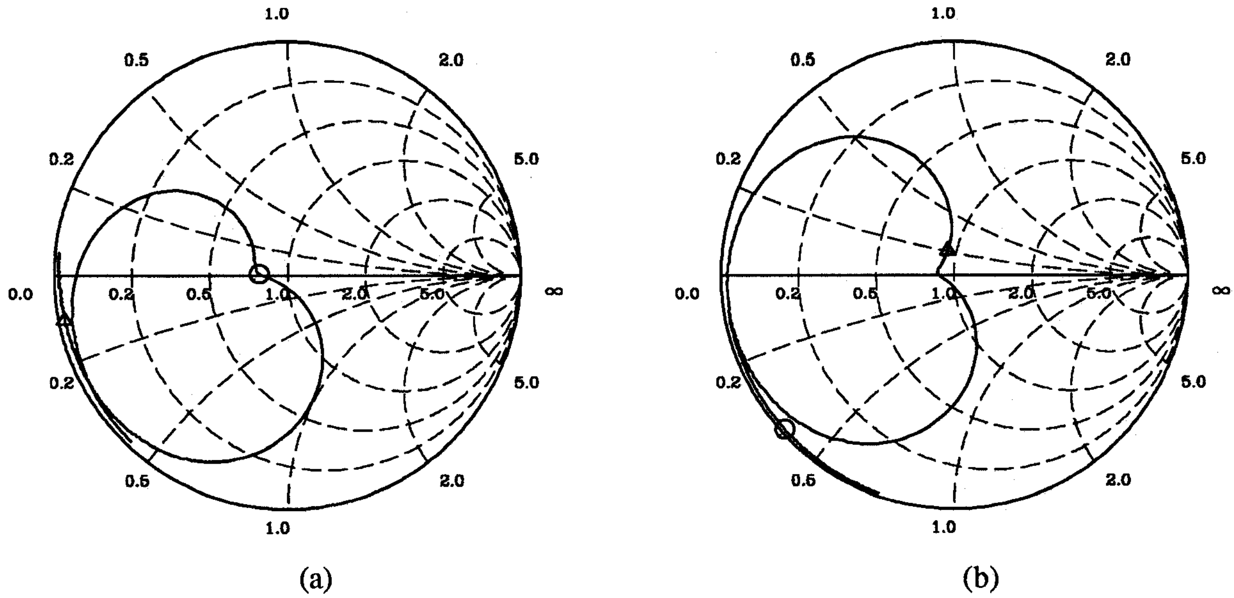

Fig. 5. Phase characteristics
(a)900MHz filter, (b)1.9GHz filter

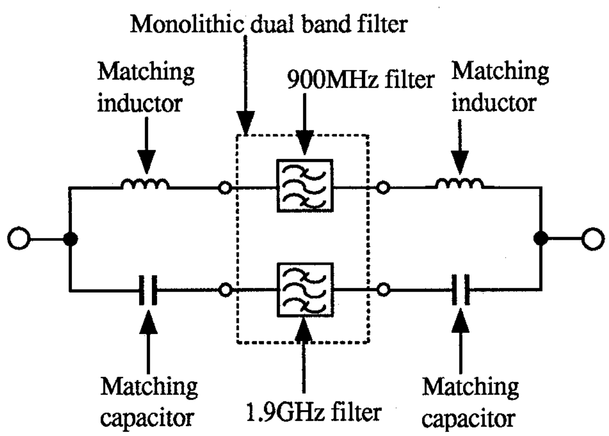

Fig. 6. Impedance matching network for dual band filter

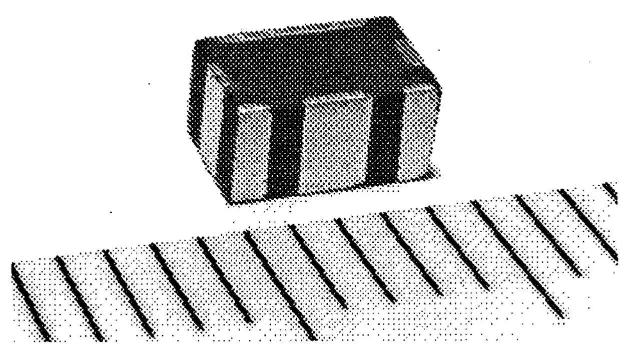

Fig. 7. Photograph of monolithic Dual Band Filter

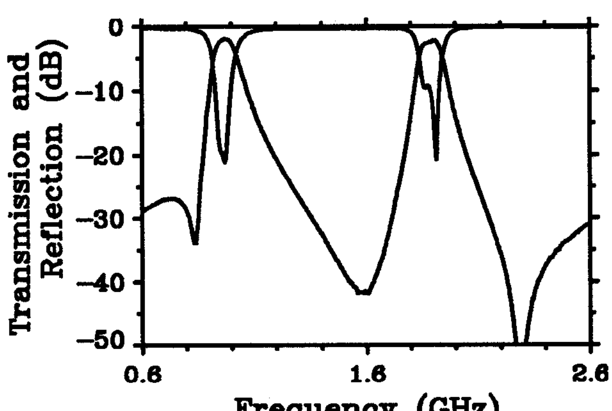

Fig. 8. Performance of monolithic dual band filter