RIGOROUS ANALYSIS OF NOVEL DIELECTRIC RESONATOR FILTERS WITH PRINTED TUNING SEPTUM

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ABSTRACT

This paper describes the analysis of dielectric resonator filters with printed tuning septum in waveguide sections operating below cutoff. In this design approach a thick dielectric slab of high permittivity is placed longitudinally in the waveguide. A bilateral ladder-shaped metallization determines the resonator and coupling sections (modified finline filter). In contrast to conventional dielectric resonator filters, this approach provides better passband separation and increased stopband attenuation. Furthermore, due to the bilateral tuning septum, the resonator and coupling sections can be manufactured accurately with photolithographic techniques rather than by expensive machining.
INTRODUCTION

Dielectric resonator filters are an attractive solution when extremely compact filter components are required. These filters can be fabricated by introducing dielectric blocks of certain thickness (approximately equivalent to $\lambda g/2$) into a circular or rectangular waveguide operating below its cutoff frequency [1], [2]. The most common approach is to use a rectangular waveguide and fill the resonator section totally with a dielectric material. The resonator blocks are then separated axially by air-filled (evanescent-mode) waveguide sections (Fig. 1a). The entire filter component is embedded between two standard waveguides operating above cutoff. However, this approach has certain disadvantages. Firstly, the practical design requires precision machining of the resonator blocks which have to be adjusted mechanically in the waveguide mount. Secondly, their stopband attenuation towards higher frequencies is only moderate, and the harmonic passband suppression is poor, especially when a resonator material with low permittivity is used.

To alleviate the second problem, a structure was proposed in [5], in which the resonator blocks were coupled via a triple waveguide section (Fig. 1b). This measure virtually eliminated the highpass behaviour of the filter since the cutoff frequency of the higher-order modes in the coupling section was significantly increased. This led to an additional reduction of the total filter length. Nevertheless the mechanical design was still too complicated, and hence, this solution was not suitable for low-cost manufacturing and accurate realization.

This paper proposes a third solution in which a modified version of the ladder-shaped finline filter is used to operate in a waveguide section below cutoff. The main idea is to use the substrate not only as supporting material for the ladder-shaped metallization (as in the conventional finline circuit where a thin substrate with a low permittivity was required in order to reduce dispersion effects) but also to increase the thickness and the permittivity of the dielectric in order to allow propagation of the fundamental