Small Sized Microstrip Filter for Receiver-Indicator of GLONASS+GPS

V.M. Vladimirov, S.N. Kulinich, Yu.Y.Shikhov, P. L. Podgurskiy

Abstract — **The method of miniaturization of microstrip filters with a narrow passband is offered. The suggested method allows one to simply control the main electric filter characteristics and optimize its dimensions.**

Keyword — **Microstrip filter, bandwidth, coupling coefficient.**

I. Introduction

Recently small sized mobile receiver-indicators of the navigation systems GLONASS and GPS have been widely used, in their devising strict demands are made of mass bulk characteristics of electronic components. In particular, minute frequency-selective devices are required. Microstrip filters most fully satisfy these requirements, they possess good electric / mass bulk indices, but they need further perfection. In this paper one way of parameter optimization of microstrip filters is considered.

II The Computer Simulation Model and Filter Design

As is known, the electromagnetic coupling between microstrip resonators is determined by the inductive and capacity interaction and quantitatively characterized by corresponding coupling coefficients. Common coupling coefficient of the resonators k is defined by the expression [1]:

$$k = \frac{k_L + k_C}{1 + k_L k_C} \qquad (1)$$

Where, k_L and k_C are the inductive and capacity coupling coefficients, respectively. In the general case inductive and capacity couplings can both act in the phase and in the anti-phase. With anti-phase interaction, the coefficient k can be equal to zero, when $k_L = k_C$ (coupling compensation). Because of coefficients k_L and k_C are frequency-dependent function, coupling compensation can occur at definite frequencies. Consequently, selectively changing the character and order of capacity and inductive coupling of microstrip resonator, one can, on the whole, influence the amplitude-frequency characteristic of a microstrip filter, for instance, by the width of the filter ΔF passband, or by the position of attenuation pole on the frequency axis.

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Consider a two-pole quarter-wave microstrip filter of a resonator array (See the lower insertion in Fig.2.) In this

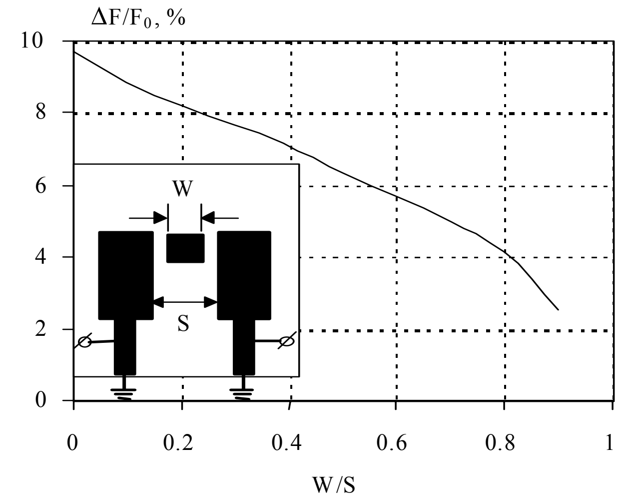

Fig 1. Dependence of the fractional bandwidth *ΔF* on the gap

construction the coupling coefficients k_L and k_C act in the anti-phase, with the common coefficient k, which defines the filter passband, being, mainly defined by the value of the inductive coupling ($k_L > k_C$).

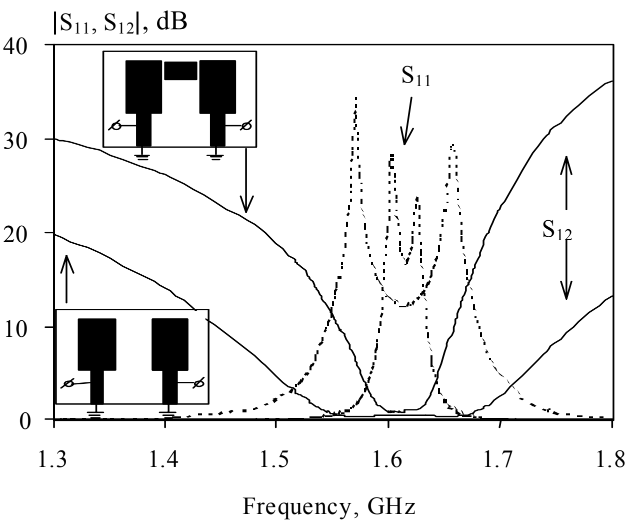

Fig. 2. Frequency response of microstrip filters

As is known, to produce a filter with a narrow passband *ΔF* (the order of 2÷3%), one must increase the distance between microstrip resonators. In the insertion of Fig.1 is given a topology of two-pole filter with additional capacity site between resonators, located near the antinode area of the electric field. In this case the capacity component k_C of the coupling between resonators will increase. Because in the filter passband inductive and capacity coupling components interact in the anti-phase and are distracted, the common coupling coefficient *k* will decrease respectively. Therefore, to obtain the previous passband ΔF, it is necessary for the resonators to be brought together, as a consequence the filter bulk decreases. In the distance between the resonators is fixed, and only the gap values between the capacity site and the resonators are changed, one can regulate the filter bandwidth. In Fig.1 is presented a calculated in a quasi-static approximation the dependence of a fractional bandwidth ΔF on the gap. In Fig.2 the frequency response (FR) of the filter under study for two cases are presented. In the first case, the additional site is missing, in the second case, the gap between the site and the resonators is 50μm. In the second case, the fractional bandwidth is 2.5%, which decreased 4 times. The distance S between the resonators in both cases is the same (1mm), in this case only trimming of the point of conductive connection to external transmission lines is required. A filter without the capacity site with analogous passband of 2.5% occupies an area two times bigger.

III. Results

The suggested method of phase compensation was used in devising a five-pole microstrip narrow-band filter used for a preliminary selection in LNA receiver-indicators of GLONASS and GPS.

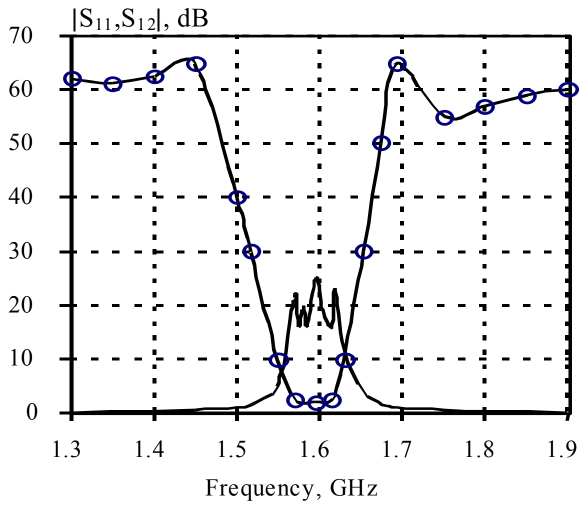

Fig. 3. Frequency response of microstrip filters

In Figs. 3 and 4 the frequency response and the draft of the filter are presented, whose bulk dimensions are 13.5 × 7 × 3.5 mm^3. The use of the suggested method, together with a decrease of the bulk, allow one to control the position of the attenuation pole at the high-frequency slope, but in this case there is observed a pronounced asymmetry of filter frequency response which should be minimized. There exists a way to obtain attenuation poles and increase selectivity in electromechanical filters using bridge communication and phase inversion between input and output [2]. To symmertize FR and obtain a maximum selectivity, in the design of the filter use is made of capacity coupling as a weak bridge link between extreme resonators.

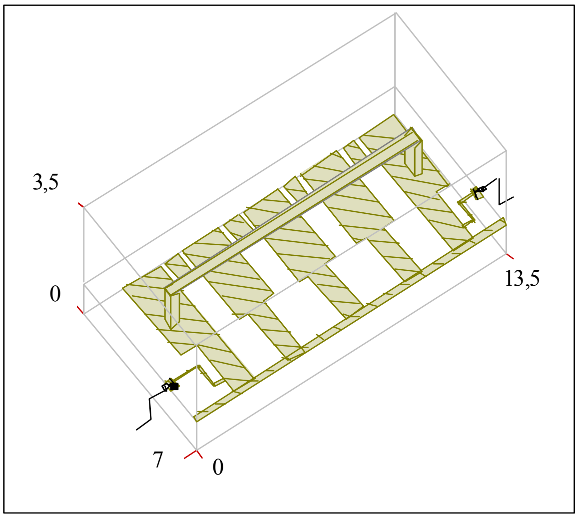

Fig. 4. Draft of microstrip filters

The suggested method allows one to simply control the main electric filter characteristics and optimize its dimensions. The devised filter possesses small losses in the passband (not more than 2.5dB), high selectivity, small bulk and mass not more than 1.4g. The filter has been successfully used in receiving devices of the system GLONASS + GPS.

References

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