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Complex Effective Dielectric Permittivity and Characteristic Impedance of Tunable Coplanar Line[1]

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Abstract—An analysis of complex dielectric permittivity and characteristic impedance of micromechanically tunable coplanar line is presented. The coplanar line parameters tuning is achieved by signal line electrode movement above the substrate or the dielectric plate above the surface of line electrodes. A reconfiguration of electromagnetic field with complex nature occurs as a result of such movement in the line. It is described in terms of effective permittivity and characteristic impedance. We studied an influence of physical and geometrical parameters of the line on characteristics of effective permittivity tuning and change in characteristic impedance and line loss. It is found that proposed method for line tuning parameters allows us to obtain a high sensitivity to movement for effective parameters, wherein the level of losses in the line is not deteriorated, and under certain conditions are reduced. These results make it possible to design high-quality tunable resonant elements and phase shifters based on micromechanically controlled coplanar line.

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1. INTRODUCTION

Modern telecommunication and radio engineering devices provide the possibility of operating frequency tuning [1], also to ensure the electromagnetic compatibility with other systems, and for operational change in use of radio frequency resource [2]. Electromagnetic interference reducing between operating radio systems is also achieved using antennas with selective radiation pattern [3].

In many practical cases for such systems use, it is implied the operational tuning of radiation pattern, which in turn requires the use of tunable phase shifters. These problems can be solved using solid state electronic components, such as pin diodes [4], varactors [5, 6], optical switches [7], and ferroelectrics [8].

Along with indisputable advantage of electronic control, these devices characterize by common drawback, namely, an increasing the electromagnetic energy losses [9, 10], changed with tuning. Mechanical tuning, for example, by geometric dimensions change of resonant elements, is devoid of this drawback, but it cannot be used for operational system tuning.

The advantage of high quality mechanically tunable components can be combined with the advantage of electronically controlled components with micromechanically tunable devices design. Magnitude of required mechanical displacements can be several tens of micrometers with proper design [11]. It allows us to use high-speed drives, such as piezoelectric actuators [12] and microelectromechanical systems (MEMS) [13].

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ADDITIONAL INFORMATION

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