IMPEDANCE TRANSFORMATION AS A WAY TO IMPLEMENT AN ACTIVE FBAR FILTER

Andrii I. Zazerin, Anatolii T. Orlov, Oleksander V. Bogdan
Department of Microelectronics, NTUU "KPI", Kyiv, Ukraine

Gyrator is a circuit element which performs the function of impedance transformation. Being incorporated into the scheme, gyrators makes capacitive circuits exhibit inductive properties (simulated inductance) and vice-versa. Consequently, the band-pass filters behave like notch, etc. Schemes with gyrators have a lot of advantages over the conventional approaches. Unlike inductors, physical capacitors are much closer to the ideal capacitors. Therefore, the use of capacitors and gyrators in non-inductive filter networks significantly improves the performance of filter compared to conventional RLC filter. It should also be claimed that these gyrator-substituted filters have the lowest sensitivity to component variations, exactly analogous to their passive RLC prototypes.

In the present paper we attempt to combine gyrators as a circuit solution with perspective and promising technology of thin-film bulk acoustic resonators (FBAR). Latter are known by their high values of power efficiency, quality factor, electromechanical coupling coefficient, and, what is most important, by their compatibility with the standard silicon production technology.

To describe the properties of the resonator we used the modified Butterworth-Van-Dyke model (Fig. 1), which has two resonances: series resonance f_s and antiresonance f_p (which is also known as parallel resonance). The result of gyration is the inversion of resonances, as shown in Figure 2. This effect can be used to develop new or improve existing active filter schemes. Also it is a promising opportunity of compensation of imitated static inductance L_0, resulting from impedance transformation. This may significantly improve the performance of the filter network.

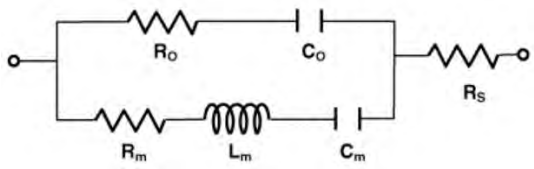

Fig. 1. Modernized BVD model of a FBAR resonator. R_m, L_m, C_m – motional resistance, inductance and capacitance respectively, R_0 - acoustic loss, R_s – motional loss, C_0 – static plate capacitance

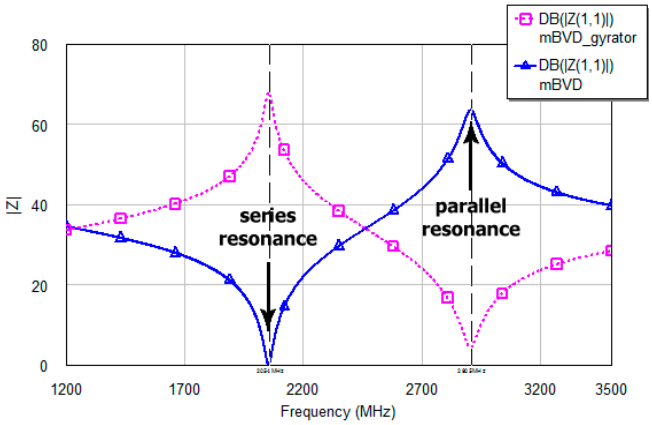

Fig. 2. Inversion of resonator's impedance using a gyrator scheme