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Short communication

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COMPACT BANDPASS FILTER WITH QUASI-ELLIPTIC RESPONSE USING STUB LOADED RESONATOR

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Abstract—In this letter, a compact bandpass filter having quasi-elliptic response is proposed using short-circuited stub loaded $\lambda/2$ stepped impedance resonator (SCSL-SIR). Five transmission zeros generated helps in achieving high selectivity and improve out-of-band rejection characteristics of BPF. A compact bandpass filter having a size of $0.109\lambda_g \times 0.104\lambda_g$, with a 3dB fractional bandwidth of 14% and having lower/upper stopband roll-off rates of 1.91dB/MHz/1.44dB/MHz is designed at 0.350 GHz for Terrestrial Trunked Radio (TETRA) band applications.

Keywords—Mixed Coupling; Quasi-elliptic bandpass filter; Roll-off Rate; Short-Circuited Stub Loaded Stepped Impedance Resonator(SCSL-SIR);Transmission Zero (TZ).

I. INTRODUCTION

Because of the advent of TETRA band after the agreement between NATO and EU for the public safety and emergency services, it has gained a lot of acclaim for its basic purpose, so demand of compact BPF which can operate at low radio frequencies with good performance has significantly increased. Lumped elements BPF have the advantage of being very compact but suffer from their low quality factor that leads to poor performance. So, planar microstrip BPF is preferred which can offer high selectivity and high quality factor.

Several filter designs have been reported for designing a BPF having characteristics like compact size, low insertion loss, high return loss, high selectivity, and better harmonic suppression. Filter performance can be improved by obtaining transmission zeros near passband and in rejection band. TZs can be generated by mixed coupling [1], [7] and source-load coupling [2]. In [3] Stepped Impedance Resonator (SIR) have been arranged in an inline configuration to make the entire circuit compact and the inline resonator array facilitates

new coupling schemes for producing a quasi-elliptic function passband response. A cascaded quadruplet bandpass filter is modeled in [4] based on connected couplings and short end parallel coupled lines but the structure is large in size. A new type of microstrip quarter wavelength SIR filter with controllable mixed electric and magnetic coupling was designed in [5]. A novel type of compact filter is reported in [6], which generates independently tunable transmission zeros which are achieved by magnetic/electric coupling between two hybrid resonators but at the cost of FBW and selectivity. A novel bandpass filter with multiple transmission zeros using open/shorted dual-behavior resonators (DBRs) is proposed in [7] but here FBW and size are not good. In [8], a miniaturized bandpass filter is designed using dual spiral resonators. A selective bandpass filter with multiple transmission zeros is designed using a parallel coupled transmission line in [9]. Every design has its own advantage in particular characteristics. But none of them acquire all the characteristics of a good bandpass filter.

In this letter, a compact band pass filter having quasi-elliptic response is proposed for TETRA band applications. The filter is designed with SCSL-SIR that helps in obtaining, compact size, wide stopband and good selectivity. Five transmission zeros are created that provides high selectivity and wide stopband. The proposed filter is optimized and simulated using CST (Computer Simulation Technology) software. The prototype is designed and fabricated on Rogers RO3010 dielectric sheet (having $\epsilon_r = 10.2$, $\tan \delta = 0.0022$, height of substrate = 1.28 mm, and thickness of metal= 0.017 mm).

II. FILTER DESIGN

Figure 1 shows the configuration of proposed bandpass filter and its coupling pattern. The proposed resonator is a dual-mode resonator and for the

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