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Compact Wideband Bandpass Filter using Quad Mode Resonator

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Abstract— This paper presents a compact wideband bandpass filter for TETRA band applications. The proposed filter design is based on a quad mode resonator designed using small rectangular loop loaded with four Stepped Impedance Stubs (SISs) and a short circuit stub. The four modes of the resonator help in generating a wide passband. The use of SISs makes the filter compact. In addition to four transmission poles, the resonator inherently generates a transmission zero above the higher end of passband. Two transmission zeros are generated by the input/output coupling which helps in increasing the selectivity and also for achieving wide stopband. This filter provides a 3 dB fractional bandwidth of 30.33% and maximum insertion loss of 1.3 dB at the center frequency 0.36 GHz with a compact size of $0.125 \lambda_g \times 0.085 \lambda_g$ ($4.1 \times 2.78 \text{ cm}^2$).

Index Terms— Bandpass filter, Compact, Quad mode resonator, Wideband

I. INTRODUCTION

As per [1] the standards set by ETSI (European Telecommunications standard institute), TETRA is a digital radio standard used for two way transceivers such as PMR and PAMR which are majorly used for telemetry tracking and radiation control applications in industries. For its basic property of rejecting out of band signals bandpass filters play a vital role in eliminating stray and unwanted radiations in communication systems.

There are several unique techniques reported to design compact bandpass filter. In [2] concentric dual mode resonators were used to design a compact bandpass filter. In [3] a compact and highly selective bandpass filter is designed using triple/quad mode resonators. The bandpass filter reported in [4] is designed by using mixed electric and magnetic coupling between stepped impedance resonators. A highly selective bandpass filter is designed in [5] by using a dual mode ring resonator and open stubs. A compact bandpass filter with tunable transmission zeros is designed by using mixed electric and magnetic coupling between hybrid resonators and has been reported in [6]. In [7], cross coupled stepped impedance resonators with zero degree feeding is used to achieve narrowband filter. In [8], stub loaded dual mode resonators are coupled both electrically and magnetically to generate a quasi elliptic response bandpass filter. Triangular stub loaded short circuited resonators are used in [9], to achieve wideband bandpass filter with wide stopband. In [10], electrically coupled stepped impedance resonators are used along with open stub resonators to get a narrow band bandpass filter with wide stopband. A multimode resonator is proposed in [12]

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