

# Development of Microstrip BPF Using Open Split Ring Resonator with Square Groundplane Window

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**Abstract** – This paper presents the development of microstrip bandpass filter (BPF) using open split ring resonator (OSRR) incorporated with square groundplane window. The microstrip BPF is comprised of 2 pairs of 3 cascaded OSRR connected with microstrip lines. Here, the incorporation of square groundplane window underneath the OSRR is applied to improve the passband bandwidth response of proposed BPF. In the design process, some parametrical study is performed to optimize the BPF in achieving the optimum bandwidth response. The proposed microstrip BPF is then realized on a 0.8mm thick FR4 Epoxy dielectric substrate with the dimension of 35mm x 60mm. The measurement result shows that realized microstrip BPF has the bandwidth response of 1.12GHz ranges from 1.50GHz to 2.62GHz which is comparable with the design result.

**Index Terms** — Microstrip BPF, microstrip lines, open split ring resonator, square groundplane window.

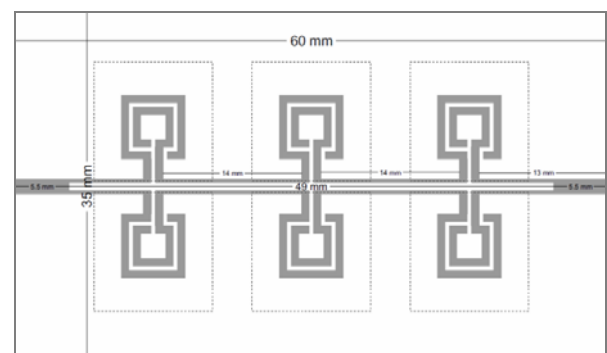
## I. INTRODUCTION

In the past decade, the growth of technology for mobile and wireless communication systems to satisfy the demand for high speed communication which supports to transmit huge amounts of information has increased rapidly. Numerous efforts to fulfill the demand have also been attempted by improving the existing technology of devices including antennas, RF amplifiers, and filters [1]-[2]. From so many devices, filters are one of the most important and essential parts for application in communication systems. As is already well-known, most of equipments for communication systems could not well-perform without adequate quality in filtering system.

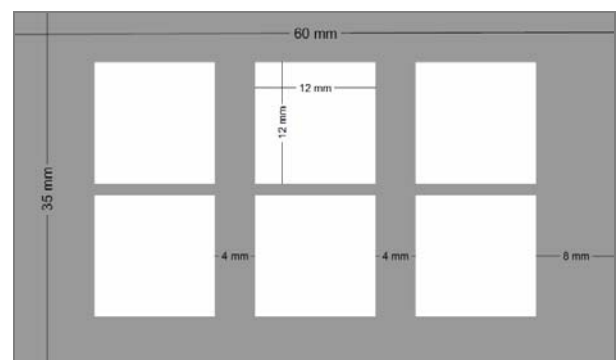
Recently, the filter development based on microstrip technology has been widely applied for the front-end device of communication systems due to its advantages such as planarity in structure, insensitivity to fabrication tolerances, and reproducibility [3]-[4]. However, since the characteristic of microstrip-based devices usually produces narrow bandwidth response, some attempts have to be conducted to enhance the performance of device. In addition, the dimension of microstrip-based devices which almost requires  $\lambda/2$  resonator has to be considered for the system with limited space. Some solution to solve the disadvantages especially for improving the bandwidth response of filter has been proposed is by introducing additional planar structure such as split ring resonator [5].

In this paper, the implementation of OSRR incorporated with squared groundplane window is proposed for developing microstrip BPF. Two pairs of 3 cascaded OSRR are employed as additional structures to be connected with the microstrip lines. The proposed BPF is developed on an FR4 Epoxy dielectric substrate with the thickness of 0.8mm. To evaluate the performance of BPF, the basic parameters such as return loss ( $S_{11}$ ), insertion loss ( $S_{12}$ ), and bandwidth response are used as key performance indicators.

## II. DESIGN OVERVIEW OF MICROSTRIP BPF



(a) top view



(b) bottom view

Fig. 1. Overall design of microstrip BPF using OSRR and square groundplane window

The overall design of microstrip BPF using OSRR and square groundplane windows is illustrated in Fig. 1. There are 2 pairs of 3 cascaded OSRRs with the detail geometry of

each OSRR is shown in Fig. 2. It shows that microstrip lines with the width of 1.5mm are used to connect each pair of cascaded OSRRs. To gain the geometry of microstrip BPF above, some parametrical studies are conducted to optimize the performance of proposed BPF.

Since the input and output signals for BPF are obtained from SMA connectors, therefore the width of microstrip line can be calculated to have the line impedance of  $50\Omega$ . The dimension of BPF is 35mm in width and 60mm in length. The shape of OSRR loop is square loop which is made of a 0.035mm thick metal copper deployed on top side of 0.8mm thick FR4 Epoxy dielectric substrate. Whilst the bottom side of dielectric substrate, it is for the groundplane of BPF. To achieve high accuracy result, the losses of conductive copper and dielectric substrate are taken into account.

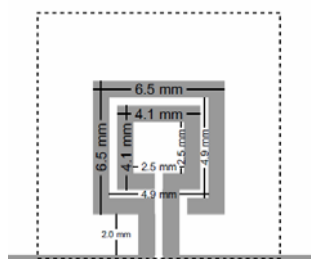


Fig. 2. Geometry of each OSRR used for BPF construction

### III. FABRICATION AND EXPERIMENTAL CHARACTERIZATION

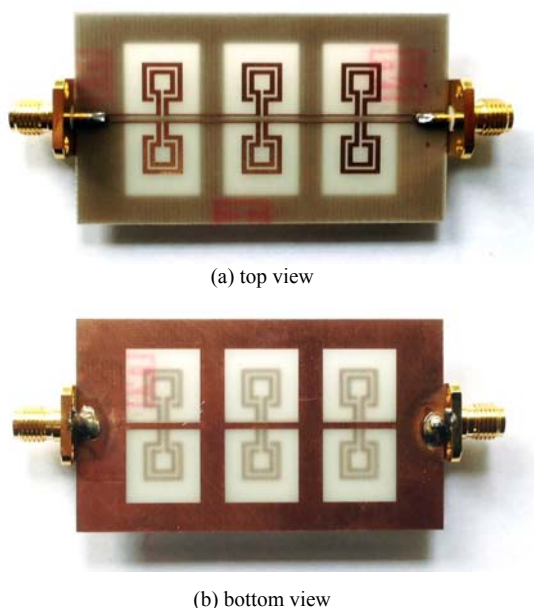


Fig. 3. Fabricated microstrip BPF prototype using OSRR and square groundplane window

Fig. 3 shows a fabricated microstrip BPF prototype using OSRR and square groundplane window. Two SMA connectors are soldered at input and output ports of realized BPF for experimental measurement. The experimental characterization result for fabricated microstrip BPF is plotted in Fig. 4 in which the design results are plotted together for comparison. In general, it shows that the experimental characterization results have agreed very well

with the design ones. The bandwidth response of fabricated microstrip BPF is 1.12GHz ranges from 1.50GHz to 2.62GHz which has coincided with the design result. The slight discrepancy of both results is probably evoked by the different value of tangent loss of dielectric substrate used in fabrication and design. It is noticeable that the tangent loss of dielectric substrate used in the fabrication seems to be higher than of the design.

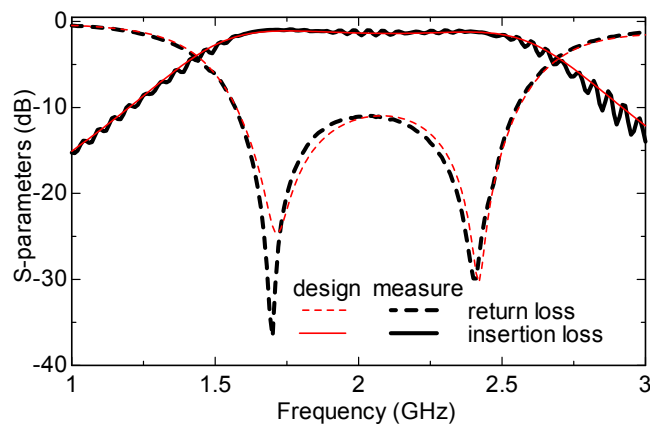


Fig. 4. Experimental characterization results for fabricated prototype microstrip BPF with the design results as comparison

### IV. CONCLUSION

The development of microstrip BPF using OSRR incorporated with square groundplane window has been demonstrated and its prototype has been fabricated for experimental characterization. The proposed microstrip BPF which has been designed on a 0.8mm thick FR4 dielectric substrate has the dimension of 35mm x 60mm. It has been shown that the fabricated microstrip BPF prototype has the bandwidth response of 1.12GHz ranges from 1.50GHz to 2.62GHz which was agreed very well with the design result.

### ACKNOWLEDGMENT

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