Rectangular Slot Resonator for Frequency Reconfigurable Active Antenna

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Abstract

This research paper presents a three port dual frequency antenna for active antenna application. There is one input port branching into two are output ports each designed for a different frequency. The output ports contain band-pass filters using coupled lines. This antenna has rectangular resonating slots in the ground plane, below coupled lines and resonating at the two operating frequencies. The proposed antenna is to be used for frequency reconfigurable active antennas. The simulated and measured results are in good agreement.

1. Introduction

Active Integrated Antenna (AIA) having a passive structure i.e. microstrip antenna and active device (diode such as Gunn, IMPATT, BARITT, etc., or a transistor such as MESFET, high electron-mobility transistor (HEMT), hetero-junction bipolar transistor (HBT), etc integrated together in a circuit. The antenna thus performs functions other than just transmission and reception of waves [1]. AIA These AIA-based designs are particularly attractive for millimeter-wave systems because they provide an effective solution to several fundamental problems at these frequencies, including higher transmission-line loss, limited source power, reduced antenna efficiency, and lack of high-performance phase shifters [2-3].

A frequency reconfigurable oscillator type active antenna requires a two port antenna in the feedback network of amplifier to behave as an oscillator. This two port antenna works as load as well as a resonator for the amplifier. For this kind of application two port antennas should be capable of both: to radiate in free space and transmit to second port equal amount of power. The discussion on one port, two port and three port antenna is published [4-5].

In this paper, we describe three port dual frequency antennas by using rectangular slot resonator. The ground plane consist of rectangular slot can be considered a complementary structure to a microstrip line. Antennas of this type of structure can radiate on both sides of the slot and can form an omni-directional pattern, which may be useful for wireless communication systems. The rectangular slot antenna is a variation of microstrip antenna with better gain, wider bandwidth and is less sensitive to manufacturing tolerances.

In this paper, we have designed the dual frequency antenna and simulation was carried out using CST microwave studio software. This antenna was fabricated using MIC techniques and measurement was carried out using Vector Network Analyser and the radiation pattern was measured in H plane and E plane using UWB Pyramidal horn antenna radiation pattern in anechoic chamber. The proposed theoretical results show the good agreement with measured results.

The proposed antenna has one input port (able to resonate at 2.4GHz and 5.2 GHz) and two output ports resonate at 2.4 and 5.2 GHz. The idea behind this antenna is to use this antenna with active device in different feedback paths. This scheme is shown in Fig. 1.

2. Design Three Port RSR

Two band pass filters at centre frequency 2.4GHz and 5.2 GHz design as a frequency selective network. This network having one input port (port 3)designed for centre frequencies 2.4 GHz and 5.2GHz and two output ports (port no. 2 and 1)each designed for 2.4 GHz and 5.2 GHz respectively. The input port bifurcate in two like a T junction and these two turn into the band pass filter of centre frequency 2.4 GHz and 5.2 GHz. Hence fed signal split into two at different frequency and appear at two output ports. A part of fed power radiate into the free space and remaining appear at the output port. But as rectangular slot introduce in the ground plane the response of antenna change. The insertion loss increase and shift in frequencies. The length and width of low frequency and high frequency slots are 21.9mm x0.98mm and 9.6mmx 1.24mm.The spacing between quarter wavelengths long coupled line (s) is 0.1 mm and 0.4mm for low frequency and higher frequency respectively, width of each coupled line (w) is 0.44mm.

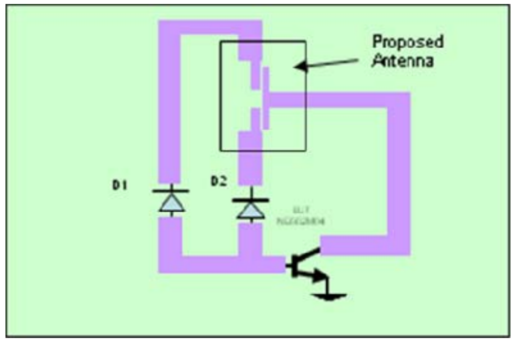

Figure 1: Active antenna Scheme

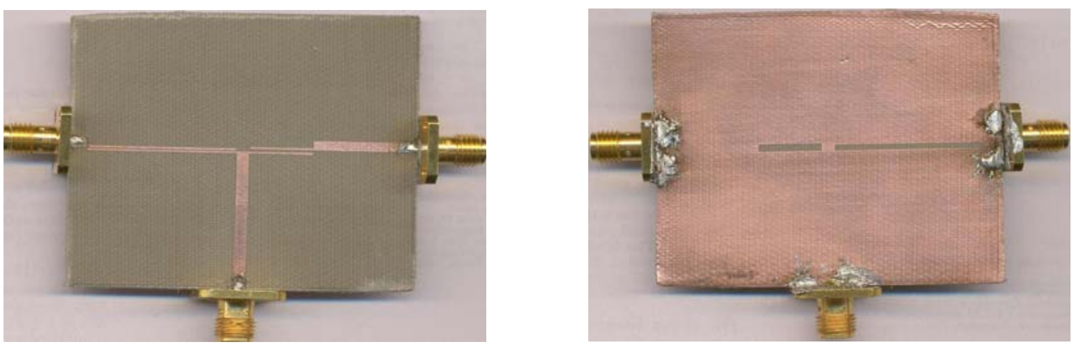

Figure 2(a): Photograph of front and back side of proposed antenna

3. Parametric Analysis

As increase the lower frequency coupling gap ‘P2’ along with slot width in step of 0.1mm the return loss improves, and no significant changes in the insertion loss but isolation between two output ports (1 and 2) decreases. Hence optimum coupling gap is chosen as 0.1mm, shown in Fig. 3 (a). As increase high frequency coupling gap ‘P1’ along with slot width in step of 0.1mm and keep P2 =0.1mm results improvement in return loss at high frequency port as shown in Fig. 3 (b).

4. Results and Discussion

4.1 Network Parameter Measurement

Proposed antenna was characterized using VNA. The measured return losses at input port were found 8.3 dB at 2.4 GHz and 13.2 dB at 5.2GHz while simulated return losses were 10.7 dB at 2.4 GHz and 12.24 dB at 5.2 GHz as shown in Fig. 4. The higher frequency port (1) have 11.5 dB and11.85 dB measured and simulated return loss respectively. The lower frequency port (2) has 16 and 11.4 dB measured and simulated return loss. The insertion loss measured at resonance frequencies was 0.6 dB and 1.1 dB corresponding to lower frequency and higher frequency ports. The isolation measured at two frequencies was 19.2 and 44 dB as shown in Fig. 4.

4.2 Radiation Pattern Measurement

A far field antenna test range was used to characterize the proposed antenna. In the test range, proposed antenna was used as a receiver that rotated through two orthogonal planes for 2.4 and 5.2 GHz frequencies while UWB standard gain horn was used as the fixed, transmitting antenna; the two antennas were separated by 1.9 m. The co- polarizations of the antenna for 2.4 and 5.2 GHz are shown in Fig. 5(a) and Fig. 5(b) respectively. The Half-power beamwidth is shown in Table 1. As the proposed fabricated antenna has sufficient insertion loss to maintain the close loop gain and good return loss to radiate sufficient amount of power that fulfils the requirements for active antenna application.

5. Conclusion

A design of three port dual frequency rectangular slot antenna was studied. The antenna was to be designed to operate at WLAN bands centred at 2.4 and 5.2 GHz, now current status of the work was presented with all results showing fairly good agreement between simulated and measured results. This proposed antenna is well suited in oscillator type active antenna applications and domestic networks because of low profile and mass production possibility.

References

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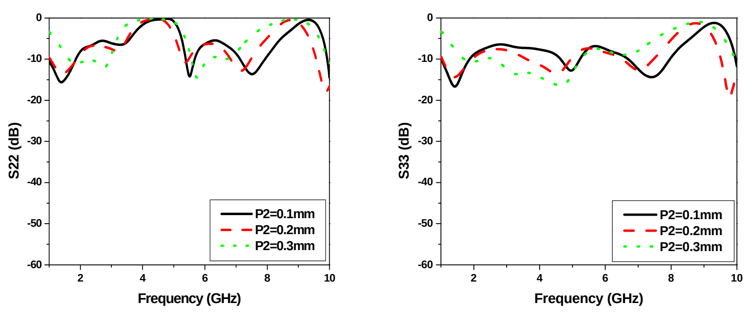

Figure 3(a): Low frequency slot width variation on simulation

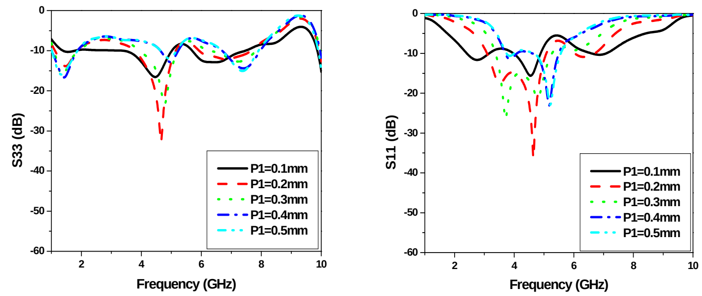

Figure 3(b): High frequency slot width variation on simulation

Table 1: Half Power Beamwidth of Proposed Antenna

Frequency (GHz)	**Beamwidth in H Plane**	**Beamwidth in E Plane**
2.4	90°	80°
5.2	70°	70°

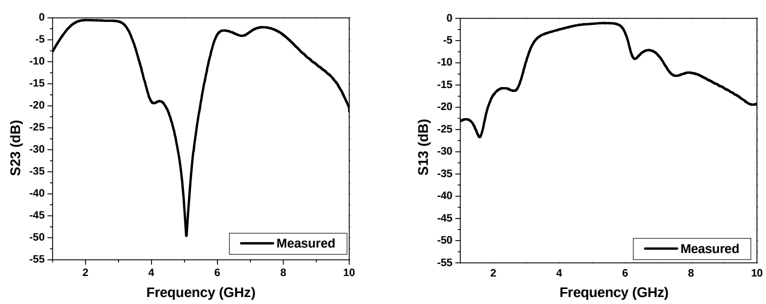

Figure4: Measured results (Port 3 input, port 2 for 2.4GHz output, port 1 for 5.2 GHz output)

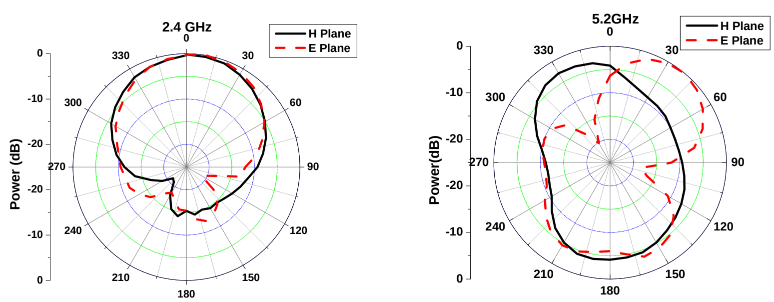

Figure 5(a) & (b): E plane and H plane radiation pattern at 2.4 GHz and 5.2 GHz resp.