Design and Development of Open Stub Truncated Rectangular Microstrip Antenna for Wideband Applications

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Abstract: This paper presents the design and development of open stub truncated rectangular microstrip antenna for wideband operation. The effect of open stub is studied for wideband applications. The proposed antenna has been realized from conventional rectangular microstrip antenna (CRMSA) by using only microstripline feed with reduced substrate area from 8X8 cm^2 to 6X6 cm^2 with actual size reduction of 44.15% and by using 73.37% smaller ground plane. The 3.67% bandwidth of CRMSA has been enhanced to 49.42%. It is also observed that the operating band variation is depends on the length of the open stub and resonance frequency shifts towards lower side of the frequency spectrum. The proposed antenna is more compact and may find application in wireless CCTV, WLAN, WiMAX, Bluetooth, 802.16.a and S-band operation.

Keywords— Open Stub, Truncated, Wideband.

Introduction

The low cost, low profile and easily fabricated antennas are the most important and are in more demand for wireless broadband communication application systems. The microstrip antenna (MSA) is the best choice and well suited for various broadband communication applications due to its advantages such as low fabrication costs, compatible with any microwave circuits technology, light weight and low profile [1,2]. The compact and broadband antennas are in more demand for present wireless broadband communication system technology. Many techniques and several designs have been reported in the literature [3-5]. Recently the single line feed, defective ground plane, truncated patch, open stubs microstrip antennas have focused more attention because of promising compactness, effects in operating bands and broad bandwidth [6,7].In this a paper truncated rectangular microstrip antenna with a pair of narrow open stubs at the center of the patch along the length and L-shape open stub along the width at the left side of the microstripline feed is presented for broadband applications. The effects of variations in length of the L-shape open stub on the operating band and shift in resonance frequency is also presented. The proposed antenna is very simple in its geometry and more compact. The detailed geometry of antenna and results and conclusion is presented in this paper.

ANTENNA GEOMETRY AND DESIGN

The geometry of CRMSA is as shown in Fig. 1.The CRMSA consists of rectangular patch of length 'L' and width 'W' fed by using microstripline feed of length 'L_f' and width 'W_f'. The quarter wave transformer of length 'L_t' and width 'W_t' is used between the patch and 50Ω microstripline feed for matching their impedances. The bottom surface is full copper which is a ground plane. The proposed antennas have been designed for 3 GHz on easily available modified glass epoxy substrate material of thickness 0.16 cm with dielectric constant of 4.2.

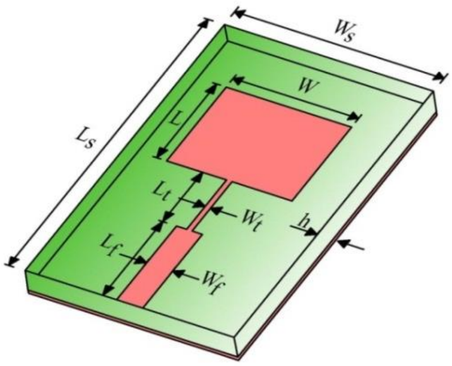

Fig. 1 Geometry of CRMSA

Fig. 2 shows the geometry of proposed antenna realized from CRMSA. This antenna uses the single microstripline feed with reduced substrate area from 8X8 cm^2 to 6X6 cm^2 used for the construction of CRMSA. This antenna is named as open stub truncated rectangular microstrip antenna (OTRMSA).A pair of narrow open stubs is used at the center of the patch along the length and L-shape open stub along the width at the left side of the microstripline feed and a partial ground plane is used as shown in Fig. 2.

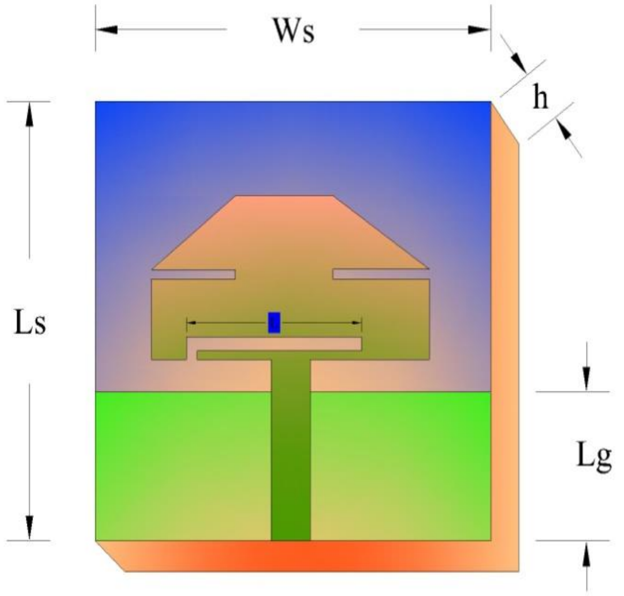

Fig. 2 Geometry of OTRMSA

RESULTS AND DISCUSSION

The simulation is carried out by using Ansoft high frequency structure simulation (HFSS) software. Figure 3 shows the variation of return loss versus frequency of CRMSA. From Fig. 3 it is clear that, the CRMSA resonates at 2.66 GHz which is very close to the designed frequency of 3 GHz. The antenna resonates between 2.60 to 2.71 GHz and bandwidth is found to be 3.67%. The peak gain of this antenna in its operating band is found to be 3.66 dB.

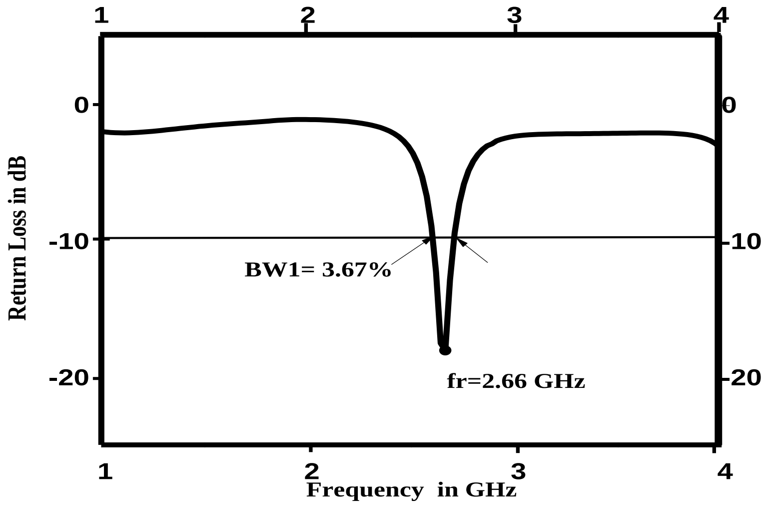

Fig. 3. Return loss versus frequency of CRMSA

The variation of return loss curve of OTRMSA with fixed narrow open stubs and variable length L-shape open stub for L = 1.5, 1.6 and 1.7 cm is shown in Fig. 4. It is seen that, the antenna operates for dual band of frequencies. The magnitude of first band increases and second band decreases when the length of the open stub increases from 1.5 to 1.7cm. It is also observed that the resonance frequencies are shifted towards the lower side of frequency spectrum.

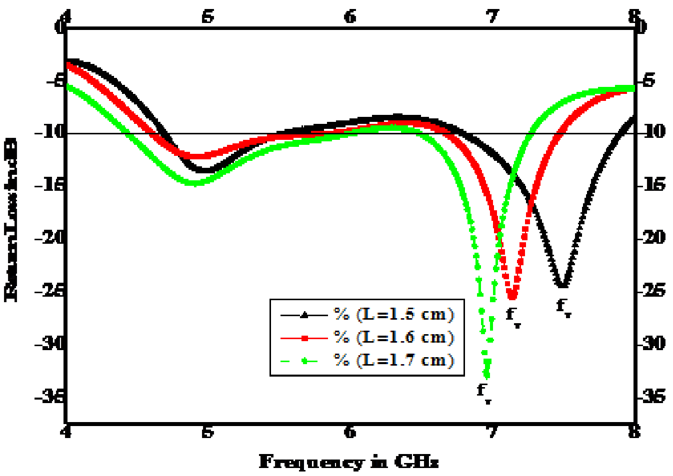

Fig. 4 Variation of return loss versus frequency of OTRMSA when L = 1.5, 1.6, 1.7 cm

The dual band operation of Fig. 4 is converted into single band as shown in Fig. 5 when L= 1.7, 1.8 and 2.0 cm and gives highest impedance bandwidth of 49.42% when L=1.8 cm. This frequency range covers the many wireless communication applications including S-band operation.

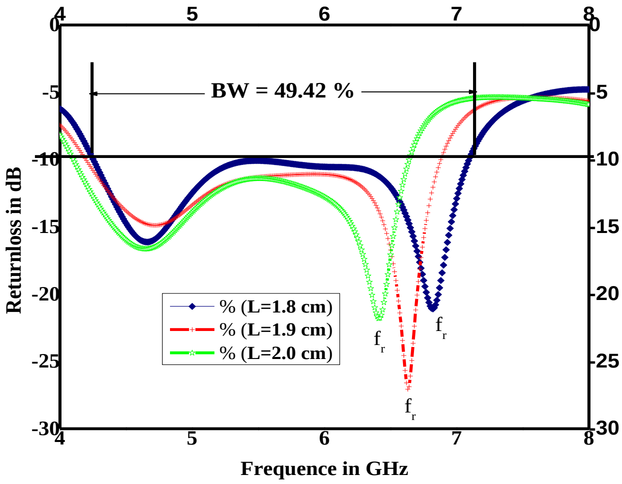

Fig. 5 Variation of return loss versus frequency of OTRMSA when L = 1.8, 1.9 and 2.0 cm

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Figure 6 (a) and (b) shows the surface current distribution of OTRMSA for L=1.8 cm measured at resonance frequencies 4.67 and 6.82 GHz. It is seen in Fig. 6(a) that the current is mainly accumulated across the fixed narrow open stubs for resonance frequency 4.67 GHz. At 6.82 GHz this current is shifted across the L-shape open stub as shown in Fig. 6(b), which indicates the effectiveness of open stub for enhancing the bandwidth.

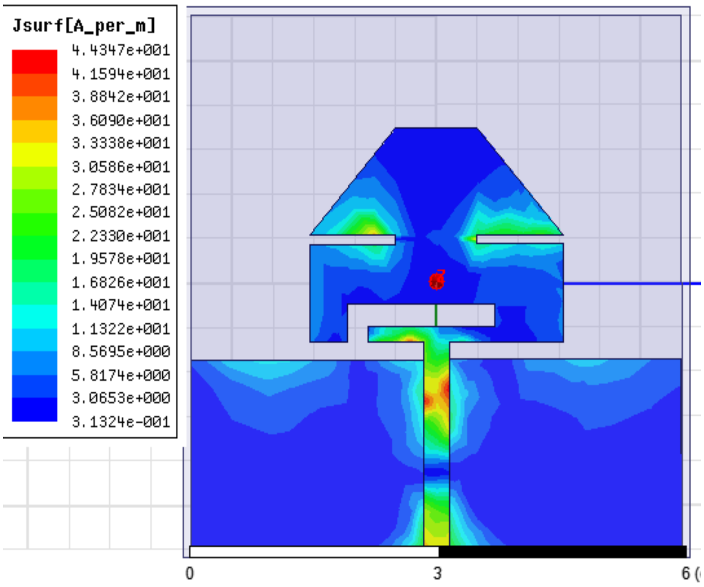


Fig. 6(a) Surface current density distribution of OTRMSA at 4.67GHz, for L=1.8 cm

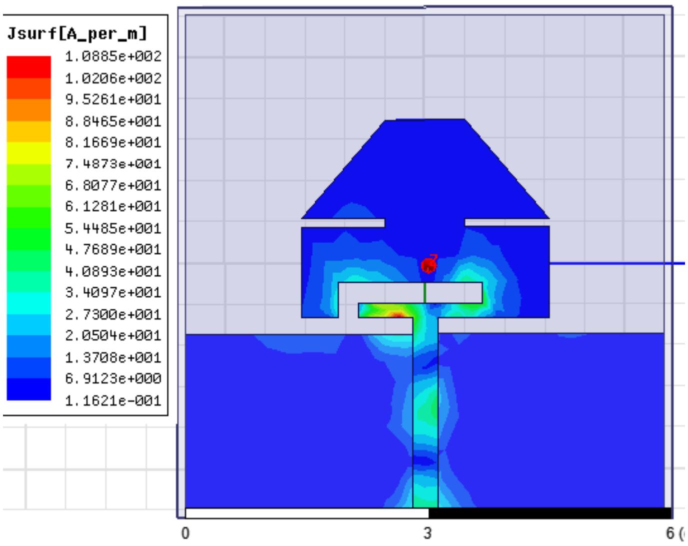
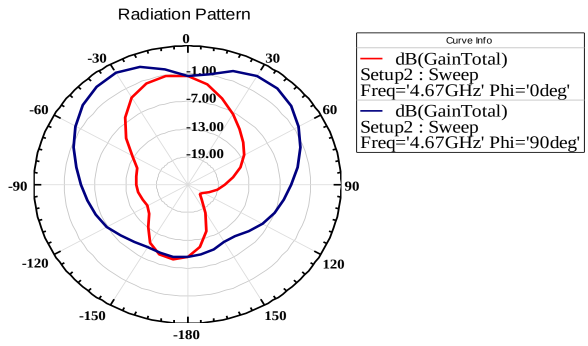
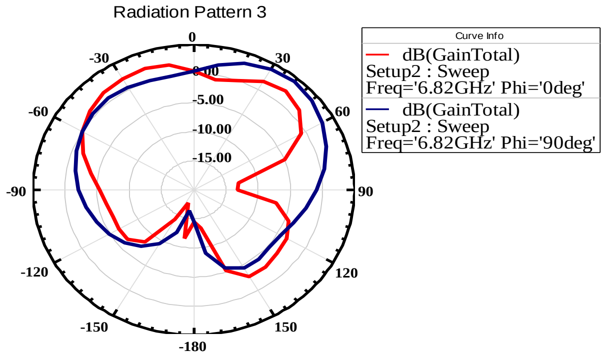


Fig. 6(b) Surface current density distribution of OTRMSA at 6.82 GHz for L=1.8 cm

Figure 7(a) and (b) shows the radiation pattern of TRMSA for L=1.8 cm measured at 4.67 and 6.82 GHz. Result shows that good broadside radiation patterns are obtained.



(a) at 4.67 GHz



(b) at 6.82 GHz

Fig.7. Typical radiation pattern for E and H-plane of OTRMSA measured at 4.67 and 6.82 GHz

IV.CONCLUSION

From the detailed parametric study it is found that, the dual band operation of open stub truncated rectangular microstrip antenna can be converted into single band by varying the length of the open stub. The 3.67% of bandwidth of CRMSA has been enhanced to 49.42% with an actual size reduction of 44.15%. It is also observed that, the operating band variation depends on length of the open stubs and resonance frequency shifts towards the lower side of the frequency spectrum. The proposed antenna is simple in its structure and cost effective because of using low cost glass epoxy substrate material. The frequencies of operating bands of the proposed antenna covers the frequency ranges used for WiMAX, WLAN, Bluetooth, IEEE 802.11a applications and S-band operation.

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