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BROADBAND GAP-COUPLED ASSEMBLY OF PATCHES FORMING REACTANGULAR MONOPOLE MICROSTRIP ANTENNA

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ABSTRACT

A novel compact planar printed gap coupled rectangular monopole microstrip antenna (CPGCRMSA) for ultra wideband (UWB) broadband operation is presented in the paper. The antenna is designed using FR4 substrate with dielectric constant 4.2, loss tangent 0.05 and a height of 1.6 mm. The designed antenna is simple in its geometry and can be constructed by splitting the rectangular monopole MSA vertically and horizontally along the width and length of the radiating patch. By proper gap coupling these splitted parasitic patch elements the UWB operation can be achieved. The antenna operates in the frequency band of 1.82GHz to11.83GHz and gives maximum impedance bandwidth of 146.6%and peak gain of 8.50 dB in its operating band. This antenna exhibits nearly omnidirectional radiation characteristics over the entire frequency band. The simulated and measured results are presented. The measured results are in well agreement with the simulated results. The proposed antenna may find application in Bluetooth, WiMax, WLAN, X -band Satellite Communication.

KEYWORDS: Gap Coupled Rectangular Microstrip Antenna, UWB, Impedance Bandwidth, Monopole, Gain, WLAN

Microstrip antennas are finding applications in those communication systems where small size, light weight, low profile and low cost antennas are required. These antennas can be easily fabricated and assembled with other circuit components. However, basic geometries of these antennas are mainly suffered by narrow bandwidth, which is of the order of few percent of the operational frequency (Garg R. P, 2001). Due to this reason, microstrip antennas in their simplest form fail to find vast commercial applications. In modern communication systems, higher antenna bandwidth is a major requirement and enhancement of bandwidth of antennas has been one of the major subjects concerning antenna designers. To meet these demands, several alternatives have been suggested in recent past for printed antennas with improved bandwidth (Behdad N., 2004 and Kumar G., 2003). The various techniques have been proposed by the researchers to improve different parameters of these antennas. These techniques are found to be use of thick substrate, stacking of patches, use of materials with low relative permittivity, monopole techniques, proximity and aperture coupling techniques, use of matching networks, multi resonators, multilayer substrates, slot loading techniques and so on (Constantie A. Balanis, 1997, Kumar G., 1994, Anandan C.K., 1990 and Kumar G., 1984]. Use of parasitic element in coplanar configurations not only increases bandwidth but also increases overall size of antenna and hence limits its applications (Kumar G., 1985). This limitation can be resolved by embedding suitable splitting slots in the radiating patch (Anandan C.K,1986.).Another technique used by many researchers to improve the bandwidth of microstripantenna is monopole technique. Monopole antennas are finding increasing application because of their significant merits like wide band, low interference to other systems, low cost, low profile, light weight, omnidirectional radiation pattern, and ease of fabrication (AgrawallN. P, 1998 and Ray K.P., J2006).

In this paper a compact simple gap coupled rectangular monopole microstrip antenna fed by microstripline is presented for broadband operation. The antenna is constructed by splitting the rectangular monopole MSA vertically and horizontally along the width and length of the radiating patch. By proper gap coupling these splitted parasitic patch elements the broadband operation can be achieved. The antenna operates in the frequency band of 1.82GHz to 11.83 GHz and gives maximum impedance bandwidth of 146.6% and peak gain of 8.50 dB in its operating band. The performance of antenna is analyzed using Ansoft HFSS Software.and Vector Network Analyzer. The measured results are in well agreement with the simulated results.

ANTENNAGEOMETRY AND DESIGNING

Figure,1 shows the optimized design of the proposed broadband gap coupled monopole rectangular microstrip antenna (CPGCRMSA).The antenna consist of a rectangular patch of dimensions Wp x Lp mm. It is printed on a low cost glass epoxy substrate material of area Ws x W_L mm with thickness of 1.6 mm and a relative permittivity (εr) of 4.2 and loss tangent (δ)=.05. The antenna is excited by using a single 50Ω microstripline feed of length L_f = 27.7 mm and width W_f= 3.2 mm. A partial

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copper ground plane of height Lg = 26mm is placed below the microstripline feed on the bottom layer of the substrate. The gap between the radiating patch and the partial ground plane is equal to 1.7mm. Further the antenna is splitted along the width of radiating patch at a distance 4.5mm' from left nonradiating edge with a gap of g_1=1.5mm, and at a distance 5mm' from right nonradiating edge of patch with a gap of g_2=1mm, similarly radiating patch is splitted along the length at a distance of 14.4mm from left top radiating edge with a gap of g_3=1.2mm and at a distance of 12.6mmfrom the right bottom radiating edge with a gap of g_4=1.2mm respectively. A small rectangular notch is incorporated at the feeding point on the bottom side which allows proper impedance matching and hence enhances impedance bandwidth. By suitably gap coupling these all splitted parasitic element a UWB operation can be achieved. The width and length of rectangular notch is $N_w$and $N_l$respectively. The optimized design parameters of the proposed antennas are as follows:

Ws=50mm,W_L=60mm,W_f=3.2mm,L_f=27.7mm,

Lg=26mm,W_p=26.6mm,Lp=20.4mm,g_1=1.5mm,

g_2=1mm, g_3=1.2mm, g_4=1.2mm, N_W=3.6mm, N_l=4mm.

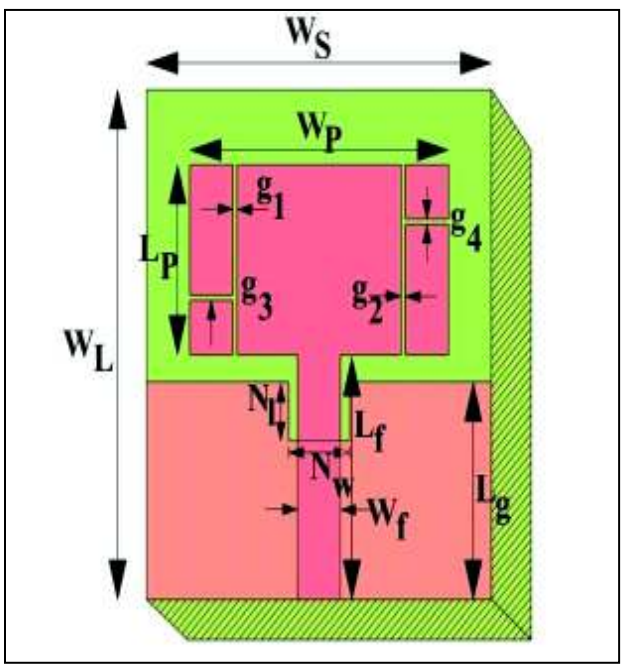
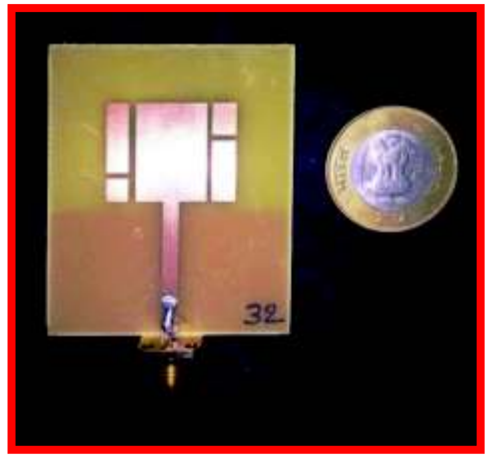
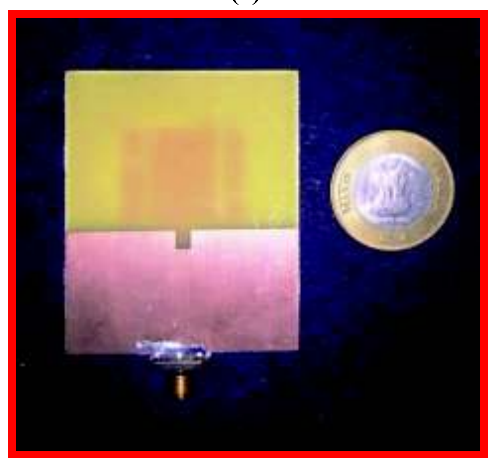


Figure 1: Top view geometry of gap coupled CPGCRMSA



(a)



(b)

Figure 2: (a) Top view and (b) bottom view of CPGCRMSA

RESULTS AND DISCUSSION

The proposed antenna is designed and simulated using Ansoft HFSS software and return loss, radiation pattern, VSWR and surface current distribution are studied. The variation of return loss versus frequency of this antenna is as shown in Fig-3. From this figure, it is clear that, the antenna operates for wide band of frequencies and gives a maximum impedance bandwidth of 146.6 % (1.82GHz-11.83GHz) with a peak gain of 8.75dB.The operating range of this antenna covers Bluetooth, WiMax, WLAN, GPS, C-band, X-band Satellite communication. Figure-4 shows the VSWR plot of CPGCRMSA. The simulated VSWR $\leq$ 2which gives impedance bandwidth of 146.6% covers the frequency range from 1.82 GHz-11.83GHz.

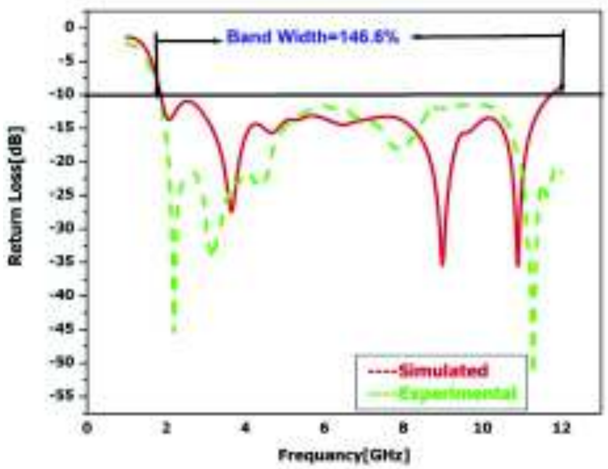


Figure 3: Return loss verses frequency plot of CPGCRMSA

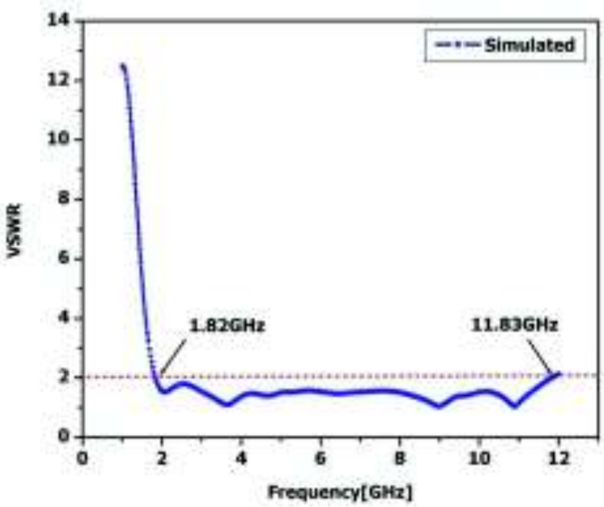
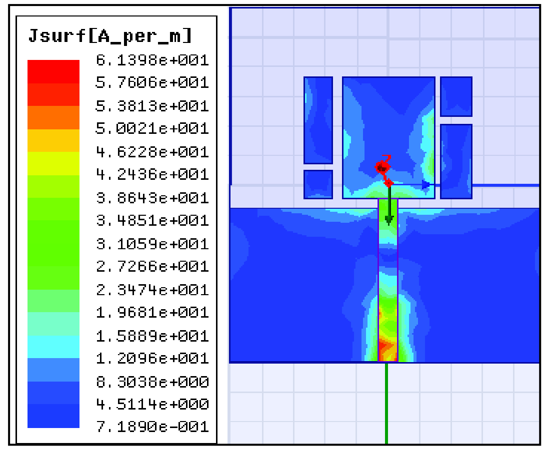


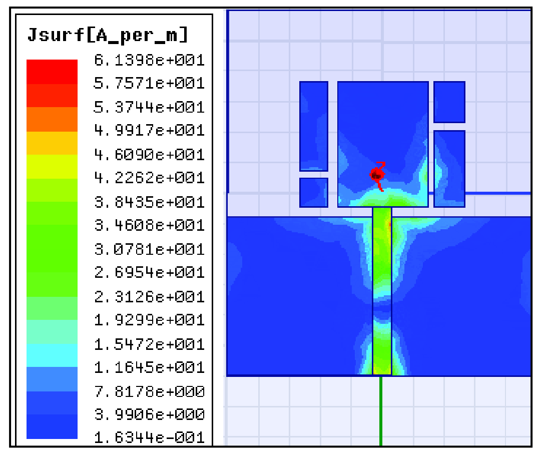
Figure 4: VSWR verses frequency plot of CPGCRMSA

Figure-5 shows surface current distributions of gap coupled RMSA measured at 2.18GHz,3.2GHz and 11.23GHz .From the figures it is clear that, the current distribution is mainly observed along the microstripline feed, slightly at the gaps on patch and uniform current distribution is also observed at the ground plane surface of the antenna causing wideband operation.

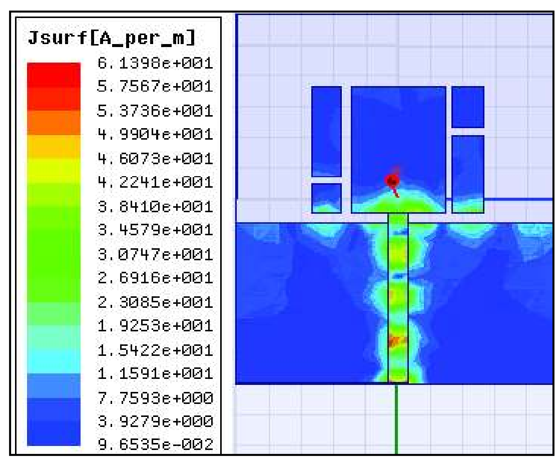
A typical 2D and 3D E-plane and H-plane radiation patterns of gap coupled RMSA is measured at the resonant frequencies and is shown in Fig-6.From these figure it is clear that the antenna radiates nearly omnidirectional radiation pattern in H-plane and E-plane.



(a)

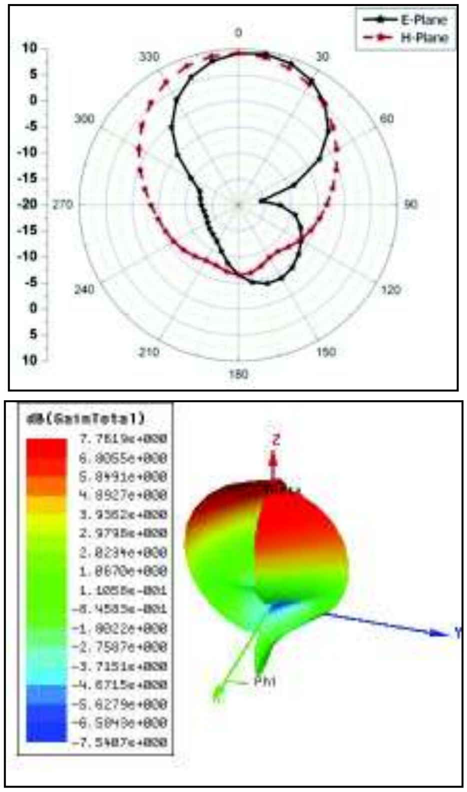


(b)

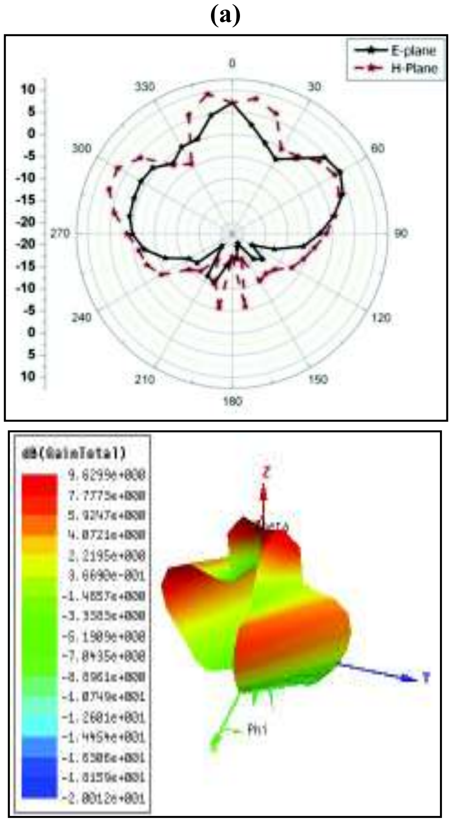


(c)

Figure 5: Current distribution of CPGCRMSA measured at (a) 2.18, (b) 3.2 and(c) 11.23 GHz



(a)



(b)

Figure 6: 2D-3D E-plane and H-plane radiation pattern of *CPGCRMSA* measured at(a) 2.18 (b) 11.23 GHz

CONCLUSION

The assembly design technique of CPGCRMSA is presented in this paper. From the detailed study it is found that, when the antenna is splitted vertically and horizontally along the width and length of the radiating patch, the antenna operates for wide band of frequencies covering UWB range of 1.829GHz to 11.83GHz with impedance bandwidth of 146.6% and gives a peak gain 8.75dB.Dimensions of the applied slots are optimized further for bandwidth enhancement without spoiling other radiation characteristics. The proposed antenna is simple in its structure and compact in nature and can be fabricated using low cost modified glass epoxy substrate material**.** The antenna exhibits good radiation characteristics, high gain and compact in its size by 8.0 % when compared to the size of conventional rectangular microstrip antenna designed for same frequency. This antenna may find application in Bluetooth, WiMax, WLAN,X-band C-band Satellite Communication. The experimental and simulated results of proposed antenna are in good agreement with each other The prototype of antenna is fabricated and measured on Vector Network Analyzer (VNA) to verify the above proposed concept and have very good agreement with simulated ones.

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