

High Gain Microstrip Antenna Capacitive Coupled To a Square Ring with Surface Mounted Conical Horn

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Abstract

In this paper, a novel rectangular patch antenna is proposed to have Zeroth Order Resonance (ZOR) generated based on the Right- and Left-Handed (CRLH) structure. Making the in-phase electric field over the entire antenna other than a half-wavelength as the fundamental resonance mode of a standard microstrip patch or its positive multiple, the metallic patch is suggested to be capacitive coupled with only one surrounding rectangular ring. The performance of the proposed antenna is simulated by a 3D field solver that inputs the sizes of the physical structure corresponding to the equivalent circuit designed to have ZOR at 12.686GHz. The gain of the microstrip patch antenna is increased by inserting a surface mounted horn antenna by 3.5dBi without affecting its bandwidth. This antenna structure has gain 11dB, its 10 dB return bandwidth of nearly 6% (745MHz.) and efficiency 96 % has been achieved from this configuration. Total height of the fabricated structure is only 2.923mm. The cross-polarization level of the antenna is -8dBi in both E-and H- Planes. The antenna presented is suitable for use in planar and conformal arrays. It could find applications in KU frequency bands.

Keywords

MACCTSRWSMCH, ZOR, RLHS

I. Introduction

In the recent years microstrip antenna and arrays are the most developing area in the antenna field, exploiting their advantage such as inexpensive, easily manufactured, low weight, low volume, conformal configuration, and compatibility with integrated circuits and so on [1]. However the microstrip antenna inherently has low gain and narrow bandwidth. The impedance bandwidth of the patch antenna is proportional to the antenna volume.

There have been many successful attempts to increase the gain of the Microstrip patch antenna. These methods include the use of single superstrate and multi superstrate [2, 3], cavity-backed microstrip antenna with superstrate [4]. However these methods may adversely affect the antenna performance characteristics, if superstrate parameters are not adequately chosen, and the structure becomes very bulky. Islam et al. [5] have experimentally examined wideband probe fed inverted multiple slot microstrip patch antenna to obtain 12.53dBi gain. This structure is very large in size. Recently nandgaonkar et al. [6] proposed a square ring single fed microstrip patch antenna having gain of 9.4 dB. Quasi-planar surface mounted short horn both circularly polarized [7] and linearly polarized [8] microstrip antenna have also been proposed to enhance the gain of microstrip patch antenna about 4.5dB. The slant length of the horn is only $\lambda_0/4$ and it is made of silver clad plastic sheet.

In this paper we report a novel square microstrip antenna

element Capacitive Coupled To a Square Ring with Surface Mounted Conical Horn. The designs adopt contemporary techniques; probe feeding, square patch, surrounded ring and surface mounted conical; horn. The composite effect of integrating these techniques and introducing conical horn, offer a low profile, high gain and compact antenna element. The slant length of the horn is only $\lambda_0/8$ to achieve high gain ie 11.16dBi. the structure has been simulated on a 3-D EM simulator, CST-Studio-08 to achieve high gain and hence directivity.

II. Experimental Investigation

Our reported structure is shown in the Fig.1. At the first, we attempt to design a coaxial feed square patch antenna and optimized it for desired performance. After that, we have tried to optimize the size of the conical horn and its placement with respect to the microstrip patch antenna in order to achieve maximum possible gain. A coaxial feed microstrip patch antenna, with dimensions 7mmx7mm is designed on the substrate of size, 30mmx30mmx1mm. A conical horn of slant length 3 mm is selected for this purpose. We know that the practical waveguide have larger dimension greater than a half wavelength, to allow wave propagation, but smaller than a wavelength, to suppress higher order modes which can interfere with low loss transmission. For more gain a larger aperture is desirable, but a larger waveguide is not. However, if the waveguide size is slowly expended, or tapered in to a larger aperture, than more gain is achieved while preventing undesired modes from reaching the waveguide.

In this structure we used patch antenna as a radiator and also a feed to the conical horn improves the electric fields distribution over the aperture along the H-plane thus becomes relatively uniform which improves the directivity.

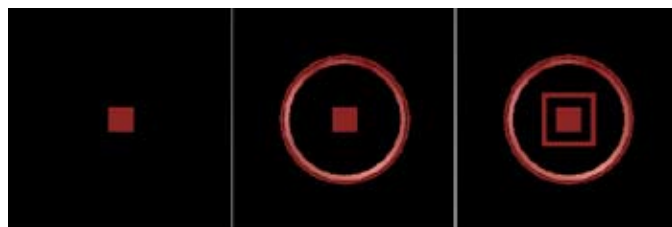


Fig. 1

III. Experimental Results

The configuration of the reported antenna with conical horn is shown in the Fig. 1. Antenna used RT duriod 5880 substrate with permittivity 2.2 with thickness of 1 mm and total height of the antenna is 3 mm. the antenna is feed by 50 ohm coaxial cable.

The surface mounted horn antenna improves the gain of the patch antenna from 7.7 dBi to 11.2dBi. Thus surface mounted horn enhances the gain of the antenna by 3.5dBi as shown

in Fig. 2.

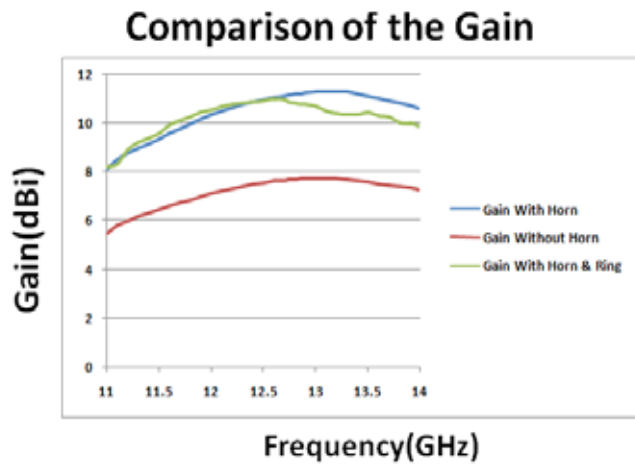


Fig. 2: Gain of the antennas

The resonance frequency of the patch without the embedded horn is 12.77GHz with 5% impedance bandwidth. The embedded horn bring down the resonance frequency to 12.74GHz and also bring down the impedance bandwidth marginally, 4.8%, it also reduces the return loss from 23.5dB to 19.2 dB. The result of the return loss with and without horn is shown in Fig. 3. Finally, we Insert a square ring around patch of width 2.43(equivalent of 50 ohm Microstrip ring) which create capacitive effect with patch which enhance the return loss as well as impedance bandwidth. Fig. 4 shows the radiation pattern of all three antennas in both the E-and H-planes. There is considerable improvement in the side lobe level of the antenna. The performance of the antenna is summaries in table I

Table I: Performance of the antenna

Parameter	Without Horn	With Horn	Surrounded with ring & mounted Horn
S11	23.2dB	19dB	42.57dB
Bandwidth	5%	4.8%	6%
Resonance freq.	12.77GHz	12.74GHz	12.68GHz
Gain	7.7dBi	11.2dBi	11dBi

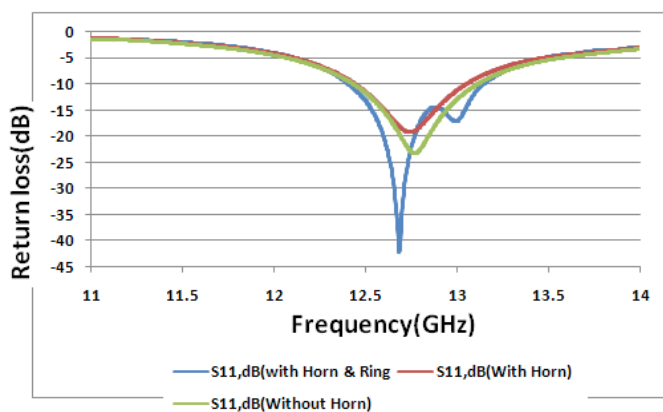


Fig. 3: Return loss of the antennas

E- and H-Plane Field

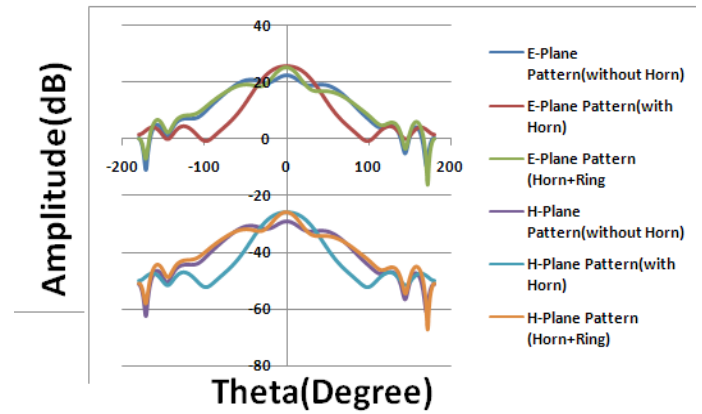


Fig. 4: E- & H-Plane field of the antennas

IV. Conclusion

In this paper we have reported Microstrip Antenna Capacitively Coupled To a Square Ring with Surface Mounted Conical Horn for the linearly polarized microstrip antenna with 3.5 dBi improved gain, i.e., 11 dBi gain with enhanced VSWR bandwidth of the patch antenna. The horn is made of the copper material of light weight of very small hight to realize as a planner structure.

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