

# Microstrip Patch Array Antenna for X-Band Applications

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**Abstract**—This paper presents a microstrip patch array antenna for x-band applications. The antenna array consists of 12 square patches which are identical to each other and functions at a center frequency of 8.2 GHz and has a bandwidth of 100MHz. The square patches are arranged in such a fashion that there are four arms, each of which have 3 elements and is series fed. The main application of x-band is radar. Hence in order to avoid sea clutter reflectivity Horizontal polarization is used because it can produce less sea clutter reflectivity when compared with vertical polarization. Therefore in order to increase the current flow to aid horizontal polarization, a slit was carved on each patch.

**Keywords**—Microstrip patch, Array antenna, Horizontal Polarization.

## I. INTRODUCTION

One of the important applications of x-band is marine radar. Since the systems using x-band has advantages of compactness and flexibility over that of the systems using s-band and ku-band. X-band is preferred for fishing boats and yachts. The x-band has a range of 8 GHz to 12 GHz.

Marine radar employs a high gain antenna which is equipped with a rotor that scans the entire horizon by transmitting the radio signals in known directions and also to receive the returning signals to detect the objects of interest. The factors such as main beam width, front to back ratio, side lobe level and polarization depends on the antenna used and also affects the performance of the radar. The undesired signals interpret falsely a target in the main beam direction thereby causing an error to be detected. Applying a horizontal polarization is necessary in order to resolve two targets in close proximity. In radar systems microstrip patch array antennas are widely applied because of their high gain, low cost, light weight and low profile in addition to which they can also accurately control radiation patterns. The two most common type of array feeding structures are parallel-fed and series-fed structures. In parallel-fed scheme, many power devices having discontinuities and also long transmission lines are essential. The presence of which aids substantial dielectric loss and spurious radiation to occur. On the other hand, short transmission lines are being used by the series fed structures which enhance the antenna efficiency. The two feeds that are

commonly used in the series-fed structure are the resonant and travelling wave feeds. Resonant feed has a narrower bandwidth compared to that of a travelling wave feed. Due to the change in phase angle between two adjacent elements along the series-fed lines, the operating frequency changes which in turn change the main beam angle causing the occurrence of inaccurate angle detection mainly in frequency-modulated-continuous-wave (FMCW) system. On the contrary, the parallel-fed structure in the middle of an array entrust the direction of the combined beam of each half array to be pointed in the broadside.

In this paper, printed array antenna specifically designed for marine radar applications is put forward. The array consists of 12 identical square patches operating at a center frequency of 8.2GHz and a bandwidth of 100MHz was developed. The arrangements of the patches were along the four arms of a one dimensional array consisting of 3 elements and are fed in the center by a series of microstrip lines showcasing a chebyshev taper distribution. To change the current path, a slit was carved on each patch element which then enables horizontal polarization.

## II. ARRAY CONFIGURATION AND DESIGN METHOD:

Fig1. shows the configuration of the developed array which was implemented on a substrate called High Density Polyethylene (HDPE) and has a dielectric constant of 2.2 and loss tangent of  $\tan \delta = 0.0009$ . The array has a feeding networking and 12 identical microstrip square patches operating at a frequency center of 8.2GHz. As depicted in the Fig 1., there are two T junctions that are connected to each other which forms the feeding network and is fed using a vertical probe. Each series fed patch array is connected to the corresponding arm of the T junction. Since there is a head-to-head arrangement of the antenna array, the array in the top and bottom were given out of phase currents. The suppression cross-polarization level is yielded by the cancellation of the electric field component along the Y-axis in the far field. In this study, advanced design system (ADS) tool was used for computing the radiating characteristics for the antenna array.

**A. Antenna Element Design:**

Horizontal polarization is achieved by feeding from the lateral edge of the patch since the polarization is related to the feeding position. But the feed line between the two patches results strong coupling to occur which in turn degrades the performance of the patch and subsequently reduces isolation. On the patch element a slit was carved in order for the feeding position to be maintained at the bottom edge of the patch which also enables the current flow along the direction for impedance matching an off-center microstrip line having 100 ohm characteristic impedance is adopted.

For the patch element the current was fed onto the lower right side. Now here the direction of the current flow i.e. the vertical direction was blocked by the slit, the current is now forced to flow along the horizontal direction. The current vectors around the slit and on the edge are directed along the horizon, thereby producing horizontal polarization. A low reflection coefficient is needed for the safety of the transmitter since high power will be transmitted for marine radar. Every patch antenna located in the array is designed to operate at a centre frequency of 8.2 GHz. The substrate thickness is another consideration. Like low dielectric constant, thick substrate material increases the fringing field at the patch edges and increases radiating power. Hence the dielectric substrate with height of  $h=2.6\text{mm}$  is used.

For the equal amount of increase in current, the voltage is also increased. By using  $Z=V/I$  equation, the input impedance of the patch element is found as in equation (1).

$$Z_{in}(R) = \text{Cos}^2(\Pi R/L) Z_{in}(0) \quad (1)$$

The dimension of the patch and slit are 8.5mm x8.5mm and 5mm x1mm respectively.

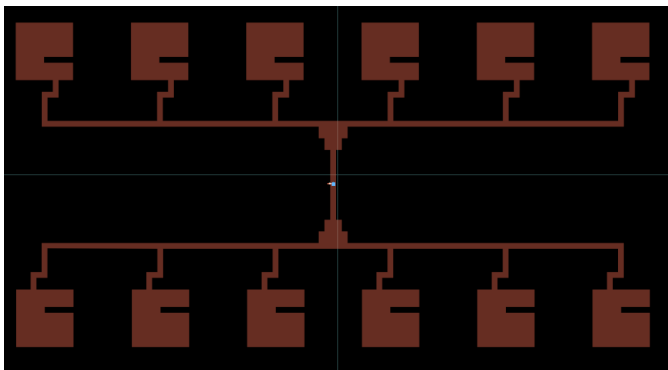


Fig1. Antenna array structure in ADS workspace

**III. SIMULATION AND RESULTS**

Fig2. shows the results of simulation of return loss of the proposed antenna. The simulation was done using ADS( Advanced Design System).

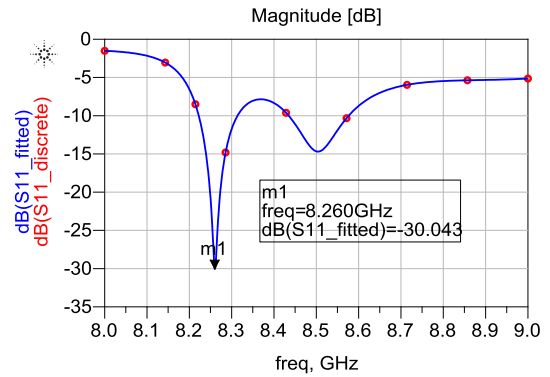


Fig2. Return loss

Fig3. shows the VSWR( voltage standing wave ratio) which is 1.065 at the frequency of 8.2GHz.

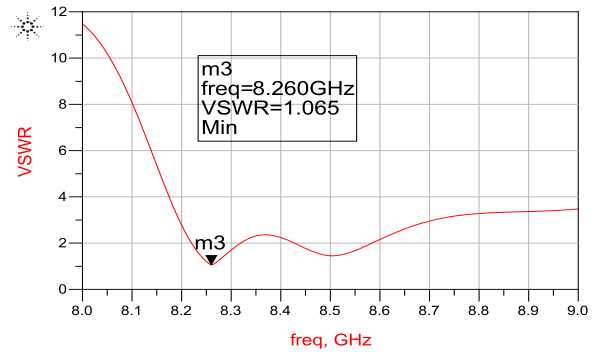


Fig3. VSWR

Radiation pattern represents as a function of space coordinates, the radiation properties of the antenna. Fig4. shows the radiation pattern of the patch array antenna.

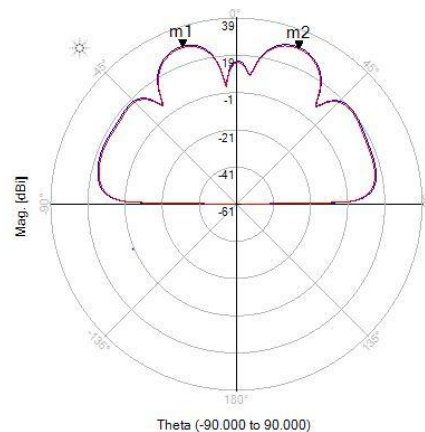


Fig4. Radiation pattern

#### IV. CONCLUSION

A microstrip patch array antenna for marine radar applications is designed and the radiation characteristics are measured. The array is made of twelve identical square microstrip patches which are arranged along the four arms of a one dimensional array with each having three elements. The cross polarization level is substantially suppressed because of the symmetric design with respect to x-axis. The side-lobe level was suppressed by using series-fed structure with chebyshev tapering. In this novel design a slit is carved on each patch and also the number of patch is considerably reduced in comparison to that of the conventional patch antenna.

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#### REFERENCE:

1. C.H.Hsu,C.L.Huang,C.F.Tsen, "MICROSTRIP-FED MONOPOLE ANTENNA WITH A SHORTED PARASITIC ELEMENT FOR WIDEBAND APPLICATION" Progress in Electromagnetics Research Letters,Vol.7,115-125,2009.
2. C.A. Balanis, Antenna Theory, 2nd ed. Ch. 14. New York: John Wiley & Sons, Inc., 1997.
3. Cheng-Chi Yu , Jiin-Hwa Yang , Chang-Chih Chen , and Wen-Chao Hsieh " A COMPACT PRINTED MULTI-BAND ANTENNA FOR LAPTOP APPLICATIONS" Progress In Electromagnetics Research Symposium Proceedings, Suzhou, China, Sept., 2011.
4. J. Anguera, C. Puente, C. Borja, and J. Soler, "Dual-frequency broadband- stacked microstrip antenna using a reactive loading and a fractalshaped radiating edge," IEEE Antennas Wireless Propag. Lett., vol. 6, pp. 309–312, 2007.