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Microstrip Rectangular Patch Antenna : Computer Aided Design Methology

Dr. R.D. Kanphade
Principal,Dhole Patil College of Engineering,Wagholi,Pune

Dr. D.G. Wakade
Director,P.R.Patil College of Engineering,Amravati

Prof. N.T. Markad
Associate Professor, BVCOE,Deptt. Of ECE.

ABSTRACT- Antenna is a means for radiating or receiving radio waves. In addition to receiving or transmitting energy, an antenna in an advanced wireless system is usually required to optimize the radiation energy in same direction and suppress it in others. A micro strip patch antenna also referred to as patch antenna is a narrowband, wide beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate with a continuous metal layer bonded to opposite side of substrate which forms a ground plane. Microstrip rectangular patch antenna simulated in FDTD software IE3D. Proposed novel microstrip rectangular patch antenna is presented. Micro strip rectangular patch antenna ha a return loss of -28dB at a frequency of 5.04 GHZ. Antenna offers a band width of 50 MHZ. Antenna offer a VSWR 1.1 at a frequency of 5.04 GHZ. By observing a smith chart it is seen that antenna offers more resistive and capacitive impendence. Inductive impendence offered by antenna is very small i.e. negligible. Antenna offers unidirectional radiation pattern. Unidirectional radiation pattern plays important role in next generation mobile communication and computing. Due to unidirectional radiation pattern cost of power is saved.

KEYWORDS : Micro strip antenna, Inset feed, substrate, radiation pattern, VSWR, Smith chart.

I INTRODUCTION

In telecommunication; there are several types of micro strip antennas(also known as printed antennas) the most common of which is the micro strip patch antenna or patch antenna.

A patch antenna is a narrowband, wide-beam antenna fabricated by etching the antenna element pattern in metal bonded to an insulating dielectric substrate with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Common micro strip antenna radiator shapes are square, rectangular, circular and elliptical but any continuous shape is possible. Some patch antennas eschew a dielectric substrate and suspend a metal patch in air above a ground plane using dielectric spacers, the resulting structure is less robust but provides better band width. Because such antennas have a very low profile; are mechanically rugged and can be conformable, they are often mounted on the exterior of aircraft and spacecraft or are incorporated into mobile radio communication devices.

Micro strip antennas are also relatively inexpensive to manufacture and design because of the simple two dimensional physical geometry. They are usually employed at UHF and higher frequencies because the size of the antenna is directly tied to the wavelength at the resonance frequency.

A single patch antenna provides a maximum directive gain of around -6 dBi. It is relatively easy to print on array of patches on a single (large) substrate using lithographic techniques. Patch arrays can provide much higher gain than a single patch at little additional cost; matching and phase adjustment can be performed with printed micro strip feed structures, again in the some operation that form the radiating patches. The ability to create high gain arrays in a low profile antenna is one reason that patch arrays are common on airplanes and in other military application.

An array antenna is a special arrangement of basic antenna components involving new factors and concepts. Before you begin studying about arrays, you need to study some new terminology. An array antenna is made up of more than one ELEMENT, but the basic elements is generally the dipole. Sometimes the basic element is made longer or shorter than a half-wave, but the deviation usually is not great.

Typically an antenna is tuned for a specific frequency and is effective for a range of frequencies that are usually on that resonant frequency. Some antenna design have multiple resonant frequencies, and some are relatively effective over very broad range of frequencies.

Gain as a parameter measures the efficiency of a given antenna with respect to a given norm, usually achieved by modification of its directionality. An antenna with a low gain emits radiation with about the same power in all directions, whereas high gain antenna will radiate in particular direction. The radiation pattern of an antenna is the geometric pattern of the relative field strengths of field emitted by the antenna. In field of antenna the term " radiation pattern" most commonly refers to directional (angular) dependence of radiation from the antenna or other source. Usually, the directivity is expressed in dBi. The reason that the units are dBi, (deciblerelative to an isotropic radiations that for n isotropic radiator, the radiated lower density is a constant and therefore equals the average radiated power density (the denominator). The angle across the main lobe of an antenna pattern, between the two directions, at which, the antenna's sensitivity is half its maximum value at the centre of the lobe. It is abbreviated as HPBW.

As an electromagnetic wave travels through the different parts of the antenna system (radio, feed line, antenna, free space) it may encounter differences in impendence (E/H;

V/I, etc.) At each interface, depending on the impendance match, some fraction of the wave's energy will reflected back to the source, forming a standing wave in the feed line. The ratio of maximum power to minimum power in the wave can be ratio (SWR). A SWR of 1:1 is ideal. A SWR of 1.5:1 is considered to be marginally acceptable in low power application. Efficiency is the ratio of power actually radiated to the power put into antenna terminals. The bandwidth of an antenna is the range of frequencies over which it is effective, usually centered on the resonant frequency. The band width of antenna may be increased by several techniques, including using thicker wires, replacing wires with cages to simulate a thicker wire, tapering antenna components (like in a feed horn); and combining multiple antenna into a single assembly and allowing the natural impedance to select correct antenna, small antenna are usually preferred for convenience, but there is a fundamental limit relating bandwidth, size and efficiency. The polarization of an antenna is the orientation of the electric field (E-plane) of the radios waves with respect to the Earth;s surface and is determined by physical structure of the antenna and by its orientation. It has nothing in common with antenna directionality terms: horizontal, vertical and circular. In high performance aircraft, satellite and missile applications, where size, weight, coast, performance, ease of installation and aerodynamic profile are constraints, low profile antenna may be required. To meet there requirement microstrip antenna can be used. These antennas are low profile, conformable to planar and non-planar surfaces. Simple and inexpensive to manufacture using modern printed-circuit technology. Mechanically robust when mounted on rigid surfaces compatible with MMIC design.

There are many configurations that can be used to feed micro strip antenna. The four most popular are :-

- Microstrip line
- Coaxial cable
- Aperture coupling
- Proximity coupling

The micro strip line feed is easy to fabricate; simple to match by controlling the inset position and rather simple to model.

Because the dimensions of the patch are finite along the length and width; the fields at the edges of the patch undergo fringing. The amount of fringing is a function of the dimensions of the patch and the height of the substrate. Due to fringing field antenna radiate. Fringing Fields Shown in Figure 1.

II FEED NETWORK

Feed is of different types but most popular feed are –

- Transformer feed
- Microstrip line feed
- Coaxial cable feed
- Aperture coupling feed
- Proximity coupling feed.

Out of above mentioned feed for micro strip patch antenna feed applied to it is transformer feed type. Suppose impendence at antenna is 100Ω by transformer type feed 100Ω.This 50Ωimpendence known as terminating impendence. Terminating impendence matches to probe impedance hence power delivered to micro strip patch antenna is maximum.

By choosing W, i.e. Width of trans former feed, tie. Thickness of substrate used and L ie. Length of transformer feed these quantities are expressed in terms of f r, h etc. By using three different standard formulae-

Inset width = 2.236mm, strip width = 1.836mm and Inset depth = 5.45mm.

III DESIGN OF RECTANGULAR PATCH ANTENNA NDF FEED NETWORK

The following physical specifications were used in the design process.

The satellite communication system utilize the 5GHZ spectrum, so our design is built for operation in this frequency band i.e. 5GHZ. The dielectric material selected for our design is RT Duroid, which has a dielectric constrt of 3.2. RT Duroid substrate is costly and not easily available. Height of substrate chosen to be 0.762mm. Then simulating rectangular micro strip patch antenna in FDTD software IE3D following design parameters of antenna got

Patch length = 16.52mm; Inset width = 2.236mm, strip width = 1.836mm; patch weidth = 20.685mm and Inset depth =5.45.

These values were used for the patch designing process, using which the approximate feed point placement was calculated.

Final patch design is shown in Figure 1.

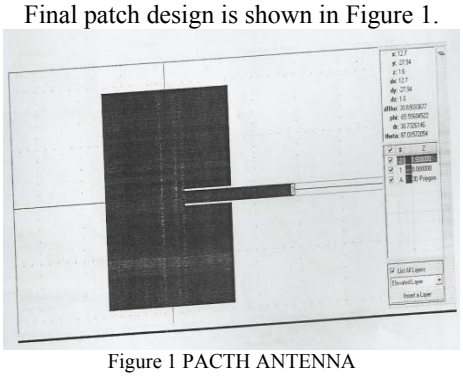

Figure 1 PACTH ANTENNA

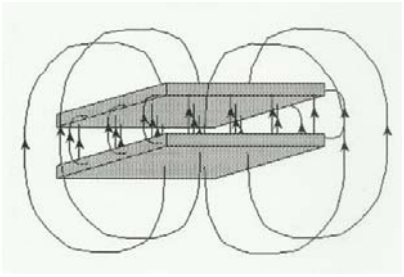

Figure 2 FRINGING FIELD

IV RESULTS AND ANALYSIS

The design analysis gave the following results. Radiation, pattern of rectangular micro strip patch antenna is shown in Figure.3.

The radiation pattern of rectangular patch antenna is unidirectional. This unidirectional radiation pattern plays important role in next generation mobile communication and computing. Due to unidirectional radiation pattern cost of power of mobile communication is saved.

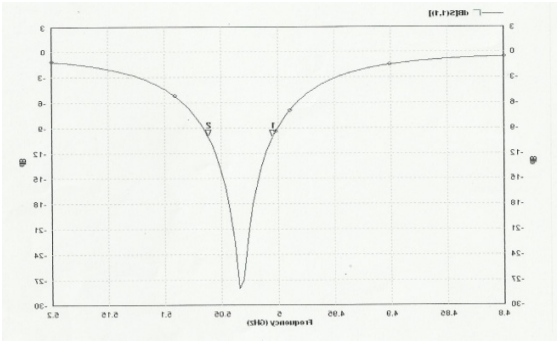

Figure 3 RETURN LOSS

Gain v/s frequency plot of rectangular micro strip antenna is shown I Figure.3. From this plot, it is seen that antenna offer sreturn loss of -28dB at a frequency of 5.04 GHZ. VSWR v/s frequency plot shown in Figure4. FromFigure.5 it is seen that antenna has a VSWR of 1.1 at a frequency of 5.04 GHZ. Smitch chart shown in Figure.5. From smith chart it is seen that antenna offered more resistive and capacitive impendence but inductive impendence offered by antenna is negligible [12].

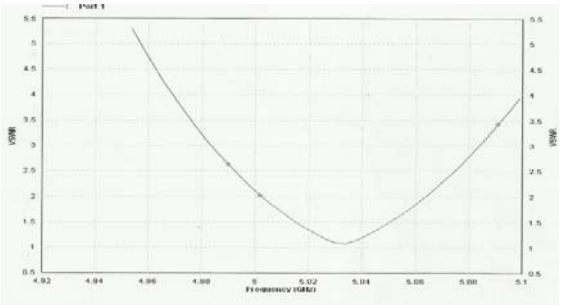

Figure 4 VSWR

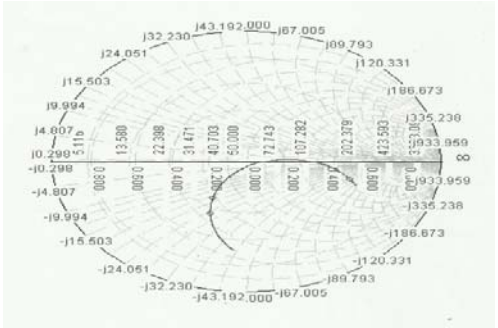

Figure 5 SMITH CHART

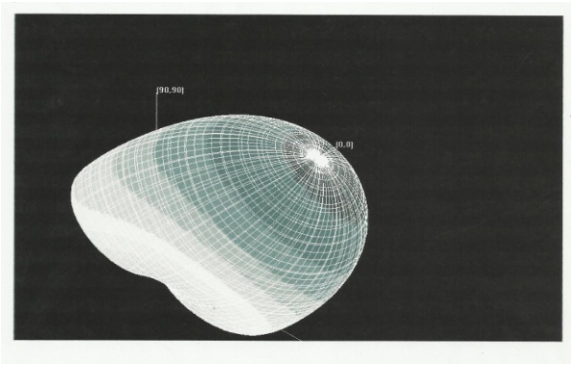

Figure 6 RADAITION PATTERN

V CONCLUSION

It is seen that the design adopted for the rectangular micro strip patch antenna are quite accurate. This antenna can be used at 5.04 GHZ frequency for satellite communication and computing application where the frequency of operation is 5.04 GHZ.

For an antenna to work properly the VSWR must be less than two and return loss must be less than 10dB; only then the antenna will radiator receive the power with minimum reflection. As designed antenna has a return loss – 28dB and VSWR 1.1 at a frequency of 5.04 GHZ, so this antenna is used in satellite communication and computing satisfactorily. The light weight rectangular micro strip antenna are ideal for satellite communication applications where the weight is the main constraint. Due to unidirectional radiation pattern rectangular micro strip patch antenna plays important role in next generation mobile communication and computing, also due to unidirectional radiation pattern cost of power for mobile communication system is saved.

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