DESIGN AND SIMULATION OF PATCH ANTENNA BASED ON A PHOTO VOLTAIC CELL FOR ULTRA WIDE BAND APPLICATIONS

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***ABSTRACT* - In the present work, this paper presents the design an antenna and analysis of ultra-wide band (UWB) applications for satellite communications. By using a photo voltaic cell, the radiating patch element of a patch antenna was replaced. Antenna is a one type of transducer converts electrical energy to electromagnetic energy in form of electromagnetic waves. Here, to design a patch antenna structure based on a photovoltaic solar cell. It is used to collecting a radio frequency (RF) as well as photo-generated current. To improving efficiency is used for solar cell in patch antenna. A simulation allowing measuring the performance of the antenna, with a n and p type silicon material and analyzing its parameters such as the gain, directivity, radiation pattern, reflection coefficient(S11) and bandwidth. The performance of proposed antenna has been simulated and designed using HFSS software**.

KEYWORDS-Patch antenna, photovoltaic cell, optical and electrical losses, HFSS.

I.INTRODUCTION

Normally antennas were combined with thin-film amorphous-silicon solar cells developed by PV-Lab. A set of conductors (resonators) is placed on the top of photovoltaic cells. This layering makes it possible for the cells to maintain up to 90% of their solar efficiency. The solar cell antenna is applicable and used in different applications like environmental monitoring system, vehicular communication and satellite systems. A slot antenna consists of a metal surface, usually a flat plate, with a hole or slot cut out. when the plate is driven as an antenna by a driving frequency, the slot radiates electromagnetic waves in a way similar to a dipole antenna. Dual band a Si:H solar-slot antenna for 2.4/5.2GHz is using an WLAN application [1]. And also the structure of solar cell in ultra-wide band dipole antenna [2]. An autonomous wireless sensor node incorporating a solar cell antenna for energy harvesting [3]. An antenna is a transducer that converts radio frequency (RF) fields into alternating current or vice versa. Antenna play an important role in the operation of all radio equipment. They are used in wireless local area networks, mobile telephony and satellite communication. By this type of technique is used in SOLPALNT. SOLPLANT in wide range from WI-FI and radar [4]. The photovoltaic systems of power generations when combined with communication systems can provide reliable and compact autonomous systems. To reduce the dependency on grid. Simulation of a PV system linked to a storage unit and increases the efficiency [5]. The DC convertor circuit for the solar cell is also designed and built. PV cell current-voltage measurements are also performed. With this system, the energy provided by the solar cell is enough to operate a wireless node without any external power source.

The study on the performance of flexible UWB antenna is carried out. The micro strip patch antenna can be explained in the simplest form as antenna with substrate confined in between two metal surfaces with radiating surface known as patch on the one side and ground surface on the other side. It improves economic viability and it can reduce the cost of renewable energy. The proposed solar cell antenna consists in an appliance for the conversion of solar energy to electric energy with at least one solar cell. Solar cell using patch antenna for WLAN and WIMAX applications [5]. Performance analysis of solar cell antenna with hybrid mesh and aght-8 material [6]. The polarization of an electromagnetic wave in which either the electric or the magnetic vector executes a circles perpendicular to the path of propagation with a frequency equal to that of the wave. It is frequently used in satellite communications. This type of antenna is designed and also newly stimulated by Circularly Polarized Solar Antenna for Air Bone Communication Novels [7]. And it conducts cells were used as an antenna for the emission and reception of simultaneously works at electromagnetic waves. Optimization and calculation of the Collecting Grid Front Side of a Photovoltaic Cell Dedicated to the RF Transmission [8]. Design and simulation of dissimilar patch antenna array for wireless application [9]. This type of micro strip patch antenna is used by ultra-wide band applications of design for space research and radio astronomy applications [10].

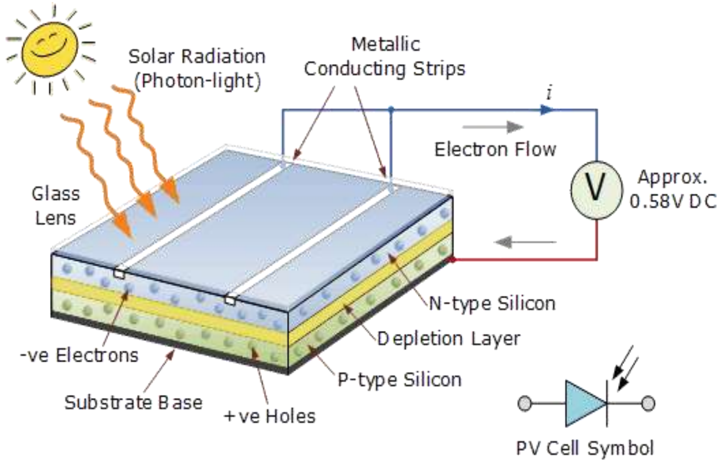

Fig.1 Principle of photovoltaic cell

To implementing of a polycrystalline silicon solar cell as ground plane in lower profile.SI cell on flexible thin film substrate yielded an improved performance. And reducing the grid and increasing efficiency. Narrow band is enhanced to increasing a performance. The frequency range has using by 12-18 GHz. The frequency range is performed by the application is satellite communication in KU band. The upper link of range is 10-7 GHz and the down link of range is 12.75 GHz.

II.ANTENNA TYPES AND CALCULATIONS

In its basic form, a micro strip patch antenna consists of a radiating patch which is built on the dielectric substrate. The micro strip patch is generally made of conducting material such as copper and it can take any possible shapes. In order to simplify analysis, the patch is generally rectangular and crescent shapes. And it provides by the better efficiency, larger bandwidth and good radiation pattern.

RECTANGULAR ANTENNA

A patch antenna (also known as a rectangular or circular micro strip antenna) is a type of radio antenna with a low profile, which can be mounted on a flat surface. It consists of a flat rectangular or circular sheet or “patch” of metal, mounted over larger sheet of metal called a ground plane. To design an antenna for dissimilar patch using ADS software and simulate the antenna arrays [9].To reducing the ground plane of return loss at resonant frequency [10].Fig.2. Basic rectangular patch.

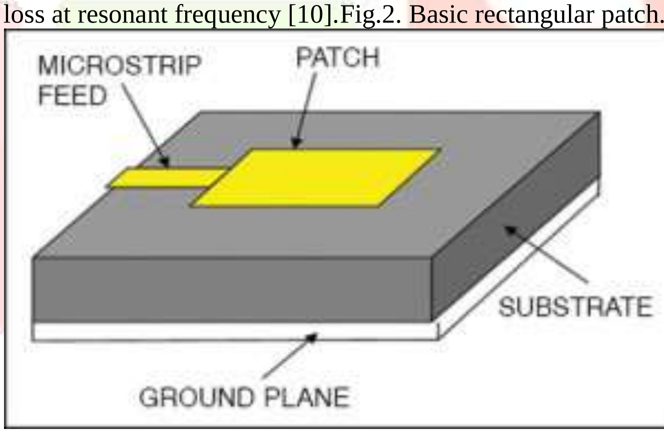

Fig.2 Basic rectangular patch

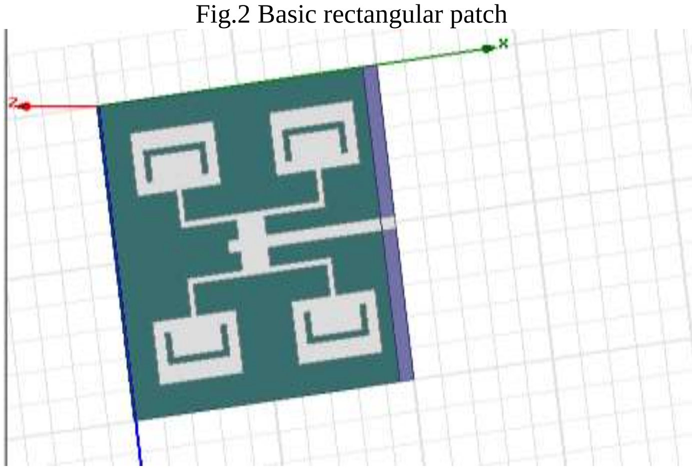

Fig.3 4x4 micro strip patch antenna

By using a fig.4.design of antenna 4x4 micro strip rectangular patch in the length of antenna decreases and increases with dielectric substrate. The load is represented by radiation loss.

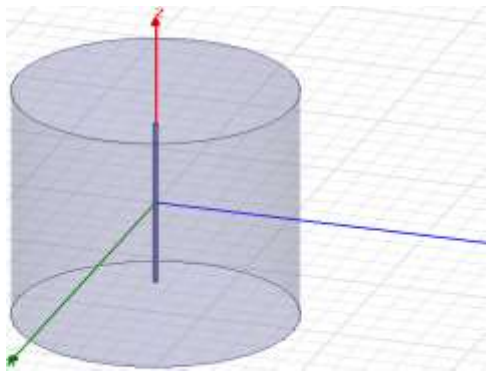

Fig.4 Rectangular dipole antenna using micro strip patch

CRESCENT ANTENNA

A Crescent antenna is an antenna that uses a crescent, self-similar design maximizes the length or increasing the perimeter (on inside sections or outer structure) of material that can receive or transmit electromagnetic radiation within a given total surface area or volume.

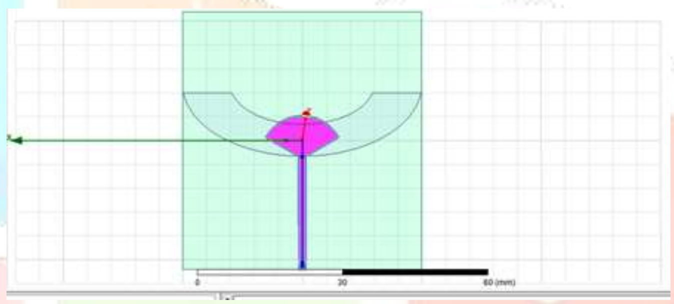

Fig.5. a) Front view -Radiating structural design having Crescent shape.

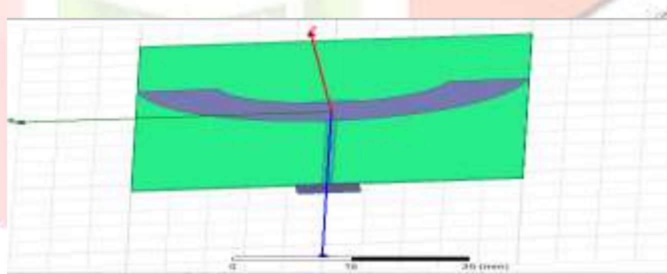

Fig.5. b) Back view - Swastic shape defected ground structure.

MPA comprises of a slotted radiating patch on top of the substrate and a ground plane which is defected with the help of swastic shape structure on bottom of the substrate. The front and back outlook of designed antenna are shown in Figure.5 a) and b) respectively. The rectangular micro strip antenna of length L_P = 12 mm and width W_P = 8 mm is designed with the epoxy glass.FR -4 substrate having dimension $L_S \times W_S \times H_S$= 24×16×1.6 mm^3, relative permittivity, İ$_r$=4.3 and loss tangent, tan į=0.0024. Excitation is made through micro strip feed line having 50-ohm characteristic line impedance. Three rectangular pen-ended slots at a distance g_1=2.1mm, g_1+g_2=3.4 and g_1+g_2+1.6 from top of patch are inserted inside the RMPA. The length of upper and lower open ended that is $L_1$and L_3 is 8.9 mm and that of middle slot that is L_2 is 10.

These two types of antenna where designed to measuring the reflection coefficients and comparing the graph can be drawn. Advantages of antennas are easy to integrate them with MIC. They are capable of supporting multiple frequency bands (dual, triple).

IV.STRUCTURE OF PATCH ANTENNA WITH SOLAR CELL

The polycrystalline silicon solar cell consists of two metal contacts, a bottom solid is positive DC terminal and a top grid is negative DC terminal. From an RF point of view, should be given to the bottom metal contact of the cell, which is homogeneous in structure allowing the cell to be used as a patch element in addition to its photovoltaic function. It is generating DC power output to power the communication system in which the proposed photovoltaic antenna can be built.Fig.6. It is explained by structure of patch antenna and Fig.7. is explained by structure of solar cell.

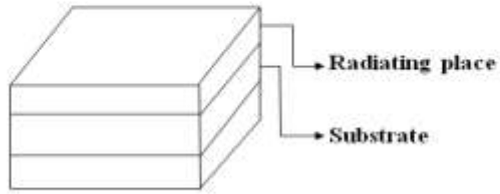

Fig.6. Structure of patch antenna

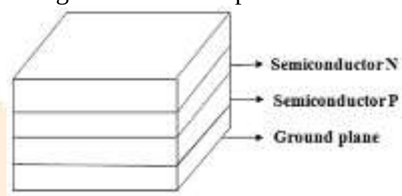

Fig.7. Structure of solar cell

Our contribution of a micro strip patch antenna based on a photovoltaic cell was deduced from structure of the solar cell and that of a simple patch antenna.

V.ANTENNA PARAMETERS

GAIN

Gain is defined as how this antenna converted in to input power to specifying direction of radio waves.

Mathematically it is being represented as

$$Gain = 4\Pi U/P_{in}$$

U =radiation intensity, P_{in}=total input power

DIRECTIVITY

The electromagnetic waves are receiving an antenna and transmitting directivity is equal to receiving directivity. Analytically, it is represented as

$$D = U / U_0 = 4\Pi U / P_{rad}$$

RADIATION PATTERN

The far field pattern is referring to the angular dependence of strength of radio waves.

RETURN LOSS

It is the power loss in the signal that is reflected due to discontinuity in the transmission line. As we already know, when impedance matching between the transmitter and antenna is not perfect, the radiations within the substrate results in to the standing waves. The return loss is formulated as

$$RL=-20\log_{10}(P_i/P_r)$$

Where P_i=Incident power, P_r= Reflected power

VI.RESULT AND DISCUSSION

The design of antenna has been discussed in terms of gain(dB), directivity(dB), VSWR, smith chart,3D rectangular plot, 3D polar plot. The antenna has been designing and simulated by using HFSS software.

Firstly, the micro strip patch antenna with U-Slot only demonstrates the return loss of -46dB and bandwidth 12GHz.Secondly, by modifying the ground plane using circular slots in it, the bandwidth was same 12GHz but the return loss reduced to -15.5dB.

OUTPUT FOR RECTANGULAR PATCH

3D RECTANGULAR PLOT

The value of 3D rectangular plot is 2.6e + 000.The directivity is measured by higher value of portion in rectangular plot.Fig.8. It is represented by directivity of rectangular patch antenna.

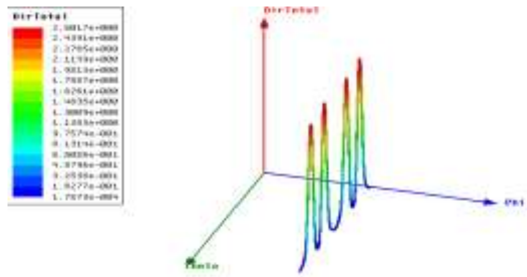

Fig.8. 3D Rectangular plot (directivity) of rectangular antenna

3D POLAR PLOT

The value of 3D polar plot is 2. 4e+000.The gain is measured by higher value of portion in polar plot.Fig.9. The diagram will have represented by gain of rectangular patch antenna.

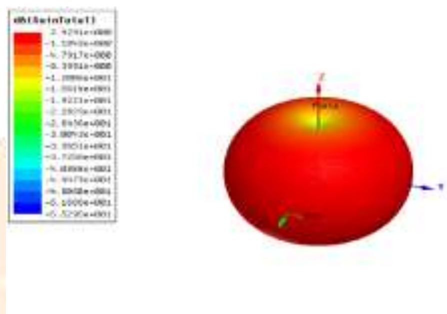

Fig.9. 3D polar plot (gain) of rectangular antenna

RADIATION PATTERN

The value of radiation pattern in rectangular micro strip patch antenna is 3. And the frequency range is processing at 12 GHz.Fig.10. This diagram will have represented by radiation pattern of micro strip patch antenna.

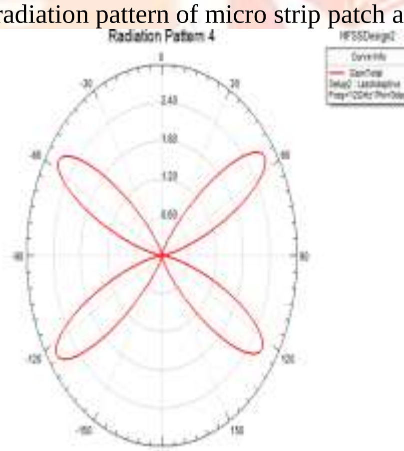

Fig.10. Radiation pattern of rectangular patch antenna

XY PLOT

The value of return loss in micro strip rectangular patch antenna is -14dB. Fig.11. The frequency range is processed by 12 GHz.

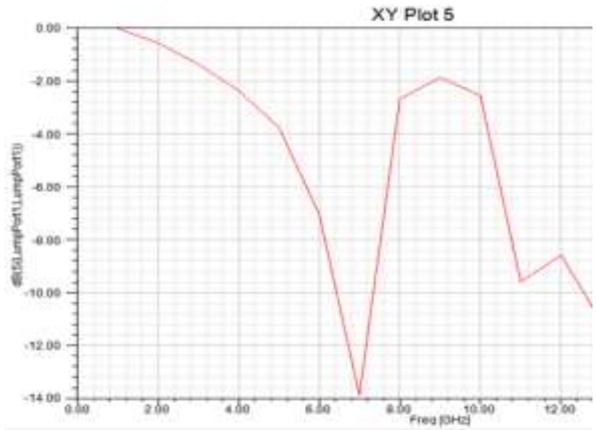

Fig.11. XY plot of rectangular patch antenna

SMITH CHART

The smith chart value in micro strip rectangular patch antenna is 0.5-j2. Fig.12. the frequency range is processed by 12 GHz.

Fig.12. Smith chart of rectangular patch antenna

OUTPUT OF CRESCENT ANTENNA

3D RECTANGULAR PLOT

The value of 3D rectangular plot is 9.46e + 000.The directivity is measured by higher value of portion in rectangular plot.Fig.13. It is represented by directivity of crescent antenna.

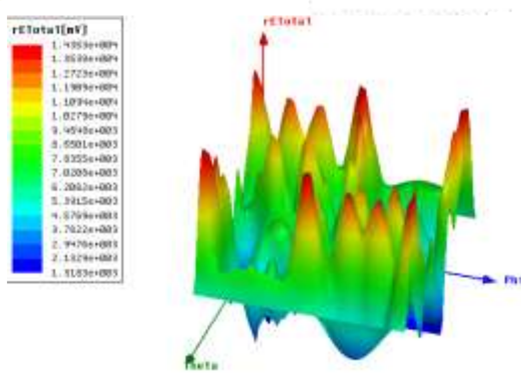

Fig.13. 3D Rectangular plot (directivity) of crescent antenna

3D POLAR PLOT

The value of 3D polar plot is 9.46e+000.The gain is measured by higher value of portion in polar plot.Fig.14. It is represented by gain of crescent antenna.

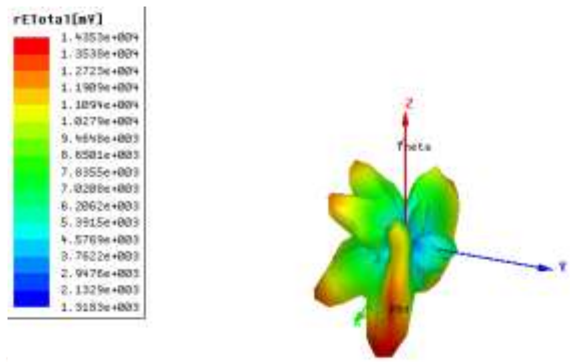

Fig.14. 3D polar plot (gain) of crescent antenna

RADIATION PATTERN

The radiation pattern of crescent antenna is 11. Fig.15. The frequency range is run by12 GHz.

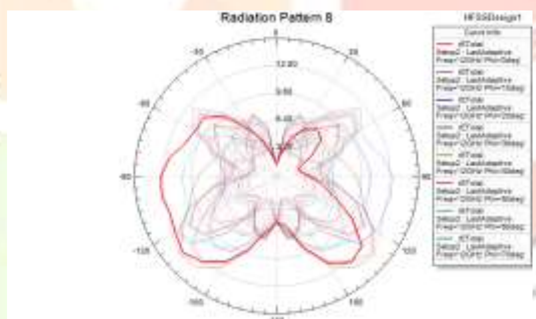

Fig.15. Radiation pattern of crescent antenna

XY PLOT

The XY plot of Crescent antenna is -15.5dB.Fig.16. XY plot of the frequency range is processed by 12GHz.

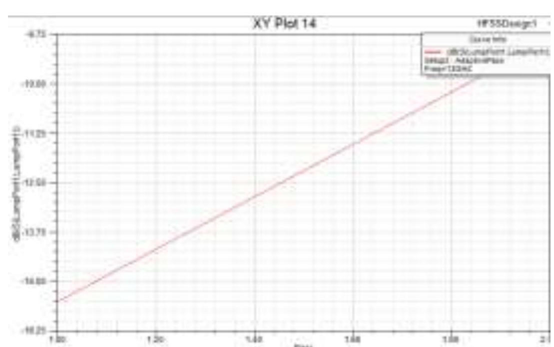

Fig.16. XY plot of crescent antenna

SMITH CHART

The smith chart value of crescent antenna is 1-j0.7. Fig.17. smith chart of crescent antenna in 12 GHz.

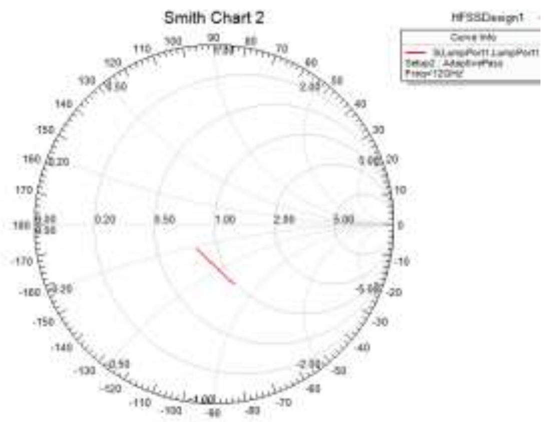

Fig.17. Smith chart of crescent antenna

VII.TABULATION

Shapes	3D Rectangular Plot	3D Polar Plot	Radiation pattern	XY Plot	Smith Chart
Rectangle	2.6e	2.42e	3	-14dB	0.5-j2
Crescent	9.46e	9.46e	11	-15.5dB	1-j0.7

VIII.CONCLUTION

In this paper the crescent and rectangular patch antenna has designed and it can be concluded from this research paper that the accomplishment to the micro strip antenna rely laboriously on the geometrical dimensionality of the rectangular lots of the patch. A compact micro strip U-slot patch antenna using DGS involving circular slots was proposed in this paper. The use of mushroom like EBG structure to achieve the enhanced performance of antenna resonating at 12GHz is also discussed. Finally, to compensate for the decrease in return loss, mushroom-like EBG structures were composed around the patch resulting in refinement of return loss to -15.5dB is the best result and remarkable suppression in back lobes. The above designed antenna is appropriate for Radio Frequency portable devices operating at 12-18 GHz.

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