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# Design of Solar Cell Antenna (SOLAN) Using Indium Tin Oxide Mixed with Silver

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**Abstract:** In this paper, combination of Solar cell and Microstrip antenna named SOLAN (Solar Cell Antenna) is proposed. SOLAN is designed by RF and optic in which it is an autonomous property of a transceiver. Also Indium Tin Oxide mixed silver (ITOS) is used, which is to generate DC power supply and produce RF signals in transceiver mode. The parameters reflection co-efficient, power, gain and directivity for hybrid ITOS are calculated and plotted. The function of ITOS is to penetrate energy towards the solar cell when the light falls on it. Here ITOS is used, because ITOS produces high reflection coefficient as well as high radiation when compared with AgHT. The design guidelines of the antenna is presented elaborately. The operation principle of Antenna is analyzed by carrying some parametric studies of surface current distribution, impedance and radiation patterns. The reflection coefficient, radiation patterns and gain of the antenna are numerically presented and the design approaches are theoretically studied to verify the operation principle. The proposed method works on the system which generates DC power supply when light falls on the surface of ITOS and penetrates towards the solar cell. Similarly EM wave falls on the surface of ITOS and produce RF signal. By using RF signal in SOLAN we can calculate reflection co-efficient, gain and power for different shapes, size and design effectively than the existing system.

**Key word:** Solar cell · Microstrip antenna · ITOS · Reflection co-efficient · Indium Tin Oxide mixed silver (ITOS)

## INTRODUCTION

Antenna became a part of electrical devices in wireless communication systems [1]. Designing antennas for embedded applications is extremely challenging because of reduced antenna efficiency, impact of the environment on the antenna. The size of the antenna should be reduced and can reduce the strong multi path loses [2]. Solar cell antenna is used in different application such as environmental monitoring system, vehicular communication and Satellite systems.

SOLAN is used in satellite communication [3], metal plate of solar supports UMTS Pico-cell base station [4], mesh patch antenna and circular grid antenna are used for car wind shields [5-7], optically transparent wide band antenna supports communication system [8-14], SOLAN array antenna power is more due to RF and Optic intelligence [15]. The amount of energy that can be harvested from a solar cell is proportional to its surface area, so the solar cell must be sized according to the power demands of the sensor node and the available light. Harvesting of solar energy through photovoltaic conversion in an outdoor environment provides a power density greater than 10 mW/cm with a crystalline silicon solar cell [16]. Solar cell antenna is the combination of solar cell and microstrip antenna.

A microstrip antenna consists of a metallic plate or patch on an electrically thin grounded dielectric slab. The patch is fed either by a microstrip transmission line or by a coaxial probe extending towards ground plane and will contact the patch [17]. Microstrip patch array antennas are extensively applied in radar systems [18] and wireless communications systems [19], which are high gain, low cost, lightweight and low profile and can accurately control radiation patterns [20]. Microstrip printed dipole antennas are thus suitable candidates for the design of

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solar antennas with polycrystalline silicon solar cells [21].Microstrip patch antennas are known to have a narrow impedance bandwidth [22].

Adaptive antennas with reconfigurable pattern have been extensively deployed in the wireless communication systems in order to improve the transmission quality and increase the channel capacity [23]. The integration of the solar cell and the antenna into a single device can provide a more compact surface area for smaller systems. Accordingly, various configurations have been suggested to minimize degradation in both the solar and the microwave performances [24]–[28]. The purpose of the integration of solar cells and antennas is to optimize the available surface for both communication and power generation. In printed array antennas, the radiating regions (where no solar cells can be placed) are well delimited. The rest of the surface could, thus, be covered by solar cells [29].

Reflection coefficient describes how much of electromagnetic wave is reflected by impedance in transmission medium. Also Antenna gain is a key which combines antenna directivity and electrical efficiency. The proposed work defines SOLAN, combination of solar cell and antenna with ITOS. The method works on the system which generates DC power supply when light falls on the surface of ITOS and penetrates towards the solar cell. Similarly EM wave falls on the surface of ITOS and produce RF signal. By using RF signal in SOLAN we can calculate reflection co-efficient, gain and power for different shapes, size and design effectively than the existing system.

**Related Work:** Alice Pellegrini *et al* [30] proposed a new hybrid MM-FE-SD approach for analyzing finite large arrays. Firstly, the MM-FEM has been applied to the analysis of infinite phased arrays of arbitrarily shaped apertures, arranged in a triangular lattice and fed by rectangular waveguides with thick irises. The FE method has been used to model arbitrarily-shaped irises. The MM procedure has been applied to the single unit cell to ensure the continuity of the fields and the use of the SD has enabled us to analyze the finite problem by superposing the results of the doubly periodic infinite one. The generalized three-dimensional problem has been analyzed by using appropriate depolarization coefficients. The results obtained by applying the proposed methodology have been compared both with those available in literature and those obtained by using commercial software. The reliability of MM-FE-SD approach has been achieved.

Wen-Jun Lu *et al* [31] proposed a novel dual-band, loop-dipole composite antenna, as well as explained its design approach. Design principles of the antenna and its operation modes were presented at first. Then, prototypes were designed, fabricated and measured to successfully verify the operation principles, design approach and numerical results. By incorporating multiple modes, dual-band performance was achieved. It was seen that impedance bandwidth of 71.1% and 32.9% (for smaller than dB), high average gain of 6.7 dBi and 6.5 dBi in both bands. Also explained that the antenna can cover multiple wireless spectrum and it is suitable for multi-band indoor base station applications.

Wen-Shyang Chen, Chun-Kun Wu and Kin-Lu Wong [32] proposed a novel method for polarized square microstrip antenna. They implemented a single feed compact CP microstrip antenna with four slits and compared with the existing work. The proposed model gave good radiation characteristics with a compact CP design.

Fang-Yao Kuo and Ruey-Bing Hwang [20] proposed a high-isolation printed antenna array for marine radar applications was designed and fabricated and the radiation characteristics were measured. The array was composed of 32 identical square microstrip patches arranged along the four arms of a 1-D array containing eight elements. By using the series-fed structure with Chebyshev tapering, the side-lobe level was suppressed. Moreover, the symmetric design with respect to the -axis substantially suppressed the cross-polarization level. Compared with the conventional patch element design, the novel design proposed in this study with a slit and off-center feed mitigated the electromagnetic coupling that occurred through the feed-line to patch coupling. Furthermore, applying the metallic baffles to the exterior of the antennas substantially enhanced the isolation between the transmitting and receiving antennas. The measured and simulated results agree well. Additionally, the electrical performance of the developed antenna is able to meet the specifications of the antennas applied in marine radar systems.

S.V. Shynu *et al* [22] defined the implementation of polycrystalline silicon solar cell as a microwave ground plane for a 2.19 GHz microstrip patch antenna design with a low-profile and reduced-footprint is reported. Measurements and simulations show that the integration provides acceptable antenna/solar cell performance. The reduction in gain is attributed to increased conductivity losses due to the semiconductor properties of the silicon.

An anisotropic electrode lattice of silver mitigates some of the losses when the antenna polarization is suitable aligned. The antenna stability is in sensitive to light intensity variations typical of countries at northern latitudes.

**Similarity Between Antenna and Solar Cell:** Compare Solar cell, Microstrip antenna, ground plate, coaxial port and subtract are similar. In Solar cell upper part silicon wafer is used for receiving of light and metallic plate is used in microstrip antenna for trans receiving EM waves. In Solar cell antenna design, the solar cell is placed under the micorstrip antenna. A transparent conducted coated film (ITOS) is placed in microstrip antenna for interleaved light towards the solar cell. It generates DC and RF due to falling of light and EM.

**Solar Cell Equivalvent Circuit:** Solar cell antenna Electronic work bench simulated results are summarised as follows current (I) =872.8mA Voltage (V) =8.728mV and Power (P) =7.6177984mW.This results are high compare with separate equivalent circuit of Solar cell and Microstrip. So we conform that Solar cell antenna design is possible.

**Analysis of Solar Cell Antenna Parameters Using Hybrid Itos with Ads Simulated Results**

**Reflection co-efficient ITOS Hybrid Patch Solar Cell Antenna:** The Reflection co-efficient of the ITOSADS simulated results summarized in table 1 with frequency range from 1.5GHz to 5.5GHz. From the table shows the ITOS Hybrid patch provides better reflection co-efficient,reflection co-efficient and radiation are reciprocal so that radiation highwith low reflection co-efficient is clearly shown in figure 1.

Table 1: Reflection co-efficient values in dB of ITOS Hybrid patch

| Frequency(GHz) | ITOS HYBRID Patch |
|---|---|
| $S_{11}$(dB)1.5 | 0 |
| 2 | -1 |
| 2.5 | -4 |
| 3 | -7 |
| 3.5 | -3 |
| 3.9 | -34 |
| 4 | -15 |
| 4.5 | -3 |
| 5 | -4 |
| 5.5 | -7 |

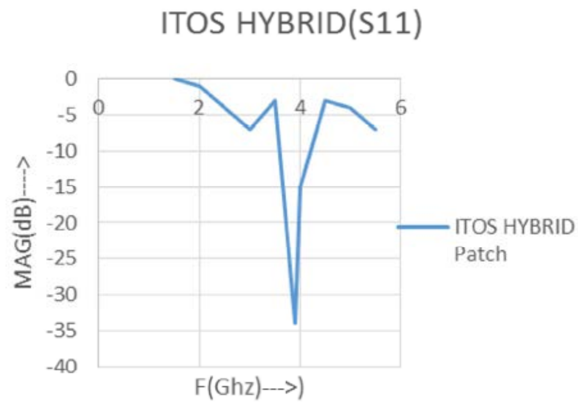


Fig. 1: Reflection co-efficient values of ITOS Hybrid patch

**Gain ITOS Hybrid Patch Solar Cell Antenna:** The Gain of theHybrid patch ITOS Simulated with ADS is summarized in table 2. From that the ITOS Hybrid patch provides better gain, gain and signal strength are proposal to each other if more signal strength, gain is high.

Table 2: Gain values in dB of ITOS Hybrid patch

| ITOS HYBRID Patch |
|---|
| G(dB)2.23592 |

**Power of ITOS Hybrid Patch Solar Cell Antenna:** The Power of the ITOS Hybrid patch is simulated with ADS are summarized in table 3.From that results the ITOS Hybrid patch provides better Power,Power and signal strength are proposal, high Power give high signal strength.

Table 3: Power values in Watt of ITOS Hybrid patch

| ITOS HYBRID Patch |
|---|
| P(W)0.00000284 |

**Directivity of ITOS Hybrid Patch Solar Cell Antenna:** The Directivity of ITOS Hybrid patch is simulated with ADS are summarized in table 4.From that result we observed the ITOS Hybrid patch provides better Directivity, Directivity and signal strength proposal, high signal strength is more one direction. So that directivity is high.

Table 4: Directivity values in dB of ITOS Hybrid patch

| ITOS HYBRID Patch |
|---|
| D(dB)6.65374 |

**Simulated ADS Model of ITOSHybrid Patch Solar Cell Antenna:** The design of ITOS Hybrid patch was simulated in ADS and its two or three dimensional designed as shown in Fig.2.

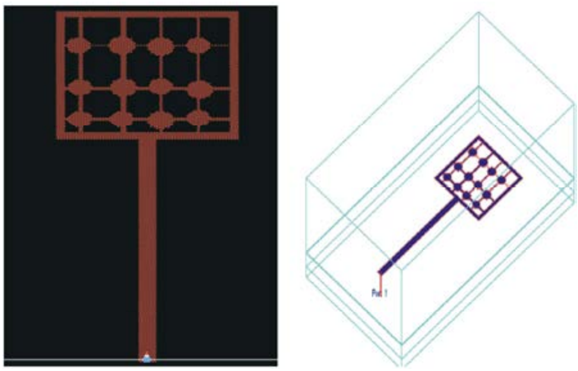

Fig. 2: Simulated design of ITOS Hybrid patch Solar cell antenna

**Design Equvation Solar Cell Antenna:** Design equation used for ITOS Hybrid patch Solar cell antenna, the dielectric layer is called Perspex and the equations depends on patch length(L), width(W), substrate height(h), frequency(f) and also length($L_{st}$) and width($W_{st}$) of the Microstrip.

$$?_{reff}=( ?_r +1/_2)+( ?_r-1/_2)[1+12 h/w]^{-1/2}$$

$$f = c / 2(L+h)\sqrt{?_{reff}}$$

## CONCLUSION

The ITOS Hybrid patch Solar cell antenna simulated using ADS software and the results obtained.From the obtained results the ITOS hybrid patch Solar cell antennagives better performance. Because ITOS hybrid patch has more transparent conducting film. Hence the ITOS hybrid patchSolar cell antenna can be used as basic platform for many communication applications and it can also be used as a transceiver for RF signal and to generate direct current.

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