IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

WIRELESS POWER TRANSMISSION USING MICROWAVES (USING PATCH ANTENNAS)

[1]K Vishwaroop, [2]G Sandeep Reddy, [3]K V Mahesh Chandra, [4]S Abhilash,

[5] K Giri Babu

[1,2,3,4]Under Graduates in Electrical and Electronics Engineering, [5]Asst. Prof. in Department of Electrical and Electronics Engineering,

[1]Department of Electrical and Electronics Engineering,

[1]J.B INSTITUTE OF ENGINEERING AND TECHNOLOGY,

(Affiliated to Jawaharlal Nehru Technological University, Hyderabad, Telangana) Moinabad, Hyderabad, India.

Abstract:

Wireless Power Transfer (WPT), or Wireless Energy Transmission (WET) is a point to point energy transfer through air without using wires or cables. This technology helps the researchers and engineers to have more freedom in designing several systems in different areas of industry, biomedical, healthcare, space applications, satellites, and so on. Life has increasingly become easier and more liberated for the recent generations. The appliances which are nowadays utilized by people might have never imagined by them a century ago. Individuals are seeking more flexibility and motion; hence wireless devices are becoming more desired. Wireless communication has vastly being studied in the last decades. The idea of transferring power without the need for wires and cables has not sufficiently investigated until the last couple of decades tough. When Nicola Tesla introduced the idea of wireless power transfer, not many people invested enough trust in his efforts since they were not insightful to be cognizant of the concept. Years passed until researchers started to devote time to probe into this field of science. The emergence of new material composites also helped develop more competent batteries, another assisting resource for WPT. It helped enjoying more low-profile devices. After all the efforts, still one challenge has not efficiently being addressed. All the devices should be connected to a wall-mounted power outlet.

***Index Terms* – Wireless power transmission, microwaves, MATLAB, magnetron, rectenna.**

I. Introduction

Wireless power transfer (WPT), wireless power transmission, wireless energy transmission (WET), or electromagnetic power transfer is the transmission of electrical energy without wires as a physical link. In a wireless power transmission system, a transmitter device, driven by electric power from a power source, generates a time-varying electromagnetic field, which transmits power across space to a receiver device, which extracts power from the field and supplies it to an electrical load. The technology of wireless power transmission can eliminate the use of the wires and batteries, thus increasing the mobility, convenience, and safety of an electronic device for all users. Wireless power transfer is useful to power electrical devices where interconnecting wires are inconvenient, hazardous, or are not possible.

Wireless power techniques mainly fall into two categories, near field and far-field. In near field or non-radiative techniques, power is transferred over short distances by magnetic fields using inductive coupling between coils of wire, or by electric fields using capacitive coupling between metal electrodes.

Inductive coupling is the most widely used wireless technology; its applications include charging handheld devices like phones and electric toothbrushes, RFID tags, induction cooking, and wirelessly charging or continuous wireless power transfer in implantable medical devices like artificial cardiac pacemakers, or electric vehicles.

In far-field or radiative techniques, also called power beaming, power is transferred by beams of electromagnetic radiation, like microwaves, or laser beams. These techniques can transport energy longer distances but must be aimed at the receiver. Proposed applications for this type are solar power satellites, and wireless powered drone aircraft.

An important issue associated with all wireless power systems is limiting the exposure of people and other living beings to potentially injurious electromagnetic fields.

II. RESEARCH METHODOLOGY

A. Structure of array at 2.4 GHz

The system consists of a pair of identical arrays, a transmitting and a receiving antenna which is displayed in Fig. 3.2. The reason for choosing identical arrays is the simplicityof the design and analyzing the results. Distancing between the two antennas is d. The antenna is a 4×4 array of triangular patches fed by a coaxial line beneath the substrate. The patches are fed by inset method and the coax probe is connected to the middle of the feedlines. The energy dissipation is relatively low in the current structure which leads to high efficiency of power transmission. Dimensions of the array and the feeding lattice can be found in Table 3.2. To achieve the desired characteristics of the structure, an appropriate distance should be selected. S21 or transmission coefficient describes the amount of power received at the second antenna relative to the power transmitted at the transmitter antenna. Along the x axis, the patches are H-plane coupled and along the y axis, they are E-coupled.

Several benchmarks are used in deciding the quality or efficiency of the power transfer system. An accepted one is the transmission coefficient calculated by:

$$= 10^{(S21/10)} \times 100\%$$

B. 2.4 GHz array model

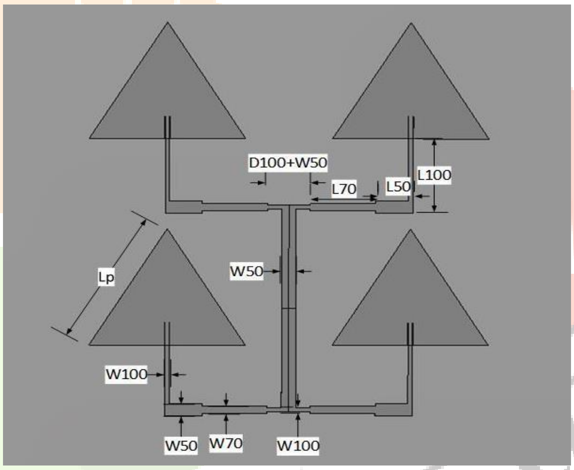

Fig 2.1:The structure of array and feedlines.

Table 2.1:Dimensions of the Array Antenna at 2.4 GHz.

Array Dimension	**Lp**	**L50**	**W50**	**L70**	**W70**	**L100**	**W100**	**D100**
Size (mm)	53.6	13	5	23	3	30	1.5	10

C. 5.8 GHz array model

The array operating at 2.4 GHz might be large for some ISM applications. Especially, for the biomedical applications, a smaller system might be needed. Therefore, the array is designed at 5.8 GHz because higher frequency provides smaller dimension. We will check if the configuration has the same transfer efficiency if used at 5.8 GHz. The structure schematic is similar to Fig.2.1.

D. Tilted array at 2.4 GHz

The array consists of 2×2 elements which are 45 degree off-axis rotated. An identical antenna functions as the receiver antenna to have the best coverage between two antennas. Fig. 2.2 shows a schematic view of the tilted array. The dimensions are similar to the array at 2.4 GHz.

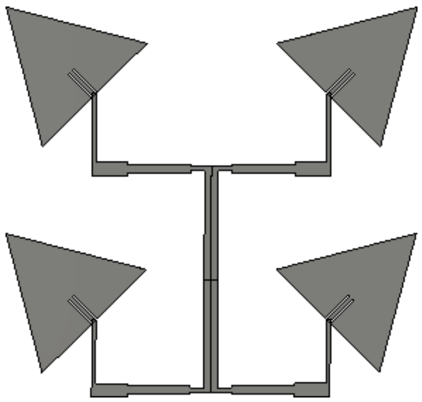

Fig 2.2: Tilted array at 2.4 GHz

III. RESULTS AND DISCUSSION

A. Array results at 2.4 GHz

The reflection coefficient for the array configuration is -28 dB at the center frequency of 2.4 GHz as displayed in Fig. 3.1. The transmission coefficient is -0.55 dB at 2.4 GHz corresponding to a power transfer efficiency of 89% at the center frequency and 50 mm distancing depicted in Fig. 3.2, compared to the single patch which offers 44% of power transfer efficiency with the same distancing and frequency band. The radiation pattern is seen in Fig. 3.3 which provides a 17.7 dB gain compared to 3 dB gain for single patch at the same frequency. Figure 3.4 shows the 3D gain pattern of the array.

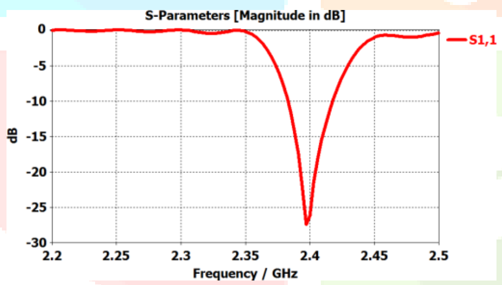

Fig 3.1: S11 parameter of array antenna at 2.4GHz

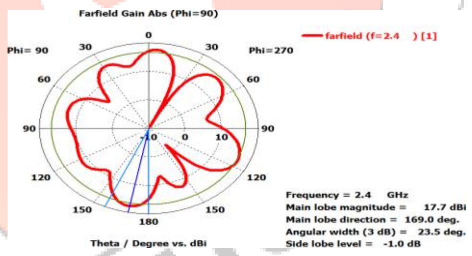

Fig 3.3: Radiation pattern of array antenna system at 2.4 GHz

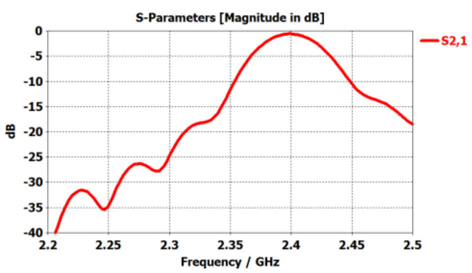

Fig 3.2: S21 parameter of array antenna system at 2.4 GHz

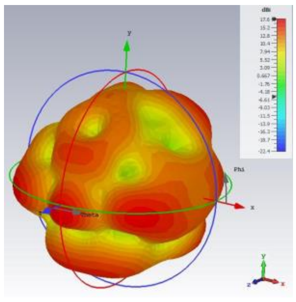

Fig. 3.4: 3D radiation pattern of the proposed array at 2.4 GHz

B. Array results at 5.8 GHz

The array results are obtained for the 5.8 GHz frequency band. The reflection and transmission coefficient are displayed in Fig. 3.5 and Fig. 3.6, respectively. S11 is -26 dB which shows a good impedance matching in the system. The polar and 3D radiation pattern are depicted in Fig. 3.7 and Fig. 3.8, respectively. As seen, S21 is -3.6 dB which accounts for 44% of power transfer efficiency. Compared to the 2.4 GHz array which improved the power transfer of single patch by 45%, the power transfer efficiency at 5.8 GHz is only improved by 11%. It implies that a more efficient design might be needed for higher frequency band.

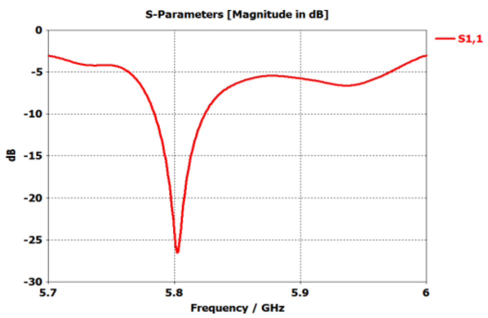

Fig 3.5: S11 parameter of array antenna system at 5.8 GHz

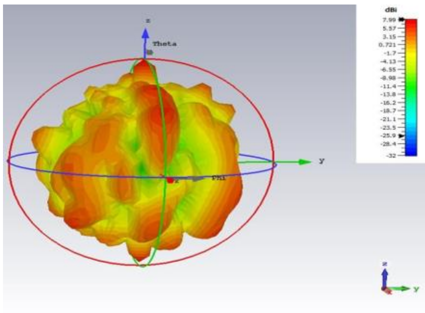

Fig 3.8: 3D radiation pattern of the proposed array at 5.8 GHz

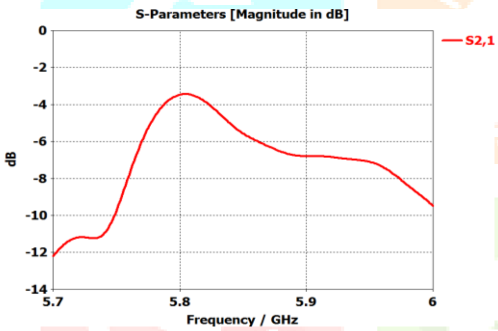

Fig 3.6: S21 parameter of array antenna system at 5.8 GHz.

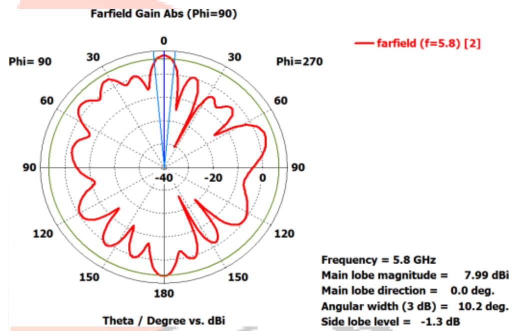

Fig 3.7: Radiation pattern of array antenna system at 2.4 GHz

C. Tilted array results at 2.4 GHz

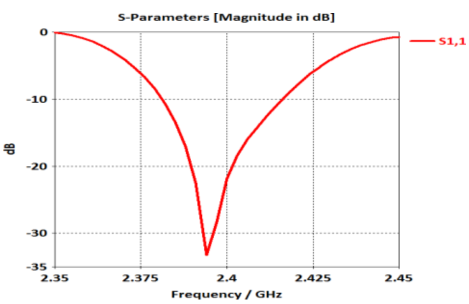

Fig 3.8: S11 Parameter Of Tilted Triangular Array At 2.4 Ghz

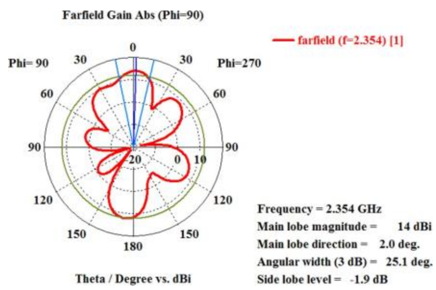

Fig 3.10: Radiation pattern of array antenna system at 5.8 GHz

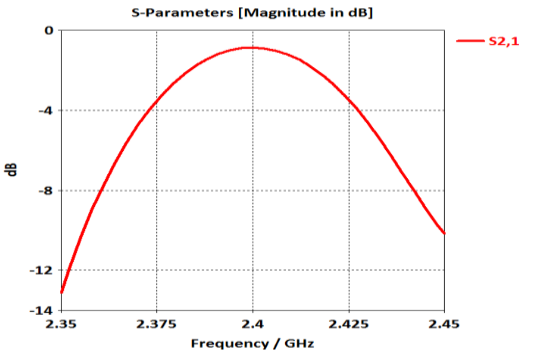

Fig 3.9: S21 parameter of tilted triangular array at 2.4 GHz

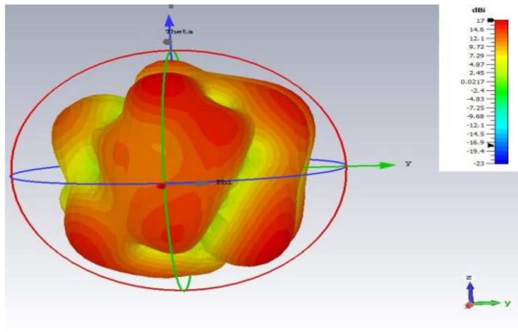

Fig 3.11: 3D radiation pattern of the proposed array at 5.8 GHz

IV. CONCLUSION

WPT has changed our inception of carrying power. It has not been a long time since the idea of transferring energy through air crossed a human being's mind, and it was not untilrecently that researchers started to look seriously into that. The recent works focused on the method of transferring power considering many elements such as efficiency, the amount of power transferred, safety, etc. The motivation behind this thesis was to increase the efficiency of the power transfer compared to the previous works. We have selected microstrip antennas since they enjoy a lightweight and low-profile structure. In this thesis, we have shown that microstrip antennas can be utilized efficiently to carry power wirelessly. One of the main features in deciding whether a WPT system is properis efficiency. We have demonstrated that using an array of triangular patch antennas can improve the efficiency of the system. Moreover, this goal is accomplished by an array which has less elements compared to similar works done before. Both transmit and receive arrays are identical to make sure they have the maximum mutual coverage. The microstrip antenna is selected since it is compact, lightweight and low-profile. Also, it is conformal meaning it can be mounted on any type of device whether planar, cylindrical or any other shape.

The approach that has been used is classified as a type of Near-field method. The design can be used in different applications. A couple of them mentioned as follows:

- This design can be used to transfer power and charge batteries for example inEVs. This type of WPT is most useful in charge stations such as highway EV charge station.
- Moreover, it can be used in biomedical implants such as stunts, defibrillator, and many other life-saving devices.

In this thesis, the novel feature that is used includes using triangular microstrip patches ina 2×2 array. The desired outcome was met which is increasing the efficiency of the powertransmission. The structure is compact, but at the same time it provides high efficiency and proper gain to optimize the power transfer.

V. REFERENCES

[1] A. T. Cabrera, J. M. G. González, José M., J. A. Aguado, Wireless Power Transfer for Electric Vehicles: Foundations and Design Approach, Springer International Publishing, 2020.

[2] J. T. Boys,G. A. Covic, "The Inductive Power Transfer Story at the University of Auckland," IEEE Circuits and Systems Magazine, vol. 15, no. 2, pp. 6-27, 2015.

[3] A. Kurs, A. Karalis, R. Moffatt, J. D. Joannopoulos, P. Fisher, M. Soljacic, "Wireless power transfer via strongly coupled magnetic resonances," Science, vol. 317, no. 5834, pp. 83-86, 6July 2007.

[4] V. R. Gowda, O. Yurduseven, G. Lipworth, T. Zupan, M. S. Reynolds and D. R. Smith, "Wireless Power Transfer in the Radiative Near Field," IEEE Antennas and Wireless Propagation Letters, vol. 15, pp. 1865-1868, 2016.

[5] R. Matias, B. Cunha; R. Martins, "Modeling inductive coupling for Wireless Power Transfer to integrated circuits," in 2013 IEEE Wireless Power Transfer (WPT), Perugia, Italy, 2013.

[6] L. Zhang, C. S. Lee and G. Yang, "Microstrip Antenna with Narrow Patches for Wireless Power Transfer," in 2020 IEEE Texas Symposium on Wireless and Microwave Circuits and Systems (WMCS), 2020.

[7] F. Jolani, Y. Yu and Z. Chen, "A Planar Magnetically Coupled Resonant Wireless Power Transfer System Using Printed Spiral Coils," IEEE Antennas and Wireless Propagation Letters, vol. 13, pp. 1648-1651, 19 August 2014.

[8] L. K. Meng, T. T. Swee, L. K. Yun, J. Kassim, "WIRELESS ENERGY TRANSFER USING MICROSTRIP ANTENNA," American Journal of Applied Science, vol. 11, no. 2, pp. 195-201,20 December 2013.