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CPW Fed Multiple Hexagonal Shaped Antenna for IoT Application

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ABSTRACT

A CPW fed antenna of multiple hexagonal shapes is proposed for Internet of Things (IoT) application. The substrate of the antenna is taken as FR4 epoxy of relative permittivity 4.4 and dielectric loss factor 0.02. The operating frequencies of the antenna are found to be 4.84GHz and 5.88GHz with impedance bandwidth of 80MHz and 70MHz respectively. The gain of radiation of the antenna is 1.4 dBi and 7.43 dBi respectively at the respected resonant frequencies. The operating bands of the antenna are in the ranges of WiFi network with the required specifications of IoT applications.

Keywords: CPW, Multiple hexagonal shapes, Internet of Things, FR4 epoxy, Relative permittivity, Dielectric loss factor

I. INTRODUCTION

The wireless communication has vigorous impact in our daily life. As the demand increases the flexibility of the system should also be increased. Development in combining two or more technology in to a single stream is widely considered in these days. The Internet of Things (IoT) is such a technology which is an integration of Wireless Sensor Network (WSN), Wireless communication network, Software, Actuators etc,. [1]. The virtual mapping of things to things or communication between the physical things without the human interaction is possible through this technology.

The each things or the device which is recognized in an IoT domain is provided with a unique IP address. These devices should also embed with sensors thus they can be identified by the conditions given by the users [2]. This WSN interconnects with wireless communication network such that the mapping of virtual world to physical world and vice versa is possible. The integration of softwares and actuators enables the practical implementations of this technology in the real world. The antenna which is used for IoT domain should works according to some prerequisites such that the operation frequency of the antenna should matched with the frequency ranges of any of the wireless communication network like Bluetooth, WiFi, WiMAX, etc,. [3].

Since IoT is an emerging technology. There should be a limit for the amount of data that has to be transferred through this technology. Otherwise the memory requirement and area of the device must be enlarged in order to compensate power handling which leads to incompatibility of the IoT module with the real world [4]. Thus as per these concerns only

few bytes of data is transferring through this technology so the bandwidth requirement of the antenna is also limited within 1GHz.

The organization of this document is as follows. In Section 2, the dimension and theoretical parameters of the antenna is given. The section 3 presents the simulated results and discussions and Section 4 concludes the work.

II. ANTENNA DESIGN

The substrate of the antenna is chosen as FR4 epoxy material of relative permittivity 4.4 and dielectric loss tangent 0.02. The conductor backed CPW fed antenna having the dimension of 25 × 30 × 1.6 mm^3 .The geometrical shape of the antenna is given in Figure 1.

A conductor backed CPW feeding technique is used for the proposed antenna where third ground plane acts as the third return conductor which covers the entire back side of the substrate [5]. The radiating patch of the antenna is a combination of five hexagons and one circle. The continuous disturbance in the geometry of the antenna alters the distribution of the surface current which makes deviations in the phase of the current [6]. This enables the antenna to exhibit more than one resonant frequency of operation [7].

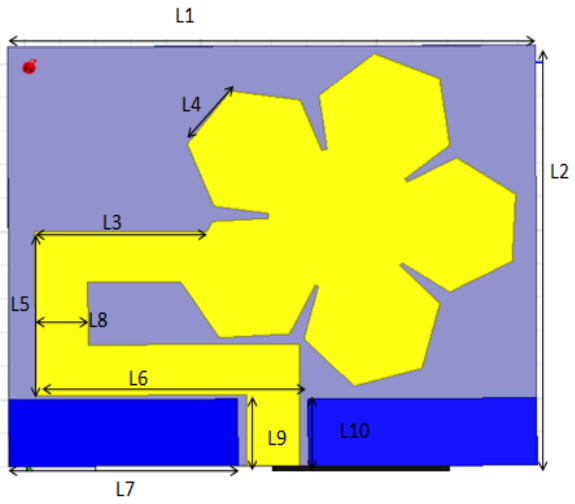

Figure 1. The structure of the antenna

The parametric dimensions of the antenna is given in the Table I.

TABLE I

The dimensions of the antenna

Parameter	Dimension(mm)	Parameter	Dimension(mm)
L1	25	L6	15
L2	30	L7	13
L3	13.5	L8	3.75
L4	10	L9	5
L5	9.75	L10	4

III. SIMULATED RESULTS AND DISCUSSION

The characteristics of an antenna is depending upon certain parameters like reflection coefficient, radiation pattern, VSWR, gain, directivity, radiation efficiency etc, These parameter values are discussed here for the proposed antenna.

A. Reflection Coefficient

Reflection coefficient is simply gives the idea of how much power is reflected back due to the impedance mismatch in the transmission medium. Generally the impedance bandwidth of the antenna is selected in the range of frequencies at which have the reflection coefficient or S_{11} value less than -10dB. The simulated graph of reflection coefficient Vs frequency is given in Figure 2.

The operation frequency bands of the antenna are (4.79-4.88) GHz and (5.84-5.91) GHz with impedance bandwidth of 80MHz and 70 MHz respectively. The resonance frequencies are 4.84 GHz and 5.88 GHz is in the ranges of the WiFi bands with the peculiarities of IoT applications.

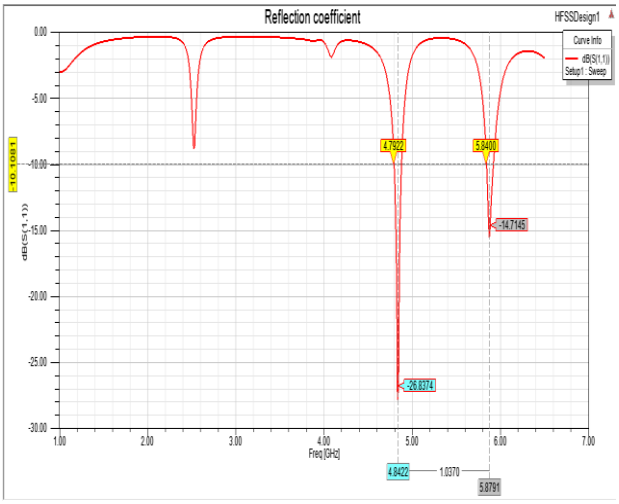

Figure 2. The S_{11} value in dB Vs frequency graph

B. Voltage Standing Wave Ratio (VSWR)

The VSWR value of the antenna gives how much efficiently the power is transmitted. The value of VSWR is less than 2 for perfect impedance match between the antenna and the transmission line. The simulated result of VSWR is shown in the Fig .3

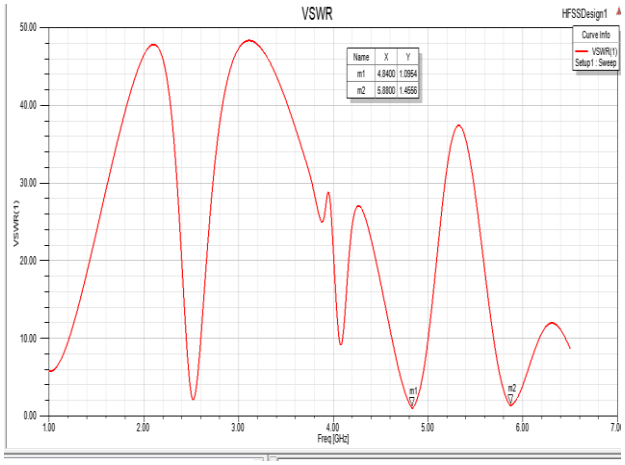

Figure 3. The VSWR value Vs frequency graph

The simulated results shows that the antenna exhibits perfect impedance match in the resonating frequencies 4.84 GHz and 5.88 GHz with the VSWR values of 1.09 and 1.45 respectively.

C. Radiation Pattern

The Radiation Pattern of the antenna illustrates about the radiation of the antenna in space. The primary sweep of the radiation pattern is the elevation angle. For the two values of azimuthal angle, 0 degree and 90 degree the radiation pattern is simulated and illustrated in the Figure 4 and Figure 5 for the respected resonant frequencies.

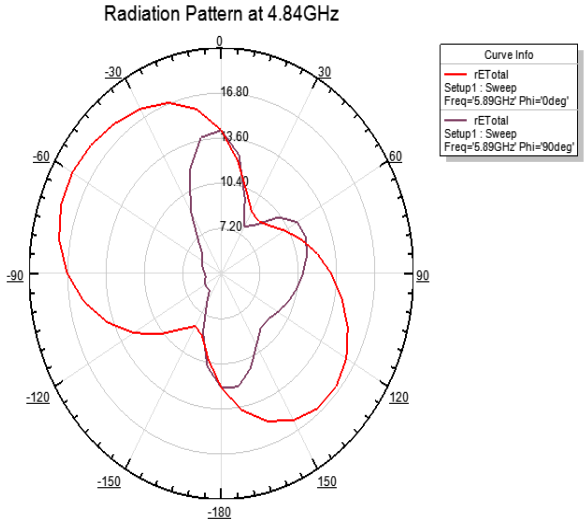

Figure 4. The Radiation pattern of the antenna at 4.84 GHz

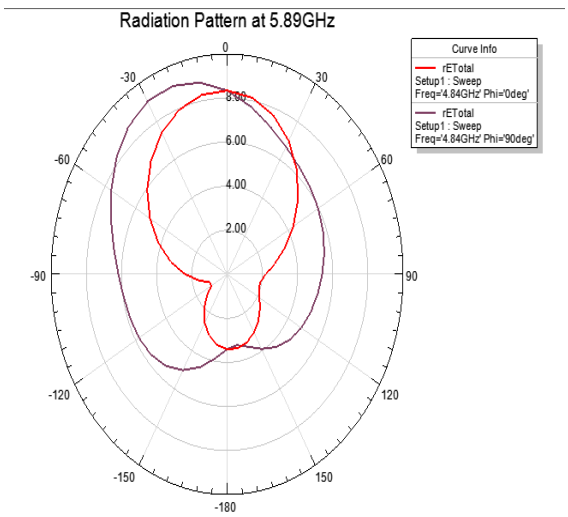

Figure 5. The Radiation pattern of the antenna at 5.88 GHz

D. Gain of the Antenna

The gain of the antenna is the parameter which describes the performance of the antenna in the far field. The simulated results of the gain of the antenna

at resonant frequencies are given in the Figure 6 and Figure 7.

The antenna proposed antenna is radiating in the far field with the gain of 1.4 dBi and 7.43 dBi at 4.84 GHz and 5.88 GHz respectively.

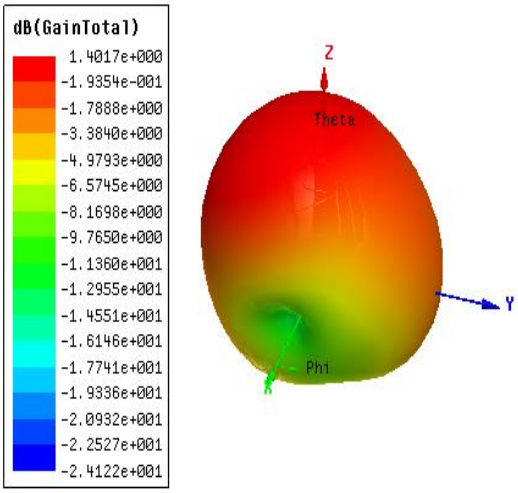

Figure 6: The Gain of the antenna at 4.84 GHz

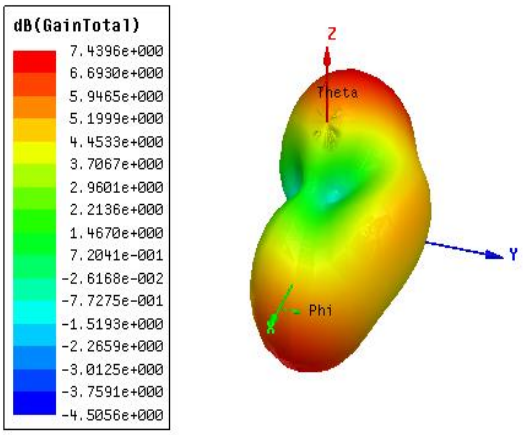

Figure 7. The Gain of the antenna at 5.88 GHz

The total performance of the antenna is shown in the Table II and comparison with the existing model in the current scenario is also provided Table III.

TABLE II

The overall performance of the proposed antenna

Parameter	**Value at 4.84 GHz**	**Parameter**	**Value at 5.88 GHz**
Bandwidth	80MHz	Bandwidth	70MHz
VSWR	1.09	VSWR	1.45
Gain	1.4dBi	Gain	7.43dBi
Reflection Coefficient	-26.8dB	Reflection Coefficient	-14.7dB

TABLE III

The overall performance of the antenna [8]

Parameter	**Value at 4.72 GHz**	**Parameter**	**Value at 5.73 GHz**
Bandwidth	890MHz	Bandwidth	720MHz
VSWR	1.15	VSWR	1.16
Gain	1.8dBi	Gain	2.5dBi
Reflection Coefficient	-22.7dB	Reflection Coefficient	-22.1dB

According to the comparison table the proposed antenna is providing better reflection coefficient and VSWR value at first resonant frequency and better gain at second resonant frequency.

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IV.CONCLUSION

A CPW fed dual band antenna for IoT application with multiple hexagonal shape is introduced in this work. The resonant frequencies of the antenna found as 4.84 GHz and 5.88 GHz with impedance bandwidth of 80 MHz and 70 MHz respectively. The working ranges of the antenna at respected frequencies are (4.79 GHz-4.87 GHz) and (5.84 GHz-5.91 GHz) with gain of 1.4dBi and 7.43 dBi respectively.

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