Design and Parametric Analysis of Wideband Micro-Strip Patch Antenna With CPW-FED

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Research Article

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Abstract

A design and parametric analysis of patch antennas (MPA) with coplanar waveguide (CPW-Fed) for wideband application. It is analyzed a compact coplanar waveguide patch antenna that has dimensions of 35 mm x 39 mm. Compact Inverted U-slotted-shaped antenna uses the material with a dielectric constant of 4.3 and the height of the antenna is h =1.6 mm. This paper analysis of different parameters of antenna dimensions and designs compact CPW-fed patch antennas for the range from 3.20GHz to 7.94 GHz. The main purpose of the parametric analysis of proposed antennas is to achieve higher impedance bandwidth for wideband applications.

1. Introduction

In the earlier few decades, the rapidly increasing requirements of high data rates. After that scientists/researchers develop and design, simulate, and fabricates fast-growing communication devices as per today's scenario/ requirements in the field of wireless communications. Which are fulfill the requirement of high rates simultaneously multiple users use that technology or communication devices. One of the communication device's names is Microstrip antennas that are helpful during signal processing. This patch antennas technology came into existence in the era of 1970s. The MPA consists of two conducting layers separated by a dielectric substrate [1]-[3]. Microstrip antenna is solitary of the greatest rising segments in telecommunication engineering and a promising technology to be used in the prospect of telecommunications [4]. Moreover, the narrowband antenna can maintain reasonable gain and established radiation patterns throughout the application band. This narrow-band is the main drawback of a microstrip [5]. This mechanism can meet the requirements of a great variety of users from those in developing nations wanting to connect a novel extraordinary speed data network with very cheaply and time required to connect a wired network, to those in rural regions wanting fast access where wired explanations may not be practical, for the reason that the spaces and charges involved [6, 7]. Now a day’s many researchers are working in the field of this microstrip patch antennas technology for the design and analysis of multi-band and broad-band antennas for some communication devices [8]-[9]. Today's market demands in the field of wireless communication systems are smart, cognitive, wideband, compact size, and high data rates for commercial and military applications [10, 11].

2. Design And Parametric Analysis Of Antennas

A wideband is achieved by keeping the primary resonant frequency very close to the basic designed frequency and without affecting the nature of broadside radiation characteristics. The design concepts of antennas are presented and simulation results are discussed. Firstly select the frequency range for simulation of proposed antennas. The material is used for designing the proposed antenna is very important because all the parameters of antennas (bandwidth, gain, return loss, etc) depend on the material's dielectric constant, its height, and dimensions of antennas (like length and width). The dimensions of the antenna is compact as compared to existing designed antennas and its dimensions is (35 x 39) mm^2. Parametrically designed antennas for simulations are shown in Fig. 1 (i), (ii), (iii), and (iv).

TABLE I: Parametric analysis between Antennas1, 2, 3, 4 and proposed antennas 5

Antennas dimensions	Antenna 1 (35x39) mm^2	Antenna 2 (35x39) mm^2	Antenna 3 (35x39) mm^2	Antenna 4 (35x39) mm^2	Proposed antenna 5 (35x39) mm^2
L	35	35	35	35	35
W	39	39	39	39	39
W_1	15.50	15.50	15.50	15.50	15.50
W_g	18.89	18.89	18.89	18.89	18.89
L_1	14	14	14	14	14
L_2	11.50	11.50	11.50	11.50	11.50
L_3	8	8	8	8	8
L_4	4.5	4.5	4.5	4.5	4.5
L_5	8.5	8.5	8.5	8.5	8.5
L_6	9	9.5	9.5	9.5	9
L_7	13	8.5	8.5	8.5	8.5
L_8	19.50	19.50	19.50	19.50	19.50
G	2	2	2	2	2
g	0.3	0.3	0.4	0.4	0.4
h	1.6	1.6	1.6	1.6	1.6
W_f	2.55	2.6	3.39	3.39	3.39
s	…	…	3	…	2

The Computer Simulating Technology software is basically used for designing of Microwave components, antennas and other electromagnetic devices, in here this software is used for design, simulate and parametric analysis of antennas whose physical dimensions are given in table 1. The designed antennas for parametric analysis are shown in Fig. 1. And the final proposed antenna is shown in Fig. 2. The optimized antennas have found out impedance matching which corresponds to 50 Ω characteristic impedance. So now describes the proposed antenna structure dimensions.

3. Simulation Results Of Proposed Antennas

The antenna will be simulated and analyzed using computer simulation technology (CST) software. The reflection coefficient ($|S_{11}|$) curves against the frequency are shown in Fig. 3. The gain curves and radiation efficiency curves are against the frequency are shown in Figs. 4 and 5, respectively.

In Fig. 3 the Return loss and VSWR of antennas 5 is shown, -49.93dB & 1.004 at 3.35 GHz, -14.472 dB & 1.49 at 3.87 GHz, -30 dB & 1.04 at 4.73 GHz, -22.10 dB & 1.16 at 5.3 GHz, -45.74 dB & 1.002 at 6.15 GHz, -67.89 dB & 1.002 at 6.35 GHz, -21.85 dB & 1.18 at 7.3 GHz.

The gain plot shows above in Fig. 4. The antennas 5 maximum gain is 3.60 dBi and the Impedance Bandwidth percentage is 85.

Figure 6 (a), (b), (c), (d), and (e) shows the current distribution furthermore exploration of wideband operation mechanism.

4. Outcomes

A parametric analysis was carried out by varying the dimensions of length, the width of slots, and the patch. This proposed wideband CPW-fed micro-strip patch antenna is simulated using Computer Simulation Technology software. The simulation results of the antenna 5 are wideband bandwidth, along with compact size of antennas and meandered gain, which is used suitable for C-Band and wireless applications.

TABLE II: Comparative analysis of antennas parameters, Bandwidth, Gain, Return loss, and VSWR between Antennas 1, 2, 3, 4, and Antennas 5 (Proposed)

	Size(mm)	Frequency range (GHz)	BW (%) & Gain (dB)	|S11| in dB & VSWR
Antenna 1	35 x 39	2.51-3.96GHz (1.45) And 5.2-5.9GHz(.7)	44.823%, 12.61 % and 2.07, 3.67	-28.43 & 1.07 at 2.63, -13.82 & 1.5 at 3.05, -12.56 & 1.62 at 3.27,-20.84 & 1.19 at 3.64 And – 14.88 & 1.43 at 5.45
Antenna 2	35 x 39	3.23–7.96 (4.73)	84.5 % & 3.50	-58.38 & 1.01 at 3.39, 39.59 & 1.013 at 4.76 18.92 & 1.25 at 5.28 48.46 & 1.01 at 6.19 46.13 & 1.01 at 6.35 22.29 & 1.15 at 7.31
Antenna 3	35 x 39	3.24–7.96 (4.72)	79.32% & 3.67	-43.52 & 1.0042 at 3.41, -27.02 & 1.36 at 3.72, -22.09 & 1.2 at 4.74,48.27 & 1.16 at 5.36, -45.814 & 1.004 at 6.33, -21.57 & 1.18 at 7.3
Antenna 4	35 x 39	2.5–2.6(.1) & 3.15–3.42(.27) & 3.64–7.92(4.28)	74% & 3.71	-10.46 & 1.87 at 2.61,-48.066 & 1.002 at3.27, -13.63 & 1.5 at 3.9, -36.66 & 1.02 at 4.69, -21.54 & 1.18 at 5.3, -43.17 & 1.002 at 6.15, -38.95 & 1.009 at 6.3, -21.19 & 1.19 at 7.33
Antenna 5 (Proposed)	35 x 39	3.20–7.94(4.74)	85 % & 3.60	-49.93 & 1.004 at 3.35, -14.472 & 1.49 at 3.87, -30 & 1.04 at 4.73,-22.10 & 1.16 at 5.3, -45.74 & 1.002 at 6.15, -67.89 & 1.002 at 6.35, -21.85 & 1.18 at 7.3

The impact of process variations on the electrical response of patch antennas was also investigated. A wideband microstrip patch antenna is proposed using CPW-fed, microstrip feed, and coaxial feed which may be useful for the Next Generation Wireless Technologies. After the design and analysis of a compact wideband microstrip antenna with CPW-Fed structure is comparable to existing results of the literature survey.

TABLE III: Comparison analyses of different designed antennas parameters with proposed antennas parameters

S. No.	Published literature references	Size (mm)	Operating frequency band	Substrate & permittivity	Feeding method
1	Pan et al.	48x58	2.01–4.27 GHz & 5.06–6.79 GHz	Teflon (2.65)	Micro strip feed
2	Karli & Ammor	60x70	2.72–2.76 GHz & 6.62-7.5GHz	FR-4	Microstrip feed
3	Tsai	50x50	1.90–2.75 GHz & 3.65-6.75GHz	FR-4(4.4)	CPW-Fed
4	Wu et al	75x75	2.410–2.785 GHz & 4.575-6.355GHz	FR-4(4.7)	Coaxial feed
5	Jen-Yea Jan, Chien-Yuan Pan, Kuo-Yung Chiu, and Hua-Ming Chen	50x50	3.3–3.8 GHz,3.2–4.2 GHz	FR-4(4.4)	CPW-fed
6	M.T. Islam, N. Mishran, M.N. Shakib, Y. Bahrin	37x37	5.02–5.42 GHz	RT5880 (2.2)	CPW-fed
7	Proposed antenna	35x39	1.78–5.56 GHz & 6.49–8.02 GHz	FR-4(4.3)	CPW-Fed

5. Conclusion

In this paper, five antennas are analyzed and simulated all antennas using CST simulation software. The Simulated results of all antennas are compared with each other. The comparative simulated results are shown in table 2, the Antenna 5 is proposed antennas which simulated results are suitable for wideband applications C-Band from 4–8 GHz. After designing and optimization of proposed antennas its simulated results are compared with existing literature survey papers. The comparative simulated results are shown in Table 3. CPW-fed is used for enhancing bandwidth, enhancement of gain, and calculate the lower return losses, etc. We are using the CST simulation tool for simulation and design, where we are using material ($\varepsilon r = 4.3$) and taking a height of 1.6 mm. It is useful for all applications; ranges from 3.20 GHz to 7.94 GHz.

Declarations

Funding: Not Applicable.

Conflict of Interest: The authors declare no conflict of interest regarding the publication of this research paper.

Availability of data and material: Not Applicable.

Code availability: All the experiments have been performed using standard Computer Simulation Technology (CST) studio software.

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Figures

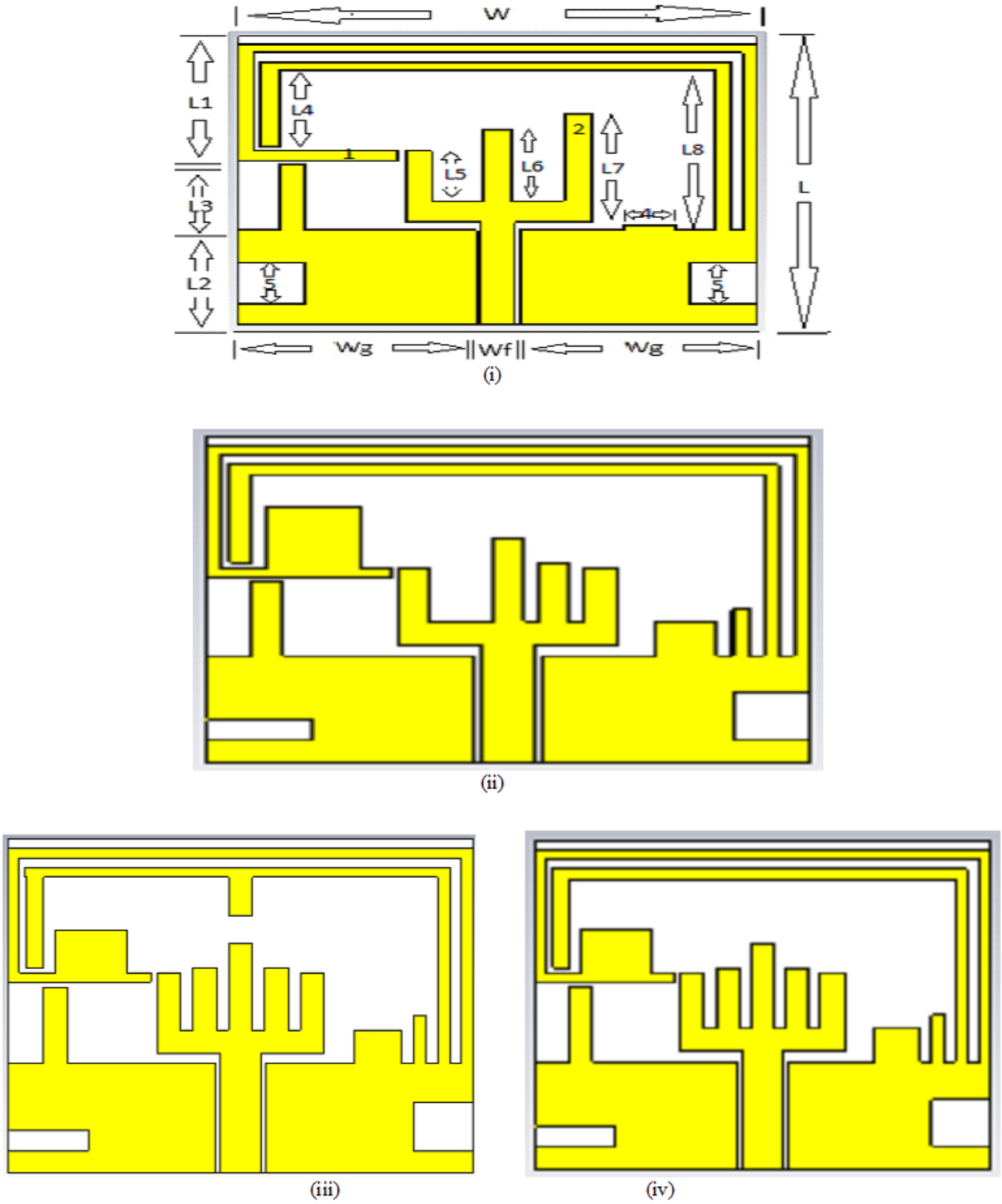

Figure 1

Schematic diagram of (i) the antenna1 structure (ii) the antenna2 structure, (iii) The antenna3 structure, and (iv) the antenna4 structure

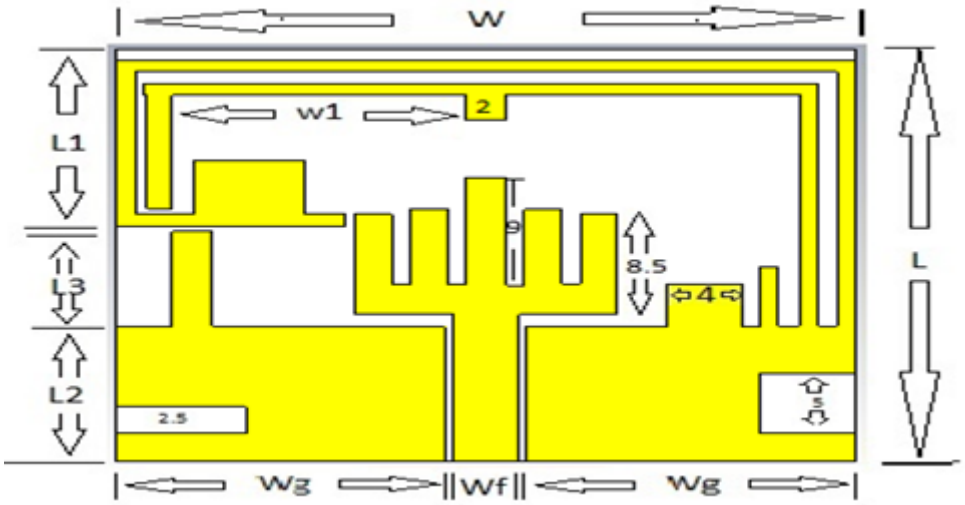

Figure 2

The Simulated structure of antenna 5

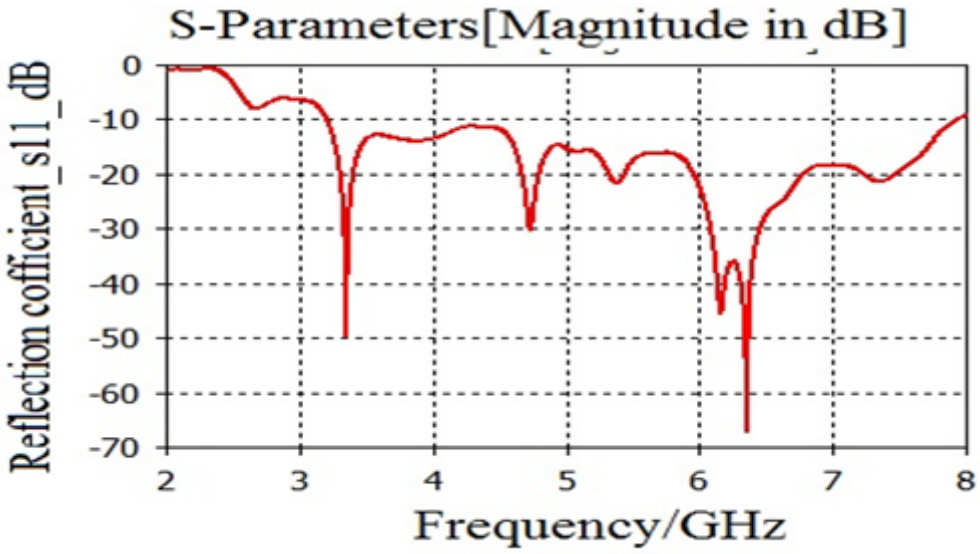

Figure 3

EM Simulation results of |S11| of the antenna 5

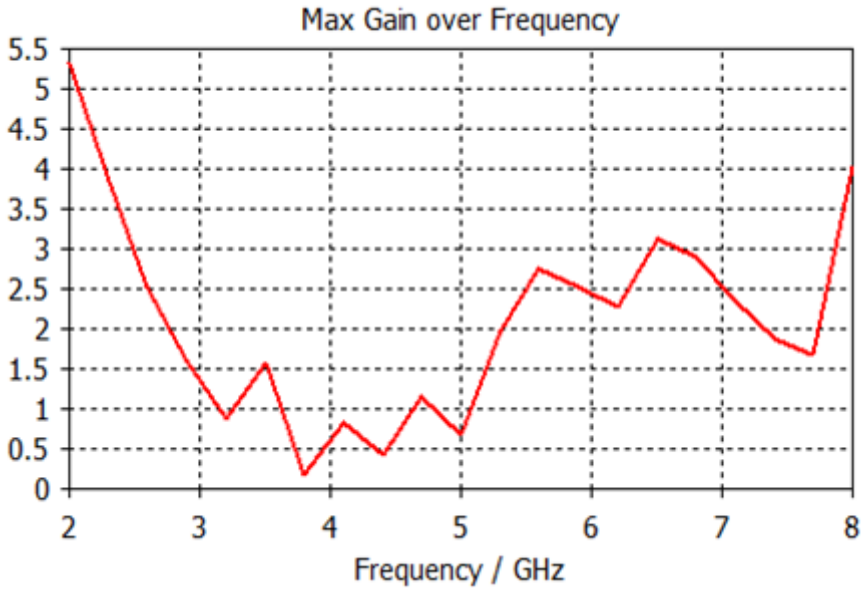

Figure 4

Gain plot of antennas 5.

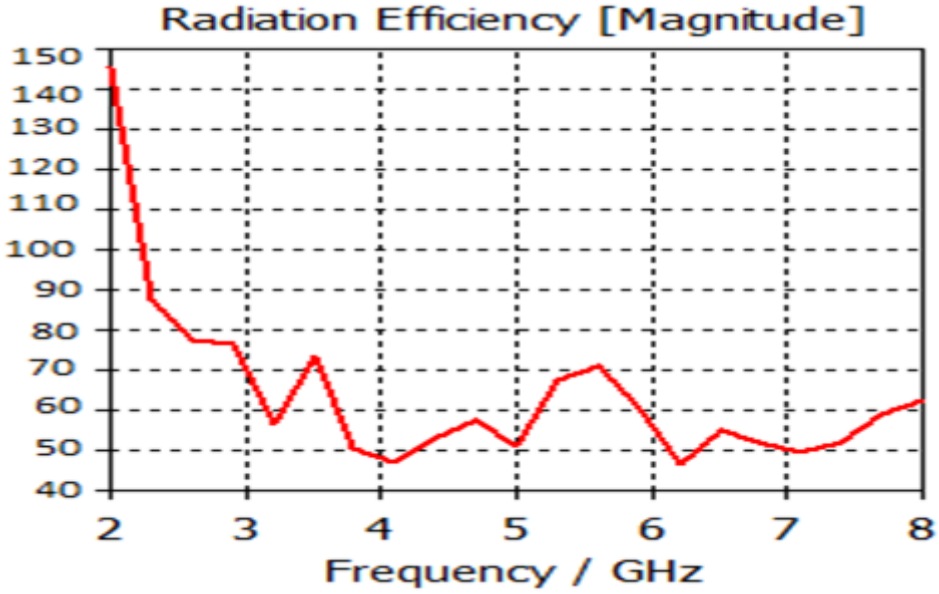

Figure 5

The radiation efficiency of the antenna 5

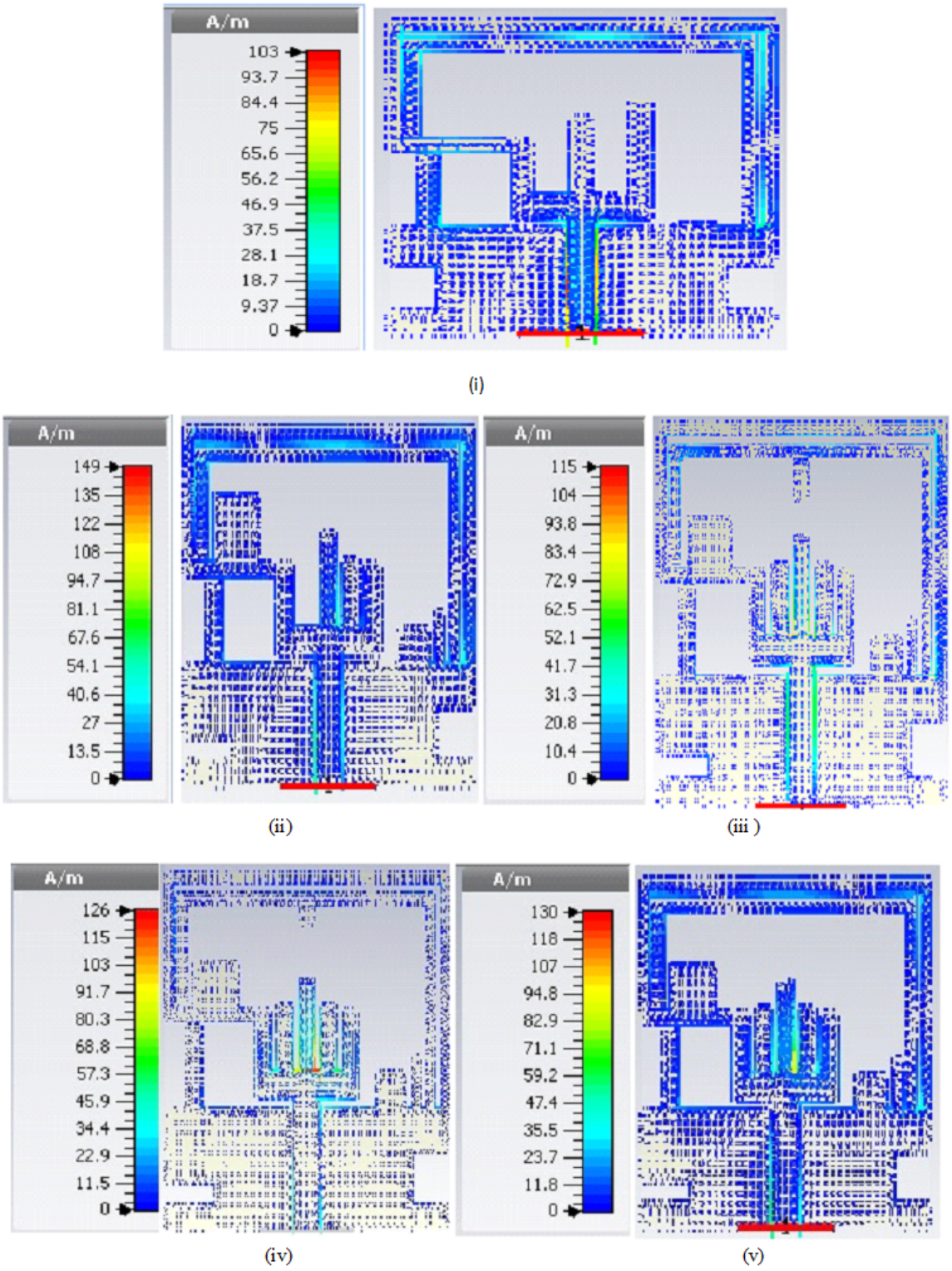

Figure 6

(i), (ii), (iii), (iv) and (v) shows the current distribution of antenna 1, 2, 3, 4 and 5