Designing a Multiband Multi Polarization BTS Antenna

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Abstract

In this paper, a new antenna is presented which has an application in cellular telecommunication systems. The designed antenna works at the frequency range of 1900-2600 MHz which is able to cover 2G, 3G and 4G (LTE) services of the cellular telecommunication. In this paper, the micro-strip structure has been used to design the antenna. The shape of the patches is triangular where a peripheral ring has been employed around the patches. A number of slots have been used over patch to increase the antenna efficiency. The obtained bandwidth for VSWR<2 is 56%. The antenna gain has been obtained within the frequency range of above 15 dB performance. The compressed dimensions, having two orthogonal polarization and simple antenna feed are considered as the advantages of the designed antenna.

Keywords: base station antenna, two-band antennas, two polarization antenna

1. Introduction

Due to the deployment of the wireless telecommunication system and increasing users of such applications, the tendency to cellular wireless telecommunication system has a significant growth. In recent years, major progresses have been made in the field of base transceiver station (BTS), however, a comprehensive design to satisfy all the requirements of a wireless telecommunication service has not been provided yet. On this basis, the major challenges in the design of cellular telecommunication antennas still remain. Having proper dimensions, high gain, sufficient bandwidth, simple feed, easy to install and pure polarization are some of the important features of the applied antennas in cellular telecommunication system.

In previous literature, the antenna gain is low, but the antenna recursive losses are desirable. In [1], a new antenna has been presented with very high bandwidth where the antenna recursive losses are very low and the discussion has focused on VSWR antenna. In [2] the structure of a new antenna has been proposed, but the gain of this antenna is about 8dB. In [3], a new antenna has been designed where its polarization is45°. This antenna consists of four bipolar elements so that they are placed orthogonal and these elements are as horizontal and vertical bipolar. In this paper, the antenna elements have been placed within the cylinder for omnidirectional radiation. The antenna recursive loss is -15dB at 1.9-2.2 GHz and its bandwidth is about 15% and 1dB gain has been obtained. In [4], an antenna has been designed which is applicable in fourth generation. In this paper, for VSWR<2, 47% bandwidth and 8dB gain are obtained.

In this paper, a new antenna structure is presented which satisfy requirements relatively in LTE systems. In section 2, the antenna structure is given. In section 3, the feed structure is discussed. In section 4 the results are presented and section 5 gives discussion and conclusion.

2. Proposed antenna structure

The structure of the bipolar antenna has been represented in figure 1. As shown in figure 1, in this antenna four patches with triangular shape have been used, so that to make two orthogonal polarizations, these four patches are placed facing each other and they are perpendicular to each other. This antenna is built initially and then placed on a 60 × 60 mm2 square dielectric sub layer. It is made up of RO4003C-1.524 mm and the loss tangent is 0.0021 and 3.55 dielectric. In the side edges of the antenna patch, the shape of curve is used. A rectangular slot with identical dimensions is applied on each triangular patch in order to optimize the bandwidth of low frequency. The dimension of triangular patch antenna and rectangular slot has been shown in table 1. L2 and W2 are the length and width of the rectangular slot, respectively. t is also the thickness of antenna patch. The triangular antenna patch feeds from the vertex of the triangular patch. The current distribution over the triangular antenna has been shown in figure 2.

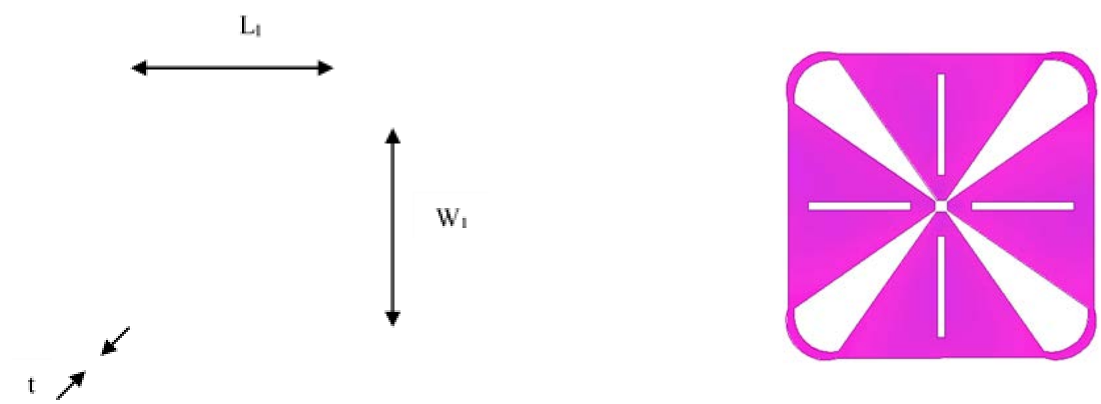
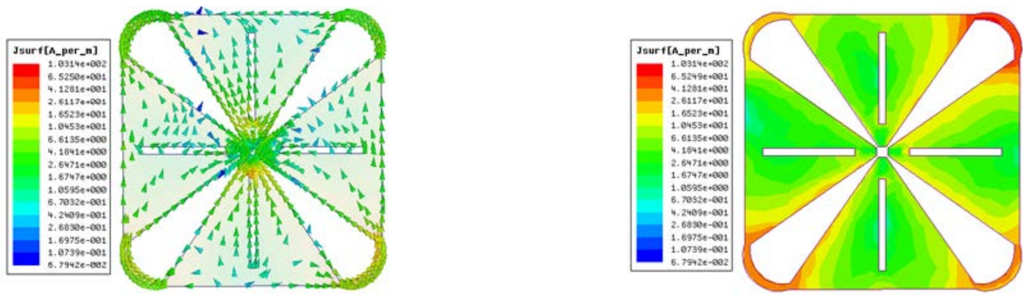


Fig.1. Ideal power curve of a wind turbine

Table 1. dimensions of triangular antenna patch (in terms of mm2)

h_c	L_1	W_1	L_2	W_2	t	parameter
60	40.32	40.32	20	1.6	1.416	value)mm(



a) Current (flow) distribution b) Surface current distribution

Fig.2. current distribution on antenna

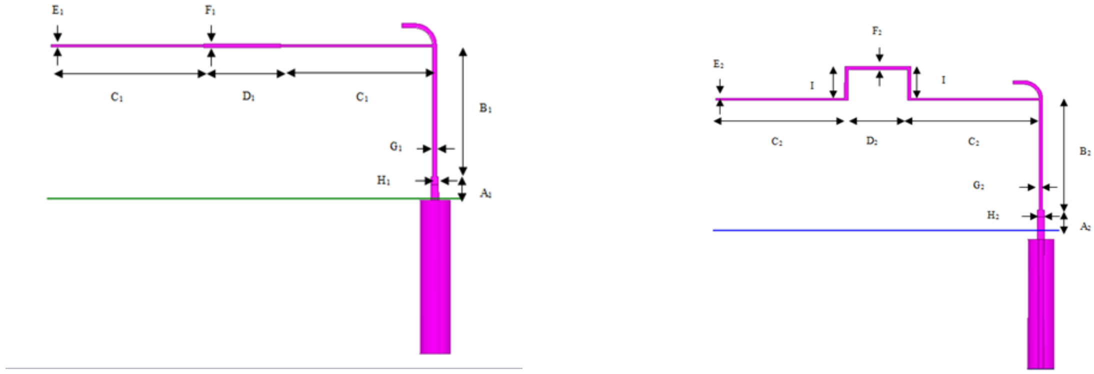
As shown in figure 2, the antenna feeds from the vertex of triangular patch and the current is distributed from the vertex of triangular and reaches to the edges of triangular. This patch is similar to paper [1] where just the antenna patch is triangular and edges are as nodes. according to this fact that the current is maximum in nodes, so it changes the edges in this paper and becomes as curved shape to make current distribution easy and has resulted in maximum radiation. As it can be seen in figure 2, a rectangle slot has been used with identical dimensions which make it different from [1], so that this alteration has led to improve the antenna efficiency at low frequency.

3. Antenna feed

Due to this fact that in the BTS antenna, applied in this paper, four triangular patches have been used fronting each other, so it is necessary that two feeds are used to motivate antenna elements in order to make two perpendicular polarizations. The coaxial cable is used for antenna feed. According to this fact that the impedance of the coaxial cable is 50ohm, to adapt the antenna impedance and source, it is necessary that the antenna impedance would also be 50 ohm in order to transmit maximum power to the antenna and reduce loss.

To adapt impedance, micro strip transmission lines have been used and shown in figure 3.

One of the transmission lines is similar to [1] and the other one is changed due to isolation between two spans. These feeds are placed on a sub layer made up of RO4003C- 1.524 mm, 0.002 loss tangent and 3.55, dielectric with 70 $\times$ 58 mm^2 dimension. There are micro strip lines on one side of the sub layer and ground plane on the other side. Both micro strip feed lines are connected to the coaxial cable where the type of its dielectric is considered as Teflon in simulation in order to be close to the real state. All dimensions of the micro strip feed lines are given in table 2.



(a) (b)

Fig.2. a brief block diagram of the proposed PMSG wind-energy system [2].

Table 2.dimensions of micro strip feed lines (mm)

Microstrp line. 1	مقادیر	Microstrp line. 2	مقادیر
A_1	3mm	A_2	3mm
B_1	17mm	B_2	17mm
C_1	20mm	C_2	20mm
D_1	10mm	D_2	10mm
E_1	0.25mm	E_2	0.25mm
F_1	0.5mm	F_2	0.5mm
G_1	0.5mm	G_2	0.5mm
H_1	1mm	H_2	1mm
		I	5mm

4. Results

In this section, the results of the proposed antenna are presented according to the antenna structure given in section 2 and antenna feed given in section 3. According to this fact that the recursive loss is significant on antennas, the less the recursive loss, the higher the antenna power is; so the antenna radiation is improved.

The antenna recursive loss of both spans is shown in figure 4.

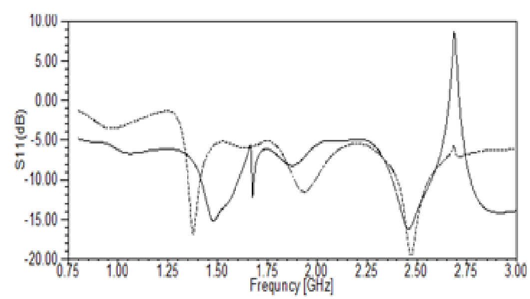


Fig.4.recursive loss of both spans (the bold line is for span 1 and dashed line is for span 2).

As figure (4-1) shown, the recursive loss of span 1 is at 1.481 GHz, 15dB. This loss is about 16 dB at 2.46 GHz which is a better result. In feed 2, it is 16 dB at 1.376 GHz and 19.6 dB at 2.475 GHz which is an improved result .

Another parameter describing the antenna efficiency is the VSWR diagram in terms of frequency. VSWR is a reflective wave ration which is created at a point antenna and micro strip lines (feed) are connected and the when its value is low, the antenna loss is also lower and more power of feed reaches to antenna. Usually, its value is chosen between 1 and 2. As there are two feeds in the proposed antenna, two VSWR diagrams have been used in terms of frequency, as shown in figures 5 and 6. Figures 5 and 6 represent the VSWR diagram in terms of the frequency of feed 1 and 2, respectively.

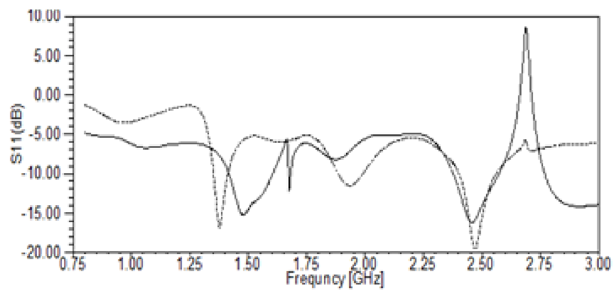


Fig.5. VSWR diagram in terms of frequency (feed 1)

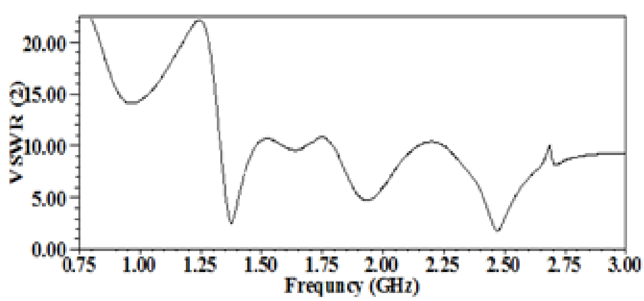
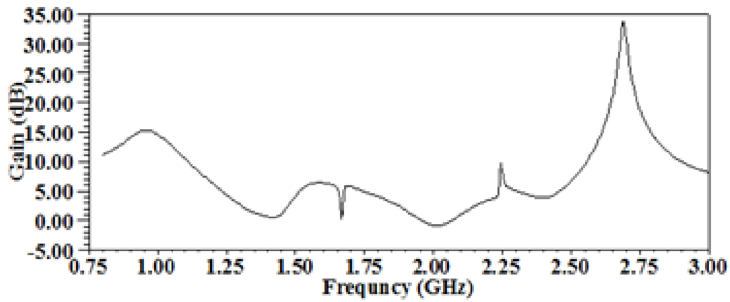


Fig.6. VSWR diagram in terms of frequency (feed 2)

As shown in figure 5, VSWR has the minimum value at 1.476 GHz and 2.454 GHz. Also, in figure 6, VSWR has the minimum value of about 1.82 at 2.47 GHz which is an improved result. The gain of the antenna presented in this paper has been shown in figure 7 in terms of dB over frequency. As shown in figure 7, the obtained gain at 0.9 GHz and 2.72 GHz is 16 dB and about 34 dB, respectively.



Fi.7. gain of the proposed antenna

5. Discussion and conclusion

The design of the proposed antenna is a micro strip antenna in which four triangular patches have been used. Two perpendicular feeds have been applied to feed the antenna where each one is used to motivate the elements of two patches. These two perpendicular feeds lead to two perpendicular polarizations. The triangular antenna patch and antenna feed both are placed on a RO4003C-1.524 mm sub layer and 0.002 loss tangent and 3.55 dielectric coefficient, where at one side of the feed sub layer, micro strip lines are placed and on the other side, the metal ground surface is placed. For antenna efficiency at low frequency, four rectangle slots have been used with the same dimensions on the antenna patch. For better antenna radiation, the triangular patch edges with curved shape have been used.

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