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Microstrip Antenna with Two Circular Grooves Corrugated in Ground Plane

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Abstract

In this paper we present a proposed design of microstrip antenna with enhanced gain and radiation pattern by two circular grooves corrugated ground plane instead of no grooved ground plane conventional aperture-coupled microstrip antenna. In the proposed antenna high gain is achieved by the constructive superposition of the electric fields radiated by the patch and grooves. The simulation shows that gain is increased by 1.03 dB and7.88dB .i.e.13.78dB.with respect to one groove corrugated antenna and conventional antenna.

Keyword: Circular corrugated plate, aperture-coupled, grooves, microstrip antenna.

Introduction

In the field of modern communication systems microstrip antenna has its own importance and known for its small size, low cost, and light weight. Aperture coupling is a way to feed the microstrip antenna and exhibits numerous advantages [1]. The aperture coupled configuration provides a benefit of isolating, the spurious feed line and patch. For much more utilization of such antenna in practical application, gain and directivity must be investigated.

The enhanced transmission phenomenon, found by Ebbesen [5], is used in designing of microwave horn antenna for improved performance. The size of antenna is reduced by inserting a dielectric material with relative permittivity $\varepsilon_r>1$ into the grooves [6].

In this paper a new aperture-coupled microstrip antenna is proposed by replacing the flat ground plane of conventional antenna with a circular corrugated ground plane. For improving the radiation performance of antenna, the constructive superposition of the radiated electric fields, may be helpful. By adjusting the resonance frequency of corrugated ground plate to the value, the optimized gain and radiation performance of the proposed antenna may be achieved. To demonstrate above design concept, this antenna is simulated. The gain of the proposed antenna is investigated. The reason for the improved performance of the proposed antenna is discussed.

Antenna Configuration and design

The proposed antenna with aperture-coupled feed and with two circular grooves is shown in fig.2 while fig.1 shows antenna with one groove in the ground plane. The corrugated ground plate is sandwiched in between two Rogers RT 5880 substrates.

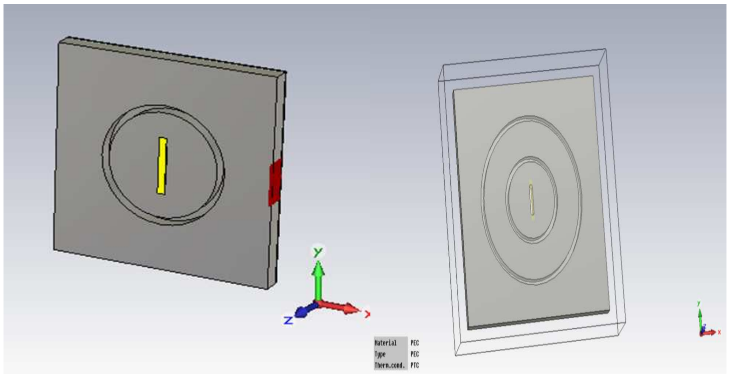

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Fig:-1 Antenna with one circular groove in the ground plane Fig:-2 Proposed antenna with two circular groovesin the`ground plane

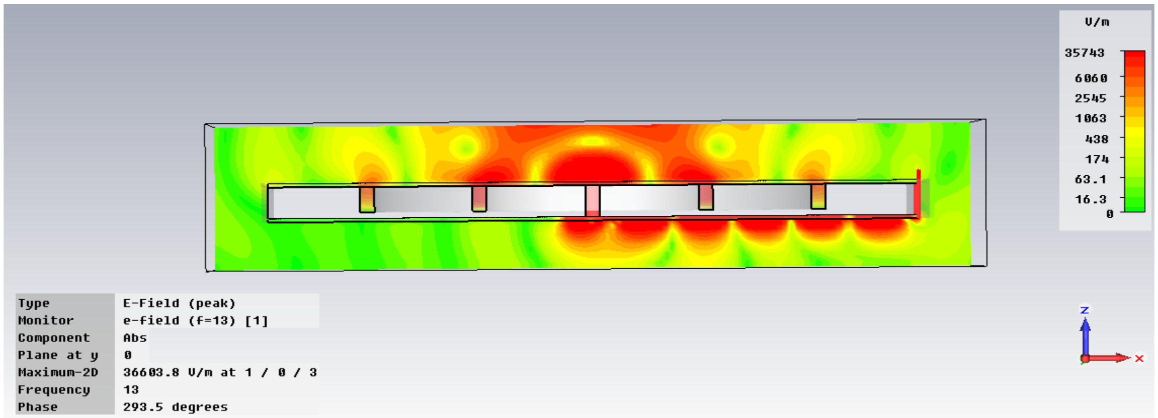

Fig:-3 Constructive superposition of radiated electric fields of the proposed antenna

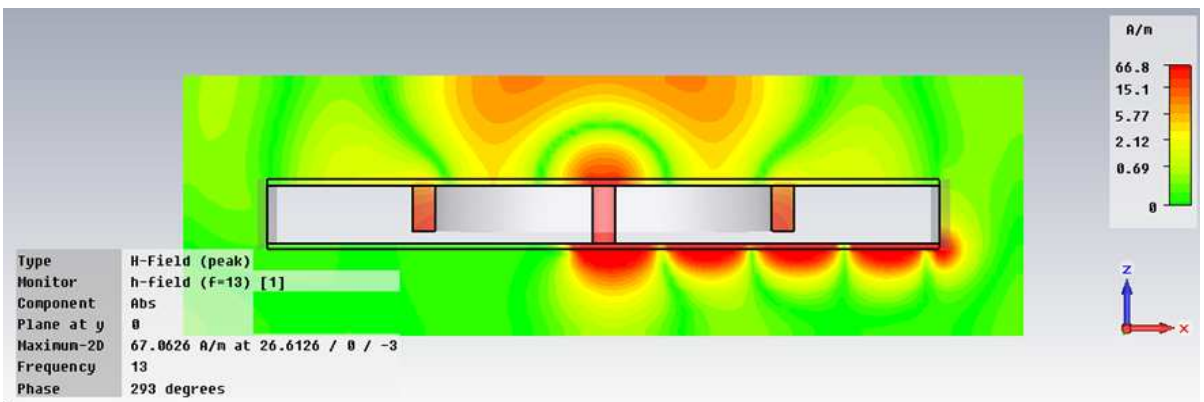

Fig:-4 constructive superposition of the radiated electric field of one grooved ground plane antenna

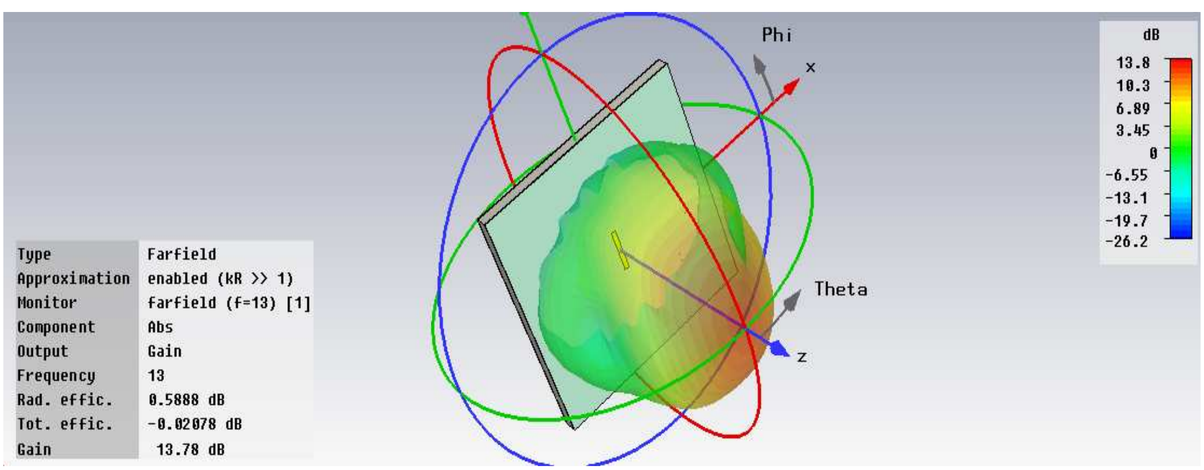

Figure:-5 Radiation Pattern of the proposed antenna with two grooves in the corrugated ground plane

The power to the antenna patch of the top substrate is given by the microstrip feed line of the bottom substrate through the ground plane which are aperture coupled. Two grooves are etched in the ground plane to generate the constructive superposition of radiated electric fields. Parameters of the proposed

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antenna are given in table .1.Figure 5shows radiation pattern of the proposed antenna

For comparison purpose an antenna with one groove is developed. The resonance frequency of the proposed antenna and the antenna with one groove are same. As the substrates are introduced for the proposed antenna with aperture coupling; the initial design rule for the resonance frequency of the corrugated ground plane can be achieved approximately based on the equations in [3] as:

$$w << \lambda_0$$
$$p \approx \lambda_0/\sqrt{r}$$
$$d \approx 1/4\ (\lambda_0/\sqrt{\varepsilon_r})$$
$$h \approx 1/2\ (\lambda_0/\sqrt{\varepsilon_r} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where(λ_0) is the free space and (ε_r) is the relative dielectric constant of the substrate. The resonance frequency of the one circular groove corrugated antenna and the two circular grooves corrugated antenna are set as 13 GHz. The dimensions of the proposed antenna are optimized by the CST STUDIO. The final dimensions are listed in table.1

Implementation and Discussion

The proposed antenna and the antenna with one groove is simulated. Fig.6 shows the S11 parameter of the proposed antenna compared to the one grooves circular corrugated antenna.

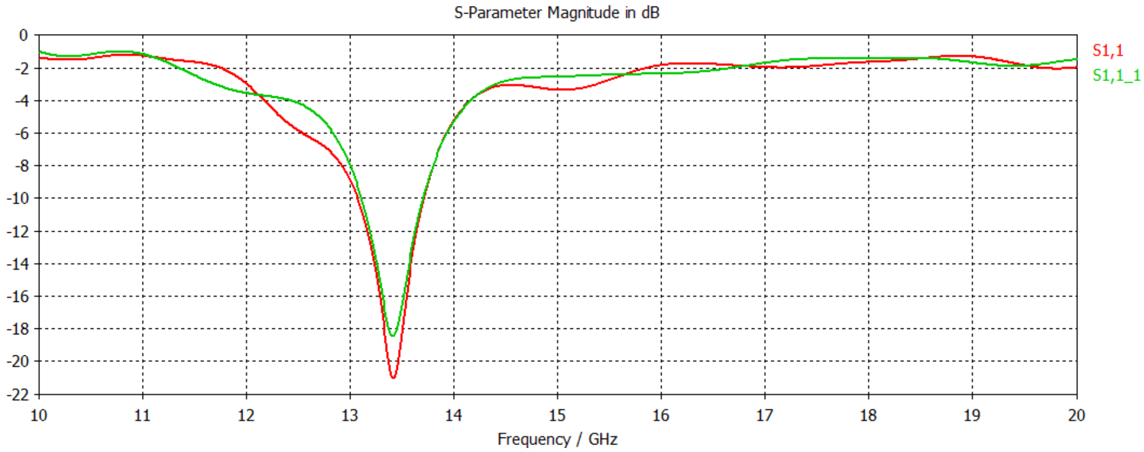

Fig:-6 Shows S11 parameter of the proposed antenna and the one groove corrugated antenna.

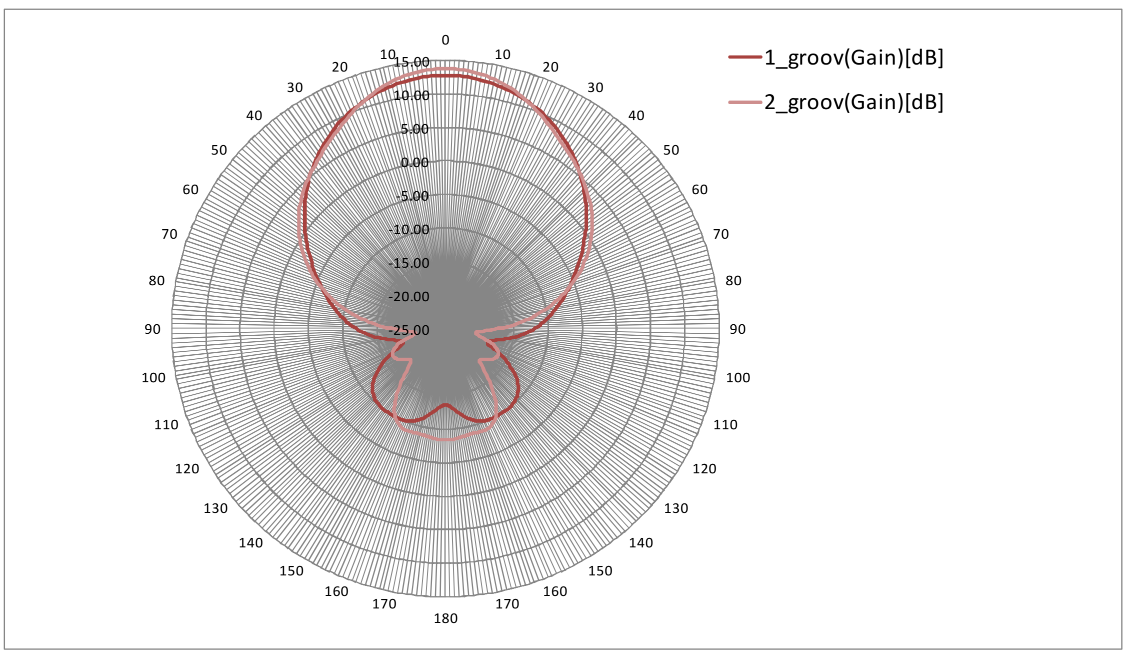

Fig:-7 Far field radiation pattern at the resonance frequency of the proposed antenna and Antenna with one groove in the ground plane

The comparison of reflection coefficients of theproposed antenna and the one groove corrugated antennais shown in fig.[6] The radiation pattern at the resonance frequency of the proposed antenna is shown in fig. [7]. In comparison with the one groove corrugated antenna which shows gain enhancement by 1.03 dB i.e.13.78 dB

Table: - 1 Dimensions of the proposed antenna

Parameter	Ls	Ws	Lp	Wp	Lf	Wf
Value/mm	**60+32**	**60+32**	**16**	**2**	**33+16**	**2**
Parameter	**hs**	**w**	**d**	**p**	**h**	**L**
Value/mm	**0.5**	**2**	**4**	**16**	**5**	**12**

The improved performance of the proposed antenna can be explained as follows. The power radiated into the free space is through antenna patch as a primary source for radiation. The surface wave propagating along the circular corrugated plate is reradiated into the free space at the region of grooves as a secondary source. Fig.[3] demonstrates the electric field distribution on the circular corrugated plate.

Table.2 Effect of groove number on the radiation performance

Number of grooves	Gain of antenna
One	12.75
Two	13.78

Whenthe grooves period is close to the operated wavelength. These secondary sources along with the primary source may bring forth the constructive superposition in the far field shown in fig.3.that leads to gain enhancementHowever, when the groove number continuous to grow, the antenna performance would not enhance obviously, as the effect of grooves far away from the aperture becomes smaller or neglected [3],[6] .

Conclusion

In this paper a new microstrip antenna with two circular grooves in ground plane is proposed. The patch and the two grooves results in constructive superposition of the radiated electric field. The proposed antenna showed enhanced gain of 1.03dB i.e. 13.78dB in comparison with the one groove ground plane microstrip antenna this can further be improved by more corrugated grooves. We have observed that the proposed antenna is better than one groove antenna. Modern communication system deserves antenna with high performance and compactness.

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