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Aperture-Coupled Microstrip Antenna with Circular Grooves Corrugated Ground Plane

Lakhan Singh Uikey[*1], Prof. Prashant Jain[2]

[*1] Microwave Engineering ,ECE Department, Jabalpur Engineering College, Jabalpur M.P., India

[2]H.O.D. Information Technology Department, Jabalpur Engineering College Jabalpur M.P., India

lakhan_uikey@yahoo.com

Abstract

A new kind of microstrip antenna with enhanced gain and radiation pattern is presented in this paper. The flat ground plane of conventional aperture-coupled microstrip antenna is substituted by the circular corrugated plane in the e proposed antenna with high gain achieved by the constructive superposition of the electric fields radiated by the patch and grooves. The simulation shows that gain are increased by 6.85 dB.

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

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 [3], 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 [5].

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 oftheproposed antenna may be achieved. To demonstrate above design concept, this antenna is simulated. Thegain of the proposed antenna is investigated. The reasonfor the improved performance of the proposedantenna is discussed.

Antenna Configuration and Design

Fig.1. shows the proposed antenna with aperture-coupled feed. It consists of two parallel Rogers RT5880 substrates separated by the corrugated ground plate. 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. One groove is etched in the ground plane to generate the constructive superposition of radiated electric fields. Parameters of the proposed antenna are given in table .1.

The resonance frequency of the proposed antenna is 13 GHz 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 [4] as

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

Where(λ_0) is the free space and (ε_r) is the relative dielectric constant of the substrate.

The resonance frequency of the conventional antenna and the corrugated ground plane 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.

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Implementation And Discussion

The proposed antenna is simulated, and Fig. 1 shows the proposed antenna. The simulation

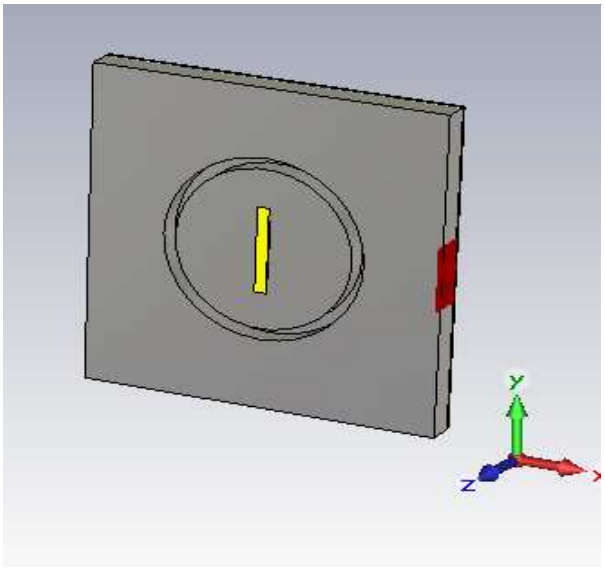

Figure:-1 Proposed antenna with circular corrugated ground plate.

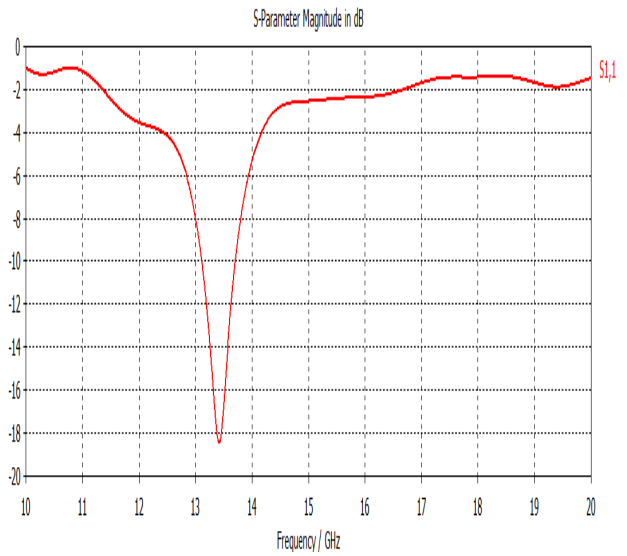

Figure:-2 Reflection coefficients of the proposed antenna

showsreflection coefficients of the proposed antenna are shown in Fig. 2,

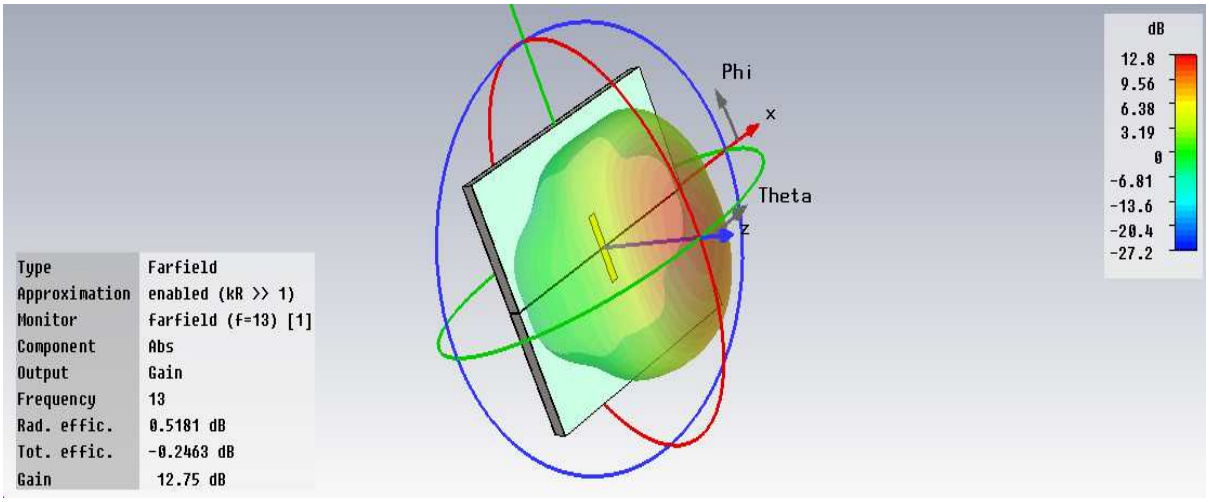

Figure:-3 Radiation pattern of the proposed antenna

The radiation pattern and the polar plot at the resonance frequency of the proposed antenna is shown in fig. [3] and fig[4]respectively showing gain is increased by 6.85dB i.e.12.75dB.

The improved performance of the proposed antenna can be explained as follows. The radiation in conventional antenna into free space is through the antenna patch. but for the proposed antenn,the antenna patch works as a primary source for radiation and the

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surface wave propagating along the circular corrugated plate is reradiated into the free space at the region of grooves as a secondary source. Fig.[5] demonstrates the electric field distribution on the circular corrugated plate.

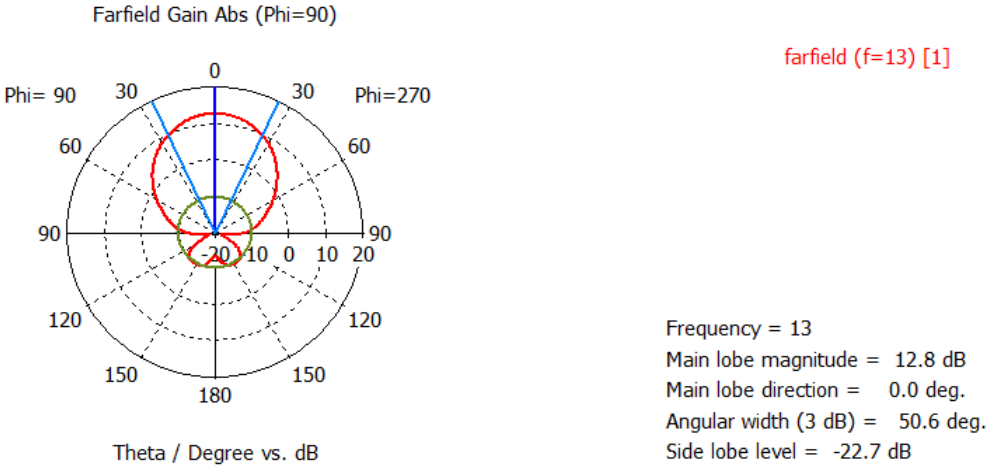

Figure:-4Polar plot of proposed antenna

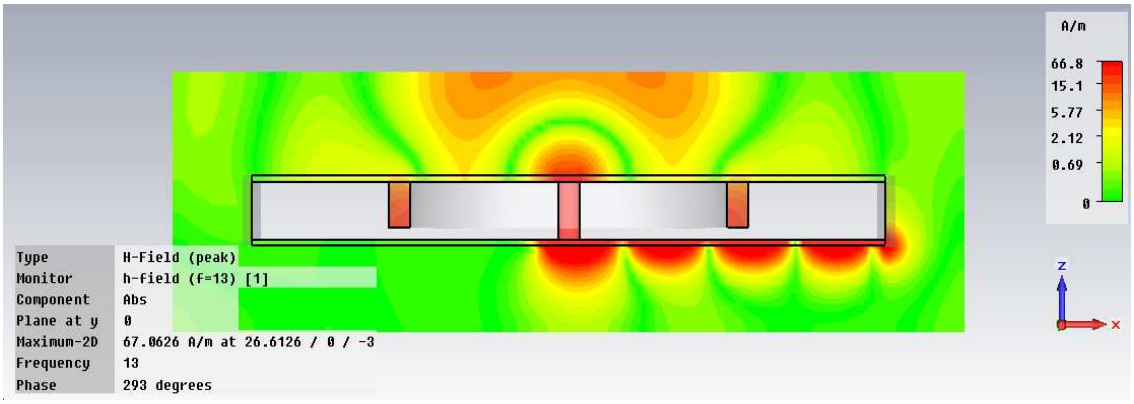

Figure:-5 Constructive Superposition of the radiated electric fields

TABLE: - 1DIMENSIONS OF THE PROPOSED ANTENNA

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

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Conclusion

In this paper a new compact aperture-coupled antenna with circular corrugated ground plane is proposed. The patch and the grooves results in constructive superposition of the radiated electric field .the proposed antenna shows a improved gain of 6.85dB this is 12.75 dB which is much more than conventional antenna's gain. Modern communication system deserves antenna with high performance and compactness.

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