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Rectangular Aperture-Coupled Slot Antenna Fed by Co-Planar Waveguide with Slits on the Ground Plane

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Abstract

This paper explore the design of aperture-coupled slot antenna with the usage of Co-Planar Waveguide (CPW) feeding with finite ground plane is proposed. The proposed design of antenna offers suitable impedance matching, unidirectional radiation sample and occasional go polarization. The antenna become analysed with extraordinary dimensions of slot with specific geometries and the effect of evaluation is carried out on this paper. Simulation effects are obtained thru rectangular aperture-coupling of width λg/4 with slits at the ground plane fed by CPW. Using substrate of different substances FR-4 and RT Duroid analysis of the advantage of an antenna is finished the use of CST software program. Slot antenna with co-planer waveguide (CPW) feeding is favoured Due to low dispersion and simplicity of integration with various energetic and passive gadgets. The ground plane is added at the back side of the substrate. This ground plane behaves as reflector this results in maximum Directivity in one direction. It is found that the proposed antenna exhibits directivity of 10dBi using reflector at the back side of a substrate. It has been observed that with increase in the width of the slot dimension from λg/10 to λg/4, gain of antenna is improved from 1.1 dB to 4.9 dB with shift in resonant frequency It suggests that using substrate of low dielectric consistent gives exact radiation pattern, high gain and directivity because of low dielectric and surface wave losses. Using RT-Duroid substrate desirable go back loss is received of -24.34 dB as evaluate to FR-four substrate due to low floor wave losses which ends up into greater fringing field and higher radiation sample. The simulation consequences are obtained by way of the usage of Computer simulation Technology (CST) Microwave studio software. The proposed antenna design may be carried out for wireless device in GSM900 and can be included with lively or passive gadgets which can be used for RF Energy Harvesting.

***Keywords*—** Coplanar waveguide, slender-slot antennas, inductive coupling, Microstrip antenna, Rectangular-slot antenna, Computer Simulation Technology, Quasi TEM mode.

1. Introduction

A Slot antenna has superb overall performance traits in phrases of its operating frequency range, less weight, and easily integration with monolithic microwave included circuits, those traits makes it suitable to use for broadband conversation machine [1]. These antennas offer numerous gains over common micro strip antennas as they provide bidirectional or unidirectional radiation sample and true impedance matching. In comparison to micro strip line feeding a slot antenna with CPW feeding gives advantage of low dispersion, low spurious radiations and clean to integrate with lively gadgets [2]-[3]. The antenna with micro strip line feeding results in misalignment because it requires etching on both the facet of substrate. In the proposed scheme Slot antenna may be excited with CPW feeding because in this approach slot etching feeding is unmarried sided, this allows in decreasing the alignment blunders.

The effective dielectric consistent and traits impedance of the feed may be predicted from the diverse parameters like measurement of centre strip, thickness, gap and the permittivity of the dielectric substrate. [4] Conductor subsidized CPW is used to have extra ground plane at the lowest of the substrate. The shape of the antenna can be benefitted of mechanical ruggedness with this extra ground plane. And it is able to be used as a warmness sink for lively and passive devices. For conductor primarily based CPW, quasi TEM is the dominant mode that offers zero reduce-off frequency. Inductive coupling having finite ground plane can also be applied for CPW feed rectangular Slot antenna. [5].For strength contributing arrays and for oscillator layout It can used with active devices [6].

Slot antenna with CPW feeding produces twin frequency bands one is 893 MHz-908 MHz and the alternative is 1450 MHz-1463 MHz. Hence it may aid the operation of GSM and CPS inside the extraordinary frequency bands This function can full fill the requirement of dual or a couple of band antennas. Transient solver method is used for simulation of the antenna in CST microwave studio package. At 900 Mhz for the impedance matching optimization, the slot width is varied from $\lambda_g/10$ to λg/6. And the simulation results for these slot width is compared.

By varying the scale of the slots the antenna may be optimized at a resonating frequency of 900 Mhz

2. Antenna Design

The shape of proposed square inductive coupled slot antenna fed by means of CPW with finite floor plane is illustrated in fig.1 . This antenna is layout by inserting a slot of half of wavelength λg/2 on symmetrical aspect with the middle of the Coplanar wave guide fed line,

$$\lambda_g = \frac{c/f}{\sqrt{\varepsilon_{eff}}} \quad (1)$$

In above equation the the dielectric consistent of CPW fed line is represented by ε_{eff} and f is the resonating frequency 900 MHz. The average of dielectric constants of air and of the substrate is termed as effective dielectric constant and is independent of the geometry.

$$\varepsilon_{eff} = \frac{\varepsilon_{air}+\varepsilon_r}{2} \quad (2)$$

$$0.5 \leq W/h \leq 2.0 \quad (3)$$

$$\frac{S}{S+2W} \leq 0.4 \quad (4)$$

Here S is the strip width and W is the width of hole of a CPW fed line as shown in Fig. 1The antenna is simulated and numerous parameters which includes Directivity, E-field pattern, H-field pattern, reflection coefficient are analyzed by converting the slot width form λg/10 to λ/6. The impedance of antenna with CPW feeding depends on substrate thickness and it vary from 25 Ω to 250 Ω. The characteristics impedance of antenna with CPW feeding is of the order of 50Ω.

2.1 DESIGN PARAMETERS.

Parameters	Dimensions/Specifications
Substrate	RT Duroid 5880 substrate
εr	2.3
Loss tangent	0.02
height of substrate (h)	1.59 mm
Size(l × w) of finite ground plane of	285 mm × 305 mm
Slot length	λ/2
Width of the slot	λg/10
feeding technique	CPW

Table 1: Design Specifications

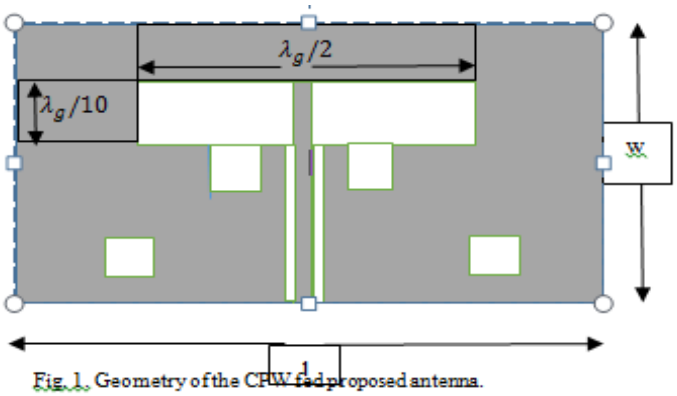

Fig. 1. Geometry of the CPW fed proposed antenna.

Fig. 2. Illustrates the design of slot antenna with CPW feeding having width $\lambda_g/10$ fed through inductive coupling with finite ground plane on CST Software.

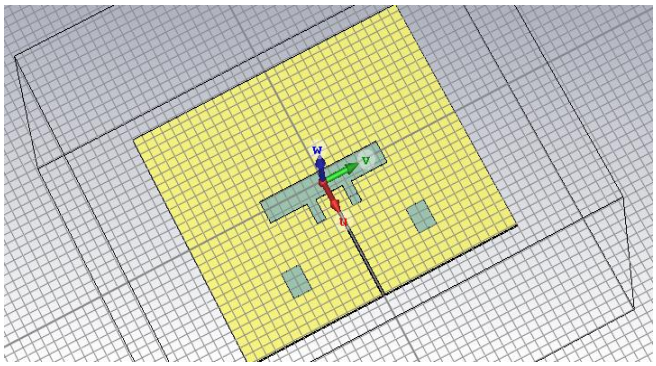

Fig. 2. Design of the CPW fed proposed antenna using CST Software.

3. Result & Discussion

Simulation of antenna with finite ground aircraft is performed on CST software program.. Fig. 3 (a). Indicates the consequences of a return loss keeping the width λg/10 of a slot antenna resonates at frequency 900 MHz. By various the slot width to λg/6 a slightly shift in resonating frequency from 900 MHz to 905 MHz. Return loss observed in CST software of proposed antenna is S11= -20.65 dB at 900 MHz frequency for the slender slot antenna with width of λg/10.

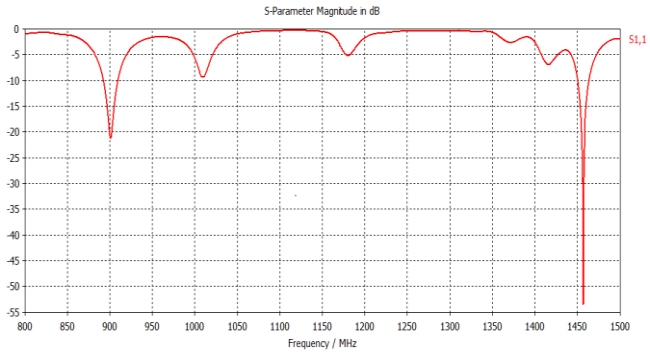

Fig. 3 (a). Simulated results of the S_{11} parameter with width $\lambda_g/10$.

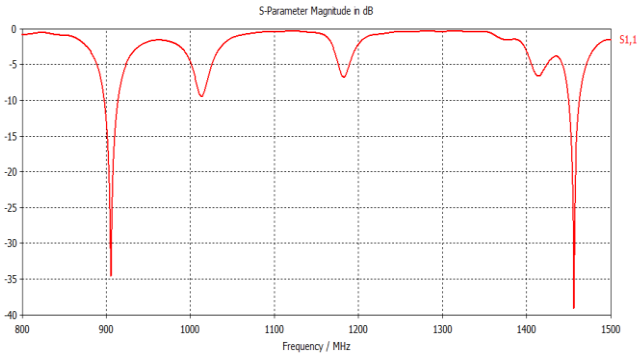

Fig. 3 (b). Simulated results of the S_{11} parameter with width $\lambda_g/6$.

Fig. 4. shows VSWR at 900 MHz frequency providing good matching of impedance for the narrow slot antenna of width $\lambda_g/10$.

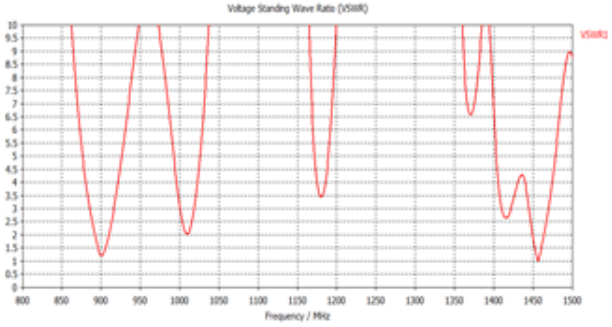

Fig. 4. VSWR of the proposed slot antenna.

Fig. 5. Shows that the direction of E-field is 0 degree having magnitude is 14.7 Voltage (dBV/m) at frequency 900 MHz for E-plane. Fig. 6. Suggests that the principle lobe path is zero degree with essential lobe magnitude of -36.7 Ampere (dBA/m) at frequency 900 MHz for H-plane when narrow slot antenna of width λg/10 is designed using RT duroid substrate having ε_r= 2.3. By increasing the width of the slot dimension from λg/10 to λg/4, it has been visible that the gain of antenna is advanced from 0.6 dB to 5.2 dB with a change-off of impedance matching at frequency 900 MHz.

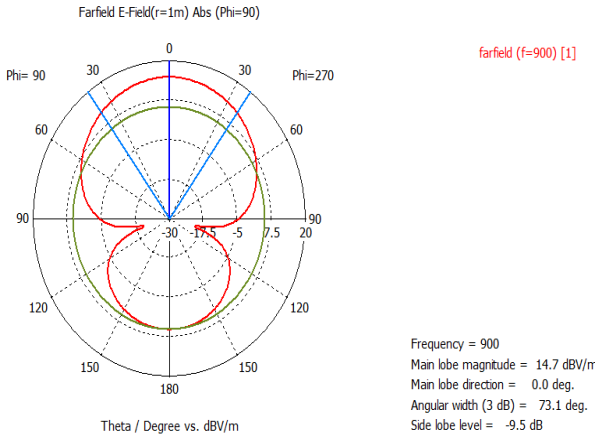

Fig. 5. Simulated results of E-Plane radiation pattern.

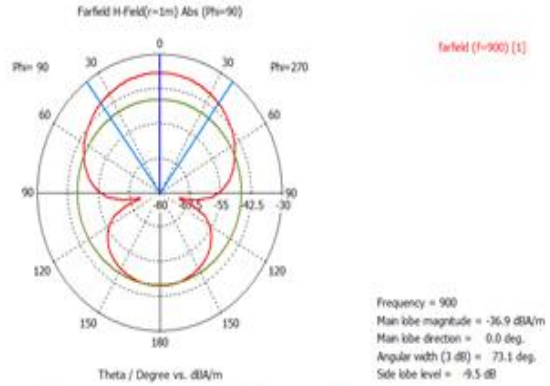

Fig. 6. Simulated results of H-Plane radiation pattern.

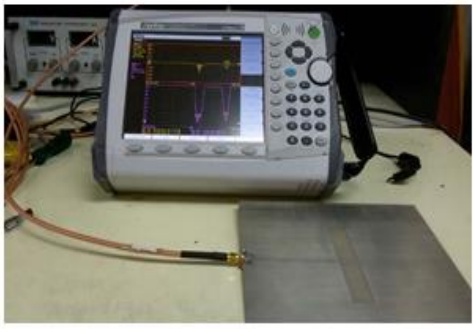

Fig. 7. Measurement of S_{11} parameter at frequency 900 MHz using Vector Network Analyzer.

Using Vector Network Analyzer, S-parameter of CPW fed inductive coupled narrow slot antenna with finite ground plane at 900 MHz is measured as shown in Fig. 7.

Conclusion

In this work a inductive coupled rectangular slot antenna having finite plane with CPW feeding is proposed. Matching of slot antenna is proper at frequency 900 MHz. Proposed antenna exhibit low cross polarization by using CPW fed, low dispersion and broadside radiation pattern. Simulated results observed on CST software for proposed antenna has significant return loss at resonant frequency 900 MHz inserting with width of dimension $\lambda_g/10$. Based on the observed results of proposed antenna fed by CPW with finite ground plane is suitable for RF Energy Harvesting system.

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References

[1] K. P. Ray and Y. Rang, "Ultrawideband printed elliptical monopole antennas," IEEE Trans. Antennas Propag., vol. 55, no. 4, pp. 1189–1192,2007.

[2] A. A. Dastrang, A. Imani, "Printed wide-slot antenna for wide band applications," IEEE Trans. Antennas Propag., vol. 56, no. 10, pp. 3097–3102, Oct. 2008.

[3] H.-D. Chen, "Broadband CPW-fed square slot antennas with a widened tuning stub," IEEE Trans. Antennas Propag., vol. 51, no. 4, pp. 1982–1986, Aug. 2003.

[4] J.-W. Niu and S.-S. Zhong, "A broadband CPW-fed bow-tie slot antenna," in Proc. IEEE Antennas and Propagation Soc. Int. Symp, Jun.20–25, 2004, vol. 4, pp. 4483–4486.

[5] R. Chair, A. A. Kishk, and K. F. Lee, "Ultrawideband coplanar waveguide-fed rectangular slot antenna," IEEE Antennas Wireless Propag.Lett., vol. 3, pp. 227–229, 2004.

[6] B. K. Kormanyos, W. Harokopus, L. Katehi, and G. Rebeiz, "CPW-fed active slot antennas," IEEE Trans. Microwave Theory Tech., vol. 42, pp. 541–545, Apr. 1994.

[7] J.-Y. Sze, C.-I. G. Hsu, and S.-C. Hsu, "Design of a compact dual-band annular-ring slot antenna," IEEE Antennas Wireless Propag. Lett., vol.6, pp. 423–426, 2007.

[8] H. L. Lee, H. J. Lee, J. G. Yook, and H. K. Park, "Broadband planar antenna having round corner rectangular wide slot," in Proc. IEEE Antennas and Propagation Society Int. Symp., Jun. 16–21, 2002, vol. 2, pp. 460–463.

[9] Asem S. Al-Zoubi, "Aperture Coupled Rectangular Dielectric Resonator Antenna Array Fed by Dielectric Image Guide" IEEE Transaction on Antenna and wave propagation, VOL. 57, NO. 8, August 2009.

[10] Joe R.S, B.Sridhar, Marin A, Harichandran A. Florence E.S "Effect of Slot on Radiation Characteristics of Rectangular Dielectric Resonator Antenna" International Conference on Computer, Communication and Electrical Technology – ICCCET 2011, 18th & 19th March, 2011.

[11] Antar Y.M.M , Fan Z " IEEE Electronic Letters, 20th July 7995 Vol. 31, No.15.

[12] S. Muhamud, M. T. Ali, M. K. M. Salleh," An Aperture Coupled Microstrip Antenna (ACMSA) with Orientations of Patch Slot" 2012 Asia-Pacific Symposium on Electromagnetic Compatibility.

[13] Zarreen A. Shrivastava S.C "Aperture Coupled Microstrip Slot Antenna" 2008 International Conference on Recent Advances in Microwave Theory and Applications.

[14] Mohamed I. Sebak A "Aperture-Coupled 2x2 Microstrip Antenna Array for 60 GHz Applications" 2015 IEEE International Symposium on Antennas and Propagation & USNC/URSI National Radio, 978-1-4799-7815-1/15/$31.00 ©2015 IEEE .

[15] M. Li and K.-M. Luk, "Low-Cost Wideband Microstrip Antenna Array for 60-GHz Applications," IEEE Trans. Antenna Propag., vol.62, no.6, pp.3012-3018, June 2014.

[16] Rao Q. Denidni T.A "Micro strip Patch Antennas with Trapezoidal Slots" 2006 IEEE Antennas and Propagation Society International Symposium, 1-4244-0123-2/06/$20.00 ©2006 IEEE.

[17] Zung T, Chiou W, Wong Kin-lu " A Compact dual polarized aperture coupled patch antenna for GSM 900/1800- Mhz system"

[18] S. Kanamaluru, Y. M. Li, and K. Chang, "Aperture coupled micro strip antenna with image line feed," in IEEE AP-S Symp. Dig., 1994, vol. 2, pp. 1186–1189.

Bibliography

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