ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 4, April 2015

Study of CPW-Fed Slot Antenna for UWB Application

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ABSTRACT: Compact coplanar waveguide (CPW) fed slot antenna for ultra-wideband (UWB) application is presented. Many UWB antennas have been developed to cover the ultrawide operating bandwidth of the UWB systems with acceptable performance. Currently, the prospective applications of UWB technology are becoming clearer and clearer. The majority of UWB R&D activities have been focused on how to meet the specific requirements of forthcoming UWB systems. This paper will review the R&D of UWB antennas since 2002 with proposed design model. A 50-Ω coplanar waveguide transmission line is used to fed slot antenna. Various slits on the ground plane is done for bandwidth enhancement. CPW fed slot antennas are attractive due to low dispersion and ease of integration with active and passive devices. CPW-fed slot antenna exhibit perfect impedance matching, broadside radiation patterns, and low cross polarization. Analysis of the effects of various slot dimensions on the parameters of the antenna design has been done.

KEYWORDS: Coplanar waveguide, Microstrip antennas, Quasi TEM mode,Slot antennas, UWB antennas.

I. INTRODUCTION

Ultra wideband (UWB) technology plays a vital role in the wireless communication world in recent years due to their great features such as low power consumption and high speed data rate. Slot antennas are currently under consideration for use in broadband communication systems due to their attractive features, such as wide frequency bandwidth, low profile, light weight, easy integration with monolithic microwave integrated circuit, low cost, and ease of fabrication [1]. These antennas have several advantages over common microstrip antennas as they provide good impedance matching, and bidirectional or unidirectional radiation pattern.

According to Federal Communication Commission (FCC) the frequency band from 3.1-10.6 GHz is specified for UWB in 2002. Slot antenna using CPW feding mechanism provides several advantages over microstrip line feed, such as low dispersion, low radiation leakage, ease of integration with active devices [2]-[3]. When the antenna is fed by microstrip line, misalignment can result because etching is required on both sides of the dielectric substrate. Using CPW feeding techniquealignment error can be eliminated. In CPW the conductor formed a center strip separated by a narrow gap from two ground planes on either side. Slot antenna results into wideband characteristic with CPW fed line having square slot [6] and CPW-fed hexagonal patch antennas [8] are demonstrated in the literature. In CPW-fed slot antenna by varying the dimensions of the slot and keeping it to the optimum value for wide bandwidth and proper impedance matching. In slot antenna geometries different tuning techniques has been carried out like circular slot [9], bow-tie slot [10], and wide rectangular slot [15].

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Antenna compact in size having a rectangular slot and an equilateral triangular patch at the anterior portion of the CPW fed line results into wide UWB. It has been observed by putting two rectangular slits on the ground plane of the CPW fed line results into dual band resonance in UWB and bandwidth enhancement. Various patch shapes such as hexagon, T, cross, forklike, and square are used to give wide bandwidth [6-12]. The dimensions of the center strip, gap thickness and the permittivity of the dielectric substrate determine the effective dielectric constant and the characteristic impedance of line [16].

Wireless networks can operate in the same UWB frequency. According to the FCC's order, any transmitting system which emits signals having a bandwidth greater than 500 MHz or 20% bandwidth can gain access to the UWB spectrum. Two types of UWB systems may be used, namely a traditional pulse-based system transmitting each pulse which occupies the UWB bandwidth and a carrier system based on multiband orthogonal frequency-division multiplexing (MB-OFDM). The latter has been adopted by the WiMedia UWB common radio platform incorporating media access control (MAC) layer and physical (PHY) layer specifications The dimensions of the slot is varied to obtain the optimum value of the slot so that the antenna resonates at dual frequency band in UWB.

II. GEOMETRY OF CPW FED UWB ANTENNA

Fig. 1. illustrates the geometry of the proposed CPW fed slot antenna with slits on the ground plane for UWB. The proposed antenna is formed by etching one wavelength slot $\lambda_g$located symmetrically with respect to the center of the CPW fed line

$$\lambda_g = \frac{c/f}{\sqrt{\varepsilon_{eff}}} \tag{1}$$

where ε_{eff} is the effective dielectric constant of CPW fed line and f is the resonant frequency. In the CPW, the effective dielectric constant is independent of geometry and is equal to the average of dielectric constants of air and of the substrate.

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

CPW fed slot antenna is model using FR-4 substrate with ε_r= 4.3, height of the substrate h= 1.59 mm and loss tangent 0.01 with ground plane of size 24×23 mm. Length of the slot is equal to one wavelength 17 mm using equation (1) and the width of the slot is$0.65\lambda_g$ which is 11mm for resonance frequency 8.5 GHz. CPW feeding technique on thin substrate,

$$0.5 \le W/h \le 2.0 \tag{3}$$

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

where S is the strip width and W is the gap width of a CPW fed line as shown in Fig. 1. Size of the strip width S and gap width W using equation (3) and (4) is 2.6 mm and 0.3 mm. Optimal value of the fed gap distance from the ground plane to the patch is d = 0.9 mm. CPW is not very sensitive to substrate thickness and allows a wide range of impedance value from 20 Ω to 250 Ω.

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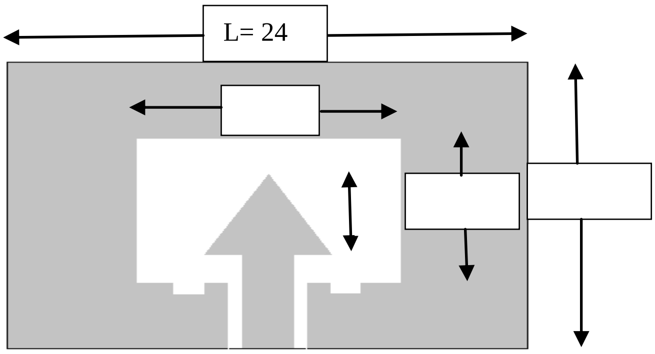

Fig. 1. Geometry of the CPW fed UWB antenna. (Dimensions are in mm.)

TABLE I. Design parameters of the antenna

Parameters	Description	Optimal Value
L	Length of the antenna	24 mm
W	Width of the antenna	23 mm
l	Length of the slot	17 mm
w	Width of the slot	11 mm
d	Fed gap distance	0.9 mm

Various optimal values of the parameters of the design UWB antenna is obtain from equations (1) to (4) as shown in Table.1 .UWB technology or concept was used in the first spark basedradio invented by Marconi in 1895. The modern UWB for wireless communications started with the study of time domainelectromagnetics in 1960s and was developed for wireless communications in 1970s and 1980s. A lot of pioneering work has established the basis of the impulsed radio systems for military communication applications. Meanwhile, academia and industry are exciting to the release of extremely wide spectrum for commercial UWB application but facing many technical challenges for practical applications. Among the UWB wireless connection systems, the high data rate wireless USB may be the most promising applications. Therefore, the antenna designers especially from industry have long paid attention on small and embeddable UWB antennas. Both academic and industry have proposed many types of small UWB antennas especially on PCB or ceramic. The antennas with low profile are easy to be integrated into other RF circuits on the PCB or embedded into small and portable devices. Proposed antenna design model is studied and is applicable for UWB technology.

III. Review Of CPW-Fed UWB Antenna

CPW feeding technique eliminates all counter problems as it provides low Dispersion, reduces Radiation loss, supports surface mounting of active and passive devices, Bandwidth enhancement , Reduces cross-talk. In CPW the E field and H field distribution is shown in Fig. 2.

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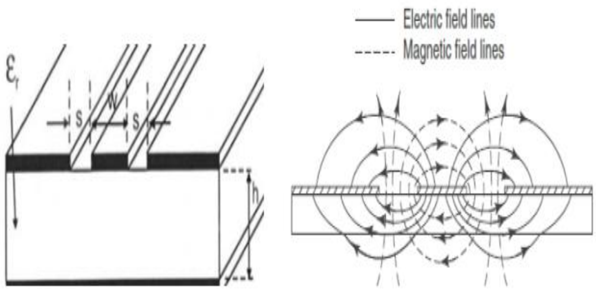

Fig. 2. CPW E-field and H-field distribution

In the CPW two fundamental modes are supported: the coplanar mode, and the parasitic slotline mode. CPW supports Quasi-TEM mode of propagation hence it has longitudinal components in the direction of propagation. Using conductor backed CPW it has additional ground plane at the bottom surface of the substrate. It provides mechanical support to the substrate and also acts as a heat sink for active and passive circuit devices. In CPW the conductors formed a center strip separated by a narrow gap from two ground planes on either side. The dimensions of the center strip, the gap, the thickness and permittivity of the dielectric substrate determined the effective dielectric constant, characteristic impedance and the attenuation of the line as shown in Fig. 2. In CPW, the substrate thickness plays a less important role due to the fact that the fields are concentrated in the slots. CPW has ODD mode also called as Co-planar mode where the fields in the two slots are 180 out of phase and an EVEN mode known as coupled slotline mode where the fieldsare in-phase. Since the number of the electric and magnetic field lines in the air is higher than the number of the same lines in the microstrip case, the effective dielectric constant ε_{eff} of CPW is typically 15% lower than the ε_{eff} for microstrip, so the maximum reachable characteristic impedance values are higher than the microstrip values. The effect of finite dielectric substrate is almost ignorable if h exceeds 2b = W+2s.

A] **Various Design of UWB Antennas**

• Omni-directional: discone, bi-conical, roll/thick/planar monopole/dipole

• Directional: TEM, log-periodic, big aperture, suspended plate antenna, traveling wave antenna

• Miniaturized: on-PCB, dielectric loading, LTCC based, DRA

• Arrays: compact, beam-steering, less-mutual coupling

• Special considerations: spectral-notched, less dispersion, diversity, circularly polarized antenna
• Co-design with: filter, amplifier, RF channel

B] **Applications**

• High/low-speed wireless communication system

• Vehicle radar systems

• Sensing/monitoring systems

• Positioning/localization systems

• Bio-imaging systems

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IV. CONCLUSION AND FUTURE WORK

CPW-fed proposed antenna exhibit low dispersion, broadside radiation patterns and low cross polarization. The study of feeding techniques plays a vital role in field pattern and impedance matching concept. The dimension of the slot should be less to obtain high efficiency and gain of an antenna. In future UWB antennas will be strongly application driven tool in all commercial devices. As it is a challenging key to obtain wide band from 3.1 GHz to 10.6 GHz while maintaining high efficiency and good impedance matching. Various appropriatedesign filters can be integrated with UWB antenna as per impedance matching requirement.

V. ACKNOWLEDGMET

The authors would like to thank Prof. Amutha Jeyakumarfrom VJTI Mumbai, for her encouragement and inspiration to work on this current research topic.

REFERENCES

1. 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.
2. J.-W. Niu and S.-S. Zhong, “A broadband CPW-fed bow-tie slot antenna,” in Proc. IEEE Antennas and Propagation Soc. Int. Symp, vol. 4, pp. 4483–4486.Jun.20–25, 2004.
3. Lin, Y.-C., and Hung, K.-J, “Compact ultrawideband rectangular aperture antenna and band-notched designs”, IEEE Trans. Antennas Propag, 54, (11), pp. 3075–3081, 2006.
4. 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.
5. H.D. Chen, "Broadband CPW-fed square slot antenna with a widened tuning stub," IEEE Trans. Antennas and Propag. Vol. 51, No 8, Aug 2003.
6. F. Consoli, F. Maimone, and S. Barbarino, "Study of a CPW-fed circular Slot antenna for UWB communications," Microwave and Optical Technology Letters, vol. 48, pp. 2272-2277,2006.
7. K. P. Ray and Y. Rang, “Ultrawideband printed elliptical monopole antennas,” IEEE Trans. Antennas Propag., vol. 55, no. 4, pp. 1189–1192,2007.
8. 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.
9. 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.
10. 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.
11. 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.,vol. 2, pp. 460–463, Jun. 16–21, 2002.
12. A. U. Bhobe, C. L. Holloway, and M. Piket-May, “CPW fed wide-band hybrid slot antenna,” in Proc. IEEE Antennas Propag. Soc. Int. Symp. Dig, vol. 2, pp. 636–639.Jul. 2000.

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