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COMPACT WIDEBAND CPW ANTENNA FOR C AND X BAND APPLICATIONS

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ABSTRACT:

Planar Microstrip Patch Antennas are well-known for their light weight, tiny size, and ease of construction. A microstrip patch antenna (20mm X 20mm X 1.6mm) with a permittivity of 4.4 and a loss tangent of 0.02 was built utilizing a FR-4 Glass Epoxy substrate. As a radiating element, a semicircular patch with a diameter of 11.84mm and a microstrip feed line with a width of 3.8mm was created. The simulation was carried out using the HFSS tool, which employs the Finite Element Method. In the frequency range from 6.06 GHz to 12.24 GHz, a reflection coefficient of less than -10dB was found, encompassing a bandwidth of 6.18 GHz. In the specified frequency range, a maximum gain of 7.86 dBi was obtained. For the suggested CPW-based microstrip, an ideal radiation pattern with Omni direction in E-Plane and Isotropic in H-Plane was obtained.

INTRODUCTION

Multiband applications can be realized by creating a double U-slot rectangular patch antenna. The equivalent circuit of a U-slot patch is described, and the return loss is theoretically determined using the [A] matrix formulation. The CST Microwave Studio program was used to construct the microstrip antenna with a transmission line feed and simulate return loss and radiation patterns. The antenna was built in-house on a printed board CNC machine, and its return loss was tested and compared using a portable network analyzer.

The introduction of Coplanar Waveguide (CPW) fed antennas changed the antenna business in terms of cost, compactness, bandwidth, and so on. The uniplanar qualities of CPW structures, together with their appealing advantages such as reduced radiation loss and dispersion in comparison to a microstrip, limited reliance of characteristic impedance on substrate factors, and so on, make them popular. 13 The evolution of Coplanar Waveguide fed antennas from their inception to the present is discussed here. Coplanar Waveguide (CPW) was designed by CPW (Cheng P. Wen) and is discussed in his 1969 publication "Coplanar Waveguide: a surface strip transmission line suitable for nonreciprocal gyromagnetic device applications."

The practical use of coplanar waveguides has been demonstrated through the measurements made on resonant insulators and differential phase shifters constructed on dielectric substrates with low loss and di electric constant. High. The upper attenuation limit and characteristic impedance of a transmission line with electrodes on one side of the dielectric were determined through calculations. Microwave scientists can now choose suitable front-end transmission lines for MMIC devices and other compact microwave applications. In 1970, Cheng P. When reported the attenuation characteristics of coplanar waveguides. They presented the Q measurements and loss characteristics of coplanar waveguides, revealing that they are related to microstrip lines with equal width and impedance. H Matino proposed the characteristic impedance measurement of coplanar waveguides. The letter presents theoretical equations and experimental data that include correction factors for the effective relative permeability of a material with respect to its characteristic impedance. The following year, the dependence of the characteristic impedance of coplanar waveguides was reported by P.A.J.Dupuis and C.K. Campbell measurements as a function of slit width and substrate thickness

A theoretical method presented by T. Kitazawa in 1976 to analyze coplanar waveguides coated with a thick metallic coating. The thickness of the metal coating of a coplanar waveguide has been shown to cause an increase in wavelength and a decrease in characteristic impedance. They also note that these changes are quite similar to a line of casino games. E. Mueller measured the effective relative permittivity of unshielded coplanar waveguides. The dependence of the effective relative permittivity of the coplanar waveguides was measured as a function of frequency from 3 to 12 GHz and compared with calculated values. The transmission characteristics of coplanar waveguides printed on conductive substrates were analyzed by Y.C. Shih and T. Itoh in 1982 used spectral domain techniques

An interesting new concept of slotted antenna arrays was proposed by Aleksandra Nasik in 1982, in which the slots and power supplies are etched on the same side of the circuit board. A channel is cut perpendicular to the slits and a coplanar waveguide to excite the slits is introduced into the channel and the concept is verified experimentally on a model. The analysis of slow wave phenomena in coplanar waveguides on semiconductor substrates was proposed by Y. Fukuoka and T. Itoh using mode matching technique. This waveguide is suitable for monolithic microwave integrated circuits due to their 14-plane configuration. After many studies on the slow wave phenomenon of coplanar waveguides, scientists and microwave research have been carried out closely.

Anand Gopinath in 1982 extensively studied losses in coplanar waveguides. Conductor losses in coplanar waveguides are calculated using the quasi-static Green's function method. Conductor, dielectric, and radiation losses are used to calculate the quality factor of the half-wavelength resonator and compare with the measurement results. A final coupled resonant band pass filter powered by a coplanar waveguide was proposed and studied by Dylan F. Williams in 1983. Band pass filter design rules were developed to facilitate the synthesis of filters from "prototype" low pass designs.

Conductor-backed coplanar waveguide (**CBCPW**), also known as **coplanar waveguide with ground** (**CPWG**), is a common variant which has a ground plane covering the entire back-face of the substrate. The ground-plane serves as a third return conductor. Coplanar waveguide was invented in 1969 by Cheng P. Wen, primarily as a means by which non reciprocal components such as gyrators and isolators could be incorporated in planar transmission line circuits. The electromagnetic wave carried by a coplanar waveguide exists partly in the dielectric substrate, and partly in the air above it. In general, the dielectric constant of the substrate will be different (and greater) than that of the air, so that the wave is travelling in an inhomogeneous medium. In consequence CPW will not support a true TEM wave; at non-zero frequencies, both the E and H fields will have longitudinal components (a hybrid mode). However, these longitudinal components are usually small and the mode is better described as quasi-TEM.

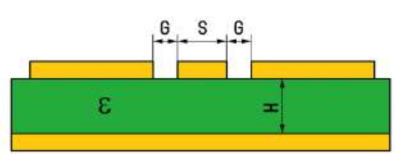

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Fig 1 .coplanar waveguide

Proposed CPW Antenna Design

A Coplanar Waveguide (CPW) fed Micro strip patch antenna (20mm X 20mm X 1.6mm) was printed of one side of Glass Epoxy FR-4 substrate and the copper on other side was completely etched. Substrate has dielectric constant 4.4 with thickness of 1.6mm. Width of the feed line was optimized to 3.8mm for getting better impedance matching. Two ground planes of 7.5mm X 8mm were considered on either sides of micro strip feed as shown in figure 4.1.

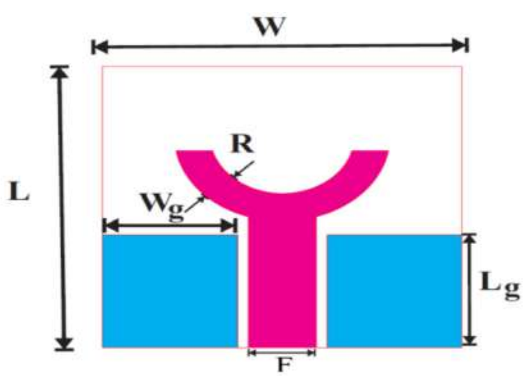

Figure2: Top View of Proposed CPW based Micro strip Patch Antenna

The above shown is top view of proposed micro strip patch antenna. The optimized antenna dimensions are shown in table1.

Parameters	L	W	R	Wg	Lg	F
Dimension in mm	20	20	2	7.5	8	3.8

Table1: Optimized dimension of proposed CPW based Micro strip Patch Antenna Proposed CPW based micro strip patch antenna was designed on one side of FR-4 epoxy substrate and simulated using HFSS software. A schematic design of proposed antenna has been shown in below figure 4.2.

RESULT

Reflection Coefficient.

The CPW fed micro strip patch antenna printed on one side of FR-4 substrate and copper etched completely on other was simulated using HFSS software and reflection coefficient verses frequency was plotted as shown in figure 3. A wideband from 6.06 GHz to 12.24 GHz with a bandwidth of 5.18GHz, and maximum return loss of -16dB was achieved. Figure 2 shows the reflection coefficient of proposed CPW fed micro strip patch antenna, reflection coefficient below -10dB was found in the frequency range from 6.68 GHz to 11.38 GHz. Width of micro strip feed has been optimized for better impedance matching. The proposed antenna is designed for C- band & X-band applications. Applications like LTE/LTE-A and WLAN technologies were used as it also covers the sub-6 GHz band.

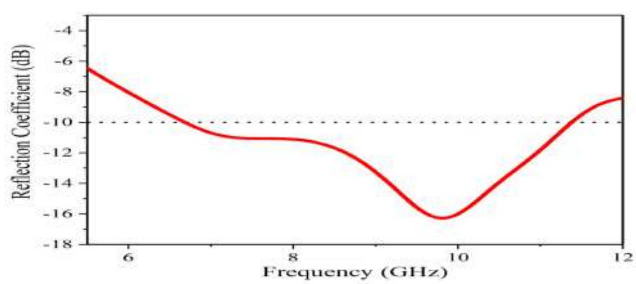

Figure 3: Reflection Coefficient of Proposed CPW based Micro strip patch antenna.

A maximum gain of 4.67dBi was achieved with an average of 3 dB in entire band were as there was slight dip in gain at higher frequencies as shown in figure 7.2.

Current distribution:

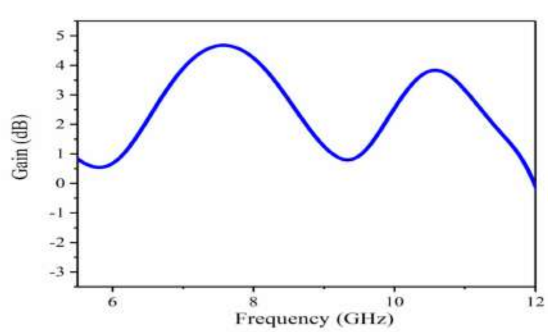

Figure 4. Gain vs. Frequency of Proposed CPW based Micro strip patch antenna.

The radiation pattern of proposed CPW based micro strip patch antenna for E-Plane is shown in figure 5(a), A conventional micro strip patch antenna with patch on one side & ground plane on other side of substrate has radiation in only one direction but in CPW based antennas, both ground plane & patch are on one side of substrate with other side completely etched, there is backward wave propagation. As a result antenna radiates equally in both directions having Omni directional in E-Plane and nearly isotropic in H-Plane as shown as Co-Pol & X-Pol in figure 5. Similarly radiation pattern of proposed CPW based micro strip patch antenna for H-Plane is shown in figure .

Radiation Pattern

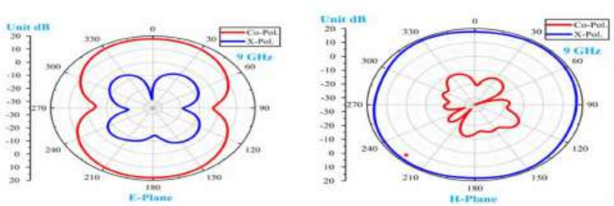

Figure 5: Radiation Pattern of proposed CPW based Micro strip Patch Antenna

Conclusion:

Conventional CPW based micro strip patch antenna has a wideband from 6.68 GHz to 11.38GHz which covers C and lower X band making it suitable for many applications like Wi-Fi, WLAN, Satellite communication between Ground station to satellite communication, Wideband has been observed which make CPW antenna suitable to operate downlink for satellite communication, WLAN & WiMAX

By increasing the number of slots, we can improve the number of bands. Higher gain could be achieved if a dielectric material; such as Rogers/Droid with a relatively lower dielectric constant and a lower dielectric loss is used.

References

1. J.-W. Wu, H.-M. Hsiao, J.-H. Lu, and S.-H. Chang, "Dual broadband design of rectangular slot antenna for 2. and 5 GHz wireless communication," Electronics Letters, vol. 40, no. 23, pp. 1461–1463, 2004.

2. C.-M. Su, H.-T. Chen, and K.-L. Wong, "Printed dual-band dipole antenna with Uslotted arms for 2. /5.2 GHz WLAN operation," Electronics Letters, vol. 38, no. 22, pp. 1308–1309, 2002.

3. M. T. Islam, N. Misran, and A. T. Mobashsher, "Compact dual band microstrip antenna for Ku-band application," Information Technology Journal, vol. 9, no. 2, pp. 354–358, 2010.

4. M. Samsuzzaman, M. T. Islam, B. Yatim, and M. A. M. Ali, "Dual frequency triangular slotted microstrip patch antenna for Ku band applications," Przegląd Elektrotechniczny, vol. 89, no. 1, pp. 275–279, 2013.

5. C. P. Hsieh, T. C. Chiu, and C. H. Lai, "Compact dual-band slot antenna at the corner of the ground plane," IEEE Transactions on Antennas and Propagation, vol. 57, no. 10, pp. 3423–3426, 2009.

6. C.-M. Wu, "Dual-band CPW-fed cross-slot monopole antenna for WLAN operation," IET Microwaves, Antennas and Propagation, vol. 1, no. 2, pp. 5 2– 546, 2007.

7. Satthamsakul S Puntheeranurak set. al 2010. " A Broadband Microstrip Patch Antenna for IEEE 802. 11a/WIMAX/HIPERLAN 2 Applications " International Conference on Control Automation and Systems pp 2214-2217.

8. Liu Chung Wen Wu Ming Chao and Chu Chang Nien 2012. "A compact low profile antenna for WLAN and WAVE applications" International Journal of Electronics &Communications Vol 22 pp467-471.

9. Singh Indrasen Tripathi S. V et. al 2011. "Microstrip Patch Antenna and its Applications: a Survey" Int. J.

ISSN: 2456-4265, Volume 6, Issue 1, January 2021, http://ijmec.com/

Comp. Tech. Appl. Vol. 2(5) pp 1595-1599. 51. Books Modern Antenna Design by Thomas Milligan (2nd edn- Thomas Wiley and sons.

10. Ojaroudi, N. (2014). Compact UWB monopole antenna with enhanced bandwidth using rotated L-shaped slots and parasitic structures. Microwave and Optical Technology Letters, 56(1), 175- 178.

11. Emadian, S. R., Ghobadi, C., Nourinia, J., Mirmozafari, M. H., & Pourahmadazar, J. (2012). Bandwidth enhancement of CPW-fed circle-like slot antenna with dual band-notched characteristic. IEEE Antennas and Wireless Propagation Letters, 11, 543-546