

Multiband Aperture Slot Microstrip Patch antenna with DGS for Bandwidth Enhancement

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Abstract—this system includes circular aperture slot antenna & the filter used is common mode rejection filter. microstrip coupled transmission lines are used to differentially fed this antenna. Three non-periodical defected ground structures are implemented to remove CM noise. Fractional BW of 125% is achieved by this system. For the different frequencies various radiation patterns in E & H planes is obtained. We get 3 bands namely at 1.3 Ghz., 2.3 Ghz and 3.2 Ghz. Which are useful in GSM Applications, LTE Application and wimax Applications. We get maximum Efficiency at 3.2 Ghz. With this system wide band range from 2 Mhz to 10 MHz is possible. The system is used in radio astronomy applications.

INDEX TERMS—MICROSTRIP, MICROWAVE FILTERS, NOISE MEASUREMENT

I. INTRODUCTION

As wireless technology has grown-up between the variety of microwave devices, differentially fed system are of abundant curiosity. The main advantage of differential system is higher gain, signal can travel longer distances also it rejects the influence of cross-talk coupling [2]. Also they monitor common mode currents which will subsidize more than differential mode currents. The defected ground plane structures (DGS) below a pair of coupled microstrip transmission lines have been used in digital applications to remove CM currents without influencing DM currents [4]–[8]. There are some applications like radio astronomy which require bandwidth more than 100%.

The basic necessity of these applications is wide band for observation with decreased noise. The CM current component naturally introduced as noise when we use Vivaldi antenna fed by differential signal given by rat race coupler [13]

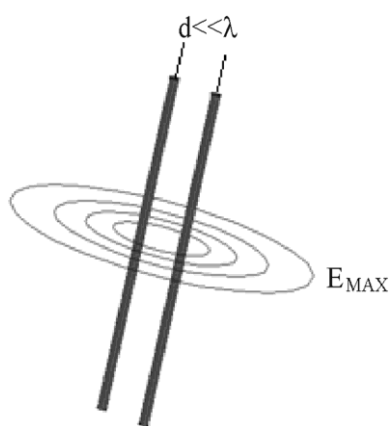


Fig 1. Electric field lines produced by CM currents in nearby wires

This system (filter-antenna) with CM noise rejection for wide band around 125% from 2 to 10 GHz is presented which is required for radio astronomical observations. This system is built from two component circular aperture slot antenna differentially fed & DGS technology which is filter based. This paper is structured with section II is of theory of CM noise, section III design procedure of circular aperture slot antenna, section IV DGS filter is represented and section V implementation of antenna filter system

I. DIFFERENTIALLY FED ANTENNA COMMON MODE NOISE RADIATION

It is difficult to design digital circuits at high frequencies due to CM noise.as shown in fig 1 electric field produced in an omnidirectional mode by the two wires which are transversal to the direction where the transmission lines are placed.

By Half wave dipole theory electric field produced by a wire conductor will be $L=\lambda/2$.The resultant electric field produced by two wire conductors which are placed close to each other will be product of superimposing the field of each metallization.This is similar to the linear array, where the total electric field (E) is the sum of the other two electric fields

$$E_T = E_1 + E_2 \quad (1)$$

$$|ED_{max}| = 1.316 \times 10^{-14} \frac{|I_D| f^2}{d} \times L \quad (2)$$

$$|EC_{max}| = 1.257 \times 10^{-6} \frac{|I_C| f}{d} \times L \quad (3)$$

Where **L** is Length of conductor wire,f is frequency,**I_D** differential current,**I_C** common mode current,s is separation between two conductors,and

d is distance where field is measured [3].

The electric field of common mode increases linearly as frequency increases. Also this field does not depend on the separation between the conductors.By observing (2) & (3) it is clear that total **E** is conquered by **CM** Current moderately than **DM** current

II. CIRCULAR APERTURE SLOT ANTENNA

For broad operational Bandwidth tapered slot antennas are used [20].In this system Circular Aperture Slot Antenna is presented. To construct aperture of this antenna two quarters of (different radii)of circles is used. It also maintain narrow beam in Plane B.The Space between two antennas is filled by rectangle C.As **P1** & **P2** must be fed by differential currents to achieve this width & separation between microstrip lines calculated also to achieve odd mode propagation of 50Ω.The rectangle D is required for optimization on each line. The optimization is done in full wave simulator.

The calculation of S parameter and Reflection coefficient will be simple. The reflection Coefficient(**S_{11dd}**)is given for **DM** by (4)

$$s_{11dd} = \frac{1}{2} (s_{11} - s_{12} - s_{21} - s_{22}) \quad (4)$$

The S parameter can be obtained by preparing Matrix of Port 1 & Port 2.The advantage of this CASA is in results In Radiation Pattern there is high level symmetry. Cross Polarization result of Balanced current more than antipodal.As we are using this antenna with the common mode noise rejection filter which is DGS

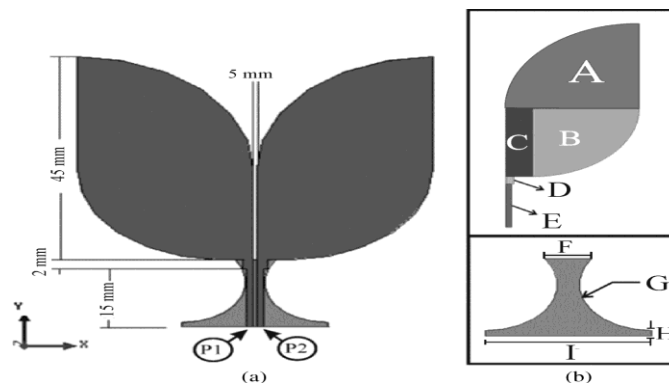


Fig.2. a) CASA Design b) Description of one half of top metallization and ground plane

LETTER	BRIEF DESCRIPTION	DIMENSION (mm)	DIMENSION (λ_g)
A	Radius of major quarter	25	.83
B	Radius of minor quarter	20	0.66
C	Rectangle C	10 × 20	0.33×0.66
D	Rectangle D	1.5×32	0.04×1.06
E	Rectangle E	1× 68	0.03×2.25
F	Minor base of ground plane	5.7	0.18
G	Radius of curved slot in ground plane	8.9	0.28
H	Height until curved slot of ground plane	1.1	0.03
I	Major base of ground plane	20.5	0.68

Wide band or broad band BW is possible. Which is useful in radio astronomical Applications .The Detailed Dimensions for the design of Circular Aperture Slot Antenna are shown in Table 1.as to achieve Narrow Plane Part A and Part B are taken of different radii. To fed differential signal Port 1 & Port 2 is used.

III. Defected Ground Structure Design

As here the CM noise has to remove as it dominant over DM the filter used is Defected Ground Structure Base. This filter used is of balanced type filter.as DM signal travels through top lines by odd mode, due to which in ground plane low current is flowing.As CM current travels in even mode by the ground plane so DGS will consequence influence on CM signal [7],[8] and [24].

The Design for the DGS is as shown in fig 4.The center Slot of the DGS is curved by the adjusting the design of ellipses. The Special purpose of these curved slots is to increase the BW & smoothness in capacitance.BW can be wide bandwidth excess of 100%.In this Filter three Non-

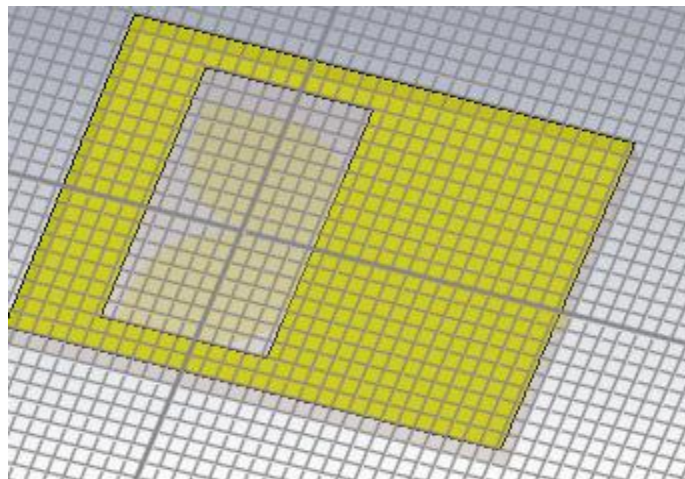


Fig 3 DGS with Dimensions

Periodical Structures (DGS) is designed. The working of these filters depends on insertion loss of DM (S_{21dd}) & insertion loss of CM (S_{21cc}), which are given by (5) & (6)

$$S_{21dd} = \frac{1}{2} (S_{31} - S_{32} - S_{41} + S_{42}) \quad (5)$$

$$S_{21cc} = \frac{1}{2} (S_{31} + S_{32} + S_{41} + S_{42}) \quad (6)$$

The S parameters in (4) can be obtained by matrix of two port network (P1 & P2). Insertion losses to Port 3 due to P1 and P2 are S_{31} and S_{32} respectively.

Similar way Insertion losses for Port 4 from P1 & P2 are S_{41} and S_{42} . With these filters BW of about 133% is obtained for insertion loss of DM less than 3 dB. At higher frequencies near to 10 GHz small ripple occurs which is due to the discontinuity between microstrip line & SMA connectors.

V. Implementation & Results

As from Fig 6 It is clear that we get bands at 1.3 GHz, 2.3 GHz, 3.2 GHz. At 1.3 GHz S parameter is 22.76 dB, bandwidth of 300 MHz, VSWR of 1.8 and 30% efficiency can be achieved. This band can be used for GSM Applications. At 2.3 GHz S parameter is 22.24 dB, bandwidth of 500 MHz, VSWR is 1.84 and efficiency will be 25%. This band can be used for LTE Applications.

The most useful band we get from this design is 3.2 GHz band. At 3.2 GHz band it is clear from Fig 6 that S parameter is -42.40 dB, bandwidth is 598 MHz, VSWR of 1.61 and efficiency of 72%. This band is known as WiMax band and is used for WiMax Applications.

As from results it is clear that this antenna can be used for LTE applications, GSM Applications & for Broad band Communication.

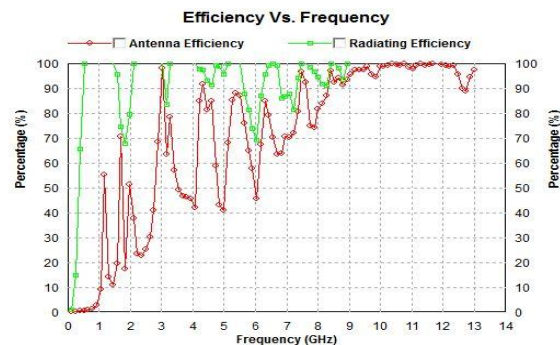


Fig.4 Efficiency Vs frequency

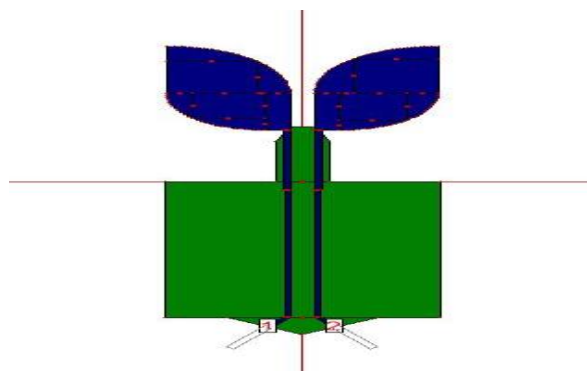


Fig.5 geometry of antenna

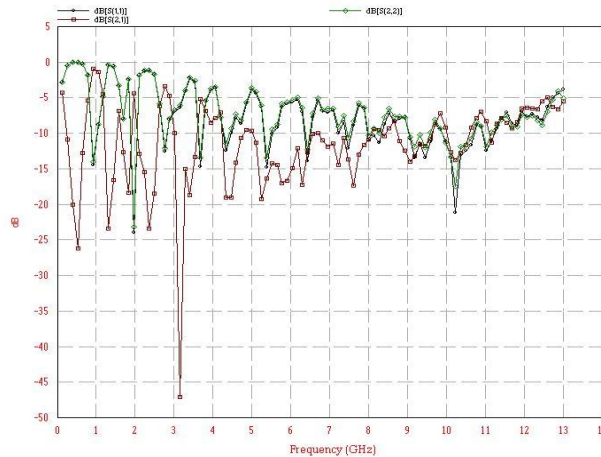


Fig.6 S parameter showing different Bands

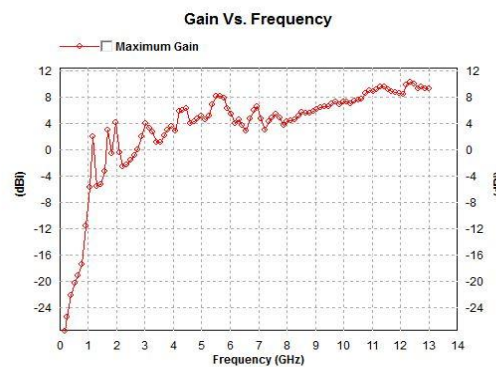


Fig.7 gain Vs.frequency

VI. CONCLUSION

Circular Aperture Slot Antenna with DGS Design is proposed. The system has main two components a circular Aperture Slot Antenna & non Periodical DGS .with this system we can achieve bandwidth excess of 100%.In results the BW is of about 125% from 1 GHz to 3 GHz.we Get Peak at 1.3Ghz ,2.3 Ghz and 3.2 Ghz.which can be used for LTE,GSM and WiMax Applications. Also can be used for Broad Band Communications.

VII. REFERENCES

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