A DESIGN OF DOUBLE SWASTIKA SLOT MICRO-STRIP ANTENNA FOR ULTRA WIDE BAND AND WIMAX APPLICATIONS

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ABSTRACT

This paper presents a design of double Swastika Slot Micro-strip Antenna which can be used in UWB and WiMAX Applications. The proposed antenna operates at resonant frequencies 3GHz and 3.11 GHz. At 3GHz obtained value of VSWR is 1 and return loss is -42dB and at 3.11 GHz VSWR is 1.7 and return loss is -12dB. RT Duroid having dielectric constant 2.2 is used as substrate. Here the double Swastika slot Antenna is fed with the coaxial feeding technique.

KEYWORDS

VSWR, Return loss, Double Swastika slot antenna.

1. INTRODUCTION

Circularly Polarized Micro-strip antennas are widely employed in UWB, WiMAX, RADAR, mobile Communication, aircraft, spacecraft, satellite communication and RFID applications where small size i.e. portability, low cost, high performance, ease of installation, low power consumption and the capability to transmit information at high data rates are major constraints. Liability to transmit and receive maximum power is influenced by polarization of the antenna. UWB is a promising technology for many real time applications as this technology consumes very low power and WiMAX technology provides portable mobile broadband connectivity across nations through a variety of devices. A Compact design of double slotted swastika antenna for circular polarization is proposed and introduced. Circular polarization is brought about by Embedding micro Swastika slot with in main Swastika slot. Since RT Duroid offers better radiation it is selected as a substrate. It offers many advantages such as lowest dielectric loss, low moisture absorption, uniform electrical properties over entire frequency range, high thermal Resistance and conductivity, excellent characteristics for High frequency and excellent high speed and functionality for portable electronic devices in rapidly expanding mobile network. Major limitations of Micro-strip antenna are its narrow Bandwidth and Gain .The design of

portable antenna configuration further deteriorates the two parameters, which is the most serious disadvantage preventing it from being used in microwave applications.

Therefore portability, along with Gain and BW enhancement is becoming major design considerations for real time applications of Micro-strip antenna for wireless communication. Here we are proposing an innovative technique to enhance gain and BW of Micro-strip patch antenna. Slots are cut into double swastika shape to improve the BW and also satisfies convenient impedance matching over entire broad frequency of operation. Characteristics such as dual and circular polarization, dual frequency operation, broad bandwidth, feed line flexibility and so on are easily obtained in this patch shape. Patch is excited by coaxial feed in this particular design. Simulation and Experimental results of antenna are prescribed and discussed here.

2. ANTENNA DESIGN & CONFIGURATION

Slots are cut in the design such that they appear in the shape of Double Swastika slot antenna. The Inner Swastika slots are extended from main Swastika slots and the legs of Inner swastika slots are smaller than the legs of the main Swastika slots. The shape of double Swastika slots could provide desired Band width because of variations in the current distribution and the radiation pattern at the edges. Patch width is properly adjusted to get improved results.
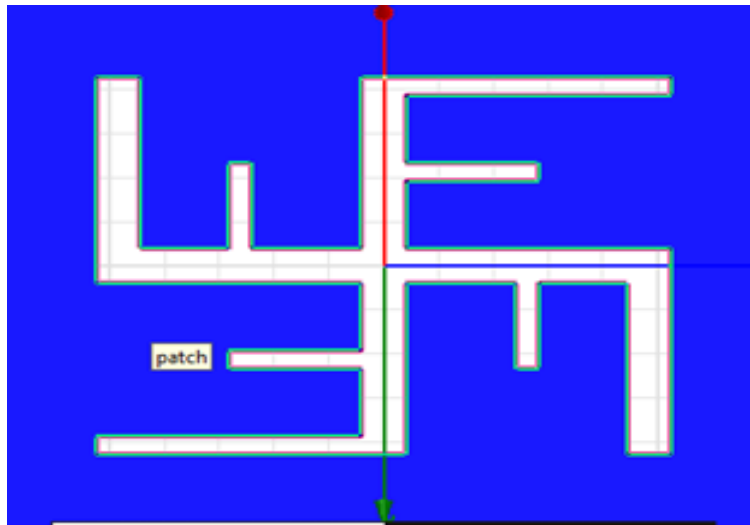

Fig.1 Double swastika slot

Design Equations:

$$\Delta L = 0.412h \frac{(\varepsilon_{reff} + 0.3)(\frac{W}{h} + 0.264)}{(\varepsilon_{reff} - 0.258)(\frac{W}{h} + 0.8)}$$

$$W = \frac{c}{2 f_o \sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

$$L_{eff} = \frac{c}{2 f_o \sqrt{\varepsilon_{reff}}}$$

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \left[1 + 12\frac{h}{W} \right]^{-\frac{1}{2}}$$

Where,

ΔL = increased length due to fringing effect

W = Patch width of the antenna

L_{eff} = Effective length of the patch

ε_{eff} = Effective dielectric constant of the substrate

C = Speed of light

h = height of the substrate
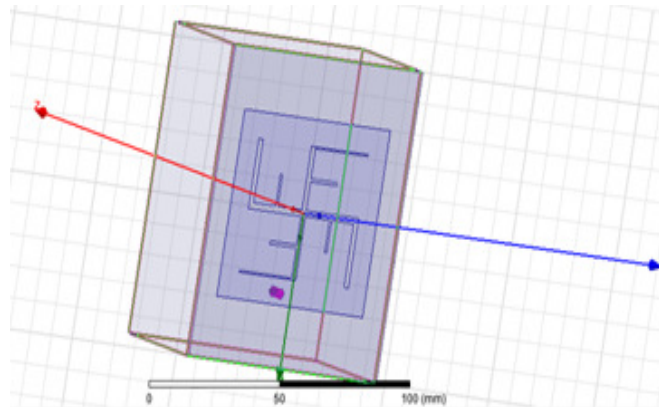
f_0 = Resonant frequency

Fig.2 The construction view of double swastika slot antenna with feed

Micro-strip antenna in general can be fed from underneath via a probe as shown in the above figure. The outer conductor of the cable is connected to the ground plane, the center conductor is extended up to reach the patch antenna and the antenna efficiency in terms of return loss mainly depend up on the impedance matching between patch and transmission feed line. We get more efficient results when both transmission feed and patch have perfect impedance matching.

The position of the feed can be altered to control the input impedance. The coaxial feed introduces an inductance in to the feed point that may need to be taken into account if the height h gets large i.e. an appreciable fraction of wavelength. In addition the probe will also radiate, which can lead to radiation in undesirable conditions. The main aim to use coaxial or probe feeding is that, it enhances the gain, provides narrow bandwidth and perfect impedance matching.
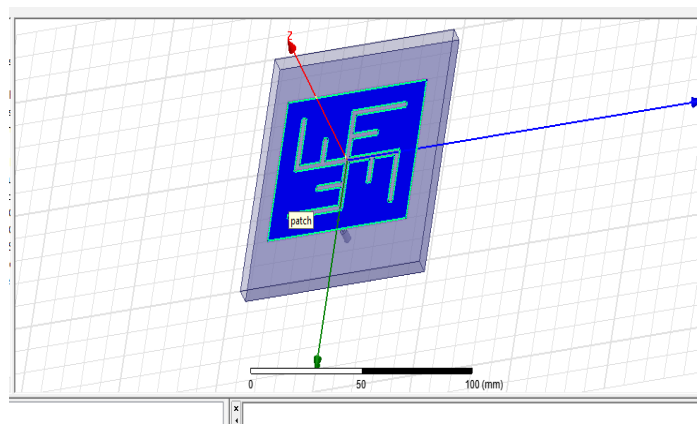

Fig.3 Top view of Double Swastika Slot Patch Antenna

Feed point is varied to different positions to get good radiation and impedance matching. While cutting the slot optimum dimensions should be considered. So the dimensions of slot are important for good efficiency of antenna.

3. THE DESIGNING PARAMETERS

Length of the patch(Lp)	60mm
Width of the patch(Wp)	70mm
Height of the substrate(Hs)	1.6mm
Length of the substrate(Ls)	100mm
Width of the substrate (Ws)	90mm
Outer cylinder Radius (Rout)	1.6mm
Inner cylinder Radius (Rin)	0.7mm
Height of the air box (Ha)	40mm

Correct position of substrate, ground and patch can be obtained by properly using the following equations. Ten rectangular boxes (gaps) are required to get the shape of double swastika slot patch antenna. Slot sizes can be varied using the following equations.

1. Substrate - Ls/2,Ws/2,0mm
2. Ground - Lp/2,Wp/2,-h
3. Patch – Lp/2,Wp/2,,0mm
4. Gap1 –lp/2-(c+e) ,-d/2 ,0mm
5. Gap2--d/2 ,-k/2 ,0mm
6. Gap3 -lp/2-e ,k/2 ,0mm
7. Gap4 -(lp/2-e)-a ,-k/2 ,0mm
8. Gap5 --lp/2+e ,-k/2 ,0mm
9. Gap6 -lp/2+e ,k/2 ,0mm
10. Gap7 -((c/2)+(d/2))/2 ,m/2+d/2 ,0mm
11. Gap8 -((c/2)+(d/2))/2 ,(m-k/2) ,0mm
12. Gap9-((c/2)+(d/2))/2,-((k/2)+(d/2))/2 ,0mm
13. Gap10 -((c/2)+(d/2))/2 ,k/4+d/4 ,0mm

14. Air box-((c/2)+(d/2))/2 ,k/4+d/4 ,0mm

Where

C=lp-(2*lp/7)

k=wp-(2*(wp/8))

e=(lp-c)/2

m=(k/2)-d/2

4. RESULTS & DISCUSSION

In the design, dual band frequency characteristics are obtained and the analysis using HFSS simulation tool resulted in acceptable values for Return Loss, VSWR and Gain.
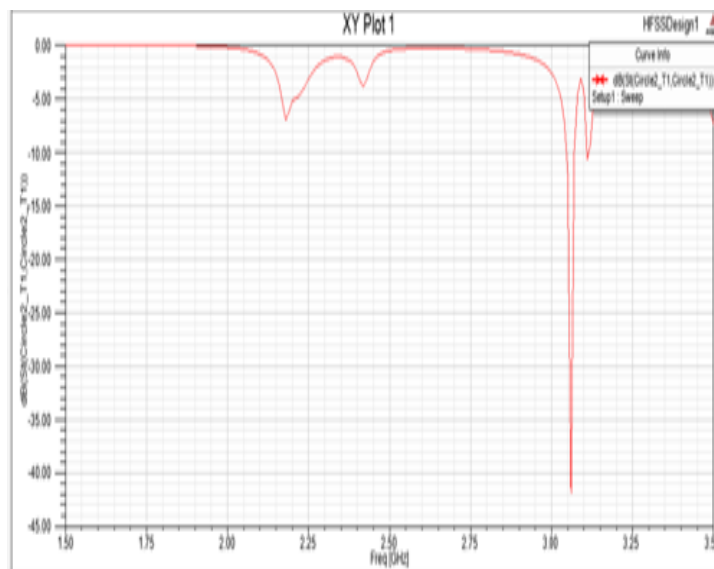

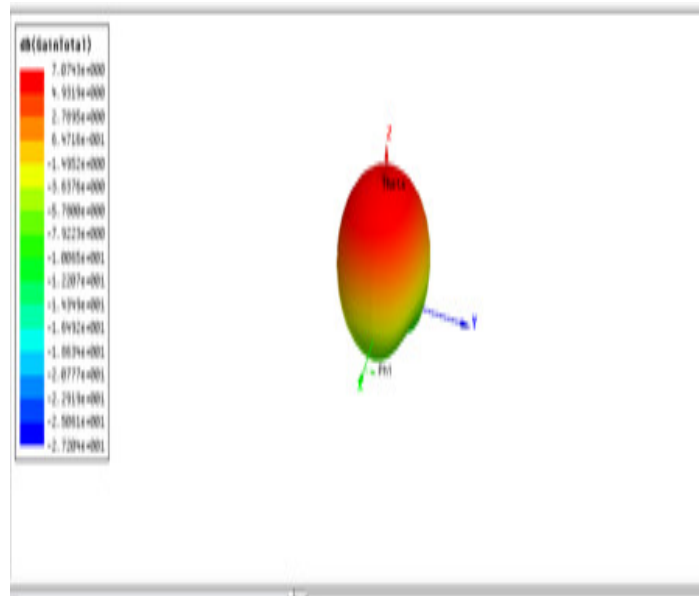Fig.4 Return loss at two proposed frequencies (3&3.11GHz)

Fig.5 Gain plot of the Double swastika slot microstrip patch antenna
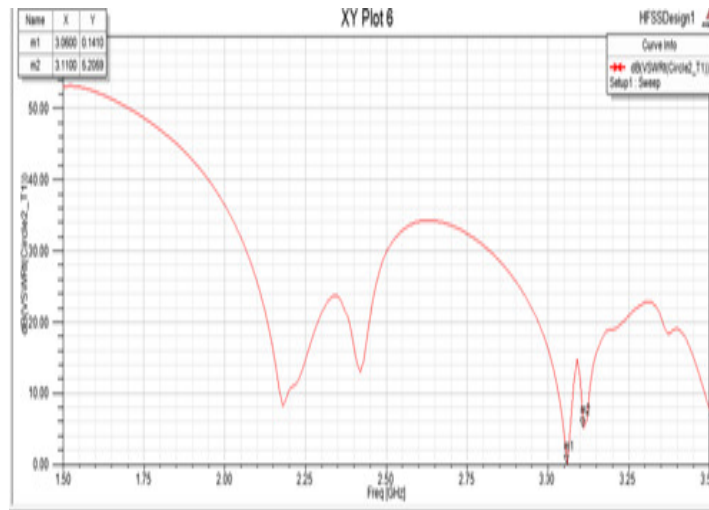

Fig.6 VSWR at two proposed frequencies (3&3.11GHz)

Above results shows that Return loss and VSWR as

At 3GHz, Return loss   = -40dB

          VSWR   = 1

At 3.11 GHz, Return loss   = -12dB

VSWR   = 1.7

Hence VSWR (<2) and Return loss (<-10dB) obtained in the acceptable range.

5. CONCLUSION

 A double Swastika slot patch antenna with coaxial feed line was designed and simulated here. The values of Return loss and VSWR were accomplished in the acceptable range. VSWR 1 and 1.7, Return loss -42dB and -12dB were achieved at resonant frequencies 3GHz and 3.11GHz respectively. Gain of about 7dB achieved. Slot dimensions were varied to get desired results. The proposed Antenna in this paper can be used in UWB and WiMAX Applications. Here HFSS Simulation tool has been used.

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