Compact Triangular Multilayer Micro strip Antenna (TMA) for Broadband Applications

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Abstract— This research paper reports a design of a wide band micro strip patch antenna (MSPA) for L frequency band. The results reported here were obtained using a full wave finite element computer simulation of the antenna with Ansoft HFSS software. The antenna uses a stacked dielectric layer structure and has desired wide bandwidth. In the design of the wide band antenna feed position of the coaxial connector probe, widths of triangular patch and height of a foam layer in the multilayer were varied and optimized to achieve desired performance for the antenna. A10-dB bandwidth of 16% was achieved for the antenna in the L-band.

Key Words - Bandwidth, triangular Micro Strip antenna, FR4

I.   INTRODUCTION

Micro strip patch antennas have various system applications. Some of the applications are Bluetooth, ,mobile access   radar systems, missiles telemetry systems, aircraft communications systems, free broadcasting, wireless radio, W-LAND broadcasting, satellite communications and mobiles handsets. Micro strip Patch Antennas (MSPAs) have the advantage of small size and low profile allowing them to be easily integrated in the body of aircrafts, missiles or computers. Micro strip patches can be fabricated easily at low cost. The disadvantage of a MSPA is its small bandwidth of 1 to 2% around the resonant frequency. Analysis and design of wideband low profile antennas are currently an important research area. The triangular geometry of the micro strip patch (Fig. 1) drew the attention of there searchers in investigating the structure as planar circuit components and as radiating elements in conventional and multi layered configurations Compared to other patch geometries, the triangular micro strip is physically smaller having radiation properties similar to the rectangular patch but has a lower radiation loss . In recent years, the TMA(Triangular Micro Strip Antenna) has found several new applications as broad band radiators.

II.   TRIANGULAR PATCH AS MICROSTRIP CIRCUIT

The first study on TMA dates back to 1977 [1]. Initial reports show that the TMA was considered as a narrow band structure owing to its high Q value. Hence, the early studies show potential applications of the TMA as oscillators, filters and circulators [1]. Almost simultaneously, Helsza jn and James [2] reported theoretical and experimental gationon equilateral TMA as disk resonator, filter and circulator. They used the cavity resonator model to determine the resonant frequencies for the TMn,m,l modes and also showed their respective field patterns. blurriness , noise, . This paper is organized as

follows. I. Previous work showing the highlights the blurriness and noise estimation in spatial domain. II Explains the design of the No-reference image quality metrics for blurriness and noise.III shows the obtained results. IV Conclusion and section V lists the used references.

Fig. 1 A photograph of the Coaxial-fed Triangular Patch Antenna printed on a dielectric substrate

III. TMA DESIGN(TRIANGULAR MICRO STRIP ANTENNA)

The stacked patches analyzed in this project are made of a driven and a parasitic triangular   patch FR4 with foam in between them. The sides of the patches are basically half wavelength of the operating Frequency 2.4 GHz used for ICM (Industrial Scientific Mediccal) band license free band,   dimensions emanates from basic equations for micro strip patch antenna design shown in Fig.
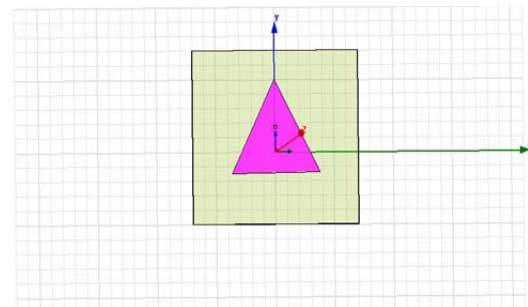
Fig.2.   Geometrical Layout of Triangular antenna.

Antenna measurements are performed on antenna only i.e. without amplifier reflection coefficient S11 & radiation level in the broadside direction are Measured.

Most antenna gains are measured with reference to isotropic radiator & are related in decibels.

As dielectric constant of substrate increases antenna bandwidth decreases. In single layer bandwidth increases and gain decreases by 60 MHz. To improve the good results add again one substrate and dielectric for better results.
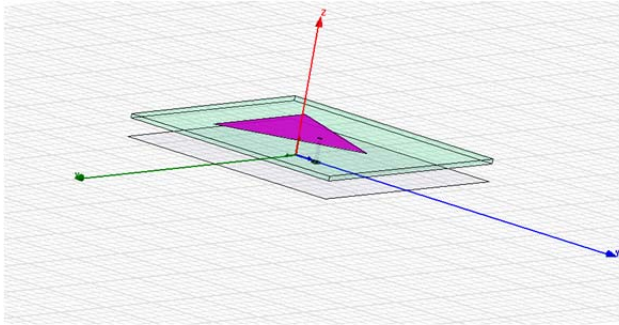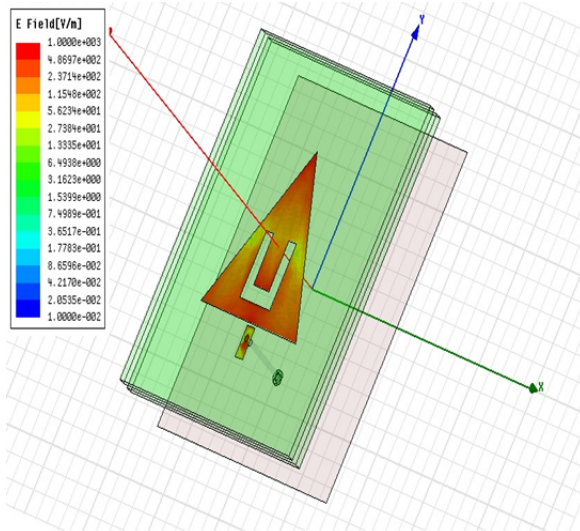

Fig.3 Side view of multilayer TMA

Multilayer Uslot
TMSA with Capacitive
Feed

IV. Design Parameters Of Micro Strip Antenna

V. Design Equations For TMA Calculation-

Patch shape	Triangular
Frequency	2.4 GHz
Feeding method	Coaxial probe
VSWR	2:1
Dielectric material	FR4(glass epoxy)
Polarization	Circular
Dielectric constant of substrate	4:4

The fundamental mode resonant frequency of such antenna is given by,

a) $Fr = (2.c) / (3.w .\sqrt{\varepsilon} r)$

Here c is the speed of light and relative Permittivity of substrate. We estimate the patch side length W for ISM band.
F = 2.4 GHz and Dielectric constant $\varepsilon r = 4.4$

b) $W (mm) =(2(cm/s)) /(3. f .(\sqrt{\varepsilon} r))$

For calculation W (mm) = 38mm

c) substrate calculations
lambda = (c/f) = 125 mm here c is the velocity of light= 3x10^8m/s
^2, F = 2.4 GHz and Dielectric constant $\varepsilon r = 4.4$

d) $D = lambda / (4x sqrt (\varepsilon r)) = 15 mm$
Orgnd plane should be lambda/2 i.e. 61 m

Numerical computer calculations were made with Ansoft HFSS (fig.3) to find an optimum position of the coaxial probe on the primary patch feed and the length of the triangular patch elements. The results are shown in fig.4. The sides of the patches were varied from 50mm to 56mm. The probe position was varied from 21mm to 26mm. The values of L and Xp that give the best return loss and bandwidth.

VI. Results / Observations

Several curves for the return loss were obtained by varying L and Xp around the calculated values. The results from Computations are shown below
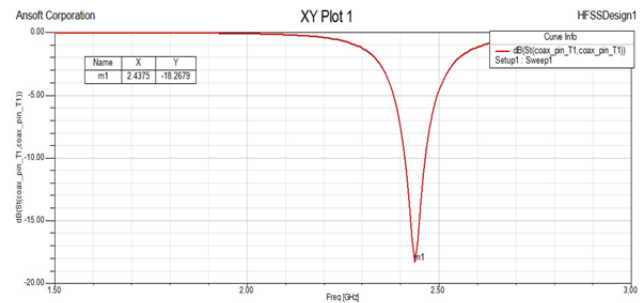

Fig. 4 return loss for single layer

The return loss = -18.26 and its value in fig. 3. Return loss for single layer for 2.4 GHz.
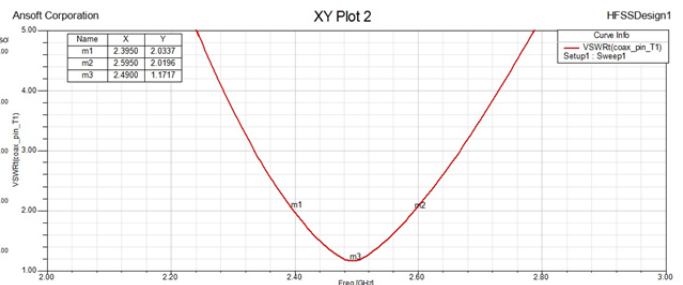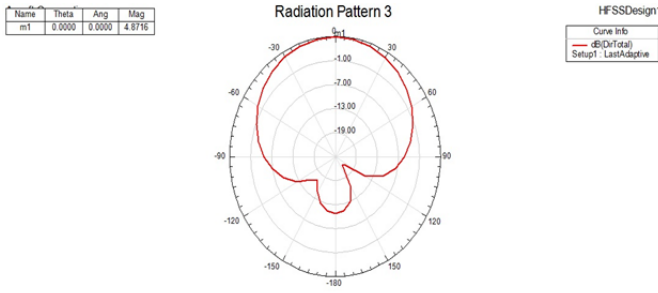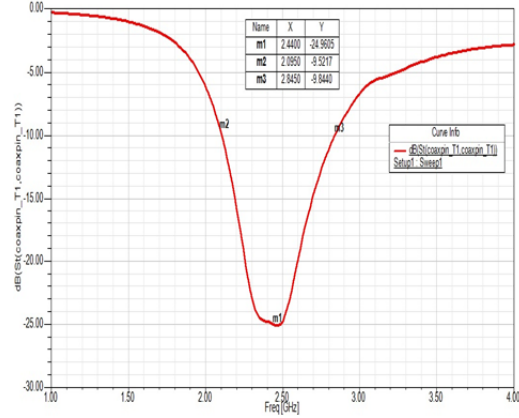

Fig .5 VSWR for single layer TMA
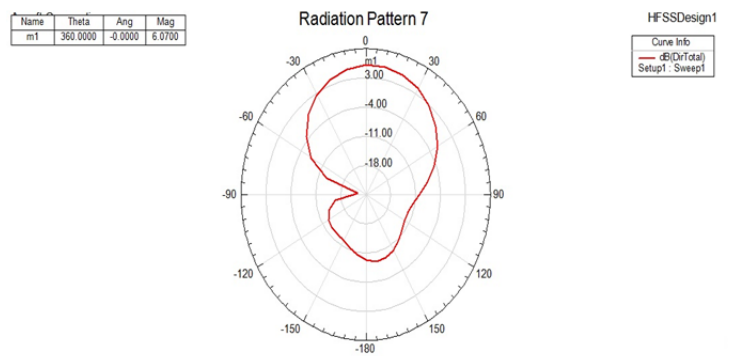
Fig.6 Radiation Pattern

Antenna measurements are performed on antenna only i.e. without amplifier reflection coefficient S11 & radiation level in the broadside direction are for single layer TMA

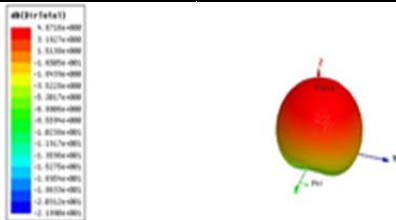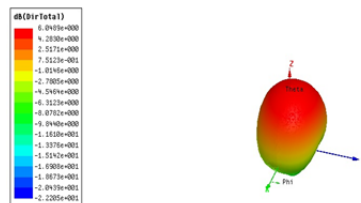Following are the results show for multilayer TMA

Design	Single Layer	Multilayer
Size	More	Less(compact)
Gain	less	more
Bandwidth	60MHz	200 MHz
Return loss	-18.26 dB	-2.2 dB
VSWR	1.27	1.17
Directivity	4.8dB	6dB
Substrate	FR4	2 Layer of FR4
Advantage	Efficiency increased	Performance improved
Application	Narrowband up to 60MHz- max 100MHz	Wide band up to 200-400MHz

Fig. 7   return loss for Multilayer TMA

Following are the results of TMA antenna design

Fig. 8   VSWR for   multilayer TMA

Fig. 9   Radiation pattern for multilayer TMA

Fig. 10 Directivity for Multilayer TMA

COMPARISONS TABLE OF DIFFERENT CONFIGURATION

Sr.No.	Type of Microstrip Antenna	Frequency (GHZ)	Return loss(dB)	VSWR	Directivity (dB)	Bandwidth (MHz)
1.	Single layer TMSA	2.43	-18.27	1.27	4.87	60
2.	Multilayer TMSA	2.49	-22.04	1.17	6.04	190
3	Multilayer TMSA without Uslot	2.46	-16.47	1.35	6.08	170
4.	Multilayer TMSA with Uslot	2.41	-19.97	1.21	5.98	175
5.	Multilayer Uslot TMSA with Capacitive Feed	2.42	-24.96	1.12	2.81	765

ADVANTAGES & DISADVANTAGES OF TMSA

Sr.No.	Type of Microstrip Antenna	Advantages	Disadvantages
1.	Multilayer TMSA with Uslot	i)easy to built ii)high directivity	i)Low bandwidth ii) larger Size
2.	Multilayer UslotTMSA with capacitive feed	i)high efficiency ii)higher Bandwidth iii)Compact size	i)Low directivity

CONCLUSION & FUTURE SCOPE

The stacked patch antenna will be as designed usingFR4. The substrate chosen has a relatively low dielectric constant ɛr 2.2 and a height of 3.175mm. By using a dielectric constant, a thick substrate and thick foam we will be to improve the bandwidth from 1.5% to 16%. The max. return loss for the designed antennas is around 27dB.

REFERENCES

1] J.Helszajn , D.S. James and W.T.Nisbet,"Circulators using triangular Resonators" IEEE Trans. Microwwave theory Tech. , vol..27.
2] M.Cuhaci and D.S.James ," Radiation from triangular and circulators resonators in micro strip,"I EEE MTT-S Int. Microwave
3] A.K. Sharma and B.BHAT,"Analysis of triangular micro strip resonators," IEEE Trans. Microwave
4] J.Bahl and P.Bhartia,"Radiation characteristics of triangular micro strip antenna"
5] E. F.Kuester and D.C. Chang,"A geometrical theory for the resonant freq. and Q- Factors of some triangular micro strip patch aantenna"
6] Y.M.Jang,"Characteristics of a large bandwidth rectangular micro strip fed inserted triangular patch in circular slot antenna"