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High Gain Circular Patch Antenna Filter

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Abstract:
In this paper high gain circular patch antenna with a superconductor filter in communication receiver proposed using microstrip feed. The patch is activated for the frequency 2-4GHz and the filter is desinged for 2-4GHz. The antenna and filters are connected serially on the substrate to receive for a frequency band of 2 to 4GHz with high gain. The sharp beem antenna with filter is desingned for WLAN applications. LCP films are used as substrate of the radiating patches to improve the gain and efficiecy of the antenna. The strip feeding gives good impedance matching for wideband applications. Simulation result of the proposed antenna shows an average gain of 2dB for the specified frequency ranges and Maximum gain nearly 5dB was achieved between 2-4GHz frequency ranges.

Keywords: *strip, BPF, circular, filter, patch, substrate.*

1. Introduction

Rectangular or elliptical microstrip patch antennas are commonly used in microwave communication transmitter and receiver with narrow band frequency.A patch antenna is normally designed by a single substrate structure with coaxial feed, It makes the probe length high and which makes the input impedance more inductive.Strip feeding simplifies the construction process by eliminating soldered connection. Impedance matching can be achieved by connecting a small strip line connected at the end of filter. Strip feed reduces the spurious radiation and increases the sharpness of the antenna .The input impedance of the antennas are selected as 75 ohms to get good impedance matching. The proposed UWB [8] filter is realized using substrate of dielectric constant 2.2 and substrate height 0.787 mm.

The concept of microstrip antenna presented by Pozer in 1992 [1]The radiating device that offers compactness and wide bandwidth operation[2].Sumanth Kumar *et al*.[1] reported a wideband aperture coupled stacked patch antenna with appreciated gain for the frequency range 5 to 10 GHz.Three element high gain microstrip antenna has been described by Nishiyama *et al.*[3] operating at 30GHz.The efficiency is low for the above mentioned structure due to the dielectric and conductor losses with in the PCB substrate.

Another issue of semi elliptic monopole slot antenna for UWB system by M.Gobikrishna *et al* .[3] has low gain of 4dB.Multiband filters with circular and Gaussian dielectric resonators is presented by Samuel Angel Jaramilo *et al*.[5] an circular structure with diamentions 80x80mm for 1.6GHz and 4GHz .More Circular patch antennas are reported for narrow band applications.High temperature fabrication process was used previously to fabricate suspended patch antenna, which makes the fabrication process very complex and also it uses expensive silicon substrate materials[6]. Recently B.Pan *et al*.[7] introduced a micromachined polymer piller between the substrate to create an air gap, but the bandwidth of the antenna is limited only 20%. In this paper we presented circuar patch antenna with two base substrate FR4 and Taconic PTFE with dielectric constant 4.4 and 2.2 respectively. Polyimide film used as the supporting substrate of the circular patches.

2. Antenna Design

The proposed antenna design equation is given below

$A_e=a\{1+2R/\pi\varepsilon_r a[\ln(\pi a/2R)+1.7726]\}^{1/2}$ (1)

Where a - actual radius,A_e – Effective radius,R- substrate height,ε_r – Permitivity of the substrate, The current distribution of the patch effective area is shown in fig1.Fig 2 shows the circular patch1 antenna demonstrated using microstrip feed in FR4 substrate for 2-4 GHz band with the axis length of the circles are 18,18 mm.The total area of the patch antenna is 40x30 mm ,the width of the strip feed **s** is 2.3mm and strip length is 4mm shows the magnitude of the parameter S11 simulated by EM simualtor.It shows minium return loss -35dB in fig 3 (blue line).

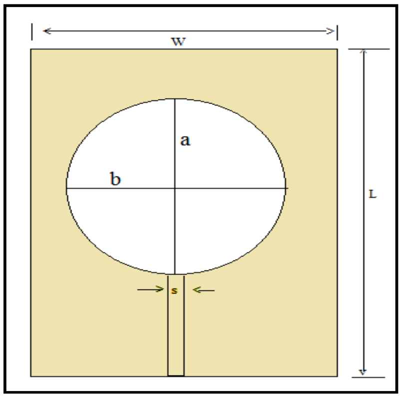

Figure 1: Diamensions of c ircular patch

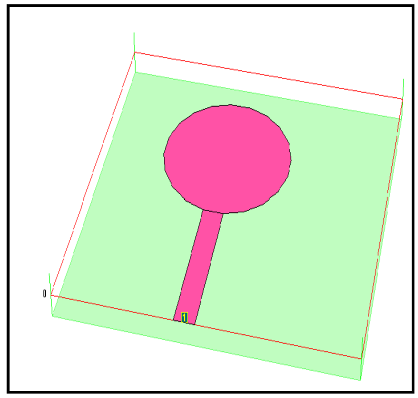
Figure 2: Circular patch on substrate (FR4 and Tacconic)

The next circular patch antenna design is proposed with axis length 18,18 mm as listed in TabeI for the band of frequency 2-4 GHz on taconic base substrate. The width of the feeds are same in both antenna. The simuation result is shown in fig 2 .It shows minimum return loss of -43dB than FR4 substrate at 3.2 GHz.

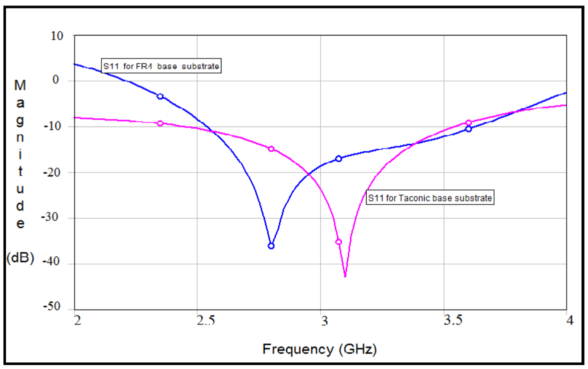

Figure 3: S parameter of Patch antenna on FR4 and Tacconic substrate

Parameter Values
Substrate thickness h 1.59mm
Loss tangent δ 0.025
Permitivityε_r 4.4
Area of the patch (L x W) (40x30)mm
Axis of circular patch (a,b) 18,18mm
Length of the fiter(one strip) 7.5mm
Width of the strip(one strip) 1mm
Gap between the strip 2mm
Length of feed line 8mm

Table 1: Design Parameters of Strip Feed Circular Patch Antenna

3. Bandpass Filter Design

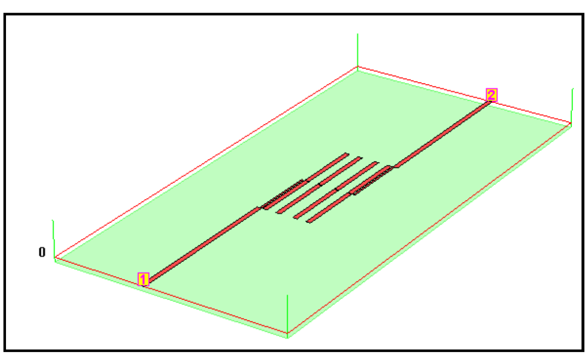
Figure 4: BPF on substrate (FR4 and Tacconic)

The superconductor Bandpass Filter is designed for the frequency of 2 GHz to 4 GHz. The filter is designed for 0.2 dB ripple. The BPF design leads to the order of filter as 4 indicating 4 filter components shown in fig 4 (Prototype - 2 capacitors and 2 inductors). The conversion of the lumped elements into distributed elements in BPF [5] is done using namely two transformations: Richards Transformation and Kuroda's Identities. To accomplish this now the elements obtained above are de-normalized and equivalent micro strips are obtained. De-normalizing involves scaling the unit element to the 50Ω input and output impedances and computing the length of the lines. Using $\lambda_0/8 = v_p/(8f_c)$, the length is found out to be $l = \lambda_0/8 = 7.5$ mm where $f_{ace} = 3$GHz. The final design of the BPF is shown below in Figure 6. Thus the overall length of the bandpass filter comes out to be 15 mm and feed line is 8mm.
The end of circular patches and filters are desinged to improve the bandwidth. The patch and the feed lines are designed to be in close resonance for idle band operation.The end tuning of antenna and filters are adjusted carefully for impedance matching.The height of strip lines chosen based on the gain bandwidth product. The overall design is simulated by IE3D EM simulator using the parameter values as mentioned in the tables.

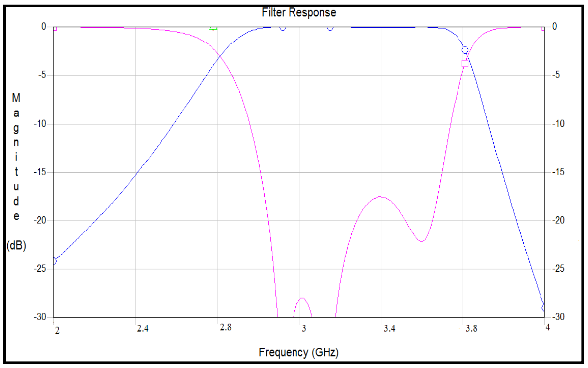

Figure 5: Simulated result of filter on FR4 substrate

Fig 5 shows the simulated supercoductor result of filter on FR4 substrate.It has a bandpass filter response from 2-4GH frequency with S11 parameter of -30dB at 3GH.The maximum gain obtained from the frequency range of 2.8 to 3.8GHz band.Fig 7 shows the simulated response of designed fiter on Taconic surface. The maximum gain is obtained from the frequency range of 2.8 to 3.4 GHz.

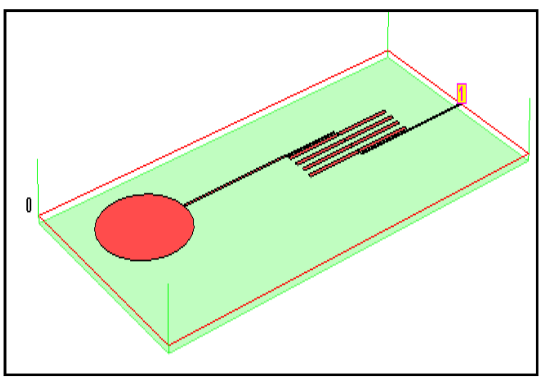

Figure 6: Antenna filter on (FR4 and Tacconic substrate)

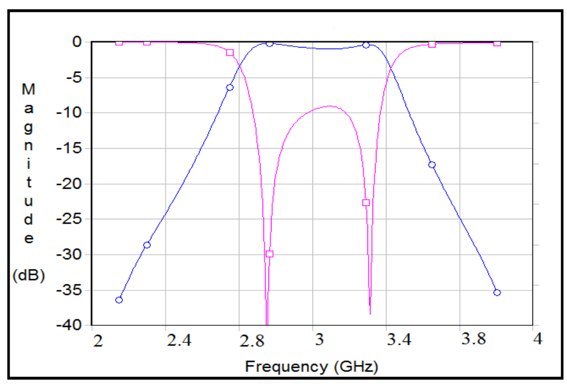

Figure 7: Simulated result of filter on Tacconic substrate

Substrate Thickness Dielectric Constant
FR4 1.59 mm 4.4
Arlon 1.51mm 3
LCP film 0.1mm 3.2
Taconic 0.5mm 2.2

Table 2: Design Parameters of Circular Patch Antenna

4. Antenna Fiter Design

Fig 6 shows the antenna filter on FR4 and Taconic surface.A arlon coated LCP film used on the bottom of the patch to increase the radiation of antenna. The simulation result shows the radiation patern in H-field direction.Inner circle shows the pattern of FR4 substrate and outer circle shows the pattern of Taconic substrate.Taconic base sustrate antenna given good result.

5. Result and Discussion

A 15dBi standard gain horn antenna is used as transmitting antenna and 20dBi standerd gain horn antenna as the reference antenna.From the simulated results it is found that Taconic substrate patch antenna is giving good performance than FR4 substrate. From fig 9, The S21 and VSWR pattern of FR4 and taconic circular patch antenna filter is determined.The VSWR value is small as 2 and the gain of the antenna is high nearly 2dB obtained from FR4 substrate and 5db Gain obtained from taconic substrate.

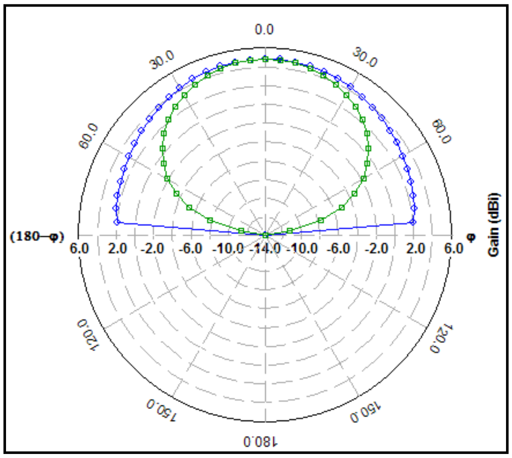

Figure 8: Radiation pattern of circular stacked patch antenna filter

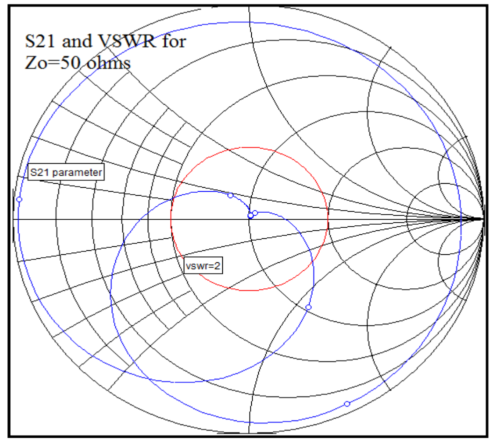

Figure 9: S21 and VSWR of circular stacked patch antenna filter

6. Conclusion

A wideband circular patch antenna filter is designed and simulated for WLAN applications. The dimensions of the proposed antenna filter is (50x40)mm.Then return loss measured at the desired antenna filter is minimum of -35dB for the specified bands.The idle band operation is achieved by optimally tuning resonances associated with the antenna device through the use of patches.The bandwidth of the desired antenna is determined to be 30 percentage. The proposed antenna filter gives a sharp beam pattern in the frequency ranges of 2.7 and 3.2GHz. The filter is having a good response at 2.8 to 3.4 GHz.

7. References

i. D. M. Pozar, "Microstrip antennas," Proc. IEEE, vol. 80, pp. 79–91, Jan. 1992.

ii. Sumanth Kumar Pavuluri,Chanhai Wang and Aan J.Sangster "High efficiency wideband aperture coupled stacked patch antennas",IEEE rans.Antennas and Propagation Vol.58no11,Nov 2010.

iii. E. Nishiyama, M. Aikawa, and S. Egashira, "Three-element stacked microstrip antenna with wide-band and high-gain performances," in Int. IEEE AP-S Symp. Dig., Jun. 2003, vol. 2, pp. 900–903.

iv. S.Mestdagh,R.Walter De and G.A.E.Vandenbuch, "CPW fed stacked microstrip antenna s" IEEE trans.Antennas and propagation Vol.52,No1,PP.74-83 Jan-2004

v. M.Gopikrishna,Deepti DasKrishna,C.K.Anandan "Design of a compact semi elliptic monopole slot antenna for UWB system,IEEE trans. Vol.57 no6, June 2009

vi. Y.C.Lin and K.J.Hing "Compact utra ideband rectangular aperture antenna and band-notched designs",IEEE trans. Antenna propagation.Vol5.no11-pp 3075-3080 ,Nov 2006

vii. Samuel Angel Jaramillo Forez "Multiband fiter with circular and Gaussian dieectric resonators planer in microwave" IEEE trans. Pp 978-1-4614-6,2012

viii. K.Kim, N.Kidera, S. Pinel, J. Papamerou and MM Tenlzerus, "Linear tapered cavity-backed sot antenna for millimeter wave LTCC module" IEEE trans Antenna wave propagation lett pp 175-178 2006

ix. F. Croq and D. M. Pozar, "Millimeter-wave design of wide-band aperture-coupled stacked microstrip antennas," IEEE Trans. Antennas Propag., vol. 39, no. 12, pp. 1770–1776, Dec. 1991.

x. G. S. Kirov, A. Abdel-Rahman, and A. S. Omar, "Wideband aperture coupled microstrip antenna," in Proc. IEEE APS Symp., Jun. 22–27,2003, vol. 2, pp. 888–891.

xi. G. P. Gauthier, J. P. Raskin, L. P. B. Katehi, and G. M. Rebeiz, "A94-GHz aperture-coupled micromachined microstrip antenna," IEEE Trans. Antennas Propag., vol. 47, no. 12, pp. 1761–1766, Dec. 1999.

xii. B. Pan, Y. K. Yoon, G. E. Ponchak, M. G. Allen, J. Papapolymerou, and M. M. Tentzeris, Analysis and characterization of a high-performance Ka-band surface micromachined elevated patch antenna," IEEEAntennas Wireless Propag. Lett., vol. 5, pp. 511–514, Dec. 2006.

xiii. K. Jeong-Geun, L. Hyung Suk, L. Ho-Seon, Y. Jun-Bo, and S. Hong, "60-GHz CPW-fed post-supported patch antenna using micromachining technology," IEEE Microw. Wireless Compon. Lett., vol. 15,no. 10, pp. 635–637, Oct. 2005.

xiv. Y. H. Cho, K. Sung-Tek, C. Wonkyu, H. Man-Lyun, C. Pyo, and K.Young-Se, "A frequency agile floating-patch MEMS antenna for 42 GHz