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MICROSTRIP ANTENNA: DESIGN ASPECTS

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ABSTRACT

The rapid growth and demand of wireless based applications for commercial and personal communication increases the demand of microstrip antennas with the advantage of being low cost, low profile, small size, capable of being integrated with VLSI design [2], [12]. However microstrip antennas have some inherent limitations i.e. narrow bandwidth, low gain, low efficiency, low power handling, radiation from feed [1]. In order to meet the miniaturization of portable equipments in wireless communication the size of microstrip antenna also needs to be reduced along with improvement in other limitations for practical applications, BW (Bandwidth) of MSA have to be increased. This paper summarized the available novel design techniques for increasing BW & reducing the size of MSA.

Keywords: Bandwidth, Fundamental Resonant Frequency Microstrip Antenna (MSA), Radiating Patch , Shorted Patch,

1. INTRODUCTION

MSA in general have a conducting patch, printed on a grounded substrate. The upper conductor i.e. patch radiates and is primary due to fringing fields between patch edge & ground plane [2]. The lower layer which is conducting acts as a perfectly reflecting ground plane bouncing energy backs in to free space through substrate [2].

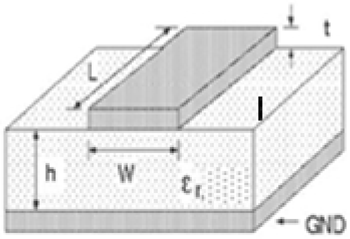

Figure 1: Basic Microstrip Patch Antennas [1]

2. DESIGN ASPECTS OF MICROSTRIP ANTENNA

This paper reviews only size reduction & B.W reduction techniques available for MSA. These are as follow

A. Size Reduction Techniques

1. **Higher Permittivity Wave Substrate** [1]: By use of higher permittivity µ wave substrate, the reduction in antenna size can be achieved but this leads to narrower BW (Bandwidth) .So there is a tradeoff between antenna size and BW [12]

2**. Use of Shorting Plate** [12]: By the use of shorting wall/shorting plate/shorting pin the antenna's fundamental resonant frequency can be lowered & size reduction can be obtained [7]. With the shorting pin the shifting of null voltage point occurs at the centre of rectangular or circular patch with respective patch edges [14]. This makes the shorted patch resonates at a much lower frequency and the reduction in the patch size is limited by the distance between the null voltage point in patch and the patch edge.

3. **Surface Meandering** [15]**:** Antenna size can be reduced by meandering the excited patch surface or ground plane.
Patch Meandering: Meandering the patch surface which are excited, the current paths in the antenna's radiating patch leads to a great lengthened current path for fixed patch dimension which results in a lowered fundamental resonant frequency & thus antenna size reduces [7], [12],. The meandering can be achieved by inserting several narrow slits at the patch's non radiating edges.
Ground Meandering: Meandering the ground plane of a MSA results in lowering of fundamental resonant frequency to patch-meandering

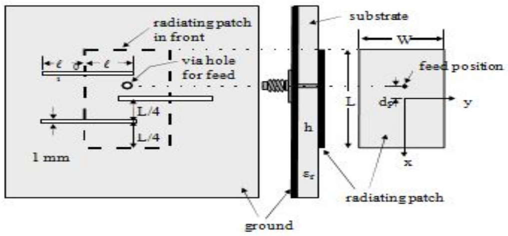

Figure 2: geometry of compact microstrip antenna with a meandered ground plane [14].

In addition the impedance BW and GAIN can also be enhanced and which is a great advantage of ground meandering over patch meandering**.** In MSA shown in Figure 2 three identical slots are embedded in the antenna's ground plane with equal spacing of L/4 and parallel to the patch's radiating edge. The slots embedded in ground plane are narrow and have a length of l_0+l_i, where l_0 and l_i respectively are slot length outside and inside projection image of radiating patch in the ground plane. The dimensions of the rectangular radiating patch were chosen to be 30mm X 20mm (LXW). The slot length l_0 was fixed to be 10mm and slot length l_i was varied. For the reference antenna $l_0=l_i=0$, the fundamental resonant mode is excited at 2387MHz with a 10db return loss BW of 2.0% [14]. For increasing the slot length l_i the fundamental resonant frequency is quickly lowered. For l_i=14mm the resonant frequency f_r is 1587MHz, which is about 0.66 times that of reference antenna. This suggests that an antenna size reduction as large as about 56% can be achieved for proposed antenna operated at a fixed frequency [14].

4. **Use of an inverted U-shaped or Folded patch** [11]: The lengthening of the excited patch surface current path for antenna size reduction can be achieved by using an an inverted U-shaped or folded patch [11] which is obtained by adding two downward rims at the two radiating edges of a planar rectangular patch. With the added rims, the effective resonant length of the inverted U-shaped patch will be greater than that of the conventional planar patch. Although the maximum length of downward rim is limited by air-substrate thickness, a lowering of resonant frequency of about 32% can be achieved for a patch antenna with an air-substrate thickness of about 5% of wavelength of center operating frequency. For the fixed patch aspect ratio and desired operating frequency, this lowering in resonant frequency corresponds to an antenna size reduction of about 54%.[11], [14]

B. Bandwidth Enhancement Techniques

A narrow BW is a major disadvantage of MSA in practical applications. Conventional MSA suffers from a very narrow BW, typically 5% with respect to the centre frequency. The required operating BW of antennas are about 7.6% for GSM (890-960) MHZ, 9.5% For a DCS (1710-1880) MHZ and 7.5 % for a personal communication system (1850-1990) MHz [14] There are numerous methods of BW enhancement .

1. **Increasing Substrate Thickness** [2]: By increasing the substrate thickness, BW of microstrip antenna can be enhanced, but this increase in thickness beyond a certain limit generates surface waves with low propagation that causes unwanted loss of power [12].
2. **Low Dielectric Substrate**: BW of microstrip antenna can be enhanced by using substrate with low dielectric constant but this will lead to increased size of antenna [9].
3. **Matching And Feeding Techniques Impedance** [3]: BW of microstrip antenna can be enhanced by using various impedance matching and feeding techniques such as aperture coupled feed, microstrip feed, capacitive coupled-probe feed etc [5].
4. **Slot Antenna Geometry**: BW of microstrip antenna can be enhanced by using slot antenna geometry. By exciting two or more resonant modes of similar radiating characteristics at adjacent frequencies to form a wide operating bandwidth [3], [9] . Such a technique includes the loading of suitable slots in a radiating patch thereby increasing the BW to 2.0-3.0 times of the conventional MSA [14].
5. **Stacked Shorted Patches** [5]: Broadband operation can also be achieved by use of stacked shorted patches [12]. One of the technique may be loading a chip resistor between patch and ground plane owing to the ohmic loss of chip resistor. The Q-factor of MSA is greatly lowered & the BW of about 10% or greater can be achieved. Shorted patch antenna fed by an aperture coupled feed is a good design for achieving broadband operation. Figure 3 shows the geometry of broadband aperture coupled shorted patch antenna with an H-shaped coupling slot. By tuning $W_{s,\ S1,\ S2}$ and tuning length t of feed line, good impedance matching over a wide range can be achieved for this antenna

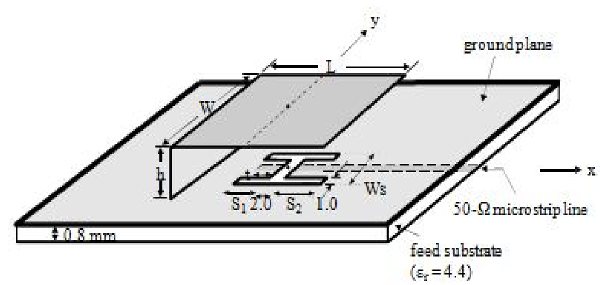

Figure 3: Geometry of a broadband aperture coupled shorted patch antenna with an H-Shaped coupling slot [14].

Return loss for aperture coupled shorted patch antenna shown in fig 3.1 with L=30mm, W=40mm, h=12mm, Ws =18mm S_1=11mm,S_2 =13mm and ground plane size = 100 x 100 mm^2 shows that for MSA The impedance BW defined by 10-db return loss ,is 450 MHz ,or about 26.2% to the centre frequency 1715 MHz [14] .
6. **Additional Microstrip Resonators** [14]: By the use of additional microstrip resonators, a microstrip patch gap coupled (parasitic patch) or directly coupled to the radiating or non

radiating edges of a rectangular MSA results in an enhanced impedance BW [3], [6]. With two additional patches directly coupled to its radiating edges, impedance BW can be more that of a single rectangular microstrip antenna.

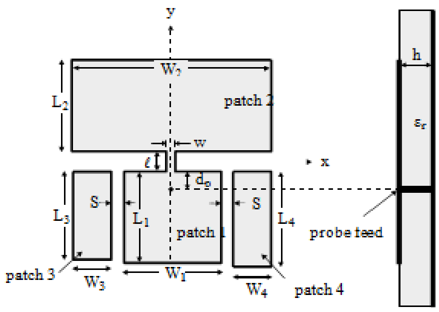

Figure 4: Geometry of a proposed broadband microstrip antenna with directly coupled and parasitic patches [14]

By selecting the four patches as in fig4. four resonant modes can be excited at frequencies close to each other thus an operating BW greater than that of the two directly coupled patches can be obtained [6].The impedance BW determined from 10-db return loss is 365 MHz which is about 12.7% of centre frequency [14]. To overcome the problem of large probe reactance owing to the problem of impedance mismatching and limiting the impedance BW around 10%, modified probe feeds design with gap-coupled, capacitive coupled feed L-probe feed have been introduced along with modified radiating patches by embedding U-shaped, E-shaped slot[3], [8], [11]. By embedding a U-shaped slot in radiating patch a good impedance matching over a wide BW can be achieved and with the proposed design an impedance BW larger than 25% can be easily achieved [1]. Design with a U –slotted patch; embedding a U – slot in the radiating patch an impedance BW of 500 MHz or about 27.5% to the centre frequency (1815) MHz is obtained. However large cross polarization radiation are also seen which can be reduce by using two out of phase feed to the antenna.

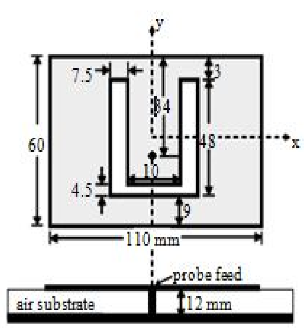

Figure 5: Geometry of a broadband probe-feed rectangular MSA with U-shaped slot [14]

3. CONCLUSION

A compact MSA can be designed by simply using higher permittivity μ wave substrate however this will reduce the BW of antenna. In same way the BW can be increased by simply using low dielectric substrate but again this will increase the size of antenna. So there has to be tradeoff between compactness in size and enhancement of BW. Also there is certain design to reduce the size like inserting shorting pin to the patch, meandering ground plane, use of inverter U-slot radiating patch. Whereas to enhance BW, use of various feeding techniques such as aperture coupled, capacitive coupled, use of stack shorted patch, use of additional resonators etc. However still there are some design aspects to achieve a considerable reduction in antenna size together with the increase in BW of antenna. One of the compact broadband techniques uses a chip resistor of low resistance between antenna's radiating patch and ground plane. With the chip resistor loading technique, similar antenna size reduction to the design using shorting pin can be obtained, and owing to the introduced ohmic loss quality factor of MSA is greatly lowered and BW is increased. Other technique may be a shorted patch fed by an aperture-coupled feed or capacitively coupled shorted patch reduce the overall length from one-quarter wavelength to one-eight wavelength while meeting the BW requirements is a good design to achieve compact broadband operation.

REFERENCES

1.Sridhar Pattanaik, **A study on the engineering techniques adopted for microstrip antenna for achieving some specific performance for commercial /personal communication**, European Journal of Applied Engineering and Scientific Research, 1 (2):50-56, 2012

2. S B Kumar**, Analysis of dual band microstrip antenna, Global journal of researches in engineering**: J general engineering volume 11 issue 5 version 1.0 July 2011.

3. C.K. Wu and K .L Wong" **Broadband microstrip antenna with directly coupled and gap coupled parasitic patches**", Microwave opt.technol.Lette22. 348- 349 Sept 5, 1999

4. Targonski, S.D,R .B, Waterhouse, and , Pozar, 1998**, Design of wide-band aperture stacked patch microstrip antennas",** *IEEE Transactions on Antennas and Propagation 46(9), pp.1245-1251.*

5. Egashira, S. and E, Nishiyama, 1996. **Stacked microstrip antenna with wide bandwidth and high gain**", *IEEE transaction on Antennas and Propagation 44, pp. 1533-1534*

6. W.H Hsu and K.L Wong "**Broadband aperture coupled shorted patch antenna** " microwave opt. technol. Lette 28, 306-307 march 5,2001

7. Waterhouse, R.B, tangonski, S.D, and Kokotoff, D.M, **Design and performance of small printed Antennas**," *IEEE*

Trans. ANTENNAS and propagation, 1998, vol 46, pp. 1629-1633

8.Mohammad tariqul islam, Mohammad Nazmus shakib, Norbahiah Misran, **High gain microstrip patch antenna** ,European journal of scientific research *ISSN 1450-216 X Vol. 27.No.2 (2009) pp.174-180*

9. Sze, J.Y and K.L, Wong, 2000. **Slotted rectangular microstrip antenna for bandwidth enhancement***",* *IEEE transactions on Antennas and Propagation 48, pp.1149-1152.*

10. J.S KUO AND K.L WONG**, Dual-frequency operation of a planar inverted L antenna with tapered patch width**," Microwave opt. technol. Lett. 28, 126-127 Jan 20, 2001

11. K.L, Wong and H.C Tung, **A compact patch antenna with an inverted U-Shaped radiating patch**,:*2001 IEEE Antennas propagat.soc.int.symp.pp.728-731*

12.Manish Kumar, Manish Kumar Sinha, L.K Bandyopadhyay, Sudhir Kumar**, Design of a wideband Reduced size microstrip antenna in VHF/Lower UHF Range,** URSI Proceedings procGA05/K_ page 12

13. D.M pozar and G.I. cost ache**, Microstrip antenna**, *IEEE press, 1995, New York*

14. KIN-LU WONG, **Compact and broadband microstrip antennas**:, john willey and sons.inc 2002

15. J.S KUO AND K.L WONG, **A compact microstrip antenna with meandering slots in the ground plane**, "microwave opt.technology.Lett.29, 95-97, April 20, 2001

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