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Peer Review on Broadband Techniques of Microstrip Patch Antenna

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Abstract-The study of microstrip patch antennas has made great progress in recent years. Compared with conventional antennas, microstrip antennas have more advantages and better prospects. They are lighter in weight, smaller in dimension and lower in price. Moreover, the microstrip antennas can provide diversity feature of operating resonant frequency, polarization, and radiation pattern. The latest researches of the microstrip antenna are analyzed and summarized in this paper to present the characteristics and classifications.

Keyword- Microstrip patch antenna, compact, broadband, shorted patch, slot loading.

I. Introduction

Microstrip antenna (MPA) configurations have numerous advantages in wireless communication and radar systems applications. This is because of low weight, low profile, low cost, conformable to surfaces, mechanically sturdy and flexible with regard to polarization, frequency, pattern & impedance. A patch antenna is made by etching metal on one side of dielectric substrate where as on the opposite side there is continuous metal layer of the substrate which forms a ground plane [1]. MPAs are inherently a narrowband low efficiency, low power and high Q antennas so; various bandwidth enhancement techniques are involved

keeping its size as compact as possible to be perfectly match as a low profile antenna. Due to which many studies and researches are being done throughout the world. Practically bandwidth of MPAs is narrow but, today wireless communication systems require higher operating bandwidth. Such as about 7.6% for a global system for mobile communication (GSM; 890-960 MHz), 9.5% for a digital communication system (DCS; 1710-1880 MHz), 7.5% for a personal communication system (PCS; 1850-1990 MHz), and 12.2% for a universal mobile telecommunication system (UMTS; 1920-2170 MHz) [2]. Taking concern these parameters of bandwidths many techniques are employed and some of them are explained further in this review paper.

II. Antenna Designing Parameters

In microstrip antenna resonant length determines the resonant frequency and is about $\lambda_d/2$ for a rectangular patch excited in its fundamental mode where λ_d is the wavelength in the PCB material. The patch is actually a bit larger electrically than its physical dimensions due to the fringing fields and the difference between electrical and physical size is mainly dependent on the PC board thickness and dielectric constant of the substrate[3].

A good approximation for the resonant length is:

$L \approx 0.49\lambda_d = 0.49\frac{\lambda_0}{\sqrt{\varepsilon_r}}$

This formula includes a first order correction for the edge extension due to the fringing fields, with:

L = resonant length

λ_d = wavelength in PC board

λ_0 = wavelength in free space

ε_r = dielectric constant of the printed circuit board material

Other parameters that have less influence on the resonant frequency include:

- Ground plane size
- Metal (copper) and dielectric thickness
- Patch (impedance) width.

III. Techniques Used For Compact And Broadband Microstrip Patch Antenna

As the integration of communication devices with are smaller and smaller day-by-day, so the microstrip patch antenna used in these devices should have compact size, as the bandwidth of microstrip patch antenna depends upon the size of antenna, so smaller the antenna size, smaller is the bandwidth achieved. For enhancing the bandwidth by keeping the small size different techniques like Shorted Patch, Stacked Shorted Patch, Slot-Loading Technique and Slotted Ground Plane Technique are used by manufacturers. All these techniques are further discussed in this review paper.

A. Compact And Broadband Microstrip Antenna With Shorted Patch

In shorted patch technique diverging patch of microstrip antenna is shorted by a shorting pin through ground via substrate material. This short circuit could also be complete, by wrapping a copper strip around the fringe of the antenna, or it's going to be simulated by shorting post [3]. it's simple to construct a shorting post than wrapping a copper strip around the edge. Position of shorting pin depends on the appliance. A compact size microstrip antenna configuration [4] is shown in Figure.1.

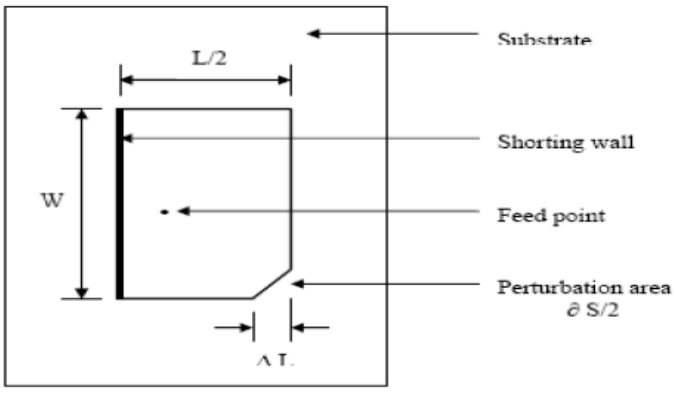

Fig 1: Configuration of microstrip antenna with shortedpinq4

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1 Jan. 2019

This configuration is style for GPS antenna that works at frequency one.575 GHz. Size reductions of 24.6% is achieved as compare to traditional microstrip patch antenna. One way design of a compact and broadband microstrip patch antenna for the IMT-2000 mobile handset [5] application with single shorting posts yields information measure of 17.8% at frequency vary of I.862-2.225 GHz.
Dimension of this proposed antenna is 44.4mm (length) x 37.Smm (width) x 7mm (thickness) [5]. Antenna with this dimension is suitable of IMT -2000 mobile handset.

B. Compact and Broadband Microstrip Antenna With Stacked Shorted Patch

By mistreatment two stacked shorted patch and build each patches radiate equally as potential and creating radiation quality issue as low as potential, one can achieve enhance impedance bandwidth for fixed antenna volume [6]. Design of a compact and broadband S-shaped microstrip antenna is shown in Figure.2.

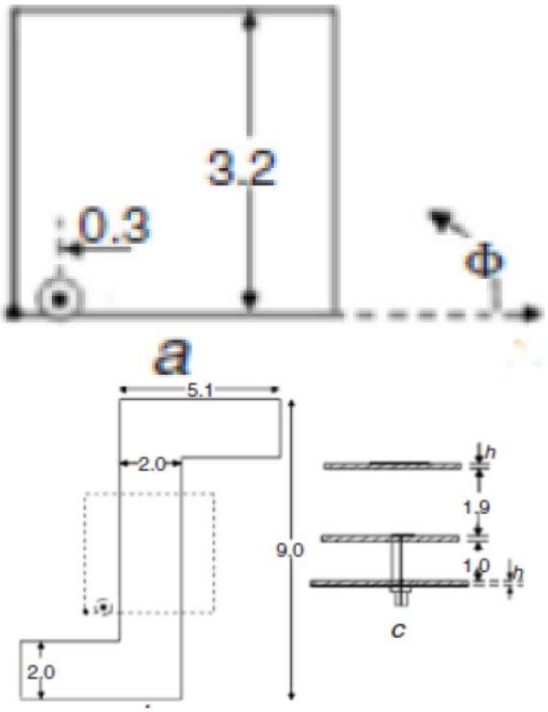

Fig 2: Fed corner shorted SMSA

The projected broadband S-shaped MSAs, uses stacked configuration with a corner shorted square MSA (SMSA) or by cutting a resonant S-shaped slot within the S-shaped MSA. The BW must be improved by using either multi-resonator gap-coupled and stacked configurations or by cutting a resonant slot inner part of patch. The gain S-shaped MSA is healthier than compared to the C-shaped MSA [7]. S-shaped MSA is needs thicker substrate and might be reduced by victimization its stacked configuration with either a fed S-shaped MSA or a fed corner shorted SMSA, which can any raise the BW.
Another design of antenna is square shaped stacked patch with slots and two walls at the edge yields the bandwidth of 76.25% at frequency 4.95GHz to 11.05GHz the input VSWR is <2. ,-14 dB is the minimum return loss. The dimension of the proposed antenna is h1 (2.524 mm), h2(5.75mm), permittivity of the lower substrate(5.4), permittivity of the upper substrate(4), loss tangent of lower substrate for hl(0.002), loss tangent of lower substrate for h2(0.02), L(20mm), U(5mm), size of the square slot(2mm×2mm).

C. Compact and Broadband Mlcrostrip Patch Antenna with Slot-Loading

In slot loaded antenna a slot is fixed on the radiating patch of microstrip antenna, which leads to wider bandwidth while keeping the size small [8]. Slot increases the present path length on patch that increases the information measure and reduces the scale. A triangular patch [9] exploitation this system. Two branch-like slots square measure created on the diverging patch. First two broadside-radiation modesTM10 andTM20 of the triangular microstrip antenna are often rattled such that their resonant frequencies square measure lowered and close to one another to make a good impedance bandwidth.

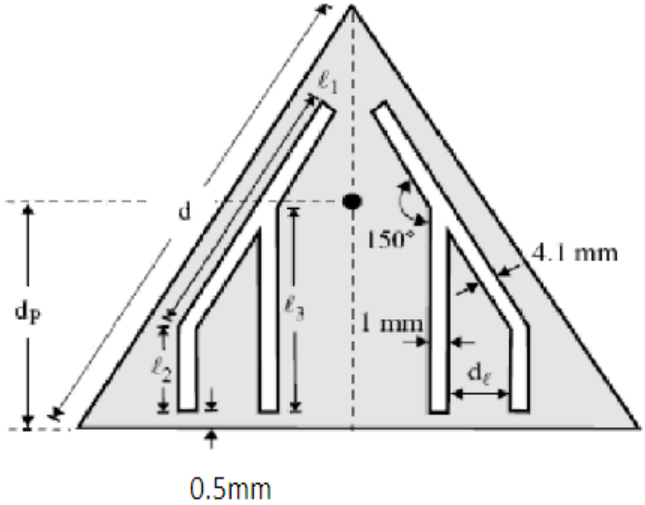

Fig 3: Slot loaded Triangular Microstrip Patch Antenna.

Impedance bandwidth achieved by this design is three times to that of regular triangular microstrip patch antenna and size reduction is about 25 % [10]. Another study of rectangular-slot-loaded and V-slot loaded proximity-coupled microstrip antennas are reported and results are verified by measurement [11]. Results verify that this antenna is with compact size and wider information measure. Figure 3 shows the geometry of each rectangular and V -slot loaded microstrip patch antenna. The planned rectangular-slot-loaded proximity coupled microstrip antenna the peripheral space of the patch is reduced by sixty fifth and victimization V-slot-loaded proximity-coupled microstrip antenna the peripheral area of the patch is reduced by hour [12]. Impedance bandwidth of V -slot-loaded microstrip antenna is above rectangular-slot-loaded microstrip antenna.

D. Compact and Broadband Microstrip Patch Antenna with Slotted Ground Plane Technique.

In this technique a slot is formed on ground plane of microstrip antenna. By increasing the length of slot impedance information measure will be redoubled. As slotted patch will increase the present path length same will be applied to the bottom plane. Design of a compact and broadband microstrip patch antenna with slotted ground [13] was projected by J. S. Kuo. Here three identical slots area unit created on ground plane aligned with equal spacing is shown in Figure.4.

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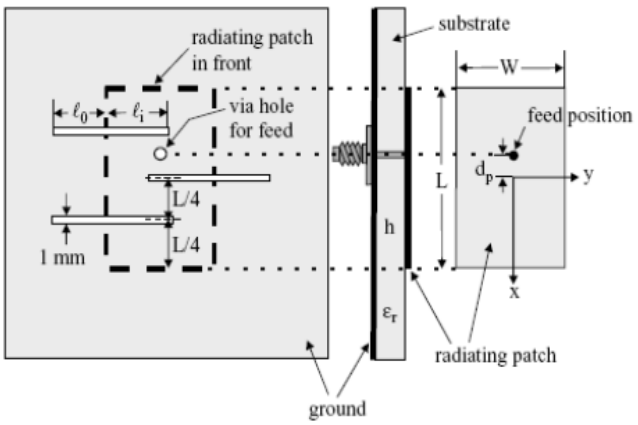

Fig 4: Design of compact microstrip antenna with meandering slots in the ground plane.

This configuration produces an antenna with size reduction of 56%; it additionally ends up in inflated bandwidth [13]. Another design for slotted ground plane [14] will be generated by embedding combine of slim slots; these slots area unit perpendicular to the antenna's resonant direction. Size reduction of approximately 39% is achieved in this configuration.

Another related design to slotted ground [15] yield wider bandwidth up-to three times to that of a conventional one and 60% reduced size. This technique depends on exciting two modes with close resonant frequencies.

This proposed design produce wider bandwidth than conventional microstrip antenna [16]. All these above discussed techniques produce compact size antenna with wider bandwidth, which is suitable for any hand held devices. Technique depends on exciting 2 modes with shut resonant frequencies.

This projected design turn out wider impedance measure than conventional microstrip antenna [16]. So for discussed techniques turn out compact size antenna with wider bandwidth` measure, that is appropriate for any hand held devices.

V. Conclusion

Bandwidth improvement and size reduction area unit becoming major design issues for sensible Applications of microstrip antenna. Several techniques have been popular into market to cut back the size of microstrip antennas. This paper shows the review and survey of their ideology of such techniques. Out of all techniques discussed above in this paper Slot Loading Technique and Slotted Ground Plane Technique give up maximum bandwidth and compact in size.

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1 Jan. 2019

IV. Table For The Comparative Characteristics Of Broadband And Compact Techniques

S.No	Broadband and compact techniques	Configuration	Remarks
1	Shorted Patch Technique	Shorted patch for GPS antenna	Size reduction is 24.6% achieved when compared with conventional antenna
		Broadband antenna for IMT-2000 mobile set	Bandwidth achieved is 17.8% with 1.862-2.225 GHz frequency
		Rectangular microstrip patch	Yields bandwidth of 17.4% at 1.8 GHz frequency and 3% at 2.4 GHz frequency
2	Stacked Shorted Patches Technique	S-shaped stacked patch	Yields Simulate bandwidth of 12.7% and measured bandwidth of 14%
		Square shape stacked patch	Yields Bandwidth of 76.25% at frequency 4.95GHz to 11.05GHz the input VSWR is < 2. Return loss IS -14 dB
3	Slot-Loading Technique	Triangular patch	Achieved Impedance bandwidth is three times to that of regular triangular micros trip patch antenna and size reduction is about 25 %
		Rectangular slot loaded	Size reduced by 65% and impedance bandwidth is less than V slot
		V slot loaded	Size reduced by 60% yields impedance bandwidth higher than rectangular patch
4	Slotted Ground Plane Technique	Microstrip antenna with Meandering slot	Size is reduced by 56% and increased bandwidth
		Compact microstrip antenna with slotted ground	Size reduced by 39%
		Configuration of four slit on the patch	Bandwidth achieved is 3 times greater than the conventional one and size reduced by 60%