Review of Techniques to Design Multiband Microstrip Patch Antennas

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Abstract – In this review paper, author have studied various research papers and compared different design techniques to design multiband patch antenna. Multiband antennas are much in demand due to its superior performance. Multiband is useful in such cases where multiple operations need to be performed through a single antenna. Literature review of past few years shows that the multiband patch antenna demand has grown tremendously. Author studied design techniques and design issues while designing a multiband antenna and made a comparison chart of the same. Review of this study results shows which technique is better than others to design a multiband antenna.

Keywords – probe fed, MGP, array, parasitic element, Metamaterial.

I. INTRODUCTION

Patch antenna having a very simple structure and produces low profile, broadside radiation pattern [1] that's why its demand has been increased in recent wireless communication systems. Recently trends shows that there have been a demand to integrate multiple wireless communication systems into a single small wireless device, demand for and research on small and multiple antennas have correspondingly increased.[2]

Multiband and wideband antennas are preferred to avoid using different antennas for different operations on separate frequencies. However designing of such antennas which can cover Bluetooth, WLAN, UMTS and latest demand of LTE bands is a difficult task. Recently various design techniques were proposed to design such multipurpose antenna.

Recently, various studies focusing on U-slot MSA as multiband or broadband antenna were conducted. By adding U-slot on a coax-probe fed MSA, the operating bandwidth of the antenna is increased. The U-slot has the effect of creating another resonance near the resonance of the MSA. With this new technique, the bandwidth can be increase without increasing the substrate thickness and can be fabricated easily. Still using coax probe feeding system, a dual-band MSA was obtained by using two U-slots.

In spite of MSA with slots, L-probe feeding system also gained popularity recently since it has been found by several studies to increase the bandwidth of MSA. The capacitance composed of the horizontal part of the L-probe compensates for the inductance of the vertical part of the L-probe. The combination of U-slot and Probes a wideband antenna was also been reported and was found to further increase the overall antenna bandwidth of 42.7%.

One basic technique for designing multiband MPAs involves the use of multilayered structuring [11] in which a series of microstrip patches operating at multiple frequency ranges are vertically stacked onto a ground plane, increasing the height of the MPA. A further refinement of the multiband microstrip antennaconcept involves adding a stub, which increases the antenna size, and a slot, which produces the radiation pattern of the harmonics. Some inserted grooves into the design of an annular ring patch antenna to attain multiband operation. However, their antenna design did not cover the required bandwidths with the result that the polarization of the antenna had to be varied by the resonant frequencies.

II.TECHNIQUES USED TO MODIFY SINGLE BAND PATCH INTO MULTIBAND

Various techniques have been proposed to modify a single band antenna into a multiband antenna. Few of them are compiled in this review paper and compared.

A. CPW-FED Technique

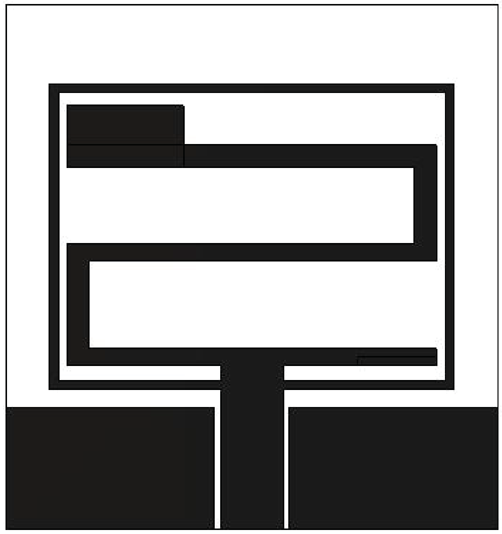
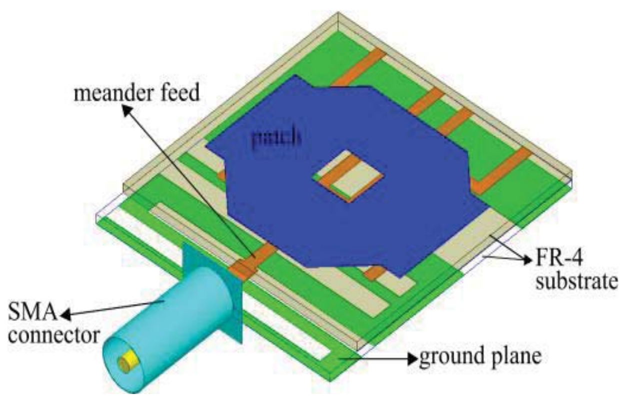


Figure.1 Antenna Configuration with CPW-FED technique

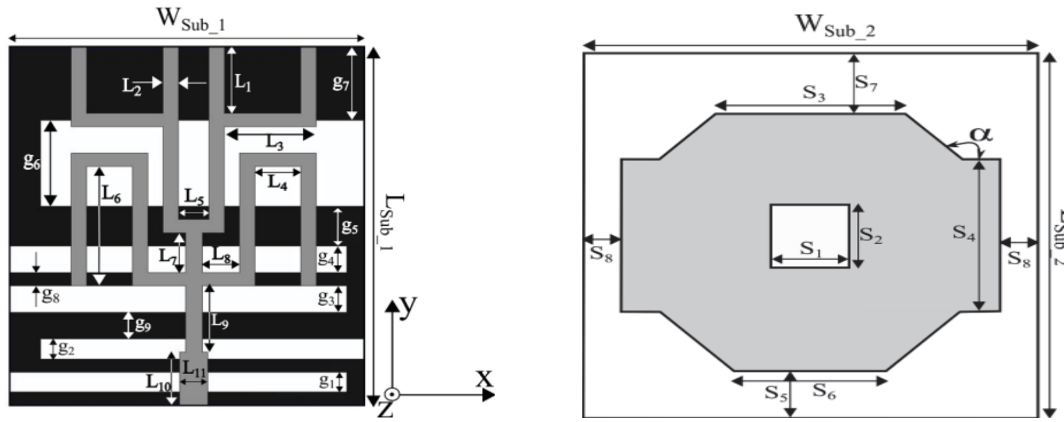
The designed antenna configuration is depicted in Fig.1. As seen, the microstrip antenna composed of two coupled metallic elements fed by 50 ohm coplanar waveguide (CPW) line. The outer element is consisting of rectangular ring microstrip antenna. As stated in [13], a rectangular ring microstrip antenna is formed when a rectangular slot is cut in the center of rectangular microstrip. With an increase in the slot dimensions, the rectangular microstrip antenna becomes rectangular ring microstrip antenna and then a printed loop antenna, and the resonance frequency decreases.

B. PROXIMITY COUPLED

A corner-truncated rectangular patch with a rectangular slot at its center is printed on top of the upper layer. The bottom side metal of this layer is fully etched out. Proximity coupling is obtained by a meandered microstrip feedline printed on top of the lower substrate layer. The slotted ground structure is on the lower side of this substrate. Length of the upper layer is slightly smaller than the lower layer in order to keep a provision for connection of inner conductor of a SMA connector to the microstrip feed.



(a)



(b) (c)

Fig. 2. Configuration of the proposed antenna: (a) 3D view, (b) geometry of ground and feed line, and (c) geometry of upper patch

C. PARASITIC ELEMENTS

A new multiband MPA incorporating inverted-Land T-shaped parasitic elements is proposed to cover Long-term Evolution time-division depleting number 34 (LTE TDD No. 34: 2.0175 GHz), wireless local area network (WLAN:2.45 GHz), and Worldwide Interoperability for Microwave Access (WiMAX: 3.5 GHz) bands. Inverted-L- and T-shaped parasitic elements that resonate through perturbation and coupling with the MPA are used in this design. Because resonance can occur at low frequencies without the need to increase the antenna size, especially height, our proposed multiband MP Adesign can be compacted. Furthermore, the antenna has the capability to tune independent resonant frequencies.

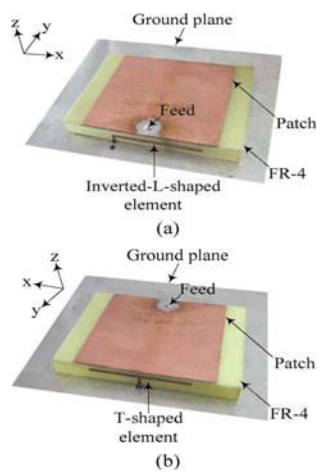


Fig. 3. Fabricated prototype of antenna: (a) showing inverted-L-shaped element; (b) showing T-shaped element.

D. L-PROBE WITH SLOTS

In this study, instead of focusing on broadband operation, L-probe fed MSA with multiple U-slots will be used as a multiband antenna. By increasing the number of U-slots, multiple frequencies can be obtained. An L-probe feed is used to obtain good matching on all four frequencies using thin substrate. The antenna should have good return losses, gain and radiation patterns on all frequencies.

The multiband operation was due to the multiple U-slots loaded on MSA. By changing the dimensions of the U-slots and L-probe feed, the antenna characteristics can be controlled.

After conducting parametric studies, a test antenna was simulated and fabricated. Good agreement between simulated and measured response was obtained on all four operating frequencies making it suitable multiband antenna. As a variation to U-slots, the slot geometry was slightly changed to V-slot with base. V-slot with base MSA gives higher operating frequencies and provided better overall antenna gain. [9]

E. *FRACTAL TECHNIQUE*

Fractal has unique property that it can make copies of itself at different scales. The concept of fractal antenna is very old but designing for broadband application is quite new.

The antenna utilized a coaxial feeding technique and simultaneously possesses multiband, almost uniform radiation, and low profile. The self-similarity [14] of fractal gives rise to multiple bands. The length of the fractal at resonance is increasing dueto space filling property, whereas the height reaches an asymptote reductionallowing an antenna to operate at lowerfrequency and shows a low resonant frequency.In 1970, Dr B. Mandelbrot coined the term Fractal. Fractalantenna has demand in military as well as commercial areaMandelbrot explained the complex structure toown the self-similarity geometrical structure. The phenomenalexpansion in wireless communications has posed a greatchallenge to design compact, portable and multibandantennas to support several applications. Fractalantennas seem to be a viable solution to meet thechallenges. Therefore active research initiatives are taken upat various organizations to develop new fractal antennas.These antennas not only have an effective length but thecontours of its shape give a capacitance or inductance tomatch the antenna to the circuit.

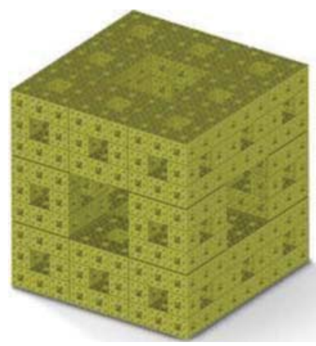


Fig. 4. Basic structure of fractal antenna.

TABLE I:COMPARISON CHART

S. no.	Modification Techniques	Configuration	Remarks
1	CPW-FED Technique	The microstrip antenna composed of two coupled metallic elements fed by 50 ohm coplanar waveguide (CPW) line. [5]	The proposed antenna provides four desirable resonant frequencies and impedance bandwidths which are applicable for ISM band, CCTV and wireless video links, and WLANs.
2	PROXIMITY COUPLED	A corner-truncated rectangular patch with a rectangular slot at its centre [6]	It exhibits simultaneous operation at UMTS, LTE, Bluetooth, Wi-MAX, and WLAN bands.

3	PARASITIC ELEMENTS	Inverted-L- and T-shaped parasitic elements at both radiating apertures of the microstrip [7]	In this letter, a compact multibandmicrostrip antenna for LTE TDD No. 34, WLAN, and WiMAX bands was proposed.
4	L-PROBE WITH SLOTS	MSAwith multiple U-slots loaded in the centreimplemented on a two-layer PTFE substrate [9]	Return losses onall four modes are better than -10 dB. The averagemeasured gain is around 7 dBi.
5	FRACTAL	Microstrip fedmodified star triangular fractal antenna. [8]	Antenna resonated at five frequencies, The impedance bandwidthof antenna on theses frequencies are 500MHz, 400MHz, 650MHz, 500MHz and 500MHz, respectively.

After the comparison it has been observed that fractal and proximity coupled techniques were way better than any other technique available to modify a single band antenna into multiband. These two techniques were modified a single band patch to operate in five distinguished frequencies by applying only one resonating frequency.

III. CONCLUSION

Multiband antennas demand have grown tremendously in last decade to fulfill the demand many techniques were proposed by different authors a review of those paper was conducted and put together in this paper and found that every technique has a sound impact on the bandwidth enhancement and converting the antenna into a multiband. It has been found that fractal and proximity coupled techniques should be preferred over others.

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