Review of PIFA

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Abstract
The up gradation in technology of wireless communication leads to the expanding demands of small antennas. Due to the excellent performance, low profile, good radiation characteristics of PIFA ,it is widely used in handheld devices. In this paper we have discussed about PIFA , some methods to improve its bandwidth, size reduction techniques of PIFA and applications of PIFA.

Keywords
PIFA, Shorting Plate, Stub, Meander, Low Profile

I. Introduction

Classically, the term PIFA derived from linear inverted F antennas. These were the antennas in which a ground plane had the wire structures above it, constituting an F- shape [1].
PIFA is the most favorable antenna in the group of low profile antennas. It sustains meager size, high data rates for transmission, multiple band coverage. Along with these benefits PIFA is very easy to assemble and cheap [4-7].
In this review paper we will study and discuss the basic PIFA, its size reduction techniques, some bandwidth enhancement techniques and its applications.
Smaller size of antenna is also a major factor that makes PIFA eligible for handheld devices. In order to reduce the size of PIFA stub loading is used. Inductive and capacitive loading also reduce size and meandered slot structure is also used [9].
We will study the change in width of feeds and shorting plates and its effect on bandwidth. Also, how parasitic elements changes and enhances the bandwidth.
At last, we will discuss applications of PIFA for smartphones, PIFA for MIMO and PIFA in medical applications.

II. PIFA

A rectangular patch, a ground plane, a short plate of width narrower than the shorted side of patch and a feeding mechanism of patch [8].
To improve performance designers are always searching innovative ways to design antenna .In patch antenna design one method is the use of shorting pins. quarter wavelength patch antenna leads to the PIFA.
In mobile phones and other handheld devices PIFA is becoming very famous to reduce the space in the phone, antenna is resonant at a quarter wavelength, due to its omnidirectional pattern and low profile it is very famous.
It is concluded that there are various factors that affect the characteristics of PIFA such as height, width and position of feed to broad the antenna width, the feed plate/pin width plays a momentous role. Basic PIFA is shown in figure below.

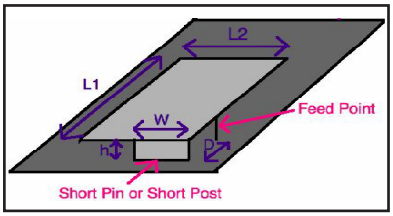

Fig. 1: Basic PIFA [9]

Antenna is fed through the feeding pin. This feeding pin connects the ground plane to the top radiating plate through dielectric substrate. Better impedance matching accomplished with radiating patch above the ground plane of size less than λ/4 is provided by the shorting pin and shorting plate [10].
Hence, the structure of PIFA is compact in size than typical λ/2 patch antenna. The feed wire for PIFA is the coaxial cable with a centre conductor that extends beyond the end of the outer conductor. At the selected feed point , the outer layer of conductor is soldered to the ground plane. The antenna dimensions can be reduced by the shorting plate of PIFA.

III. Different Size Reduction Techniques of PIFA

PIFA is already a smaller version of microstrip patch antenna but still for devices like mobile phones and other smaller devices there ia a need of size reduction. The size of a conventional PIFA can be reduced by various types of techniques. Size reduction should be done without affecting the other important parameters of antenna such as gain, bandwidth etc. for smaller size a multilayered structures are formed by folding the antennas.

A. Stub Loading

By folding the radiator length of PIFA can be reduced but at the same time height of structure is increased. This problem can be avoided by using another technique called stub loading.

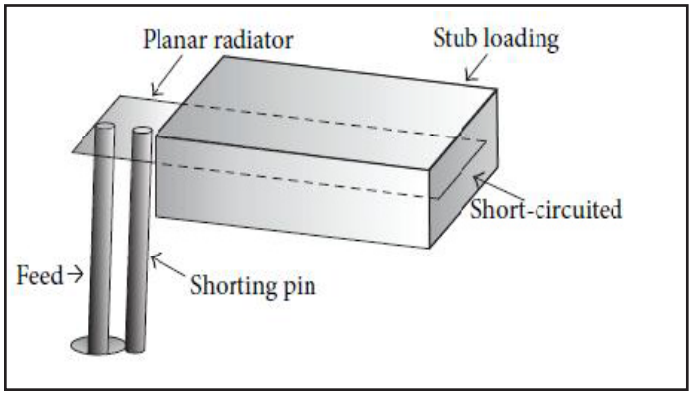

Fig. 2: Stub Loading in PIFA [10]

Rectangular waveguide implements the stub. The stub is filled with substrate. This increase the slow wave factor and longer as a result making electric length of antenna and size of antenna is reduced. The length of stub will lead to more inductive load and low frequency of resonance for smaller structures [11].

B. Inductive and Capacitive Loading

A plane is added between the ground plane and PIFA and the capacitive loading of top plate reduces the size of PIFA. To reduce the reactive part of the impedance the inductive portion of impedance is compensated by capacitive loading.

By folding the open end of PIFA towards the ground plane, a parallel plate capacitor is formed with another plate parallel to ground or a capacity is connected between the ends of two horizontal arms.

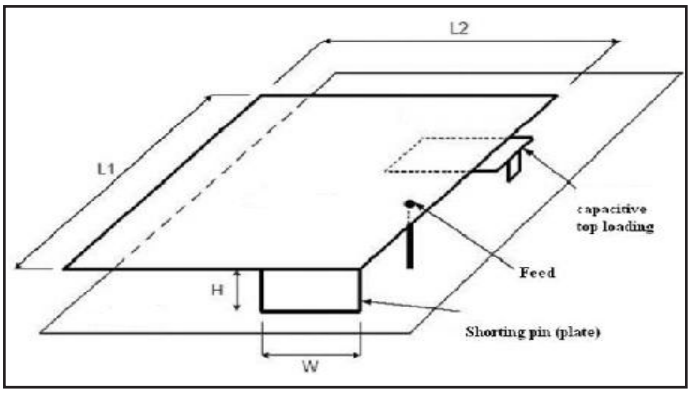

Fig. 3: Antenna With Capacitive Top Loading [12]

This reduces the overall length of antenna by inserting inductive load in frequency determined line and size of antenna can also be reduced. As the resonant frequency decreases the antenna size reduces and vice-versa [12].

C. Meandered Slot Structures

By varying the size and changing the ground plane structure the bandwidth of PIFA antenna can be enhanced because as the height of antenna reduced, bandwidth becomes narrower because there is need to improve it.

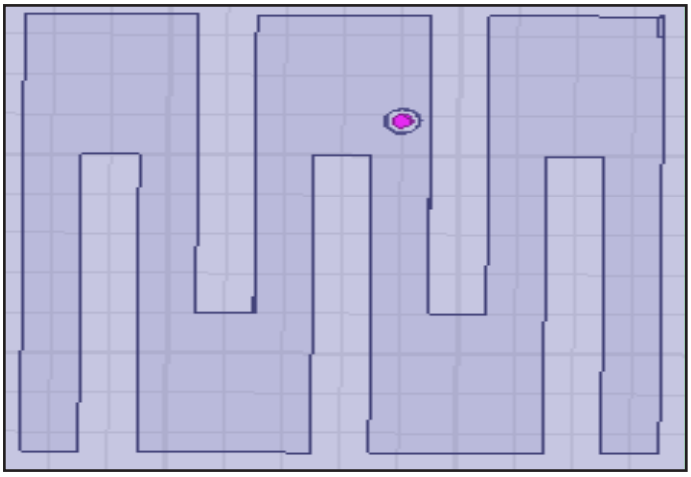
Fig. 4: Meandered PIFA[13]

Antenna size can be effectively reduced by 50% by a slotted meandered ground plane. This technique can improve the bandwidth as compared to general PIFA.

It can be considered as the configuration where the phase velocity of the propagating wave is smaller than the velocity of light i.e. called as slow wave structure.

Physically, the size of PIFA reduces but a slotted meandered ground plane appear electrically longer [13].

IV. Techniques of Bandwidth Enhancement of PIFA

A. Width of Feed and Shorting Plate

Width of feed will affect the PIFA parameters. Increasing the width of feed will increase the fractional bandwidth upto a particular value than increase in the feed plate width only serves to decrease the fractional bandwidth. So , an optimum value for width of feed plate should be selected for achieving the maximum bandwidth. When the width of shorting plate is increased the bandwidth to about 25% but if increased further bandwidth is decreased. It is observed that increasing the widths shorting +and feed plates result in increased resonant frequency and the maximum bandwidth is achieved by keeping the width of shorting plate small. The reason for bandwidth enhancement is that the half wavelength dipole has impedance bandwidth increased by increasing its diameter . similarly, PIFA has impedance bandwidth that can be improved by increasing the size of feed plate [14].

B. Adding Parasitic Element in PIFA

The parasitic element is added between the shorting plate and the feed plate in a way that a second resonant frequency is created at such a value that the reflection coefficient remains below -10dB level.

The bandwidth achieved by this broad with a fractional bandwidth of near about 95%.Thus, parasitic element creates the multiple resonances [14].

V. Applications of PIFA

A. PIFA for Smartphones

PIFA antennas are used in various devices because it is low profile, smaller in size and have low SAR. SAR value and other considerations evaluates the antenna used by a particular phone. SAR is the specific absorption rate that is the measure of electric magnetic radiation absorbed by body while using the phone. PIFA antennas are used in various devices because it is low profile, smaller in size and have low SAR.

For example. mobile phones has PIFAs fabricated onto it. Each antenna is used for different purpose like Wifi, GPS etc. mobile terminals are designed for 2G, 3G & 4G and also national roaming.

PIFA ultra wide band antenna with large bandwidth are designed to improve the bandwidth of PIFA which is very less and better performance.[15]

B. PIFA for MIMO Applications

A technique in which more than one antennas are used at both ends of transmitter and receiver called multiple input multiple output (MIMO). More number of antennas provide a linearity with capacity gain of MIMO [16]. To increase the isolation between antenna elements low coupling techniques are used in design. The technology that is used in it is capacitive load and capacitive feed to avoid the flow of current from one port to another [17].

The isolation between elements is good and loss is also reduced. It also reduces the high current density in ground plane.

C. PIFA in Medical Applications

Bioimplantable antennas re used to find the diseases in medical applications. In this PIFA ia used inside the indestructible capsule which help for long and short communication.

It is an omnidirectional antenna that produces a low radiation effect that don't harm the patients. PIFA enhances performance and minimum wave production due to power absorption. It has maximum gain and bandwidth can be tuned by changing the size of ground plane. Same slits are inserted into the ground plane to boost the bandwidth.

For proper matching and bandwidth , resonance length can be reduced by capacitive loading. As width of PIFA is reduced, frequency also reduces and PIFA is a quarter wavelength dimension so best for medical applications [18].

VI. Conclusion

In this paper we have discussed the basic PIFA and its working. Also, various size reduction techniques are explained such as stub

loading which increase the electric length of antenna but reduces the size , inductive and capacitive loading reduces the overall length of antenna by inserting inductive load in frequency determined line size of antenna can also be reduced and meandering reduces the size of PIFA by 50%. Bandwidth of PIFA can also be enhanced by adjusting the width of feed and shorting plate by 25% and parasitic element enhances bandwidth by 95%. Some applications of PIFA such as pifa for smartphones, medical applications and for MIMO applications. This is concluded that PIFA antenna has many advantages over other antennas.

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