A Review on Performance Improvement of Microstrip Patch Antennas Using Slotting Techniques

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Abstract - This paper presents a compendious review of various slotting technique in microstrip patch antenna, its applications related to antenna design and developments to get better the transmission rate of transmission. The performance of different slotting technique based microstrip patch antennas has been reviewed and presented in this paper there is raise in demand on microstrip antenna works for wireless application covering all high frequency range. The one which is most suitable for such utility is microstrip patch antenna because of its plentiful advantages such as low cost, light in weight, and small in size. MPA has drawbacks of low gain and small bandwidth. To surmount these limitations various methods have been working such as a slotting, shorting pin, metamaterial usage. Slotting technique is one of the best techniques used to extend the performance of microstrip patch antenna. With the use of specific shape of slot the performance of microstrip patch antenna has been optimized in terms of gain, bandwidth, directivity and reduction in size.

Keywords: Resonating Structure, Dual band, Microstrip Antenna, Directivity, Microstrip patch antenna, Slotting, Wi-Max, WLAN.

I. INTRODUCTION

Now a day, the electromagnetic spectrum, has been employed for communication, with the use of radio in human region. Antenna is one of the best appropriate elements for wireless transmission. In wireless communication region required element is antenna. In high performance applications, where to achieve higher bandwidth, high gain and high directivity, multiband operation with compact size are the main constraints for microstrip patch antennas. Antenna engineers are determined to design substantially miniature antennas according to the gradually reducing size of the communication devices and handheld devices with efficiency, high gain and high bandwidth, multi band operational antennas.

Slotting technique is most commonly used for large bandwidth, gain improvement, broad-band operation, and reduction in size. In this slotting technique, a slot of specific shape is introduced on the patch. The slot may be of rectangular, square, hexagonal, circular, triangular, L-shaped, U-shaped, H-shaped, E-shaped, diamond shaped etc. The length, size and position of a particular slot affect the impedance and bandwidth of microstrip patch antenna. By adding the suitable slots in the radiating edges of a patch improvement in bandwidth and multi band can be obtained. Along with single slot multiple slots are also used to manage the impedance of the patch antenna. The analysis of slot on the patch has been done by using duality and complementary relationship between the dipole and slot.

II. REVIEW OF SLOTTING TECHNIQUE

In this section, a review of various slot loaded microstrip patch antennas has been discussed.

U. Chakraborty, et.al designed and proposed a compact dual-band rectangular microstrip antenna (RMSA) by two different single-slots on rectangular microstrip antennas with slotted ground plane. Groups have been initially designed two -10dB impedance bands by two dissimilar designs of compact microstrip antennas with same dimensional slotted ground-plane geometry. After, these two designs are united to form the geometry of the dual-band (5.15–5.35 GHz and 5.725–5.825 GHz) antenna. Each open-ended slot in the single-slotted antenna is in charge to generate a wide impedance band that is shifted to lower frequencies by the effect of the slot in ground. Authors achieved compactness of about 54% with respect to a conventional unslotted rectangular microstrip patch antenna. [1]

A new H-Slot is proposed for differentially microstrip antennas for improved bandwidth. The researcher has designed and proposed that the H-slot provides the improved bandwidth of about 4%. However, it has been experimental that there is no substantial enhancement in the gain of the antenna[2]. The analysis of slot microstrip patch antenna

using equivalent ckt. concept is studied by S. Sharma, and B. R. Vishvakarma. The slot is considered as capacitive reactance on the patch. It is also found that resonance frequency decreases with increase in slot width for a given slot length. There is also the decrease in resonance frequency in the higher side for lower slot length and it is minimum for longest slot length. The placing of slot in the patch makes resonating frequency shift from its actual position, it affects the bandwidth, input impedance and gain [3].

Further to this a novel feeding technique for microstrip patch antenna is presented, which consists of a coaxial probe and shorting pin divided by a narrow slot which is centrally cut at the radiating patch. The impedance, radiation characteristics of a usual probe-fed microstrip patch antenna and the proposed antenna are examined and compared by researcher. The property of the slot length on the antenna operation is also discussed and experimented [4].

A new broadband design of a probe-fed microstrip patch antenna with a pair of wide slots is proposed and studied by Kin-Lu Wong and Wen-Hsiu Hsu. The design is with an air substrate, and results show that, simply by inserting a pair of wide slots at one of the radiating edges of the patch, good impedance matching over a wide bandwidth (400 MHz) can easily be achieved for the designed antenna. With an air substrate of thickness about 8.5% of the wavelength of the base operating frequency, the proposed antenna has an impedance bandwidth of about 25%. For frequencies within the bandwidth, have good radiation, with a peak antenna gain of about 7.20 dBi [5].

A Dual-band patch antenna array element has been proposed for Dual-band operation (1.34 GHz and 2.87 GHz) by modifying the primary resonant mode of the patch antenna and its higher order modes. Resonant frequencies are achieved by adding the antenna with non radiating slots at planned locations along the microstip patch. This results is a compact, dual-band antenna with symmetric radiation patterns and same radiation characteristics at both bands.

The microstrip patch antennas are broadly used in wireless communication system, though the conventional microstrip patch antennas have the drawback of narrow bandwidth. The U-slotted antenna has been proposed by Shing-Lung Stevan Yang *et.al*. By adding of U shaped slot on the microstrip patch antenna is technique proposed to enhance the impedance bandwidth (2.65-3.35 GHz). With the use of U shaped slot antenna can further add additional mode to the resonant frequency helps to design the dual band antenna [8].

A large operating bandwidth for a single; coaxially fed rectangular microstrip patch antenna is obtained by adding a U-shaped slot on the patch. This antenna structure has newly been found to provide impedance bandwidths of 10%–40% experimentally, even with non air substrates [9].

With the pair of right-angle slots and a modified U shaped slot in rectangular microstrip patch, bandwidth enhancement (1.1%) of microstrip antennas is proposed. Necessary dimensions of the right-angle slots and U-shaped slot for bandwidth improvement with good radiating characteristics have been determined experimentally and achieved an antenna bandwidth as large as about 2.4 times that of a subsequent unslotted rectangular microstrip antenna [11].

A compact tri-band microstrip-fed printed monopole antenna for WLAN and Wi-MAX has been proposed. The antenna consists of a rectangular radiating patch with L and U design slots and ground plane. A study on the lengths of the U and L shaped slots of the designed antenna is provided to obtain the required operational frequency bands for, WLAN (2.4, 5.2 and 5.8GHz) and WiMAX (2.5, 3.5 and 5.5 GHz). The proposed antenna is small (15x15x1.6 mm), when compared to previously known double and triple band microstrip antennas. The simulation and measurement results prove that the designed antenna is capable of operating for 2.25–2.85, 3.4–4.15, and 4.45–8 GHz frequency [11].

A planar dual-band antenna with a very compact radiator to cover the frequencies 2.4/5.2/5.8 GHz for WLAN operating bands is proposed. The antenna consists of L-shaped and E-shaped elements which are resonating at around 5.5 and 2.44 GHz, respectively [12]. The L shaped is microstrip fed and the E-element is placed very close to the L shaped and is coupled fed through the L shaped radiator. As only one feed point is used for the two different elements, the overall size is very small. The antenna is designed and analyzed using the EM simulation software CST.

A rectangular microstrip patch antenna with many rectangular slots has been proposed. A dual band, compact single probe-feed rectangular microstrip patch antenna with miniaturize in size has proposed. The single layered antenna has been tested to resonate in two frequency mode (3.1 GHz and 5.5 GHz). The new design is achieved by cutting rectangular slots at two sides of the patch. As compared with the conventional rectangular patch antenna, proposed

antenna can achieve reduction in patch size up to 70%. In the proposed antenna researchers have concentrated on size reduction of the microstrip antenna by introducing rectangular slots on the patch [18].

A novel dual frequency and wideband operations of a triangular microstrip antenna is proposed by adding properly arranged slots in a patch antenna. The design consist of two pair of thin slots in the triangular patch in which one of the slot is close to the side edges of patch and second one is inserted at the bottom edges of patch with small width [20]. The outcome is two operating frequencies (1.71 GHz and 3.37 GHz) and have same polarization planes Also researcher gets bandwidth 2.5 times more than conventional triangular microstrip patch antenna.

Wireless communication is one of the major areas of research in the present world of communication systems. With the fast advancement of various applications these antenna need to work at different frequency band such as dual, triple, and multiband operations are needed. So designers, design a coplanar capacitive coupled; probe feed microstrip antenna for dual band frequency of operation. The proposed antenna is supplied by a single probe feed connected to a capacitive feed. This radiating patch and feed are etched on the same dielectric substrate. The SMA connector used to connect the feed strip which couples the power to a radiating patch by capacitive feed [21]. A vertical slot is added to get antenna operate and work at lower frequency with proper impedance matching.

To improve the antenna performance scientists presented a single band microstrip patch antenna with two slots in radiation patch. The antenna was proposed for WLAN application mostly. In respected work, a simple rectangular patch antenna was designed for frequency of 2.4 GHz and analyzed by transmission line model [22]. Further to improvement, the two slots are inserted on patch parallel to radiation patch. Due to change in slot width results in increasing slot width increases the return loss and changing slot length primarily affects the resonant frequency.

III. CONCLUSION

In this paper, review of slot loaded microstrip patch antenna has been presented. By inserting a proper shape slot will enhances the gain, bandwidth and reduction in the size of microstrip patch antennas. It also helps to achieve the multi-band operation with considerable gain and bandwidth. It can also provides a good impedance matching at lower frequencies. Antenna researchers can easily develop the MSA antennas for different portable devices using slotting technique to hold the need of present RF and mobile communication devices. The Slotting technique has been adopted to design high performance antennas for many wireless applications. This technique is also extended to design compact large bandwidth, high gain antennas with the appropriate metamaterial structure for high gain and high gain antennas.

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