Microstrip Patch Antenna Parameters, Feeding Techniques & Shapes of the Patch – A Survey

Udit Raithatha, S. Sreenath Kashyap

Abstract— The wireless communication is revaluating rapidly in recent years. So, as per the comparative study of the different types of antennas, microstrip patch antenna is having more advantages. Even it can provide dual and circular polarizations, wide bandwidth, dual frequency operation, flexibility in feeding line, beam scanning omnidirectional patterning. It is having a variety of feeding technique applicable to them. Likewise, microstrip patch antenna is having lots of parameters like VSWR, Gain, Bandwidth, Return loss, Directivity etc. The shape of the microstrip patch also matters to get the different outputs. In this paper, we discuss microstrip patch antenna, its different parameters, feeding techniques and shapes of the patch.

Index Terms— Microstrip Patch Antenna, Feeding Techniques, VSWR, Gain, Bandwidth, Return loss, Shapes of the patch.

1 Introduction

ANTENNA is a device, which is used to transmit and receive the signals.

There are lots of types of an antenna like horn, dipole, loop, microstrip patch etc. but among them, microstrip patch antenna has more advantages and better prospects. That's why it is used in many wireless applications like Wi-Fi, Wi-MAX and Bluetooth. The simple structure of the microstrip patch antenna is shown below in Figure 1.

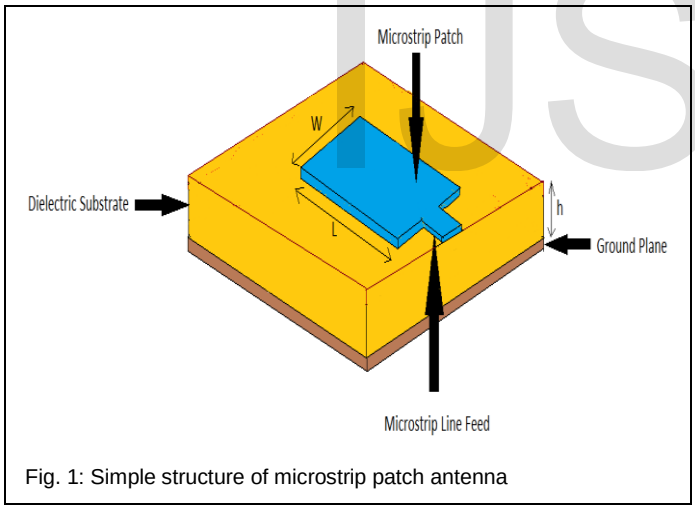

Fig. 1: Simple structure of microstrip patch antenna

2 Microstrip Patch Antenna

Microstrip patch antenna is having four basic components in it and they are microstrip patch, dielectric substrate, ground plane and feed [1]. The front view of it is shown in Figure 2.

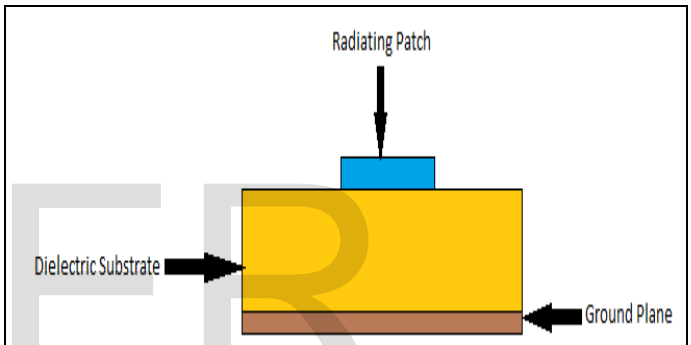

Fig. 2: Front view of microstrip patch antenna

The conducting patch of the antenna radiates the signals and is of many shapes. It is made up from any conducting material like copper, gold etc. [2]. The dielectric substrate can be made from the materials like FR-4, RT-Duroid, Foam, Nylon fabric etc. These dielectric substrates are having different dielectric constants which are useful for the fabrication and performance of an antenna. To get the good antenna performance, better antenna efficiency, larger bandwidth and better radiation, the dielectric substrate must be thick and having a low dielectric constant [4]. Different feeding techniques are used to feed the microstrip patch antenna. The different design techniques of the microstrip patch antenna like different shapes and notches of the patch and cutting slots are used to get the better output [3].

3 Antenna Parameters

3.1 Gain

Gain is one of the realized quantities in antenna theory. In general, gain is less than directivity. It introduces ohmic and other losses. It is defined as the ratio of the radiation intensity in a given direction from the antenna to the total input power accepted by the antenna divided by 4π.

$$G = 4\pi U / P_{in}$$

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3.2 VSWR

VSWR is for Voltage Standing Wave Ratio. It is the ratio of maximum to minimum voltage of the antenna.

First, the reflection coefficient ρ can be written as the absolute value of the magnitude of a voltage reflection coefficient at the input terminals of the antenna Γ,

$$\rho = |\Gamma| = \text{VSWR} - 1 \,/\, \text{VSWR} + 1$$

So, we can write,

$$\text{VSWR} = V_{max} / V_{min} = |1+\Gamma| \,/\, |1-\Gamma|$$

3.3 Bandwidth

The bandwidth of an antenna is the range of frequencies over which the antenna can operate properly. If the highest frequency of the band is F_H, lowest frequency of the band is F_L and the center frequency of the band is F_C, then bandwidth can be defined as,

$$BW = 100 \times (F_H - F_L) / F_C$$

Different antennas have their own bandwidth as per its design considerations.

3.4 Return loss

Return loss is the reflection of the power of a signal, when it is entered in a transmission line. If Γ is the voltage reflection coefficient at the input terminals of the antenna, then in dB, s_{11} return loss can be written as,

$$s_{11} = -20 \log |\Gamma|$$

And the reflection coefficient Γ is defined as the ratio of amplitude of the incident wave V_i to amplitude of the reflected wave V_r.

4 Feeding Techniques

Feeding techniques are classified in two categories. The one is contacting and the other is non-contacting [4]. There are four types of the feeding techniques and they are coaxial probe, microstrip line, aperture coupled and proximity coupled.

4.1 Coaxial Probe Feed

In this feeding method, inner conductor of coaxial cable is connected to the microstrip patch of an antenna and outer one is connected with ground plane [1]. Mostly, the feed networks are isolated from the microstrip patch, but in this mechanism, it is not like that [6]. Spurious radiation minimization, easy fabrication and efficient feeding are the advantages of coaxial feeding method. The coaxial probe feed is as shown in Figure 3.

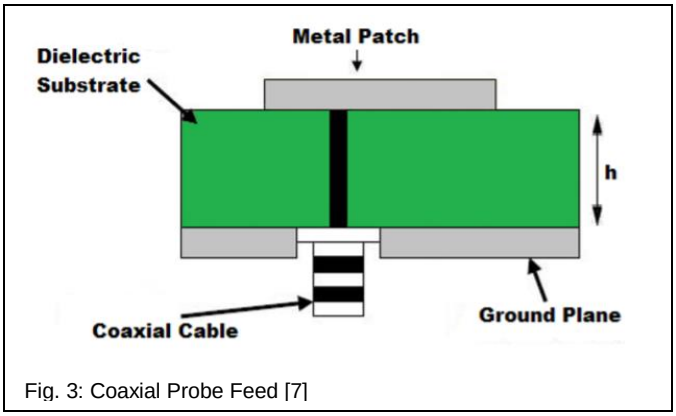

Fig. 3: Coaxial Probe Feed [7]

4.2 Microstrip Line Feed

It is a feeding technique, in which the microstrip patch is directly connected with the conducting microstrip feed line. The dimensions of the feed line are different than microstrip patch. It is easy to fabricate and match. The microstrip line feed is as shown in Figure 4.

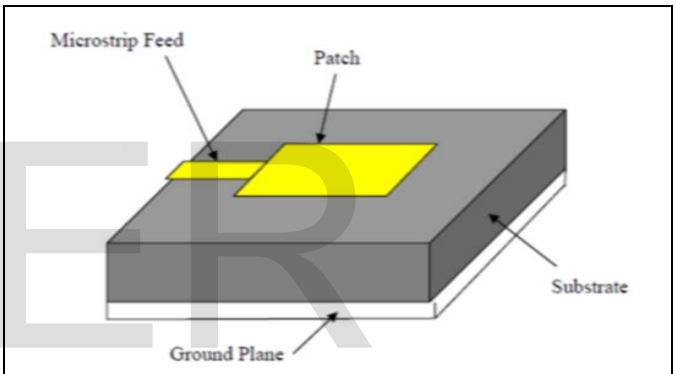

Fig. 4: Microstrip Line Feed [2]

4.3 Aperture Coupled Feed

This feed is having two substrates, which are different from each other and are separated by a ground plane [1]. In this method, the microstrip patch and feed line are coupled through a slot in the ground plane [2]. Minimization in interference and pure polarization are the advantages of aperture coupled feeding method. The aperture coupled feed is as shown in Figure 5.

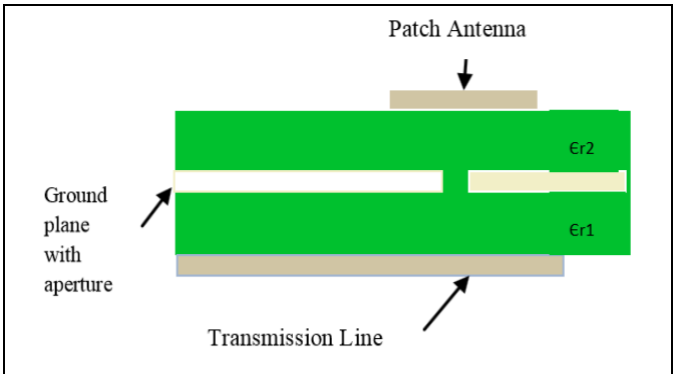

Fig. 5: Aperture Coupled Feed [1]

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4.4 Proximity Coupled Feed

The fabrication of this feeding method is bit complicated comparatively. Two dielectric substrates are used in this technique. The microstrip patch is there at the upper surface of the upper dielectric substrate and the feed line is there between two substrates. It provides highest bandwidth and avoids spurious radiation. The proximity coupled feed is as shown in Figure 6.

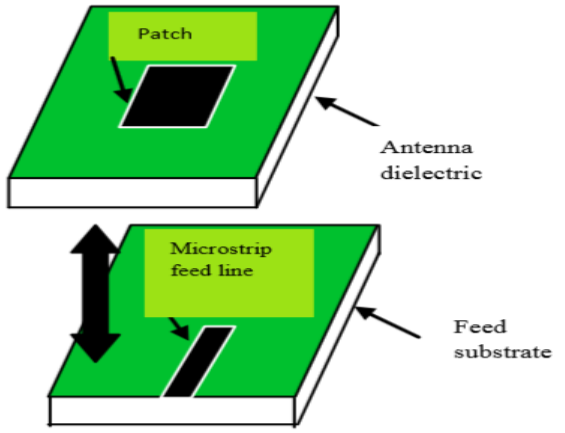

Fig. 6: Proximity Coupled Feed [1]

5 Shapes of the Microstrip Patch

Different shapes of the microstrip patch gives us the different output parameters. So, to get the better and efficient one, the shape and dimensions of the microstrip patch must be defined properly. Here are the basic shapes of the patch shown in Figure 7.

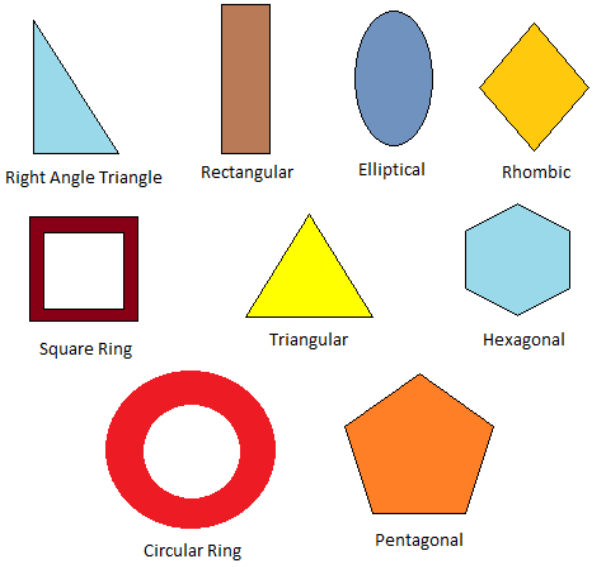

Fig. 7: Basic Shapes of the Patch

Raju Verma et.al. has designed an equilateral triangle shaped microstrip patch antenna [5]. It is as shown below in Figure 8.

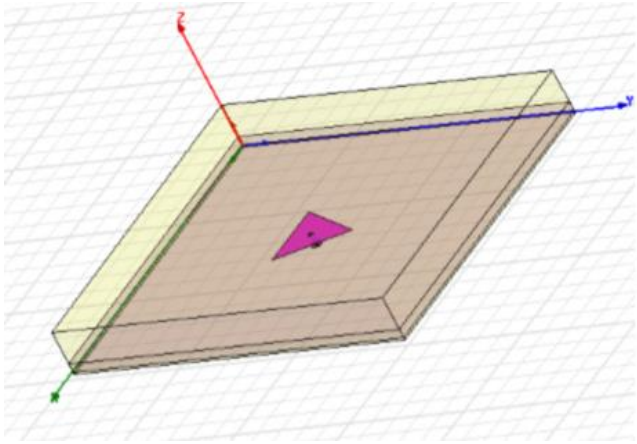

Fig. 8: Equilateral Triangle Shaped Patch [5]

In this design, they have used Rogers RT/duriod 5880™ as a dielectric substrate material and copper as a patch material. This antenna has resonated at 3.42 GHz. The bandwidth of the antenna is 34.23%. Return loss of the antenna is -19.47 dB and the VSWR of the antenna is 1.26. This antenna can be used in wireless applications.

Khushboo Naruka et.al. has designed a bottle shaped cut slot microstrip patch antenna for WiMAX application [8]. In this antenna, FR4 is used as a dielectric substrate material and copper as a patch material. The antenna resonates at 4.5 GHz, 4.9 GHz, 7.1 GHz and 7.82 GHz. 2.6 dB, 3.1 dB, 4.7 dB and 3.5 dB are the gains and 1.4, 1.8, 1.1 and 1.03 are the VSWRs of it. The coaxial probe feed is used to feed the antenna. It is as shown below in the Figure 9.

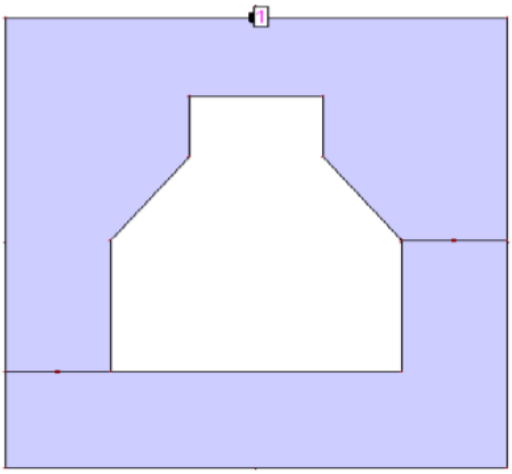

Fig. 9: Bottle Shaped Cut Slot Patch [8]

Dr. D.K.Srivastava et.al. has designed extended C shaped microstrip patch antenna for wideband applications [9]. It is as shown below in Figure 10.

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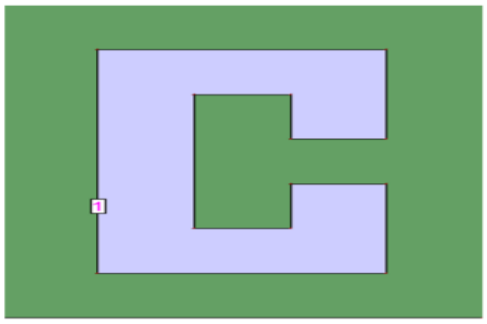

Fig. 10: Extended C Shaped Patch [9]

In this design, they have used Glass Epoxy as substrate material and copper as a patch material. The antenna resonates at 1.476 GHz and 1.12584 GHz. The bandwidth of it is 31.15%.

Shobhit K. Patel et.al. has designed S shaped multiband microstrip patch antenna [10]. It is as shown in Figure 11.

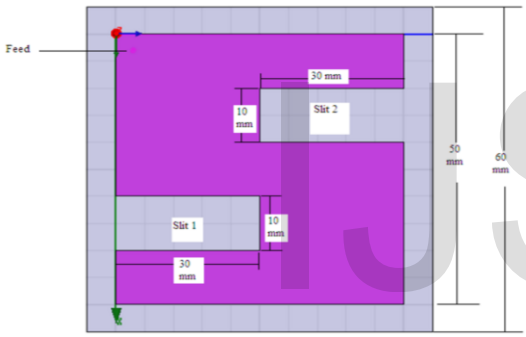

Fig. 11: S Shaped Patch [10]

In this design, they have used FR4 epoxy as substrate material and copper as patch material. The antenna resonates at 1.3740GHz, 2.4760GHz, 3.0760GHz. It is used as medical, bluetooth and ISM band applications.

Alak Majumder has designed H shaped microstrip patch antenna for bluetooth applications [11]. In this design, FR4 substrate material is used and copper is used as patch material. The antenna resonates at 2.4 GHz. The gain of it is 8.9367 dB and the return loss of it is -22.9 dB. The VSWR of it is 1.5089. The design is as shown below in Figure 12.

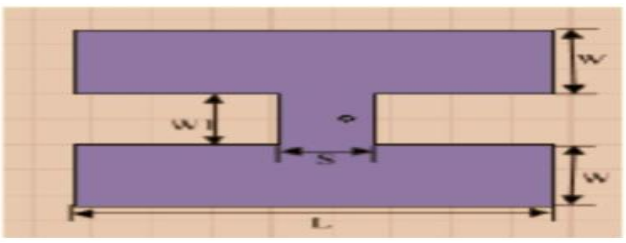

Fig. 12: H Shaped Patch [11]

So, here is all about the different shapes of the patch for different applications.

Conclusion

A survey on microstrip patch antenna parameters, feeding techniques are presented in this paper. The different feeding techniques have different factors based on the applications. There are such parameters like gain, VSWR, bandwidth and return loss which shows the output characteristics of the antenna. The recent developments in MSTPA is discussed, the influence of shape and dimensions of the patch, substrate also matters to get the proper output parameters.

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