Designing of an antenna using Proximity coupled feed for 4G applications

Anju Munday¹, Swati Bhasin²

¹M.Tech Student, ECE Department, G.I.M.T (Kanipla), India
mundayanju@gmail.com

²Assistant Professor, ECE Department, G.I.M.T (Kanipla), India
swatibhasin@gimtkkr.com

Abstract— In this paper a rectangular Microstrip patch antenna is designed for proximity coupled feeding technique for wireless microstrip patch antenna i.e 4G applications. In this paper the antenna is resonating at 2.2 GHz frequency range which is desired frequency for IMT-advance (4G) range. The frequency range for 4G is vary from 1710 MHz to 2690 MHz. The proposed antenna is designed by using rectangular type patch for particular feeding technique (proximity coupled feed) is used. From the four feeding techniques, microstrip line and coaxial probe feeds are contacting schemes whereas proximity and aperture coupled feed are non-contacting schemes. The Paper gives a better understanding of design parameters of an antenna and their effect on return loss, S-Parameters, smith chart, radiation pattern, bandwidth, VSWR and resonant frequency. Finally simulation is done using design software HFSS.

Keywords— Rectangular microstrip patch antenna, S-Parameters, smith chart, radiation pattern, bandwidth, VSWR, resonant frequency, proximity coupled feed, HFSS.

I. INTRODUCTION

An antenna is an element used for radiating or receiving electromagnetic wave. Although antennas may seem to be available in numerous different shapes and sizes, they all operate according to the same basic principles of electromagnetic. Many types of portable electronic devices, such as cellular phones, GPS receivers, palm electronic devices, pagers, laptop computers, and telemetric unit in vehicles, need an effective and efficient antenna for communicating wirelessly with other fixed or mobile communication units. Advances in digital and radio electronics have resulted in the production of a new breed of personal communications equipment posing special problems for antenna designers. Personal wireless communication devices have created an increased demand for compact antennas. The increase in satellite communication has also increased the demand for antennas that are compact and provide reliable transmission. In addition, the expansion of wireless local area networks at home and work has also necessitated the demand for antennas that are compact and inexpensive.

A microstrip patch antenna is a type of antenna that offers a low profile, i.e. thin and easy manufacturability, which provides a great advantage over traditional antennas [1], [2]. Patch antennas are planar antennas used in wireless links and other microwave applications. Microstrip antennas have many attractive features that are draws the attention of researchers over the past work [1- 2]. Microstrip antennas are used in number of applications like biomedical diagnosis and wireless communication [3]. With the rapid growth of the wireless communication system the future technologies need very small, compact and multiband antennas. Nowadays, people demand multiband wireless phone supporting more than one network, having different frequencies and simultaneous transmission of video, audio and data. These services are possible with the help of microstrip patch antenna having multiband characteristics. Modern wireless communication system also requires low profile, light weight, high gain, ease of installation, high efficiency, simple in structure to assure reliability and mobility characteristics. Microstrip antennas satisfy such
requirements. Research on microstrip antenna in 21st century aims at size reduction, increasing gain, wide bandwidth, multiple functionality and system level integration. Significant research work has been reported on increasing gain and bandwidth of microstrip antennas. Many techniques have been suggested for achieving wide bandwidth [4-5]. Main advantage of microstrip antenna includes low profile easy to fabricate (use etching and photolithography), easy to feed (proximity coupled, microstrip line, etc.) and easy to use in array of incorporate with other microstrip circuit elements [6]. In this paper four feeding techniques are compared for IMT (4G) band (1.71 – 2.69 GHz).

II. TECHNIQUES USED

Feeding Techniques are classified into following four categories.

A. Microstrip Line Feed

Microstrip line feeding is a technique in which a conducting strip is connected directly to the edge of the microstrip patch as shown in figure 1. The width of conducting strip is smaller as compared to the patch. This type of feeding arrangement has the advantage that the feed and patch can be etched on the same substrate to provide a planar structure. However as the thickness of the dielectric substrate being used increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation also leads to undesired cross polarized radiation. This method is advantageous due to its simple planar structure.

B. Coaxial Probe Feed

The Coaxial feed or probe feed is a very common technique used for feeding Microstrip patch antennas. The inner conductor of the coaxial connector extends through the dielectric and is soldered to the radiating patch, while the outer conductor is connected to the ground plane. The main advantage of this type of feeding scheme is that the feed can be placed at any desired location inside the patch in order to match with its input impedance. However, its major drawback is that it provides narrow bandwidth and is difficult to model since a hole has to be drilled in the substrate and the connector protrudes outside the ground plane, thus not making it completely planar for thick substrates. Also, for thicker substrates, the increased probe length makes the input impedance more inductive, leading to matching problems. It is seen above that for a thick dielectric substrate, which provides broad bandwidth, the microstrip line feed and the coaxial feed suffer from numerous disadvantages. So to reduce these types of disadvantages, we will study non-contacting schemes.

C. Proximity coupled Feed

This method uses electromagnetic coupling between the feed line and the radiating patches, printed on separate substrates [7]. Two dielectric substrates are used such that the radiating patch is on top of the upper substrate and feed line is between the two substrates. The advantage of this coupling is that it yields the largest bandwidth compared to other coupling methods, it is somewhat easy to model and has low spurious radiation. This feeding method also provides choices between two different dielectric media, one for the feed line and one for the patch to optimize the individual performances. Matching can be achieved by controlling the width-to-line ratio of the patch and length of the feed line. The major disadvantage of this feeding scheme is that it is difficult to fabricate because of the two dielectric layers which need proper alignment. Also, the overall thickness of the antenna also increases [7].
D. **Aperture coupled feed**

In this type of feed technique, the radiating patch and the microstrip feed line are separated by the ground plane. Coupling between the patch and the feed line is made through a slot or an aperture in the ground plane and variations in the coupling will depend upon the size i.e. length and width of the aperture to optimize the result for wider bandwidths and better return losses. The coupling aperture is usually centered under the patch, leading to lower cross-polarization due to symmetry of the configuration. Since the ground plane separates the patch and the feed line, spurious radiation is minimized.

Aperture coupled feeding is attractive because of advantages such as no physical contact between the feed and radiator, wider bandwidths, and better isolation between antennas and the feed network. Furthermore, aperture-coupled feeding allows independent optimization of antennas and feed networks by using substrates of different thickness or permittivity.

### III. DESIGNING WITH PROXIMITY COUPLED FEED

**Proximity coupled Feed**

Observation from return loss at or below -10dB as shown in figure 3-6.

1. Resonant frequency=2.20 GHz at -27.90dB
2. Band width = f2 - f1 = 2.26 - 2.13 = 0.13 GHz = 130 MHz
3. VSWR = 1.04
4. Impedance Matching = 52.45 ohm.
IV. CONCLUSION

The rectangular microstrip patch antenna for 4G applications and dimensions using proximity coupled feed has been designed and simulated using HFSS V13 software. A simulation is made in terms of bandwidth, return loss, VSWR and patch size and smith chart. So, we can see that selection of the feeding technique for a microstrip patch antenna is an important decision because it affects the bandwidth and other parameters also. A microstrip patch antenna excited by different excitation techniques gives different bandwidth, different gain, different efficiency etc.

The performance properties are analyzed for the optimized dimensions and the proposed antenna works well at the required (1.71- 2.69) GHz IMT-Advance (4G) frequency band. The maximum bandwidth can be achieved by proximity coupling. It also gives the best impedance matching and radiation efficiency. We can also conclude that by changing the feed point where matching is perfect, the high return loss can be achieved at the resonant frequency. Various microstrip patch antennas with proximity coupled feeding technique are presented. The various parameters like return loss, radiation pattern, smith chart, electric field and VSWR are plotted for each antenna.

REFERENCES


