L- Probe Fed Microstrip Antenna

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Abstract

Two layered substrate antennas are used to enhance the bandwidth. The bottom patch is fed with a coaxial line, and the top parasitic patch is excited due to electromagnetic coupling with the bottom patch. The strip loaded slotted broadband microstrip antenna is fed by an L-strip feed line to achieve impedance matching and has an overall dimension of 42× 55× 3.2 mm^2. Operating frequency range of antenna is from 4.96 GHz to 5.76 GHz when the horizontal arm of L-probe is on right side. The antenna gives bandwidth of 15%. The gain of antenna is 5.50 dBi. We get further increase in bandwidth when there are two symmetrical rectangular strips incorporated in hexagonal slot. The bandwidth of antenna obtained is 25% (1.2 GHz) which is much higher than earlier two geometries. We get 43% increase in bandwidth. Also, gain of antenna increases by 11% (6.09 dBi).

1. Introduction

Microstrip antennas (often called *patch* antennas) are widely used in the microwave frequency region because of their simplicity and compatibility with printed-circuit technology, making them easy to manufacture either as stand-alone elements or as elements of arrays. In its simplest form a MSA consists of a patch of metal, usually rectangular or circular (though other shapes are sometimes used) on top of a grounded substrate. [1]

The origin of MSA apparently dates back to 1953, when Deschamp proposed the use of microstrip feed lines to feed an array of printed antenna elements. The printed antenna elements introduced there were not microstrip patches, but flared planar horns. The microstrip patch antenna was first introduced by Munson in a symposium paper in 1972, which was followed by a journal paper in 1974. These papers discussed both the wraparound microstrip antenna and the rectangular patch. Shortly after Munson's symposium paper, Howell also discussed rectangular patch antennas in another symposium paper in which he credits Munson with the basic idea by referencing a private communication. [1]

Conventional microstrip antennas in general have a conducting patch printed on a grounded microwave substrate, and have the attractive features of low profile, light weight, easy fabrication, and conformability to mounting hosts. However, microstrip antennas inherently have a narrow bandwidth, and bandwidth enhancement is usually demanded for practical applications. In addition, applications in present-day mobile communication systems usually require smaller antenna size in order to meet the miniaturization requirements of mobile units. Thus, size reduction and bandwidth enhancement are becoming major design considerations for practical applications of microstrip antennas. For this reason, studies to achieve compact and broadband operations of microstrip antennas have greatly increased [2], [3]. Lot of researches has been carried out for enhancing the bandwidth of microstrip antennas.

Abstract

The technique for widening the bandwidth of a microstrip antenna using thick substrate is of interest due to its possible single-layered structure. Increasing the substrate thickness increases the bandwidth of microstrip antennas. When the thickness exceeds about 0.05 λ_o, the increased inductance of the feed deteriorates 50 ohm impedance matching. This problem can be avoided by modifying the feed in to the form of an L shape, in which the increased inductive reactance of the probe is suppressed by the capacitance of the L-feed. Besides providing good impedance matching characteristics, the L-probe excites higher order modes which further enhance the bandwidth [4], [5].

2. Antenna Design

The geometry of the proposed antenna is shown in Fig. 1 & Fig 2. The prototype is fabricated on a substrate of relative dielectric constant $\varepsilon_{r=4.4}$ and thickness h=1.6 mm. Initially a hexagonal slot of dimension 14.3 mm is etched on a square microstrip antenna of

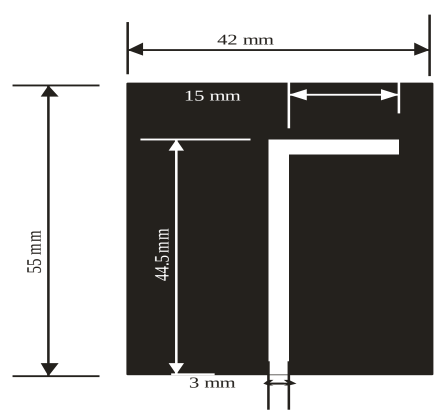

Fig 1. Bottom Substrate

dimension 35×35 mm^2.[6] In order to achieve proper impedance matching, a rectangular strip of length (L_3)= 4.7 mm and width 3 mm is incorporated symmetrically on the top portion of the slot. The antenna is electromagnetically coupled using a printed L shaped microstrip transmission line having a horizontal length of 15mm, vertical length 44.5 mm and width 3 mm printed on the same substrate. Two different configurations of antenna are discussed:- (1) With single rectangular strip & (2) With two rectangular strips.

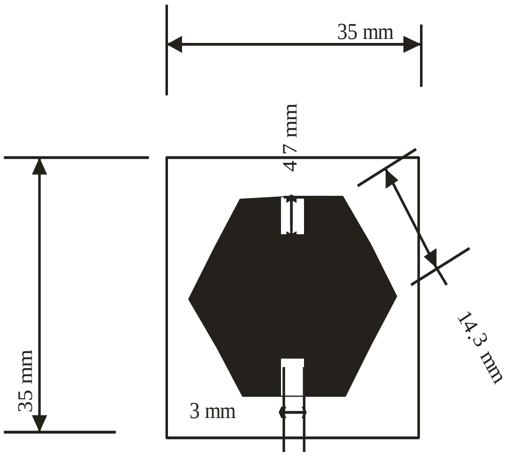

Fig 2. Top Substrate

3. Result & Discussion

The simulated & the experimental results of antenna are measured using Ansoft HFSS version 13.0 & HP8510C Network Analyzer, respectively. As we know for proper transmission of signal by antenna, the S_{11} parameter of antenna should be less than -10dB. For the antenna having only one rectangular strip, the return loss below -10dB has started from 4.96 GHz and the same characteristics has been shown till 5.76Ghz as shown in Fig 4. The VSWR bandwidth of antenna is 840MHz.

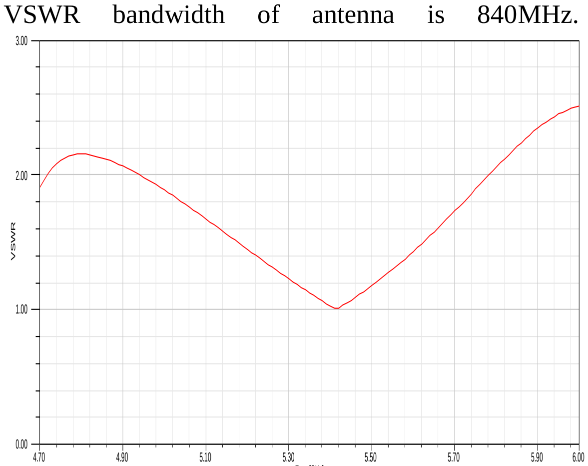

Fig 3. Simulated VSWR vs frequency for single strip

For this antenna, VSWR against frequency graph is shown in Fig 3. The gain of antenna is 5.50 dbi.

For the antenna having two rectangular strips, the return loss below -10dB has started from 4.50GHz and the same characteristics has been shown till 5.70 GHz, as shown in Fig 5. The simulated bandwidth of antenna is 1.2 GHz. For the measured result, the return loss below -10db is from 4.37 GHz to 5.5 GHz. Hence, the measured bandwidth is 1.13 GHz. So, we get very good agreement with simulated & practical results. The VSWR bandwidth of antenna is 1.2 GHz, shown in Fig 6. The measured gain of antenna is 6.06 dbi.

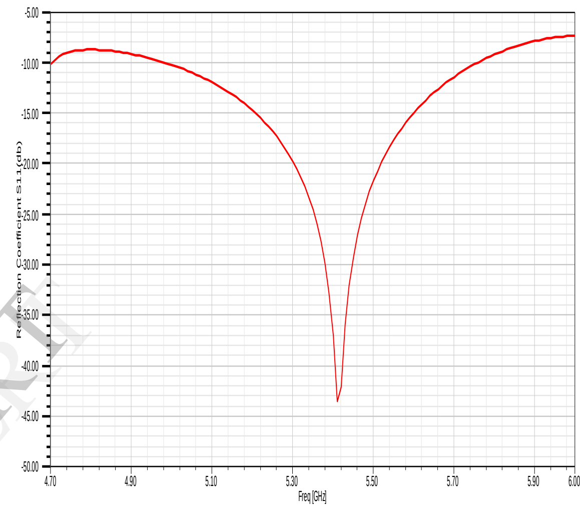

Fig 4. Simulated reflection coefficient vs frequency for single strip

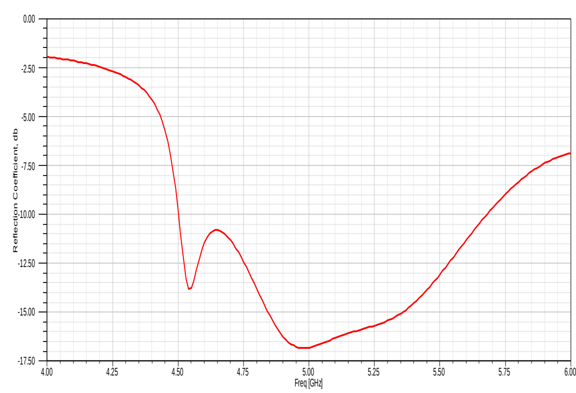

Fig 5. Simulated reflection coefficient vs frequency for two strips

Fig. 7, shows the effect of change in length (L_3) of the rectangular slot on the bandwidth as well as reflection coefficient of the antenna. As the length increases, the return loss characteristics of the antenna improves. The bandwidth of antenna increases upto 2.7 GHz when the length incresed by 1mm. 'a' indicates change in length of L_3.

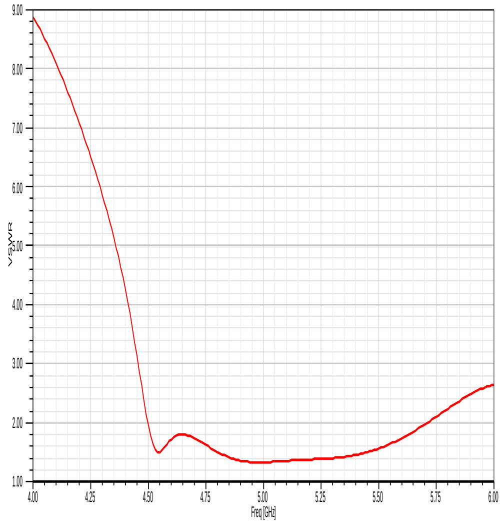

Fig 6. Simulated VSWR vs frequency for two strips

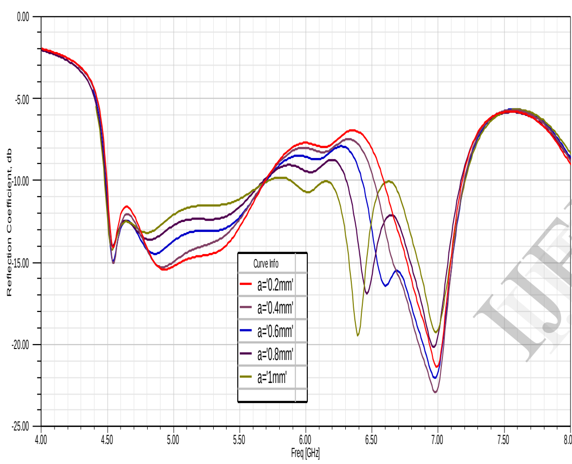

Fig 7. Variation of S11 parameter with change in length of rectangular strip

4. Conclusion

L-probe fed slotted single patch microstrip antenna is designed. The patch has a dimension of 35×35 mm^2 when printed on a substrate of dielectric constant 4.4 and thickness 1.6 mm. Operating frequency range of antenna is from 4.96 GHz to 5.76 GHz when the horizontal arm of L-probe is on right side. The antenna gives bandwidth of 15% (840 MHz) with centre frequency of 5.41 GHz. The gain of antenna is 5.50 dBi.

We get further increase in bandwidth when there are two symmetrical rectangular strips incorporated in hexagonal slot. The bandwidth of antenna obtained is 24% (1.2 GHz) with centre frequency of 5.1 GHz, which is much higher than earlier geometry. We get 43% increase in bandwidth when two rectangular strips are incorporated symmetrically on hexagonal patch. Also, gain of antenna increases by 10% (6.06 dBi). So, antenna having two rectangular strips is more efficient than single strip.

The parametric analysis of the antenna having two rectangular strips incorporated symmetrically on hexagonal patch shows that, there is further increase in bandwidth as we increase the length of rectangular strip (L_3). For L_3= 4.7mm we get bandwidth of 1.2 GHz. As we increase L_3, the return loss characteristics of antenna improves. Bandwidth up to 2.7 GHz is obtainable, which can be used in wideband imaging applications. Good agreement is achieved between simulated & measured results.

5. References

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