(Broadband Microstrip Patch Antenna)

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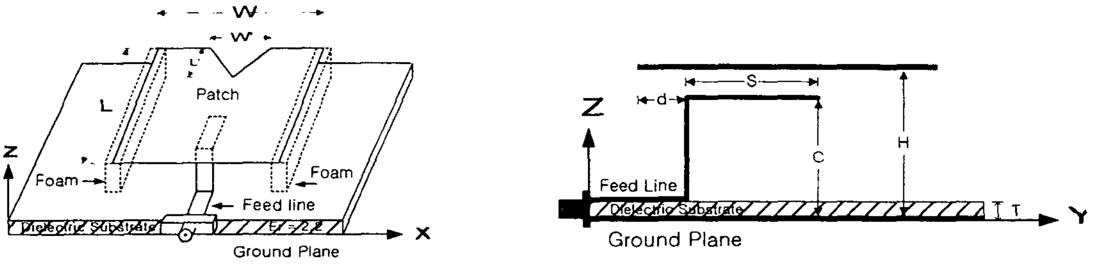
Abstract

In this paper, the wideband microstrip patch antennas for the Personal communications Service (PCS : 1750 ~ 1870 MHz) and International Mobile Telecommunications-2000 (IMT-2000 : 1920 ~ 2170 MHz) dual band are studied. Experimental and simulation results on the dual band antenna are presented. Simulation results are in good agreement with measurements. The experimental and simulation results confirm the wideband characteristics of the antenna. The studied antenna satisfied the wideband characteristics that are required characteristics for above 420 MHz impedance bandwidth for the PCS and IMT-2000 dual band antenna. In this paper, through the designing of a dual band antenna, we have presented the availability for PCS & IMT-2000 base station antenna. An impedance bandwidth of 31 % (VSWR<1.5, 615 MHz) and a maximum gain of 7dBi can be achieved. The radiation pattern is stable across the passband.

1. Introduction

IMT-2000 is the next generation service for mobile communications systems currently being implemented. This third generation of mobile communication systems is called IMT-2000 and work has proceeded for more than 10 years towards its development. In this paper, the dual band antenna for PCS/IMT-2000 service was studied, in order to make a foundation of the wideband mobile telecommunication service. Most directional antennas for mobile telecommunication base station have a dipole array structure. The PCS/IMT-2000 dual band antenna is required to be above 420 MHz wideband characteristics. Microstrip antennas offer the advantages of thin profile, light weight, low cost, and conformability to a shaped surface and compatibility with circuitry. The major weakness of microstrip patch antenna is its inherently narrow bandwidth, only a few percent can be attained. One way of improving the bandwidth to 10~20% is to use parasitic patches, either in another layer[1] (stacked geometry) or in the same layer[2,3] (coplanar geometry). However, the stacked geometry has the disadvantage of increasing the thickness of the antenna while the coplanar geometry has the disadvantage of increasing the lateral size of the antenna. It would therefore be of considerable interest if a single-layer single-patch wideband microstrip antenna could be developed. Such an antenna would better preserve the thin profile characteristics and would not introduce grating lobe problems when used in an array environment. In this paper, we report the experimental results of a rectangular patch with L-strip fed which appears to have wide bandwidth characteristics. The geometry of the L-strip fed rectangular patch antenna is shown in Fig. 1.



(a). Top view of the patch (b). Side view

Fig. 1 Geometry of the L-strip fed rectangular patch

2. Microstrip patch antenna with L-strip feed

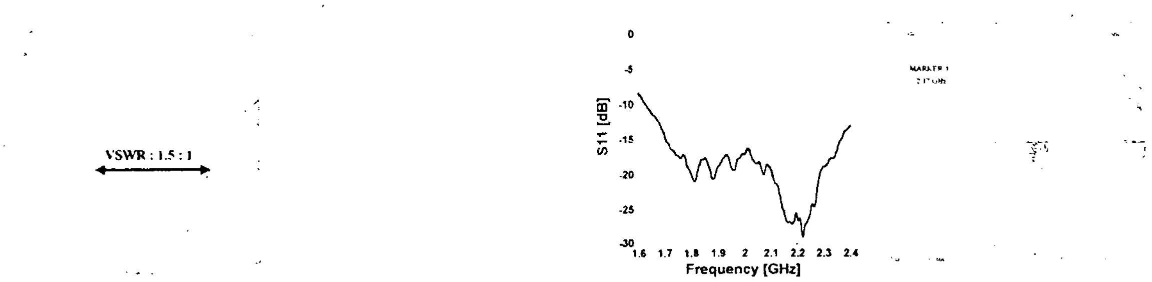
Generally, the feeding methods of a microstrip antenna can be classified as microstrip feeding, probe feeding and electromagnetically coupled(EMC) feeding. The microstrip feeding is easily fabricated by connecting the microstrip to the edge of the patch directly, but the impedance matching is not convenient compared to probe feeding and unwanted radiation can occur from the feed line. Feeding by a coaxial probe has the advantages of ease in impedance matching and low spurious radiation, and the disadvantage of having to be physically connected to the center of the patch. The coaxial-fed microstrip antenna has a narrow impedance bandwidth. The third method, known as EMC feeding, was first proposed by K.F. Lee[4,5,6]. EMC feeding is different from the other feeding methods. Spurious radiation does not occur and it has the advantage of offering a wideband characteristic without any matching circuit. Fig. 1 shows the EMC rectangular patch antenna. The structure of the L-strip feeder acts as a series L-C resonant circuit connected in series with the parallel R-L-C resonant elements of the patch. The horizontal part of the L-strip feeder within the patch provides a capacitance to compensate for the inductance introduced by the vertical part of the L-strip feeder. For the probe-fed patch antenna, the probe only provides an inductance, which degrades the bandwidth performance of the patch antenna. Here, the coupling mechanism is predominately capacitive. The patch itself is represented by a parallel R-L-C resonaut circuit. C is the coupling between the L-strip feeder and the patch. The geometry of the L-strip fed rectangular patch is shown in Fig.1. In the case of rectangular patch, coupling value changes sensitively in response to changes in L-strip feeder length(S), L-strip feeder gap(H), and patch width(W). These parameters determine coupling value, which in turn determines antenna impedance bandwidth. Therefore, after simulation by the variation of parameters that are sensitive to the characteristics of the L-strip fed rectangular patch antenna, an antenna with optimum characteristics is fabricated. Simulation was conducted using IE3D, a commercial simulator, based on MOM(methods of moment)[7]. Table 1 show design parameters of the L-strip fed rectangular patch antenna.

Table 1. Dimension of antenna (in mm)

Parameter	L	W	L'	W'	S	C	H	D
Size	55	71.5	18	40.5	18	17	20.5	13

3. Measurement results

The calculated and measured curves of impedance locus for single element antenna are shown in Fig. 2. There is reasonable agreement with the measured results shown in Fig. 2. It was found that the antenna can be designed to have either wideband or dual frequency characteristics. The measured VSWR curve of a single element is plotted in Fig. 3. The impedance bandwidth(VSWR<1.5) is 615 MHz (31 %). Fig. 2,3 shown the measured characteristics for studied antenna showed a good agreement with simulation results and a good stability of radiation patterns from 1750 MHz to 2170 MHz. The measured maximum gain is 7.0dBi. The radiation patterns are relatively stable across the passband.



(a). Calculated (b). Measured

Fig. 2 Calculated and measured curves of impedance locus for single element antenna

4. Conclusion

In this paper, simulation and experimental results have been presented for the L-strip fed rectangular patch antenna. Simulation results are in reasonable agreement with measurement. The studied antenna satisfied the wideband characteristics that are required characteristics for above 420 MHz bandwidth for the PCS and IMT-2000 dual band antenna, and it has advantages of fabrication for mass production because the antenna has a simple structure. The studied antenna was small and it could be used over all frequency ranges of the PCS and IMT-2000.

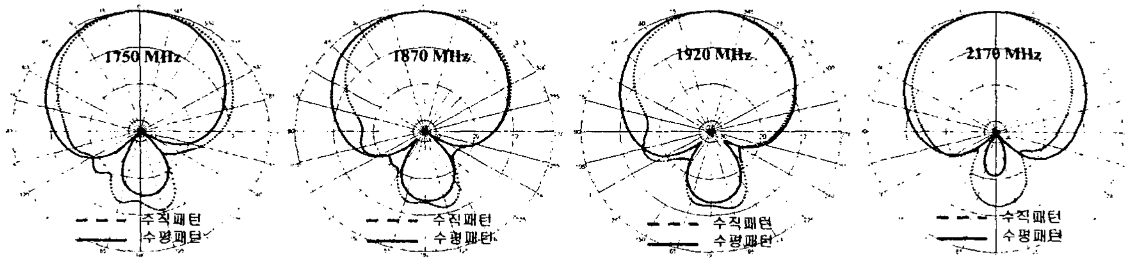


Fig. 3 Measured Radiation Patterns.

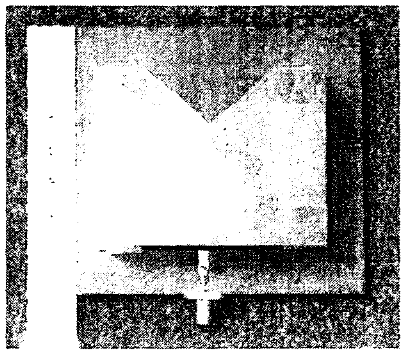


Fig. 4 Photograph of Prototype Antenna

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