Band Enhancement of 3.5 GHz Antenna for Mobile Devices using Parasitic Patch Antenna Approach

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***Abstract*—In the present era, the demand for producing cost effective and small antennas for mobile devices is increasing rapidly. Moreover, portability requirement of devices has created a need for antennas with small sizes and weight. For this reason, the technological trend has focused much effort on the design of microstrip (patch) antennas. However one of the major drawbacks of the patch antenna is its limited bandwidth. In this paper, we have proposed parasitic Antenna approach method, to increase the bandwidth of patch antenna**

Keywords-bandwidth;patch antenna; parasitic configuration;

Introduction

The small size of the patch antenna is becoming popular due to its low price, small size, ease of mounting and low fabrication requirements [1]. However, patch antennas have inherently. Bandwidth enhancement is a demand for practical applications nowadays. With the advent of new technologies, the requirement of large bandwidth is becoming a necessity.

. However, old conventional antennas cannot be used, as they do not offer any mobility and are large in size .Thus; size reduction and bandwidth enhancement are becoming major design considerations for practical applications of antennas.

Here we have proposed a design to overcome the bandwidth constraint patch antenna, using parasitic method approach.

I. Patch Antenna

The history of the patch antenna can be traced back to 1953 [2]. However few of disadvantages are [1] poor polarization, low efficiency, low power, purity, poor scan performance and very narrow frequency bandwidth It is a well-proven fact that for higher bandwidth and data rates a large bandwidth is required, whereas traditional patch antennas fail to provide large bandwidth.

II. Structure of Patch Antenna

A. Geometry

Microstrip patch antenna consists of a patch of metal with length "L" that is placed on the top of a grounded dielectric substrate of thickness h, with relative permittivity and permeability and as shown in "Fig. 1".

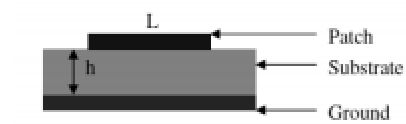

Figure 1. Structure of a Patch Antenna [3]

III. Simulation of a Regular 3.5 Patch Antenna

A. Calculation and Measurements

Calculation for patch antenna can be carried out with following equation [4]

$$W = \frac{c}{2fo\sqrt{\frac{\epsilon r+1}{2}}} \quad (1)$$

$$Leff = \frac{c}{2f0\sqrt{\epsilon reff}} \quad (2)$$

Where fo is the fundamental frequency across which the antenna is to be designed. Where ϵ_r is permittivity, and depend on the material that is being used a substrate. For simulation purpose for a regular 3.5 GHz antenna, following parameters were selected.

TABLE 1. Measurement Parameters For 3.5 Ghz Antenna Design

Physical Parameters	
Central Frequency	3.5 GHz
Dimensions	34 x 28 (mm)
Material Selection	
Name	Rogers RT 5880
Erel	2.2
Thickness	1.6 (mm)

B. Geometry

The above parameters were then used to formulate the patch antenna. The process was carried out in sonnet software. The final structure for 3.5 GHz antenna is given below in “Fig. 2” and “Fig. 3”

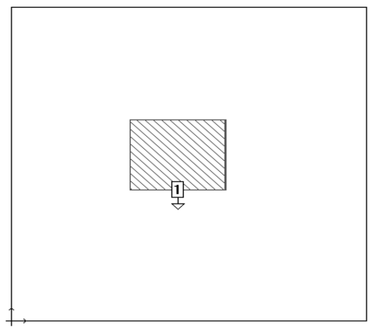

Figure 2 : 2-D View Of 3.5 GHz Patch Antenna

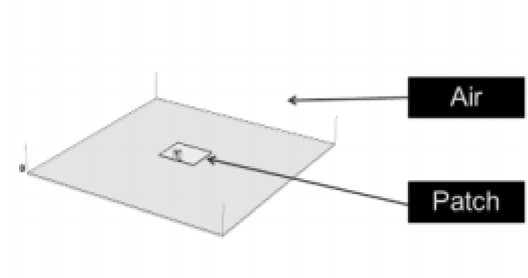

Figure 3. 3-D View of 3.5 GHz Patch Antenna

C. Simulation

For simulation purpose, sonnet EM was used. The simulation was used. Sonnet Em is a high-frequency simulator, which can simulate antennas, patch antennas, attenuator, microwave devices etc.

The simulation was carried out in different steps. A detail of the simulation process steps is given below in “Table. 2”.

TABLE 2. Simulation Process For Designing a 3.5 GHz Antenna

Step 1	Define Units of measurements
Step 2	Specify layers and frequencies
Step3	Material Selection
Step 4	Designing Antenna Structure
Step 5	Defining Power ports
Step 6	Running Simulation
Step 7	Analyzing Data

D. Results

The bandwidth of a patch is defined as the range of frequency over which antenna works effectively. A large bandwidth allows us large data transmissions resulting in increased transmission

The bandwidth of an antenna is usually defined by the acceptable Standing Wave Ratio (SWR) value over the concerned frequency range. Most commercial antennas use a 2:1 ratio, To ensure comparability with the commercial products; a decision was made to use a 2:1 ratio to calculate the bandwidth of antennas.

The simulation results were acquired in 1 minute and 12 sec. The total memory used by the software for this purpose was 14 MB. The Bandwidth was calculated by subtracting lowest effective frequency to the highest effective frequency. The results are displayed in “Fig. 4”

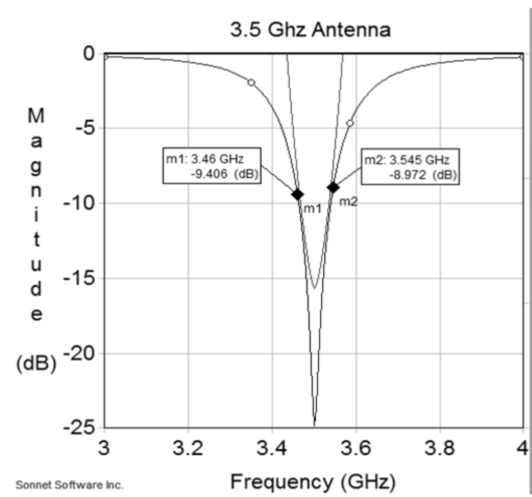

Figure 4. Simulation Results For 3.5 GHz Antenna

The total bandwidth for above antenna is 85 MHz

IV. PROPOSED DESIGN OF A PARASITIC PATCH ANTENNA

Parasitic configurations are used to achieve improvement in bandwidth efficiency. Parasitic bodies can be added to the structure in different ways. They can be introduced with the patch antenna or can be coupled or attached to the existing patch [5]

In parasitic patch antennas, different patches resonate with their own individual frequencies, resulting in single central frequency.

A. Proposed Model

The proposed parasitic patch antenna is made of the single dielectric layer. Altogether five patches were used for 3.5 GHz antenna. The central patch was driven directly via a feed line through a connector (Co-axial cable).

The central patch was then coupled directly to four other patches. All the parasitic patch used had a different width from each other, to broaden the spectrum of effective bandwidth; however, their length was kept constant. The proposed design is displayed in "Fig. 5".

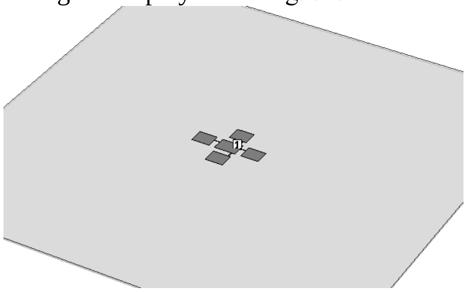

Figure 5. Design Of Parasitic Patch Antenna

B. *Design Considerations*

The placement of parasitic patch and their distance from each other and central fed patch plays an essential role in controlling the bandwidth. Several iterations were carried out before satisfactory results were achieved.

The length and width of the metallic strips used to connect the parasitic patches also acts as radiating antennas, hence they produce unwanted radiation.

C. *Results .*

The results were calculated, using Sonnet EM. Same materials for substrate was used in parasitic Patch antenna , as used in 3.5 GHz simple patch antenna, in order to compare and match results of both antennas , on basis of common substrate . The results are shown in "Fig. 6".

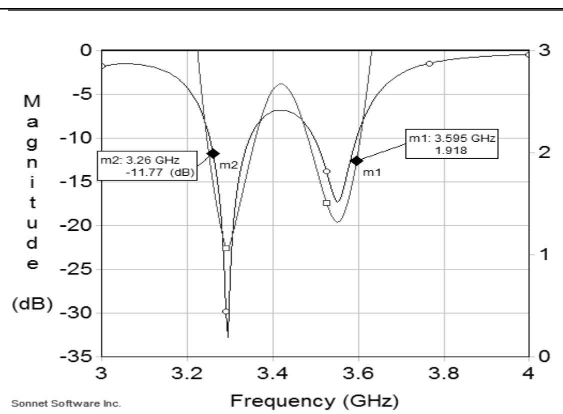

Figure 6 : Simulation Result For Parasitic Approach Antenna

The bandwidth was calculated using the following graph. This method gave us bandwidth range of 335 MHz . The software executed the task in 2 minutes and 9 sections, whereas, total 54 Mb of memory was consumed.

V. DISADVANTAGES OF PARASITIC PATCH ANTENNA

The disadvantages of parasitic patch antenna are that it increases the size of the antenna. As network increases, losses also increase, due to the increased size of patches, which effects radiation pattern.

Moreover, the metallic strip connecting different patches also resonates independently at their own frequency, which causes radiation losses, and loss of energy. [6]

I. RESULT COMPARISON

Both the antennas were fabricated, using the same material. However, the parasitic patch antenna gave us enhanced bandwidth as compared to simple patch Antenna.

Below the table represents, the comparison of both simple 3.5 GHz patches antenna and parasitic Patch antenna.

Table 2. Result Comparison Of Simple Patch Antenna With Parasitic Patch Antenna

Parameter	3.5 GHz Patch Antenna	3.5 GHz Parasitic Patch Antenna
Frequency	3.5 GHz	3.5 GHz
Substrate	Roger 500	Roger 500
Time execution Period	1 minute 12 seconds	2 Minutes 9 seconds
Memory Consumption	14 MB	54 MB
Power Feeding	via Co- Axial Cable	via Co- Axial Cable
Bandwidth	85 MHz	335 MHz

The bandwidth was increased from 85 MHz to 335 MHz overall there was an improvement of 250 MHz in the bandwidth.

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