A Novel Broadband and High Gain Antenna for GSM,UMTS, and LTE Wi-MAX Applications

Mehmet Abbak*, Cahit Karakus+, Ibrahim Akduman *

Istanbul Technical University
Electrical and Electronics Engineering Faculty
34469 Maslak, Istanbul, Turkey
akduman@itu.edu.tr

+ *Istanbul Culture University, College of Technical Profession,*
Incirli, Istanbul Turkey
cahitkarakus@gmail.com

***Abstract*—This paper describes the proposed novel broadband and high gain suspended plate antenna and its feeding structure. It is very applicable for applications which include GSM, UMTS, WLAN and LTE Wi-Max technologies. Simulations are performed using a commercial EM software package, additionally suspended plate antenna is realized and validated by measurements. From the network analyzer and anechoic chamber measurements of the proposed antenna, impedance bandwidth of 58% obtained between the frequencies of 1.735GHz and 3.145GHz, and measured antenna gain range is between 6.4dBi to 9.3dBi for the given frequency band.**

I. INTRODUCTION

With the developments of various standards for wireless communications, demand increased for broadband antennas. In most of these systems small terminals and base stations have to work simultaneously with more than one frequency band, therefore multiband antennas are required. One of the main goals of this research is to achieve improved efficiency with a microstrip patch antenna for the GSM, UMTS and LTE Wi-Max operation frequencies. However while achieving wideband there could be performance degradation in the other aspects of the antenna like gain. One of the most effective ways to achieve high efficiency is to use a substrate material with a dielectric constant close to air. The dielectric losses associated with the microstrip patch antennas are also set the achievable gain levels. Analysis of these losses is given in [1]. Because microstrip antennas have attractive features such as low profile structure and directed beam, it is aimed to achieve broad bandwidth and high gain with a microstrip antenna. In this work a novel patch antenna design which does not require substrate is proposed. Design methodology allows us to achieve an antenna which radiated in the desired broadband frequency range. Here, by considering current wireless network systems an antenna operating in the frequency range of 1.735GHz and 3.145GHz is presented. The antenna has gain of 6.4dBi to 9.3dBi in this frequency range. It is observed that the simulation results through Ansoft HFSS and measurements have a good agreement for several antenna parameters such as gain, return loss, radiation pattern etc.

II. SUSPENDED PLATE PATCH ANTENNA

A suspended plate patch antenna is a structure that a planar metal plate (radiated part) is located over a ground plane without any substrate material. Such kinds of antennas are first investigated by Herscovici [2] [3]. It has been shown that the feeding is an important parameter in the impedance matching which determines the radiating bandwidth. In this work a novel feeding mechanism is developed which yields a broadband radiation for a given frequency range. Such a feeding allows us to achieve maximum power transfer from feeding point to radiating plate at broadband. The structure of the feeding is demonstrated in the Fig. 1. Dimensions of suspended plate patch antenna are; patch with a width of 6.3cm and length of 5.4cm, with a height of 2.84cm from ground plane, with a 60^o inclined feed with a length of 3cm and 15.5x15.5 cm ground plane.

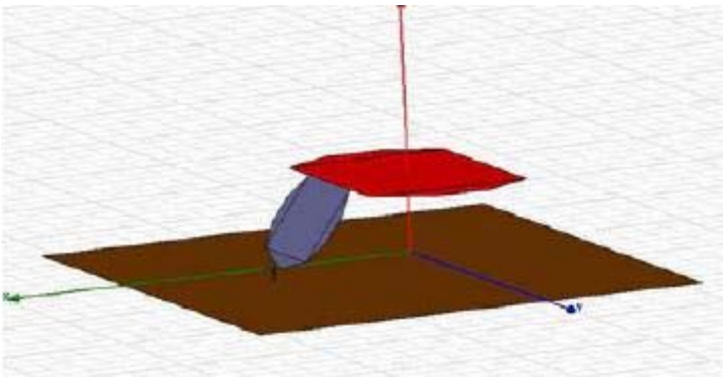

Fig. 1(a): Suspended Plate Patch Antenna

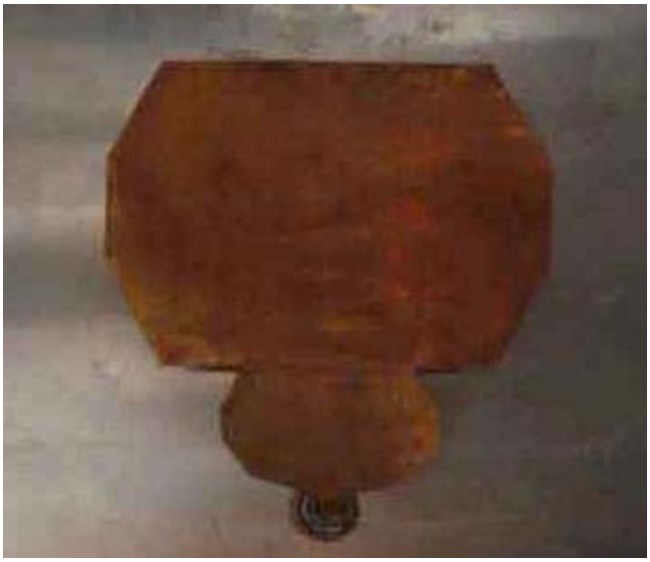

Fig. 1(b): Suspended Plate Patch Antenna

III. Simulations, Implementation and Results

The antenna given in Fig. 1 is first analyzed by using HFSS software. In Fig. 2 we first present the variation of amplitude S11 in the frequency range of 1.5GHz –4GHz. After the simulations suspended plate antenna is also manufactured (see Fig. 1). In Fig 3 the measured value of S11 through an Agilent N5230A PNA is given. As can be observed from Fig. 2 and Fig 3 both simulations and measurements are in a good agreement for the return loss. The measured impedance bandwidth, below 10 dB return loss, is between 1.735 GHz and 3.145 GHz which meets the bandwidth specifications for 1.8GHz GSM, 2.1GHz UMTS, 2.5GHz WLAN, 2.7 GHz LTE Wi-Max. After return loss measurements, radiation pattern measurements are completed in a full anechoic chamber. The measured far field 2-D radiation patterns of E-plane and H-plane are given in Fig. 4 and Fig. 5, in polar form for the 1800MHz, 2000MHz, 2200MHz and 2400MHz, respectively. Average 3dB beamwidth of H-plane is 51^{o} and for the E-plane measured average beamwidth is 61^{o} for the frequency range. From the E-plane and H-plane radiation pattern measurements average directivity is calculated as 10.4dB. Antenna peak gain measurement is also done with the comparison of a calibrated horn antenna. The antenna has gain of 6.4dBi to 9.3dBi in this frequency range.

IV. Conclusions

A novel suspended plate patch antenna which operates in the frequency range of 1.735GHz and 3.145GHz is designed and manufactured. The antenna has high gain and radiation characteristics which allow us to use it for the GSM, UMTS and LTE Wi-Max applications.

V. References

[1] *R. A. Pucel, J. D. Masse, and C. P. Hartwig, "Losses in microstrip," IEEE Trans. Microwave Theory Tech., vol. MTT-16, pp. 342–350, June 1968.*

[2] *Herscovici, N., ''New Considerations in the Design of Microstrip Antennas,'' IEEE Trans. Antenna Propagation, Vol. AP-46, No. 6, 1998, pp. 807–812.*

[3] *Herscovici, N., "A Wideband Single-Layer Patch Antenna," IEEE Trans on Antennas and Propagation, vol. AP-46, pp. 471–474, Nov. 1998.*

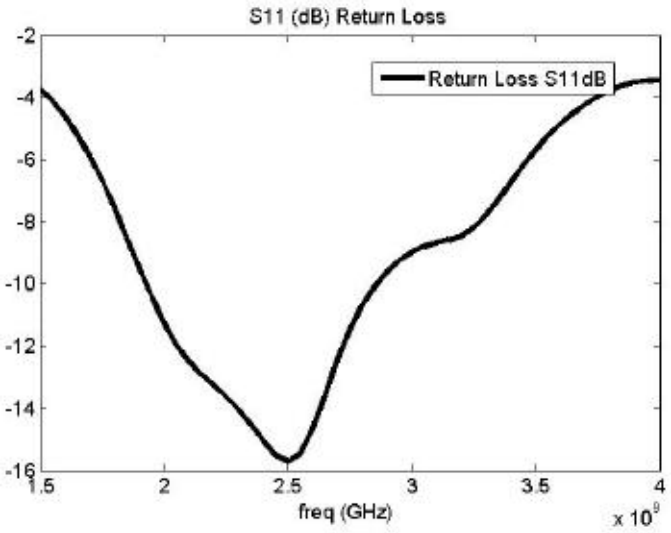

Fig. 2: Return Loss of Antenna obtained through

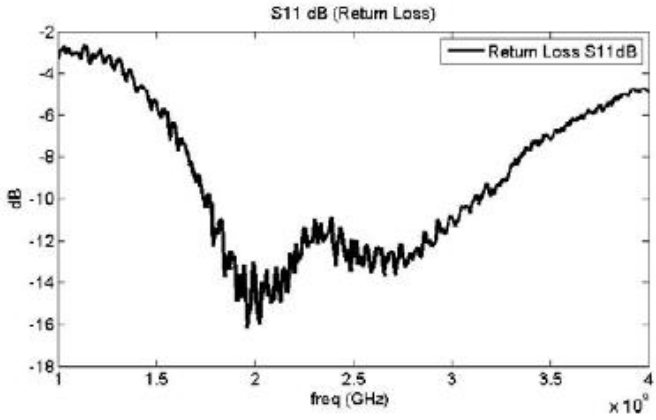

Fig. 3: Return Loss of Antenna obtained through measurements

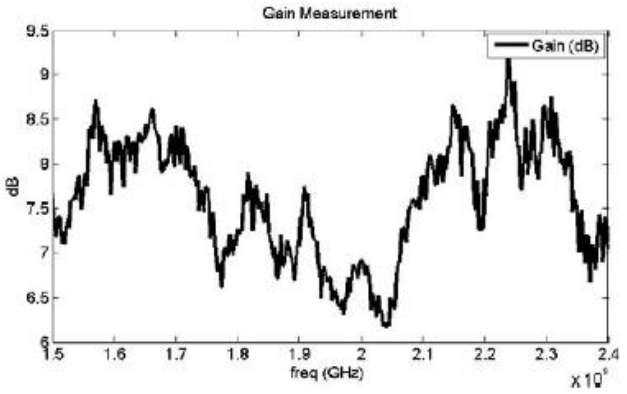

Fig. 4: Measured Gain

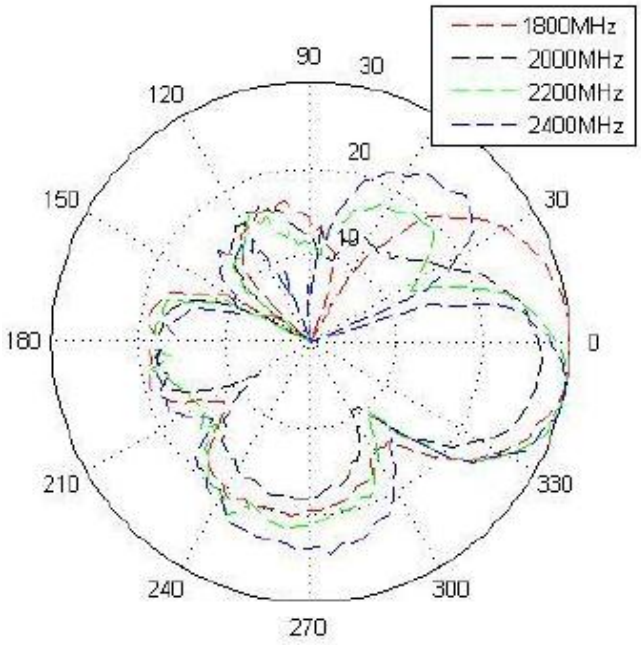

Fig. 5: Measured H-plane radiation pattern at 1800MHz, 2000MHz, 2200MHz, 2400MHz

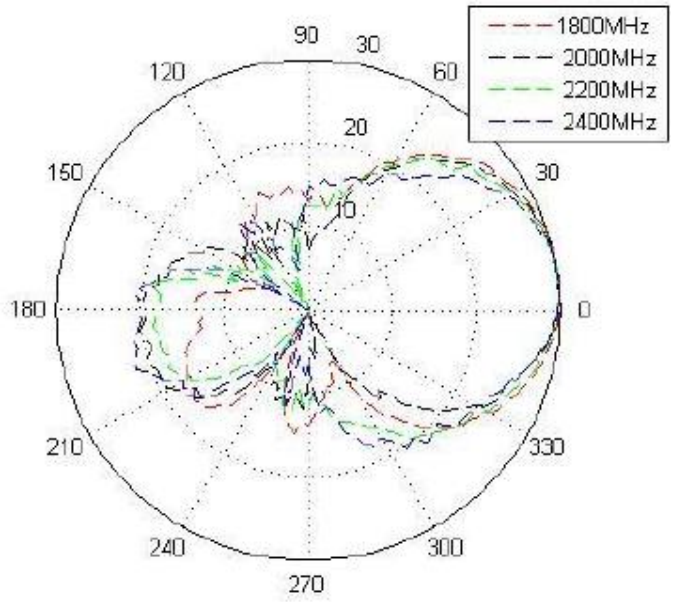

Fig. 6: Measured E-plane radiation pattern at 1800MHz, 2000MHz, 2200MHz, 2400MHz