Analysis of Circular Patch Antenna of 2-3GHz for Electromagnetic Applications

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***Abstract*—This paper present analysis of bandwidth of circular patch antenna for electromagnetic (EM) applications at frequency 2-3GHz for reflection coefficient<-10 dB. The final dimension of the proposed antenna is 48mmx30mm (LsxWs) for its FR4 substrate with thickness of 1.6mm, circular patch of radius 12.5mm and a feedline with 25mmx3mm (LpxWp). Thickness of circular patch and feedline both at 0.035mm.The proposed antenna is wideband of 24.50%, highest gain of 3.292 dB and in Omni-directional radiation pattern. Circular patch antenna is chosen because of its better directivity, easiness in fabricating process and in analyzing its structure to provide a best wideband. In EMR, it preserves Omni-directional radiation characteristic because of it equally well in process of receiving signal. Ultimately, the operating frequency range is determined and the design is analyze to be used for EM application. The performance of the designed antenna was analyzed in terms of return loss provided its stable Omni-directional radiation pattern and gain.**

***Index Terms*—Electromagnetic; Low Frequency; Microstrip Feedline; Wideband.**

I. Introduction

EMR is a form of energy that surrounds environment and existing in many forms. As shown in Figure 1, it exists in radio waves, microwaves, X-rays and gamma rays. In electromagnetic (EM), visible light is only a small portion of EM spectrum that contains a wide range of EM wavelengths.

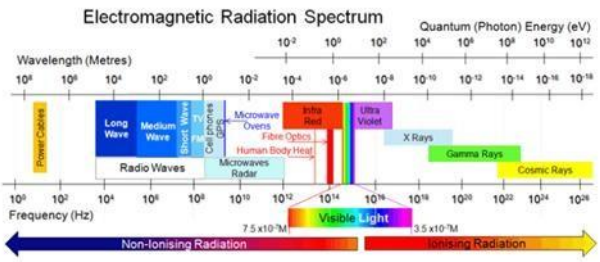


Figure 1: EMR Spectrum [1]

EMR is well known among researcher studying it and a bundle of scientific articles have been published especially concerning its effect on human health in previous years [2]. Radio wave is a common form of EMR being chosen as case study by researcher because it form main source in daily life; communication and non-communication machine or equipment. Mobile phones, base station, industrial machines, microwaves oven, Wireless Local Network (WLAN), radio transmitter and radar applications are example of radio waves in daily life [3-6].

Focusing in methodology, it is a need to have a precise receiving medium which is an antenna to determine reading value of radio waves of EMR that is below than 3GHz. And in order to have a proper reading of radio waves while doing a research, one need to have an antenna that can covers equally in all direction and have a wide bandwidth. The fact is the lower the frequency, the bigger the antenna is. Hence, a size of antenna is a major thing to be taken into consideration after type of radiation pattern and bandwidth of antenna.

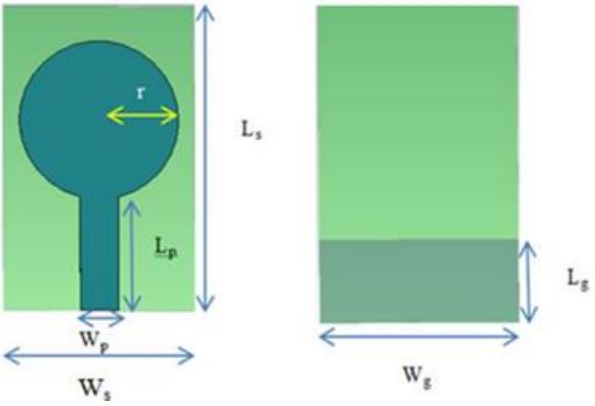
Eventually an Omni-directional microstrip patch antenna is the suitable design. Microstrip antenna is one choices of antenna that can be used in transmitting and receiving signal [7]. It is small, compact in sizes and low cost [8]; hence it is preferable in many uses.

Besides, in order to have an antenna which is not only low cost, but can receive or radiate equally well in all direction that cover up to 360 degrees, an antenna that have Omni-directional radiation pattern is to be chosen [9]. In EMR, it is an important thing to have Omni-directional radiation characteristic as it imply a good sensor behavior [10]. Since U.S Federal Communication Commission (FCC) had approved the usage of the controversy Ultra-wideband (UWB) antenna unlicensed, it received extra boost in present and future applications [11-13].

II. Antenna Design and Structure

The structure of the proposed circular patch antenna is shown in Figure 2. The antenna prints on low cost FR4 substrate with dielectric constant 4 and loss tangent of 1.0 and thickness of 1.6mm.

As defined in Figure 2, this antenna has a circular patch, a microstrip feedline with ground plane made of copper with thickness of 0.035mm. Antenna fit 50 Ω impedance in accordance with dimension port of Wpx 0.035mm.



(a) (b)

Figure 2: (a) Front View (b) Bottom View

The proposed antenna was designed and being simulated by using CST-Studio Suite Software and Table 1 shows the final dimension of chosen proposed antenna that provide a bandwidth of 24.50% with lowest frequency of 2.19 GHz and highest frequency of 2.80 GHz. Its center frequency is 2.46 GHz. Both of this frequency are below than -10 dB in reflection coefficient shown in figure 3.

Table 1
Simulated Parameters of the Proposed Antenna

Parameters	Value (mm)
Ls	48
t	30
Lg	12.5
Wg	30
Lp	25
Wp	6
r	12.5

Much enhanced bandwidth will be obtained by adjusting thickness of substrate and substrate permittivity [14], radius of circular patch [15], and length of ground plane [16].

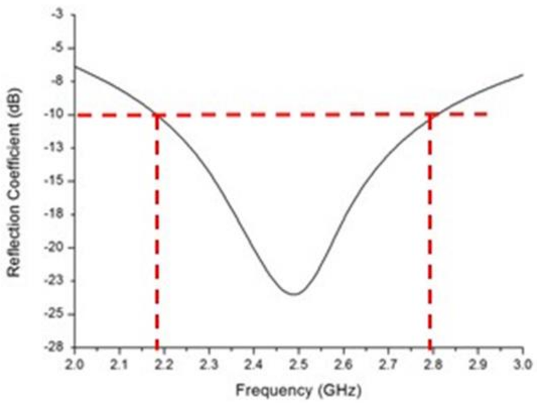


Figure 3: Final reflection coefficient result of chosen parameters

III. Analysis Result and Discussion

The circular patch antenna was constructed and studied to determine the recommended band-width improvement technique. The parameters to be varied are thickness of substrate (t), radius of circular patch (r), length of half-ground plane (Lg).

Figure 4 shows the derivative of reflection coefficient curves for various substrate thickness, t. As the t increased, the bandwidth curve shifted more to the right provided it cover more targeted frequency. -10 dB reflection coefficient decreases as t decreases.

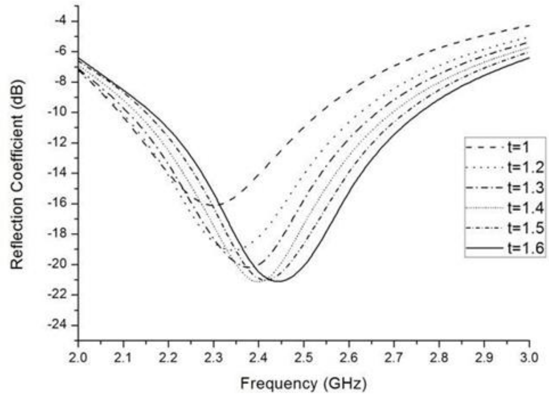


Figure 4: Reflection coefficient and thickness of substrate

Figure 5 present relationship of reflection coefficient and targeted frequency with different in circular patch radius, r. The bandwidth demonstrates better as radius increase. But, between measurement of 12mm and 13 mm, provided 12.5 mm shows better bandwidth in between those values.

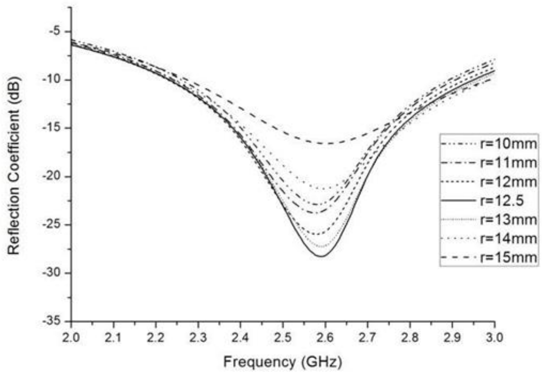


Figure 5: Various value of r influenced bandwidth of reflection coefficient.

Figure 6 represents the final parameters to be varied for the proposed antenna in this paper; length of ground plane, *Lg*. A stable bandwidth is achieved when *Lg* is in values in between 10-15mm. As *Lg* increased, its bandwidth move upward and is more than -10dB.

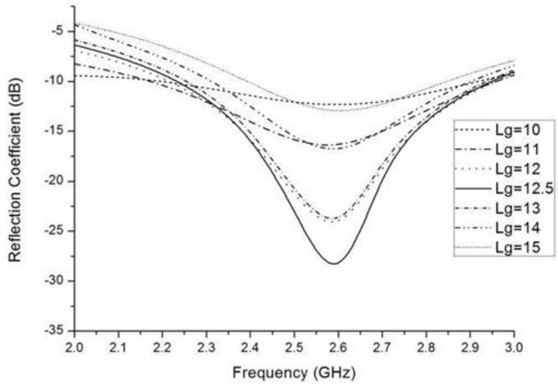


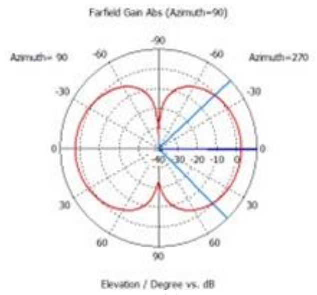
Figure 6: Graph of reflection coefficient and different value of *Lg*

From the simulation result, it is observed that the most influenced parameter towards achieving wideband is Lg. Observing its pattern in figure 6, clearly shown there is a major difference in obtaining a better wideband as value of Lg varied.

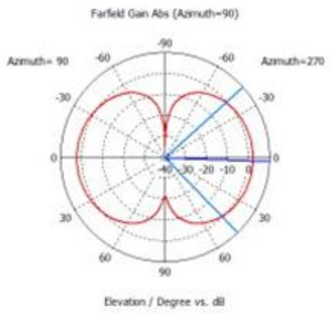
Measured radiation pattern at 2.18, 2.46 and 2.80GHz are shown in Figure 7. Monopole-like radiation patterns are observed and it shows stable Omni-directional.

IV. CONCLUSION

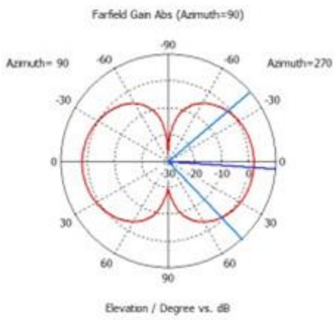
A circular patch antenna for EMR application is proposed. It is easy to fabricate and has a simple configuration. To enhance the bandwidth, four parameters was chose which are thickness of substrate, t, radius of circular patch, r and length of ground plane, Lg. The most influential parameter to achieve a good wideband is Lg. The designed antenna meet requirement of -10dB return loss from 2 to 3GHz and yield a good Omni- directional radiation patterns. These analyses demonstrate the proposed antenna could be a good candidate for EMR application that required an Omni-directional pattern and a good bandwidth.



(a)



(b)



(c)

Figure 7: Radiation pattern at (a) 2.18GHz (b)2.46GHz (c)2.80GHz

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