Dual-Band Rectangular Microstrip Antenna of 5 and 6 Ghz for Iot Devices

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Abstract—Modern IoT devices needs to transmit more data than its previous generations, this why the newer antenna has more frequency and also has more bandwidth than its previous generation as seen in the newest Wi-Fi 6E and Wi-Fi 6, Dual-Band and high frequency design can help to solve this crucial part of the IoT communication problems as an IoT Gateway antenna. Designed a Dual-Band Rectangular Microstrip antenna using a 5 and 6 GHz, using Epoxy FR4 for the substrate and copper for the patch and ground, both of this materials is the common materials for making an antenna and relatively cheap. The observation was done through the simulation step using 3D model simulation software and measurement of printed antenna. In the Simulation, the VSWR from both frequencies is reaching the target by VSWR below 2, the bandwidth for the 5 GHz is 140 MHz while its not reaching the maximum target of 160 MHz bandwidth for the Wi-Fi 6 standard, but its reached the minimum of 80 MHz bandwidth, for the 6 GHz bandwidth is 212 MHz, its reach the target bandwidth but it lacks additional channel for other 160 MHz, the value of gain reach the target by both frequency gain is more than 1.5 dBi.

Keywords—Internet of Things (IoT), antenna, dual-band, microstrip antenna, rectangular patch

I. INTRODUCTION

Wireless is evolving, driven by more devices, more connections, and more bandwidth-hungry applications. Future networks will need more wireless capacity and reliability. That's where the sixth generation of Wi-Fi comes in or as known as Wi-Fi 6. The emerging IEEE 802.11ax standard is the latest step in a journey of nonstop innovation. It builds on the strengths of 802.11ac, while adding flexibility and scalability that lets new and existing networks power next generation applications. IEEE 802.11ax couples the freedom and high speed of gigabit wireless with the predictability we find in licensed radio (LTE). IEEE 802.11ax allows enterprises and service providers to support new and emerging applications on the same Wireless LAN (WLAN) infrastructure, while delivering a higher grade of service to older applications. This scenario sets the stage for new business models and increased Wi-Fi adoption. IEEE 802.11ax lets access points support more clients in dense environments and provide a better experience for typical wireless LAN networks. It also powers more predictable performance for advanced applications such as 4K video, Ultra HD, wireless office, and IoT. Flexible wake-up time scheduling lets client devices sleep much longer than with 802.11ac, and wake up to less contention, extending the battery life of IoT [1].

The U.S. Federal Communications Commission (FCC) approved the opening of the 6-GHz band for unlicensed use in the United States in April 2020, with this move, the FCC freed 1200 MHz of bandwidth for use by Wi-Fi 6E devices, which feature an extra radio that lets them communicate in the 6-GHz band. The 6-GHz band offers more than twice as much Wi-Fi bandwidth as the 5-GHz band, the FCC 2 extended Wi-Fi into the 6-GHz frequency band to help encourage wireless innovation and support smart homes and offices and the expand [2].

The increased usage in the IoT sectors that using high data transfer rate, low latency connection and huge bandwidth presents a significant challenge, in order to fulfil this needs, the standard of the wireless is evolving, from 802.11-1997 Standard to Wi-Fi 6 or 802.11ax Standard, the 5 and 6 GHz frequency is the best choice for an IoT devices, as it can transmit more data, has lower latency, and also has bigger bandwidth, by trading off the range of the connection, this thesis observed the addition of the dual-band for an important devices as IoT, if there is a problems with one of the band, the other band will be the secondary option, the chance for the IoT devices to lost a connection will be reduced.

II. METHOD

A. Rectangular Microstrip Antenna

The microstrip patch antenna was mainly viewed as an element that could be used in a discrete implementation of a planar version of the wraparound antenna, allowing for individual control of the element phases, rectangular microstrip antenna has an element that has several wavelengths wide for the nonresonant dimension, and was fed with a periodic arrangement of coaxial feeds along the two radiating edges, a rectangular patch, is the easiest patch to adjust and create as a base for the dual-band.

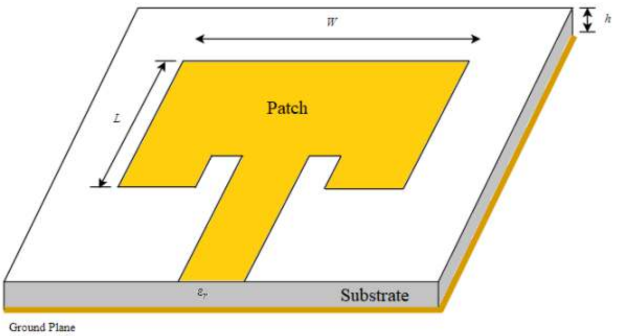

Figure 2.1 Top view of a microstrip antenna.

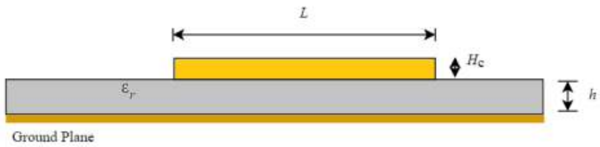

Figure 2.2 Side view of a microstrip antenna.

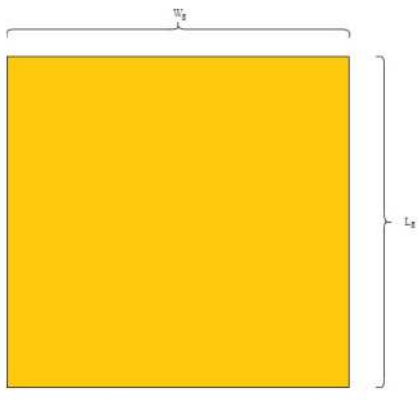

Figure 2.3 Bottom view of a microstrip antenna.

B. Design and Simulation of The Antenna

The purpose of this research is to create and realization of Dual-Band Rectangular Microstrip Antenna of 5 GHz and 6 GHz by simulating until 3 times to get the antenna that as desired. The first model used the initial design based on formulas calculation and some change by the author in the groundplane, second the size of length and width of groundplane is changed and adjust some change in patch and feed line, third the patch and feed line changed again, the fourth is the final with some change in the patch and has the best looking antenna.

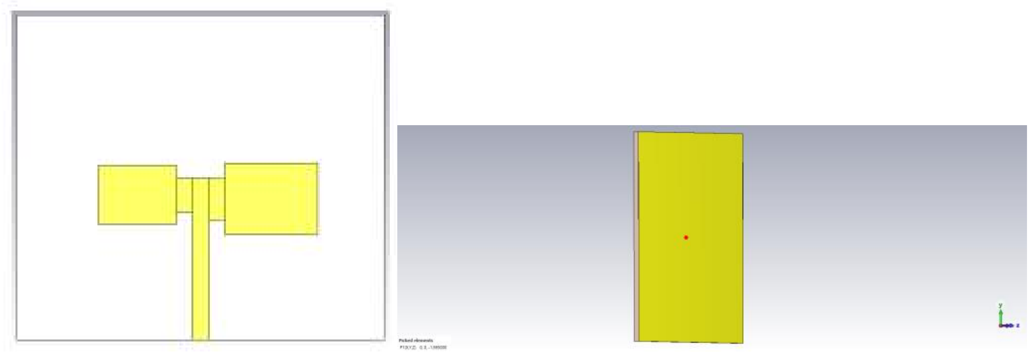

FIGURE 2.4
(The Initial Antenna design from Front view and Back View.)

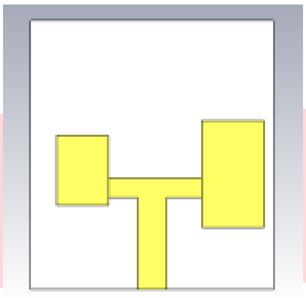

Figure 2.5
(The Antenna Iteration 1 design from Front View.)

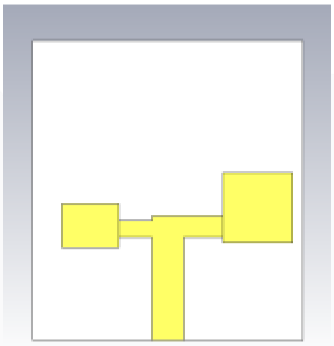

FIGURE 2.6
(The Antenna Iteration 2 design from Front View.)

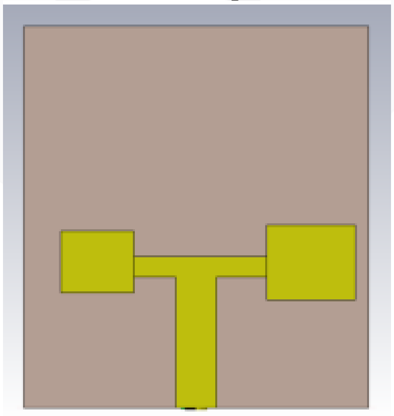

FIGURE 2.7
(The Final Antenna Iteration design from View.)

TABLE 1.
(The Final Antenna Dimension)

Parameter	Value (mm)
Copper Thickness(Hc)	0.035
Substrate Thickness (H)	1.6
6 GHz patches width(W6GHz)	11.46
6 GHz patches length(L6GHz)	9.6
6 GHz Feed Line Width(Wf6GHz)	6.59
6 GHz Feed Line Length(Lf6GHz)	3.185
5 GHz patches width(W5GHz)	13.92
5 GHz patches length(L5GHz)	11.67
5 GHz Feed Line Width(Wf5GHz)	7.91
5 GHz Feed Line Length(Lf 5GHz)	3.185
Main Feed Line Width(Wfmain)	6.31
Main Feed Line Length(Lf main)	23.56
The width of ground plane combined(Wgroundplanecombined)	54.13
The length of ground plane combined(Lground planecombined)	59.37
Substrate width(Sw)	54.13
Substrate length(Sl)	59.37

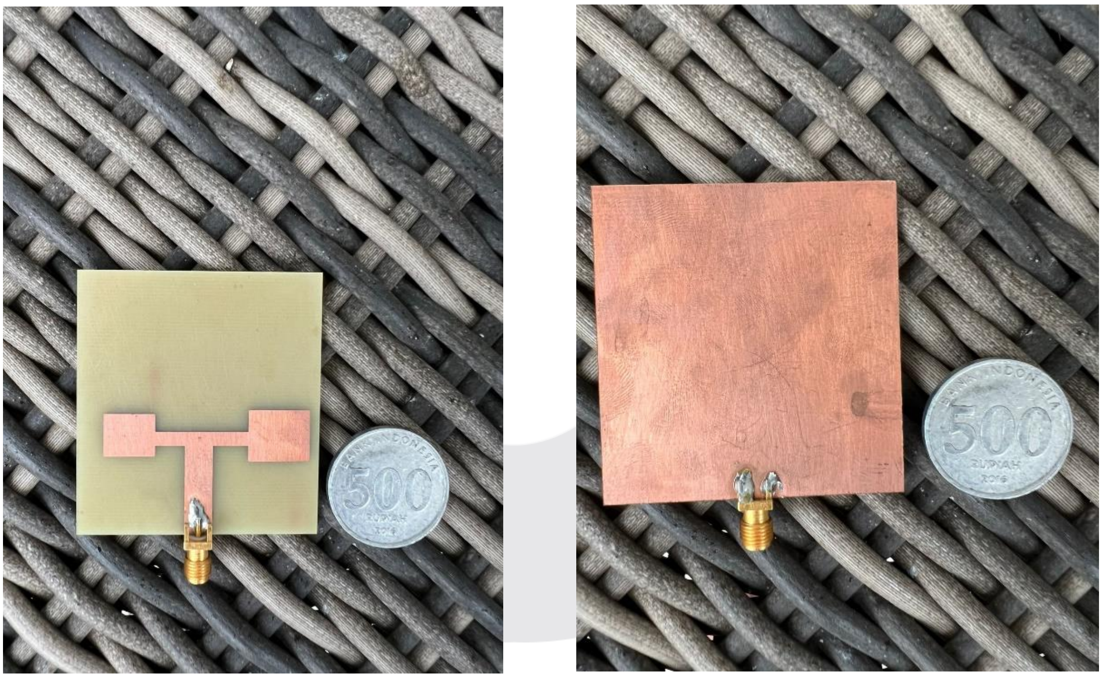

FIGURE 2.8
(Printed Antenna of Dual-Band Rectangular Microstrip Antenna of 5 and 6 GHz compared with Rp. 500.)

III. ANTENNA VSWR AND GAIN RESULT IN SIMULATION

From the model antenna that simulated this is the result of the gain and VSWR from final model.

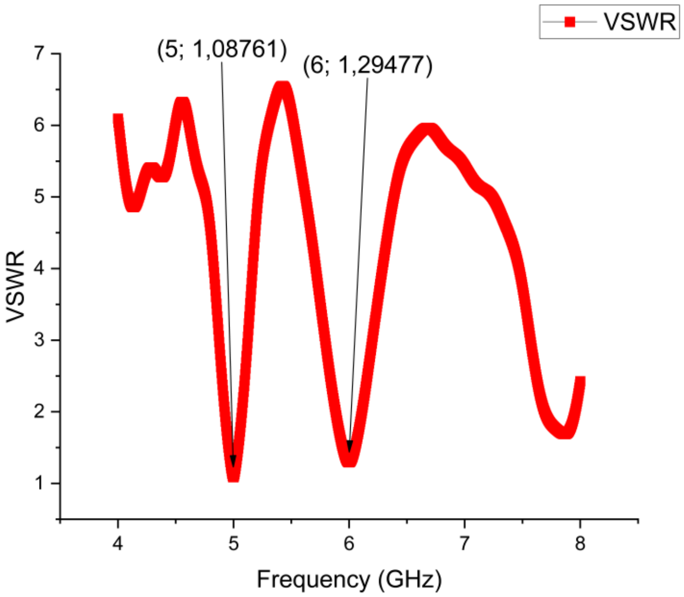

FIGURE 3.1
(Antenna VSWR Simulation Result)

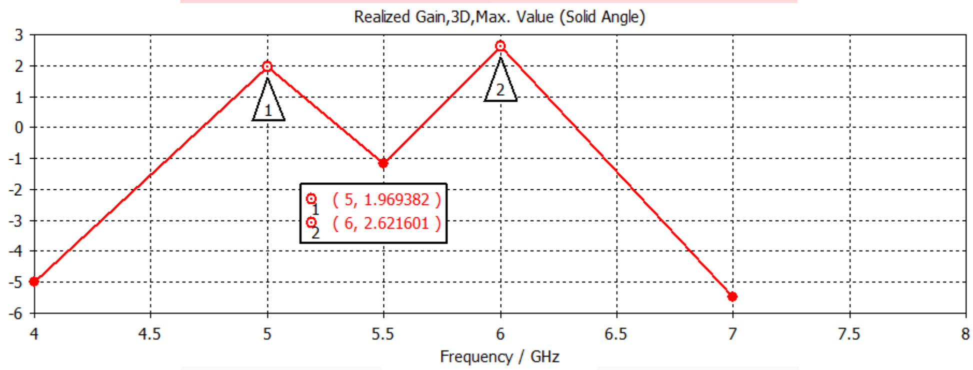

FIGURE 3.2
(Antenna Gain Simulation Result.)

IV. RESULT AND DISCUSSICON

A. VSWR Comparison from simulation and antenna lab of 5 and 6 GHz.

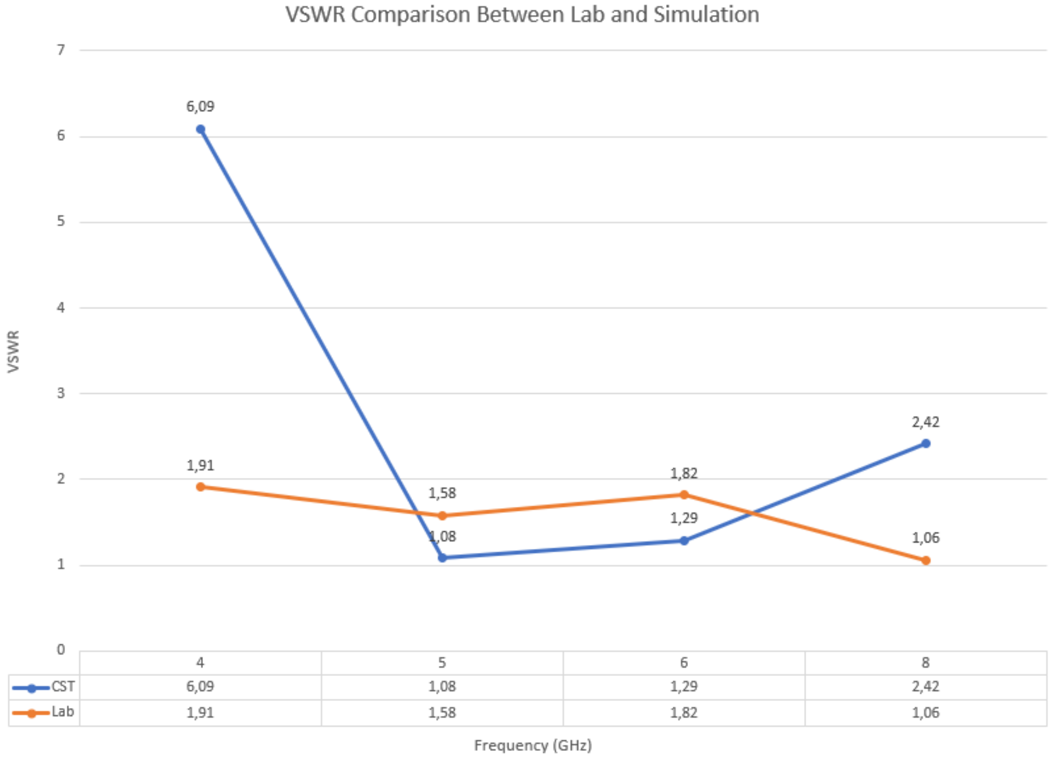

FIGURE 4.1
(Simulation and measurement VSWR result of antenna.)

B. Comparison between Azimuth radiation pattern.

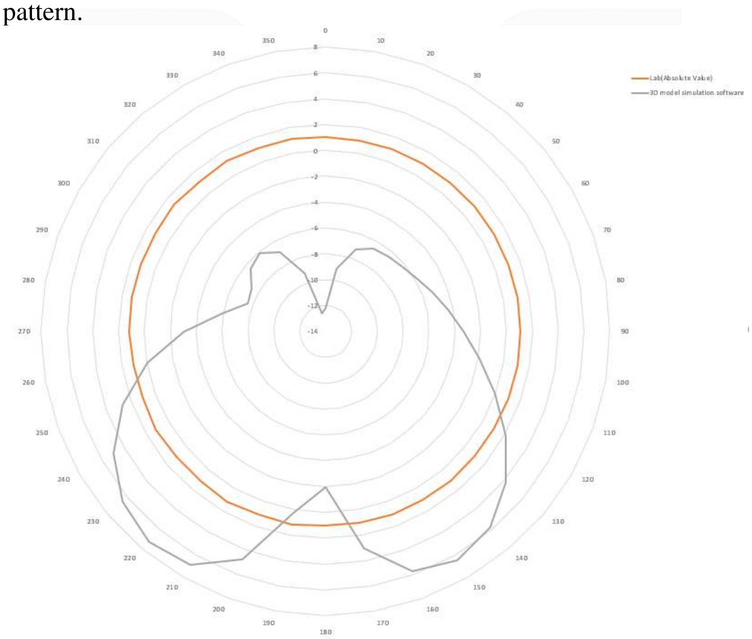

FIGURE 4.2
(6 GHz Azimuth radiation pattern between simulation and measurement.)

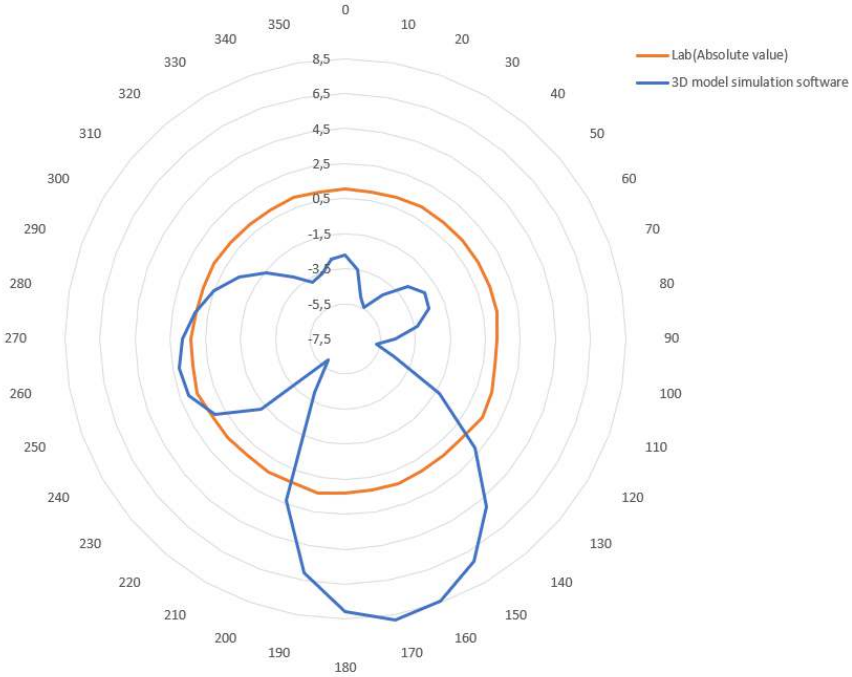

FIGURE 4.2
(6 GHz Azimuth radiation pattern between simulation and measurement.)

V.CONCLUSION

Conclusion from the results of design, analysis, and simulation using 3D model simulation software on Dual-Band Rectangular Microstrip Antenna of 5 and 6 GHz for IoT devices are as follows:

A. The VSWR of both 5 and 6 GHz frequency fulfil this thesis objective by gaining the VSWR below 2, by doing a changes to the shape of the antenna, the VSWR can have a different results.

B. The S Parameters especially the S11 or known as the reflection coefficient(Γ) or, is the one that affected the most from VSWR, the value of the S11 directly related to VSWR.

C. Rectangular patch antennas are notoriously narrowband, the bandwidth of rectangular microstrip antennas are typically 3%, the bandwidth also affected by the S11, the wider the S11 in certain frequencies, the more bandwidth will the antenna get. In this thesis, the

D. bandwidth of the Dual-Band Rectangular Microstrip Antenna of 5 and 6 GHz already fulfil the objective, that is having a moderate amount of bandwidth.

E. For the antenna gain, the amount is moderate for an antenna that didn't use metamaterial and FSS (Frequency Selective Surface) methods, the gain is affected by directivity the most.

F. The directivity of the Dual-Band Rectangular Microstrip Antenna of 5 and 6 GHz is more than 1, the greater the directivity, the narrower the antenna beam will be.

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