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Design of Wideband Antenna for Millimeter Waves Using HFSS

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Abstract—This paper reviews the objectives and requirements of wideband antenna for millimeter-wave applications using HFSS software (Ansys HFSS V.15.0). In modern era, all wireless devices are multipurpose and versatile, so this requires a wideband antenna to perform different tasks. Microstrip patch antennas are enhancing the performance of communication systems. Patch antennas are becoming more common these days because to their low profile and small weight, making them simple to build. The antenna and propagation issues are further complicated by need for more power, wider bandwidth, stronger gain, and insensitivity to the presence of human users. To provide dependable and interference-free communications and for high-performance millimeter-wave devices need efficient low-profile antennas.
Keywords—wideband antenna, HFSS

I. INTRODUCTION

Patch antennas, which are an important part of today's wireless communication systems, have played a key role in this progress. Microstrip patch antennas, in comparison to conventional microwave antennas, are small, light weight, easy to manufacture, low cost, and easy to integrate in mobile radio and wireless communication applications. Patch antennas, which are an important part of today's wireless communication systems, have played a key role in this progress.

Millimeter wave bands have been proposed as a key component of a wideband mobile network for multi-gigabit communication services like high definition television (HDTV) and ultrahigh definition video (UHDV). Future wireless networks will necessitate systems with broad band capabilities in a variety of situations to support a variety of applications such as smart grid, personal communications, home, automobile, and business networking.

Its adaptability makes it ideal for usage in mobile phones, hand -held devices, planes, ships, trains, and automobiles. A simple rectangular patch antenna working in the millimeter wave range is provided in this work, which was developed using a FR 4 Epoxy substrate. Metamaterials can be used to increase bandwidth, increase power gain, or make compact multifrequency-band antennas. To use metamaterials in an antenna, the first step is to construct their unit cells, which are atoms that provide the metamaterial specific properties at the specified frequency.

II. LITERATURE SURVEY

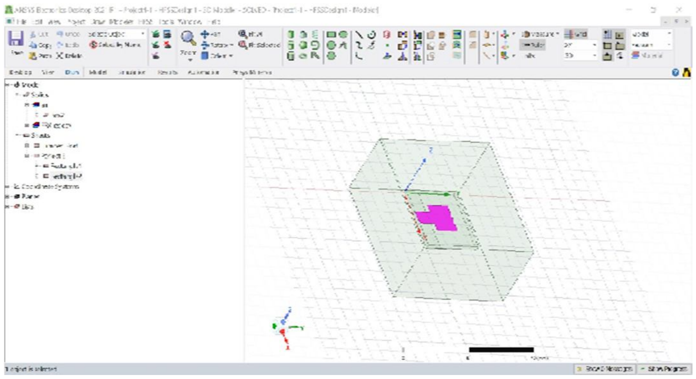
A basic microstrip patch antenna comprises of a dielectric substance called the substrate (FR 4 Epoxy) sandwiched between a metallic patch and ground. Microstrip patch antennas are utilized in a variety of applications, including military and domestic ones. According to various studies, a simple microstrip patch antenna resonates at an operational frequency of 2.4 GHz and this antenna has a gain of 1.01 dB, VSWR of 1.18 and return loss of -12.05 dB.

III. ROLE OF ANTENNAS IN 5G

One wideband antenna may efficiently replace many narrow-band antennas, lowering the antenna count. The bandwidth is the antenna's operational frequency band, within which it is desirable to achieve certain antenna characteristics such as input impedance, radiation pattern, gain, efficiency, and so on. Higher frequencies for 5G are beneficial for a variety of reasons, the most notable of which is that they offer a large amount of rapid data capacity. They are extremely directed and may be used along side other wireless signals without interfering.Millimeter wave bands span all up to 300GHz.The bands from 24GHz to 100GHz are used for 5G.

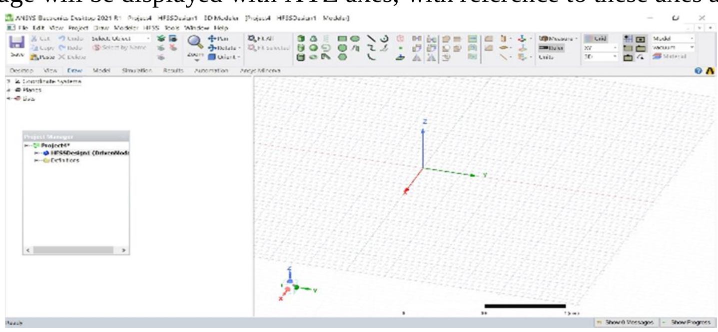
IV. SOFTWARE

Ansys HFSS is a 3 dimensional electromagnetic (EM) simulation software for high-frequency electronic products such as antenna arrays, RF and microwave components, high-speed interconnects, filters, connectors, IC packages and printed circuit boards. he HFSS software from ANSYS is an adaptive meshing technology based software used for simulating 3-D full-wave electromagnetic fields. It is one of the most powerful and used software tools in the RF & Microwave Industry. It provides state-of-the-art solver technologies based on finite element, integral equation, asymptotic and advanced hybrid methods to solve a wide range of microwave, RF and high-speed digital. A linear circuit simulator with integrated optimetrics for input and matching network design is also included in the program. Using HFSS, parasitic parameters (S, Y, Z) may be extracted, 3D electromagnetic fields (near- and far-field) may be seen, and Full-Wave SPICE models that link to circuit simulations may be generated. The program may also produce a suitable, efficient, and accurate mesh for tackling certain issues automatically.

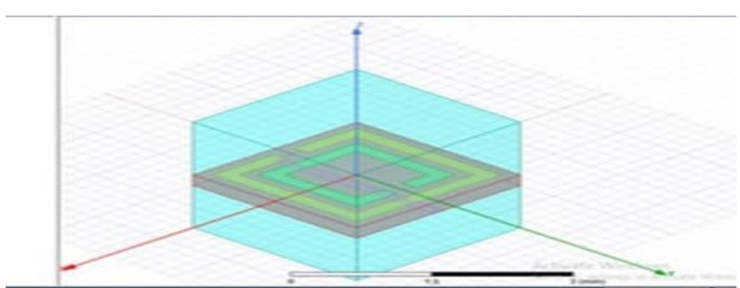


A. Design of Wideband Antenna

1) Click on Insert HFSS tool a page will be displayed with XYZ axes, with reference to these axes antenna is designed.



2) Design and select the substrate assign the dimensions to the substrate(FR 4 epoxy).
3) Design of ground.
4) Patch creation and created patch should be symmetric to the substrate.
5) Validate the antenna design.
6) Analysis setup to assign a frequency to the antenna according to the application.
7) Observe and verify S parameter plot,gain plot and radiation pattern.



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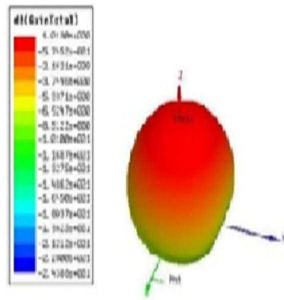
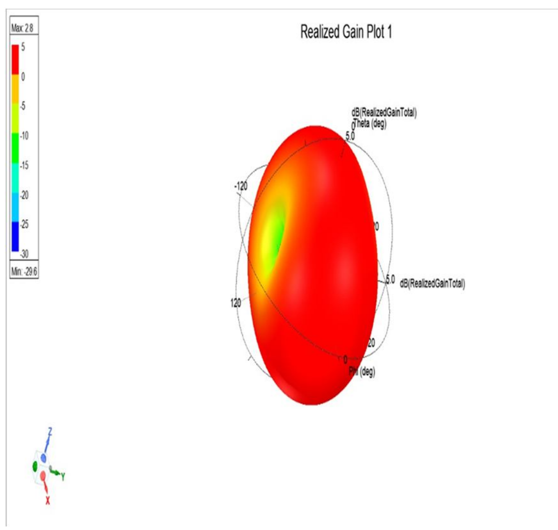
V. ANALYSIS

A. Gain Plot



Gain plot at 2.4GHz



Gain of wideband antenna

Gain of antenna at 2.4GHz is observed to be 1.01Db but gain of the wideband antenna is 2.8Db. hence we observed increase in gain

B. Return Loss and Bandwidth

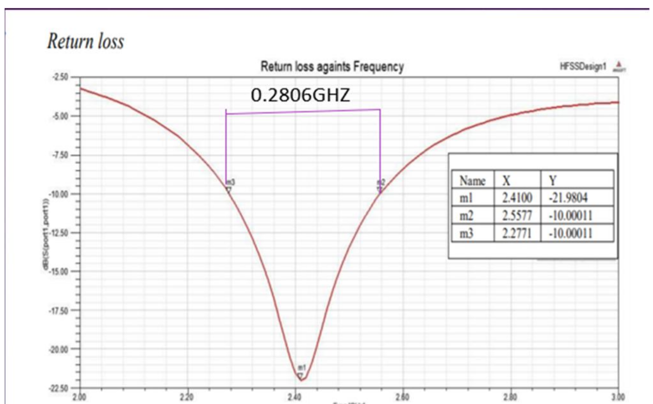
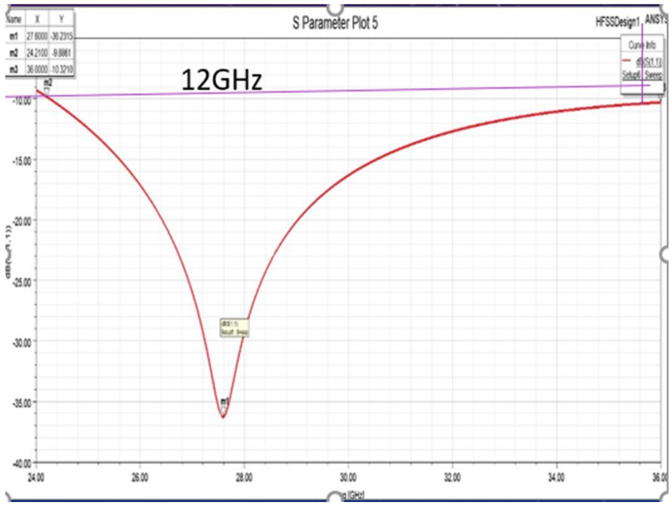


Figure 5. Return loss vs. frequency for patch antenna at 2.4 GHz frequency.

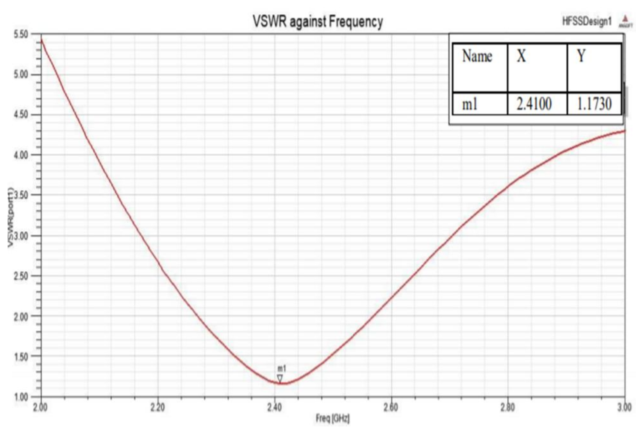


Return loss Vs frequency of wideband antenna

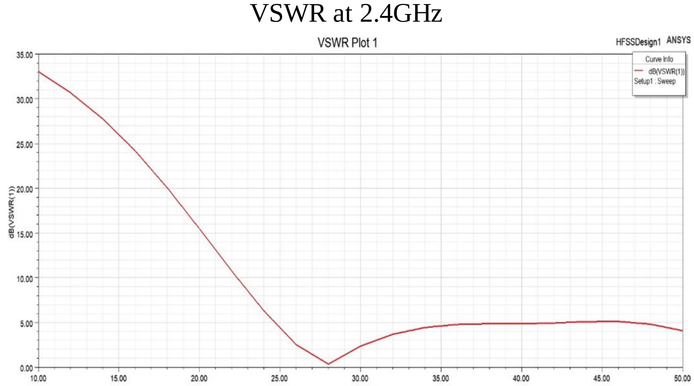
Return losses of antenna at 2.4GHz is observed to be -21.98 but return losses of the wideband antenna is -36 .Hence this shows wideband antenna has less losses.

We can also observed that bandwith from improved 0.2GHz to 12 GHz

C. VSWR



VSWR at 2.4GHz



VSWR of wideband antenna

VSWR of the antenna at 2.4Ghz is 1.17 but for wideband antenna the VSWR value is almost equal to zero

VI. FUTURE SCOPE

Microstrip antennas offer a wide range of applications. These antennas are currently being developed and utilised in Personal Communication Systems, Mobile Satellite Communication, Direct Broadcast Satellite, Global Positioning System, Wireless Local Area Network, Intelligent Vehicle Highway System, and Microwave Therapy. Simulators are essential for microstrip patch antenna design. The sophistication of the models utilized in these tools determines their suitability. Microstrip array antennas are being actively investigated for applications such as satellite communication systems, where a slim shape and light weight are critical. The current architecture may be modified to accommodate an array of microstrip patch antennas. Some extra models will be required for this development. Dual frequency was necessary in several communications and radar applications. The current technique may also be used to create a dual-frequency patch antenna.

VII. CONCLUSION

A microstrip patch antenna for 5G communication has been constructed in this study. The design simulation was done with the Ansys HFSS v.15.0 simulation tool. The acquired findings are determined to meet the 5G communication antenna's standards. The resonant frequency of the antenna is 27.954GHz. The small antenna may be used in communication devices as well as smaller base stations. Because massive antennas are required for 5G, it is recommended that comparable sorts of multiple antennas be used. The antenna is fed by coaxial cable. Fabrication of tailored antennas for real-time 5G applications with antenna arrays is planned for the future.

VIII. ACKNOWLEDGEMENT

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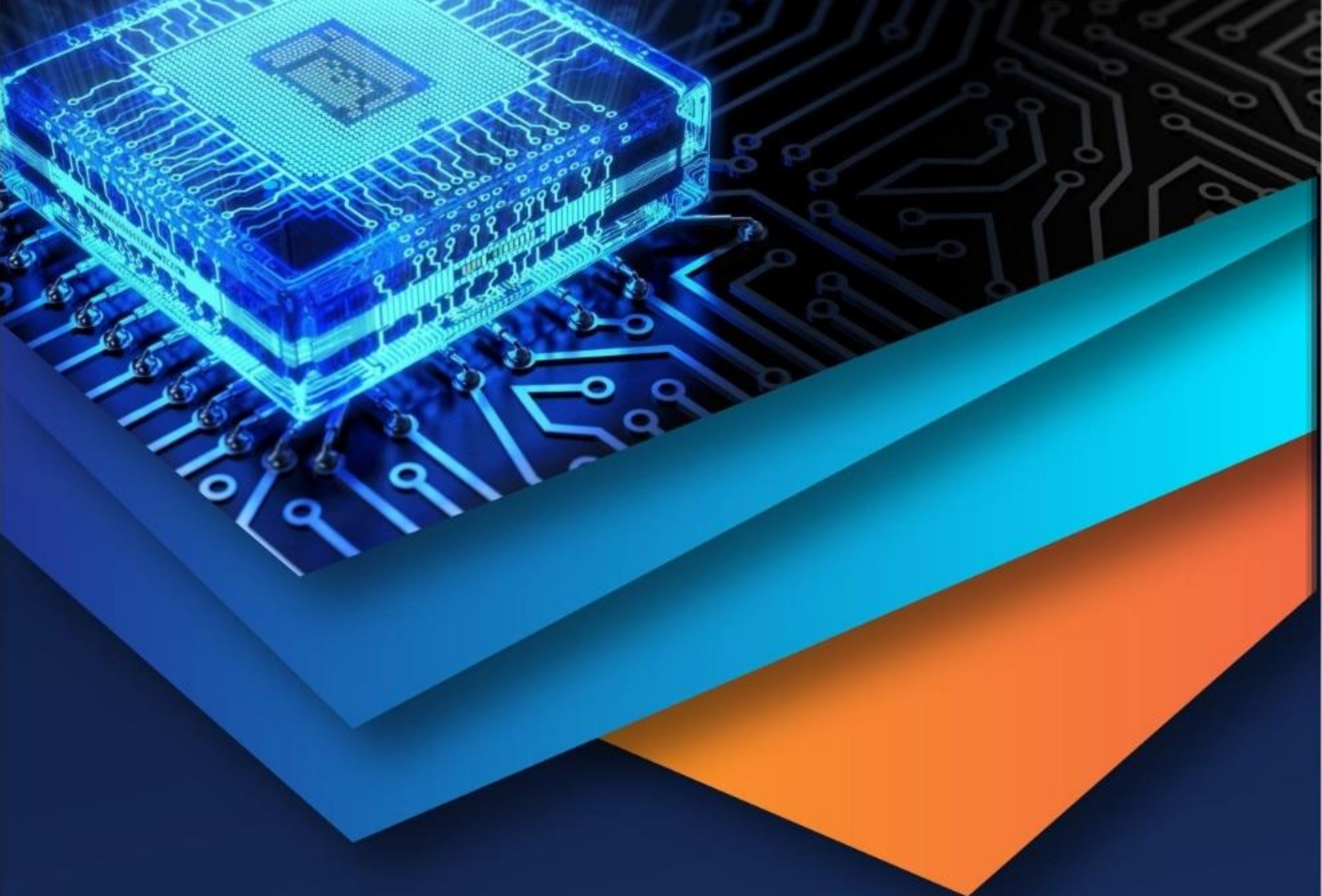

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