Design and Analysis of Array Based Micro strip Patch Antenna with DGS for LTE Application

[1]Nagendra Chaturvedi, [2]Prof. Anshuj Jain
[1]M.Tech Scholar, Department of Electronics and Communication, Scope College of Engineering, Bhopal, India
[2]Associate Professor, Department of Electronics and Communication, Scope College of Engineering, Bhopal, India.

Abstract : Today's microstrip patch antennas are mostly preferred for electronics devices and wireless communication applications. Microstrip patch array antenna are proposed for advance wireless communication application devices by many of the researchers. In this paper, proposed design and Analysis of 4X4 microstrip Patch Antenna Array with DGS for Long Term Evolution Applications at 6GHz frequency range. CST software is used for designing and simulation. FR-4 with dielectric constant of 4.4 and thickness of 1.6 mm is used as a substrate in order to increase the bandwidth. This paper includes designing of a rectangular Microstrip patch antenna array with enhanced bandwidth, return loss and gain. Simulated result shows that a DGS concept is also useful to enhance some parameters.

IndexTerms – Microstrip, Antenna, Array, Pattern, 5G, CST, FR4, VSWR, Return loss.

I. INTRODUCTION

Speed of 5G guarantees better speeds in many conditions than the 4G organize. Qualcomm displayed a recreation at Mobile World Congress that predicts 490 Mbit/s middle velocities for 3.5 GHz 5G Enormous MIMO and 1.4 Gbit/s middle speed for 28 GHz mmWave. 5G NR speed in sub-6 GHz groups can be somewhat higher than the 4G with a comparative measure of range and antennas, however some 3GPP 5G systems will be slower than some progressed 4G systems, for example, T-Mobile's LTE/LAA arrange, which accomplishes 500+ Mbit/s in Manhattan.

The 5G particular permits LAA (Permit Helped Access) also however it has not yet been illustrated. Adding LAA to a current 4G configuration can include many megabits every second to the speed, however this is an expansion of 4G, not another piece of the 5G standard.

Low correspondence inertness Inactivity is the time it takes to pass a message from sender to beneficiary. Low correspondence dormancy is one enhancement in 5G. Lower idleness could help 5G mobile systems empower things, for example, multiplayer mobile gaming, processing plant robots, self-driving autos and different errands requesting fast reaction.

New use cases-Highlights of 5G arrange, including outrageous high transmission capacity, ultra low idleness, and high thickness associations, are relied upon to empower numerous new use cases that are difficult to be done by means of more established system measures.

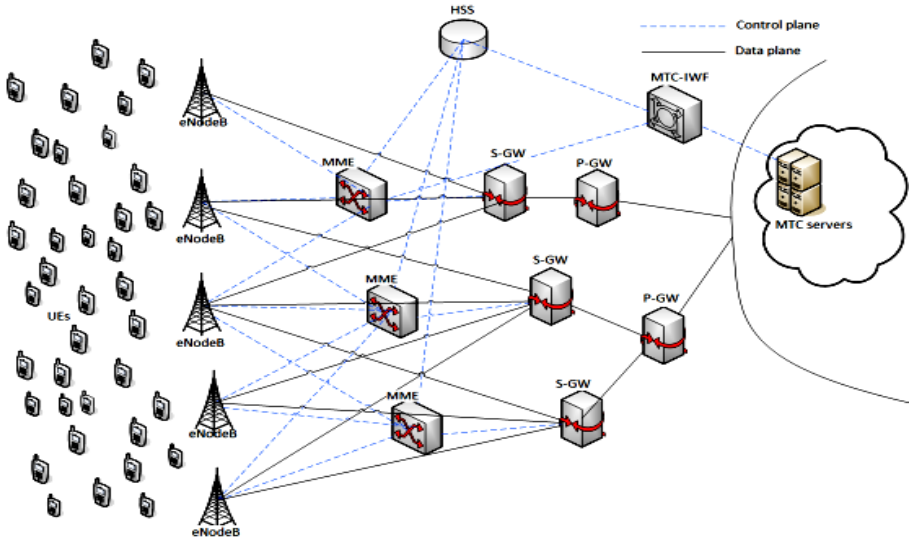

Figure 1: Antenna network LTE

Models At first, the term was characterized by the Universal Media transmission Association's IMT-2020 standard, which required a hypothetical pinnacle download limit of 20 gigabits, alongside different prerequisites for 5G systems. At that point, the industry guidelines assemble 3GPP have arranged the 5G NR (New Radio) standard together with LTE as their proposition for accommodation to the IMT-2020 standard.

II. ANTENNA IN WIRELESS COMMUNICATION

As of late, electrical-attractive dipoles composite antennas with unidirectional radiation design have highly pulled in enthusiasm because of their inspired highlights and preferences. Different plans of composite antennas have been proposed with phenomenal execution of conservative size, square with E-and H-designs, low back radiation or directional radiation designs, and so on. Such composite antennas have been utilized in different remote frameworks, for example, RFID and handsets . At first, parasitic dipole is joined with a space antenna to acquire parallel E-and H-plane examples. In any case, the natural tight transfer speed of these antennas makes them difficult to get applications in broadband correspondences. Such antennas have broadband attributes up to over 5:1, and moderately high gain. In these plans, the radiator and the feed-arrange are opposite with one another. The remote frameworks for the future 5G cell framework are progressively proposing the use of the mm-Wave range because of developing requirement for more extensive data transmissions. A portion of the hopeful groups for 5G interchanges in the frequency of 20-50 GHz are indicated. It is normal that the sending of 5G would be in the right on time of 2020s. Moving to the mm-Wave frequencies for 5G mobile terminals requires new procedures in the plan of antennas for mobile-station (MS) and base-station (BS) frameworks. So as to accomplish an effective bar steerable staged exhibit antenna, which is a standout amongst the most vital squares for 5G cell frameworks, the littler antennas orchestrated as a cluster can be utilized

Wi-Fi/WiMAX Antenna

Wi-Fi enhances the third-generation (3G) cell and long haul advancement (LTE) broadband web get to. The IEEE 802.11 a/b/g/n norms have bolster for frequency, polarization, and spatial decent variety to take care of the demand for higher throughput with more noteworthy inclusion. Wi-Fi frameworks frequency ranges from 2.4 to 2.485 GHz and in addition 5.150 - 5.350 GHz, 5.470 - 5.725 GHz, and 5.725 - 5.850 GHz. The channel transmission capacity inside each band changes from 5 to 20 MHz. A reduced Size double band WIFI antenna reproduction utilizing existing segments in cell phone can give effectiveness of 54.8% and gain is 2.0 dBi at 2.45 GHz. A circularly energized exchanged shaft antenna with example assorted variety for Wi-Fi applications covers a rakish scope of 180 degrees with 7 dB of swell and with the most extreme gain of 2.8 dB. This proposed antenna additionally can be worked for Wi-Fi framework which gives more transmission capacity around 150 MHz, directivity gain is around 6 dBi from the above writing papers. For enhancing WiMAX frequency and data transmission as of late, a few printed monopole antennas and space antennas have been proposed for Wi-Fi/WiMAX applications. Be that as it may, the majority of them have vast measurements and don't focus on impedance concealment. In this work, WiMAX and Wi-Fi both are proposed which chips away at little measurements about 3.5 × 3.6 × 1 mm3 and unique consideration is paid for obstruction concealment which makes this antenna increasingly successful from the above writing works.

III. PROPOSED ANTENNA

In figure 2, indicating top perspective of proposed Cluster microstrip patch antenna, one side of a dielectric substrate goes about as an emanating patch and opposite side of substrate goes about as ground plane. Top perspective of a rectangular patch antenna with coaxial feed has. Patch and ground plane together makes bordering fields and this field is in charge of making the radiation from the antenna.

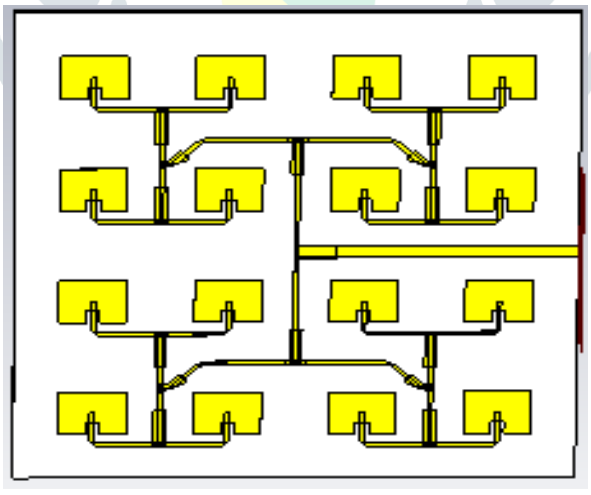

Figure 2: Top view of proposed Array microstrip antenna

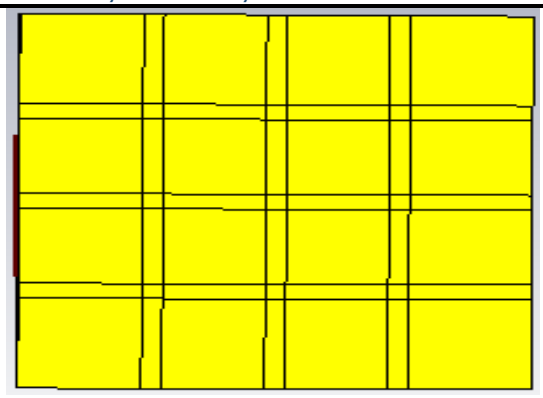

Figure 3: Finite ground structure

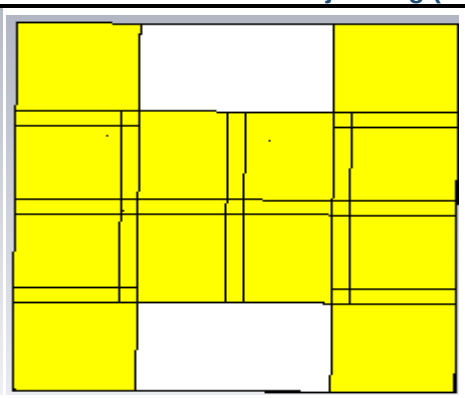

Figure 4: Defected ground structure

IV. SIMULATION AND RESULT

Proposed antenna design and simulated in CST microwave studio software.

Case-1: Finite ground structure

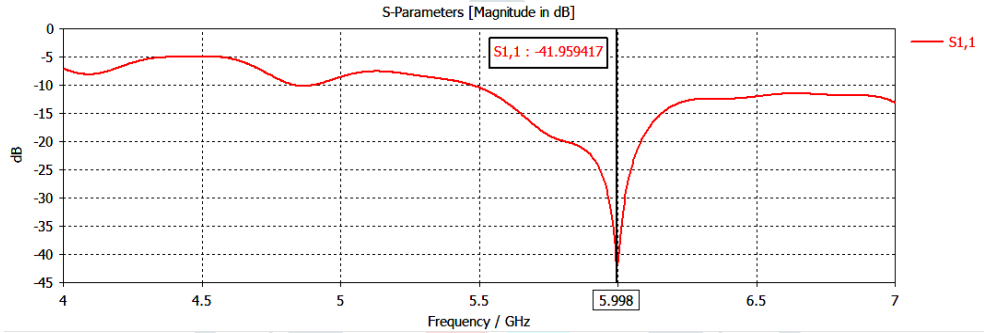

Figure 5: S parameter and Return loss

A. Bandwidth

The bandwidth of an antenna is characterized as "the scope of frequencies inside which the execution of the antenna, regarding some trademark, adjusts to a predefined standard." For broadband antennas, the bandwidth is generally communicated as the ratio of the upper-to-bring down frequencies of adequate operation.

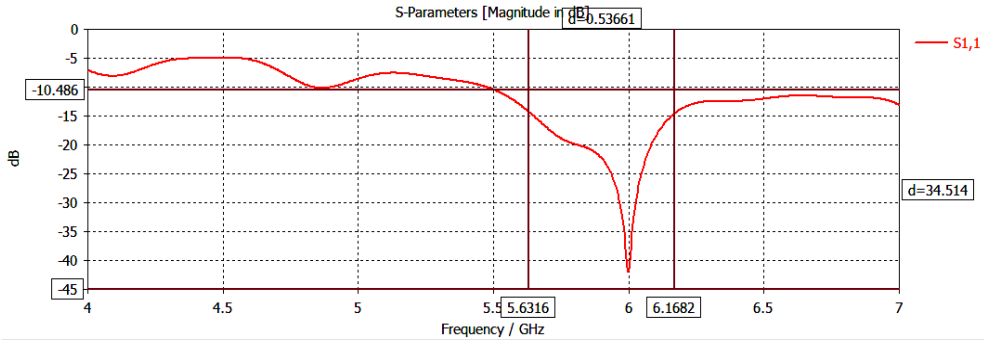

Figure 6: Bandwidth calculation

For broadband antennas, the bandwidth is communicated as a level of the frequency contrast (upper less lower) over the middle frequency of the bandwidth. The bandwidth of proposed antenna is 536 MHz, (6.1682GHz-5.6316GHz).

B. Voltage Standing Wave Ratio (VSWR)

The most well-known case for estimating and looking at VSWR is when introducing and tuning transmitting antennas. At the point when a transmitter is associated with an antenna by a feed line, the impedance of the antenna and feed line must match precisely for most extreme vitality exchange from the feed line to the antenna to be conceivable.

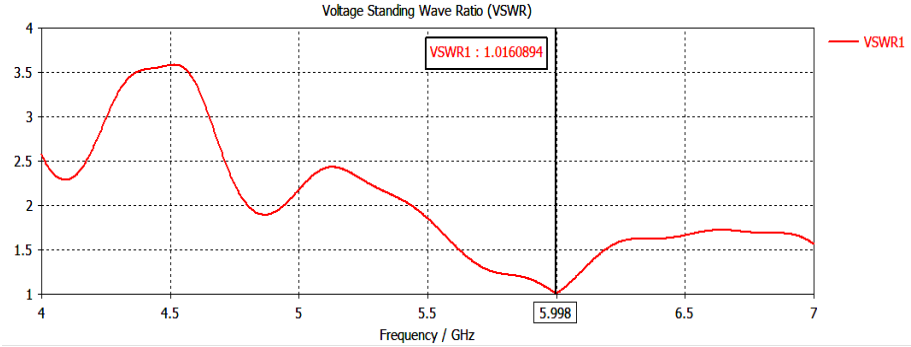

Figure 7: Voltage Standing Wave Ratios

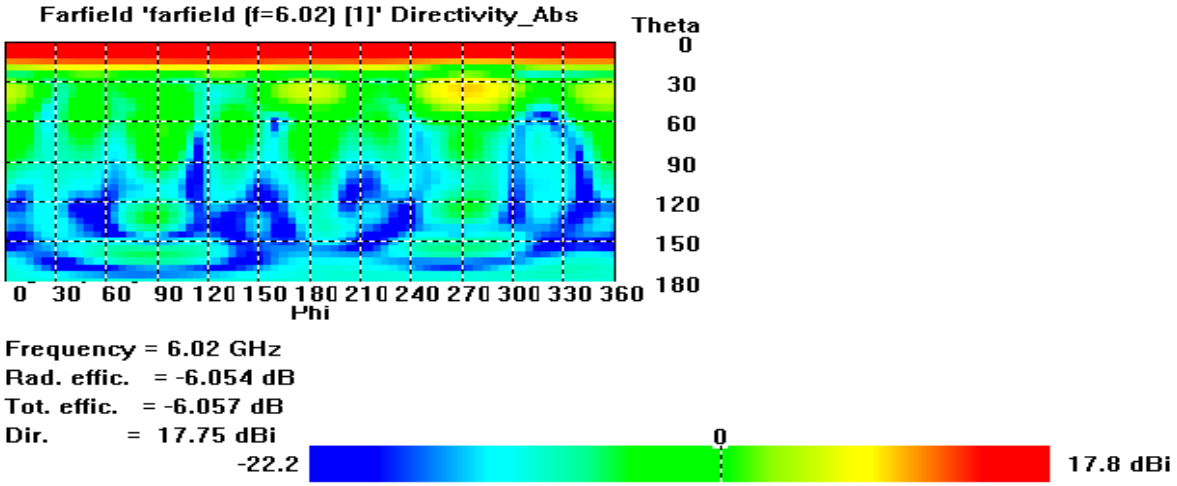

Figure 8: Far field directivity in 2 dimensional scales

Case-2: Defected ground structure

A. S11 or return loss

In figure 9, it is seen that, S11 parameter and return loss. They got estimation of S11 for 6.1229GHz is – 18.41 db and 6.598GHz is -17.39db. Here 6.1229GHz and 6.598GHz is resonant frequency, where antenna proficiency is higher.

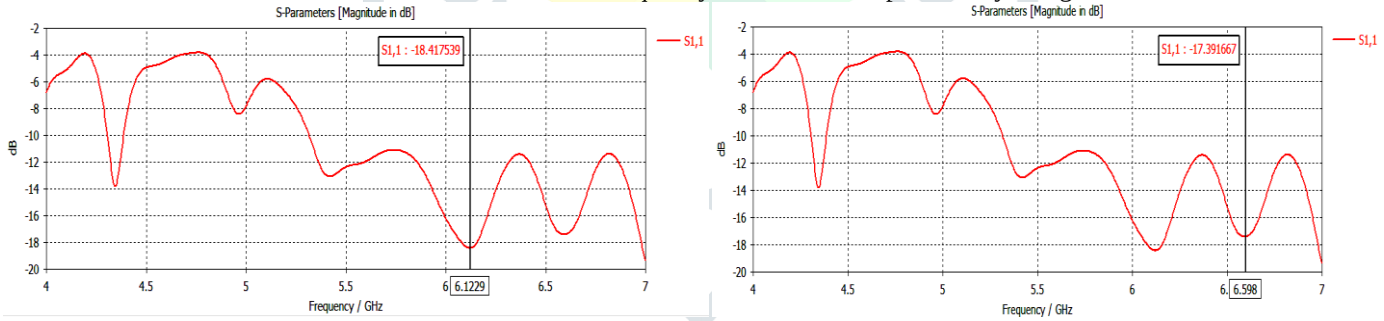

Figure 9: S parameter and Return loss

B. Bandwidth

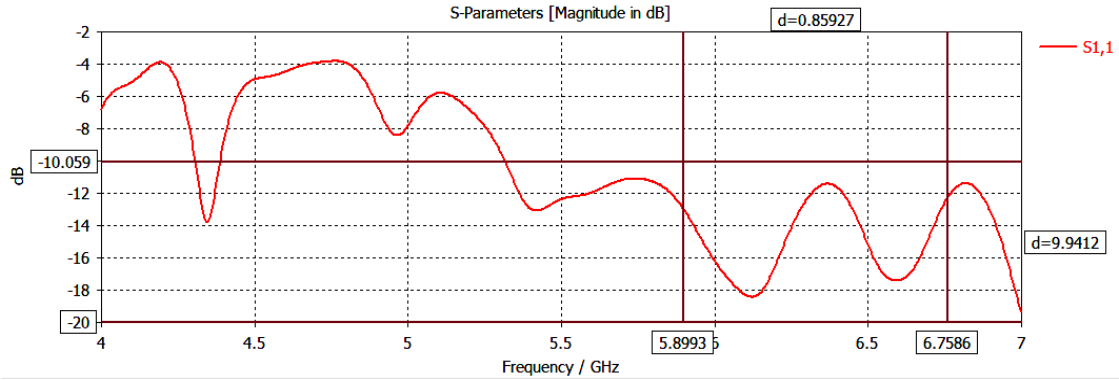

Figure 10: Bandwidth calculation

The transmission capacity of proposed antenna when DGS is 859MHz, (6.7586GHz-5.8993GHz) for all available bands.

C. VSWR

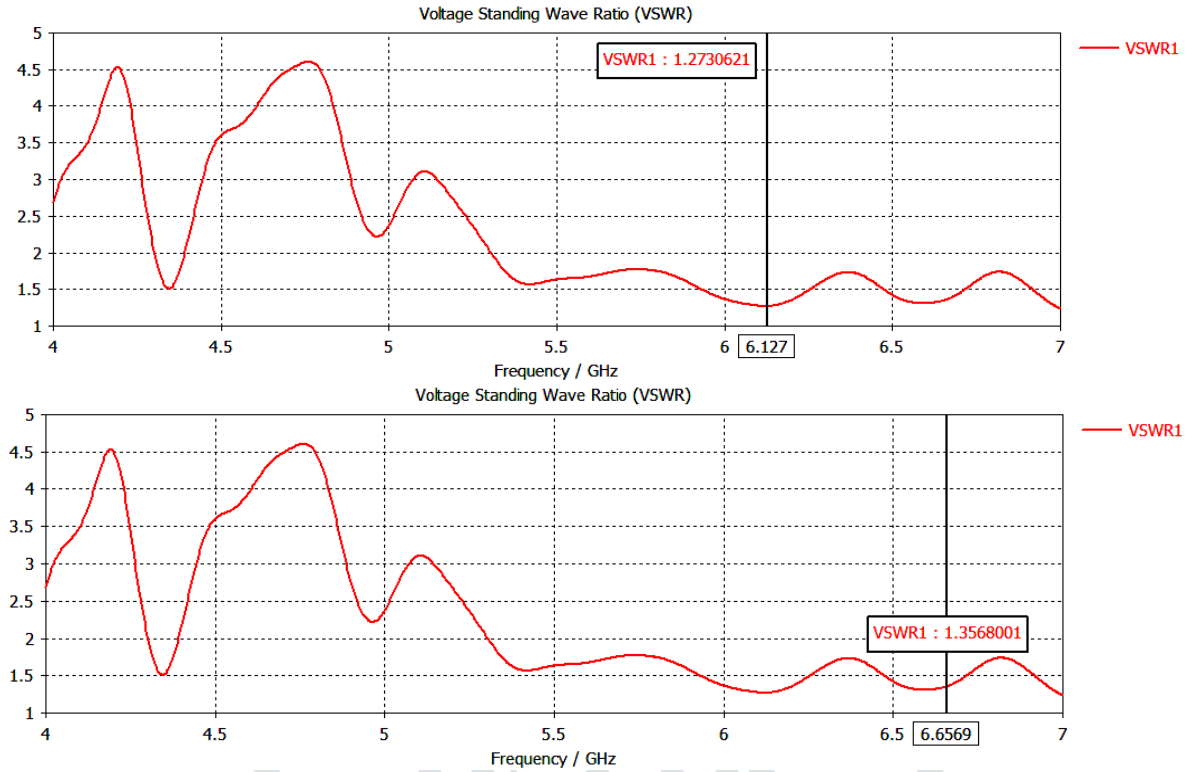

Figure 11: Voltage Standing Wave Ratios

VSWR must lie in the range of 1-2, which has been achieved for the frequencies 6.127GHz and 6.656GHz. The value for VSWR is 1.27 and 1.35 respectively.

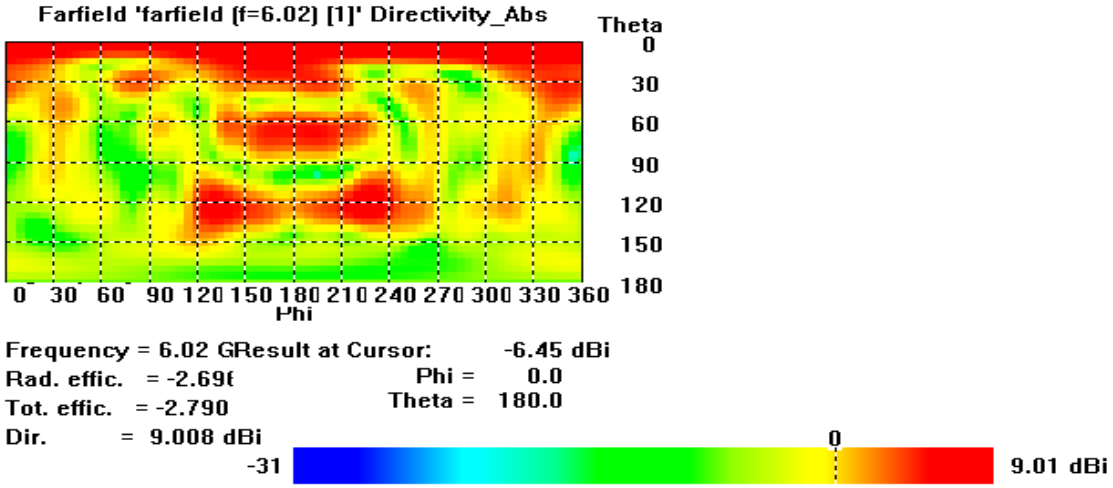

Figure 12: Far field directivity in 2 dimensional scales

Table 1: Design parameters for proposed frequency

Frequency(f_r)	4-7 GHz
Dielectric constant(ε_r)	4.4 / FR4
Metal Hegiht	0.035mm
Substrate Height(h)	1.57 mm
Line Impedance	50 Ω
Antenna Length	35mm
Antenna Width	35mm
Tangent Loss	0.06

Table 2. Comparison of proposed design result with previous design result.

Sr No.	Parameter	Previous work	Proposed work (Finite Ground)	Proposed work (Defected Ground)
1	S11 or Return loss	-24db	-41.959db	-18.417db.
2	Band Width	500MHz	536 MHz	859 MHz
3	VSWR	1.086	1.016	1.273
4	Resonant Frequency	5.5GHz	5.998GHz	6.1229GHz
5	S21 or Transmission Coefficient	-15db	-16.99db	-18.56db
6	Gain	4.2dBi	17.8 dBi	9.01dBi

V. CONCLUSION

An Array Based Microstrip patch antenna with DGS is proposed for LTE Application. There are many array combination in previous designs, most of the MIMO-Array pattern. Array based microstrip patch antenna are proposed for future wireless communication by many authors. In this paper 4X4 microstrip patch array antenna is planed and implement using CST software. Simulated results demonstrate that the frequency bandwidth covers LTE band (4-7) GHz, at resonant frequencies 5.998GHz and 6.1229GHz GHz respectively for finite and defected ground structure and VSWR under 2, and S11 not exactly - 10 dB. In above clarified working band it demonstrates great impedance coordinating and bidirectional radiation designs. Therefore, it is seen that DGS gives better bandwidth than finite structure.

REFERENCES

1. Y. Li, H. Zou, M. Wang, M. Peng and G. Yang, "Eight-element MIMO antenna array for 5G/Sub-6GHz indoor micro wireless access points," *2018 International Workshop on Antenna Technology (iWAT)*, Nanjing, 2018, pp. 1-4.
2. S. N. M. Zainarry, N. Nguyen-Trong and C. Fumeaux, "A Frequency- and Pattern-Reconfigurable Two-Element Array Antenna," in *IEEE Antennas and Wireless Propagation Letters*, vol. 17, no. 4, pp. 617-620, April 2018.
3. J. Zeng and K. Luk, "A Simple Wideband Magneto-Electric Dipole Antenna," *2018 International Symposium on Antennas and Propagation (ISAP)*, Busan, Korea (South), 2018, pp. 1-2.
4. K. D. Xu, J. Zhu, S. Liao and Q. Xue, "Wideband Patch Antenna Using Multiple Parasitic Patches and Its Array Application With Mutual Coupling Reduction," in *IEEE Access*, vol. 6, pp. 42497-42506, 2018.
5. S. Kumar M and Y. Kumar Choukiker, "Tunable wideband frequency and switching polarisation reconfiguration antenna for wireless applications," in *IET Microwaves, Antennas & Propagation*, vol. 12, no. 15, pp. 2364-2371, 19 12 2018.
6. H. T. Chattha, N. Aftab, M. Akram, N. Sheriff, Y. Huang and Q. H. Abbasi, "Frequency reconfigurable patch antenna with bias tee for wireless LAN applications," in *IET Microwaves, Antennas & Propagation*, vol. 12, no. 14, pp. 2248-2254, 28 11 2018.
7. A. T. Abed, M. S. J. Singh and M. T. Islam, "Compact fractal antenna circularly polarised radiation for Wi-Fi and WiMAX communications," in *IET Microwaves, Antennas & Propagation*, vol. 12, no. 14, pp. 2218-2224, 28 11 2018.
8. S. Gao, L. Ge, D. Zhang and W. Qin, "Low-Profile Dual-Band Stacked Microstrip Monopolar Patch Antenna for WLAN and Car-to-Car Communications," in *IEEE Access*, vol. 6, pp. 69575-69581, 2018.
9. P. Sanchez-Olivares, P. P. Sanchez-Dancausa and J. L. Masa-Campos, "Circularly conformal patch array antenna with omnidirectional or electronically switched directive beam," in *IET Microwaves, Antennas & Propagation*, vol. 11, no. 15, pp. 2253-2259, 10 12 2017.
10. Y. P. Selvam *et al*., "A Low-Profile Frequency- and Pattern-Reconfigurable Antenna," in *IEEE Antennas and Wireless Propagation Letters*, vol. 16, pp. 3047-3050, 2017.
11. C. Kumar, M. I. Pasha and D. Guha, "Defected Ground Structure Integrated Microstrip Array Antenna for Improved Radiation Properties," in *IEEE Antennas and Wireless Propagation Letters*, vol. 16, pp. 310-312, 2017.
12. D. Guha, and C. Kumar"Asymmetric Geometry of Defected Ground Structure for Rectangular Microstrip: A New Approach to Reduce its Cross-Polarized Fields," in *IEEE Transactions on Antennas and Propagation*, vol. 64, no. 6, pp. 2503-2506, June 2016.
13. C. Kumar, M. I. Pasha and D. Guha, "Microstrip Patch With Nonproximal Symmetric Defected Ground Structure (DGS) for Improved Cross-Polarization Properties over Principal Radiation Planes," in *IEEE Antennas and Wireless Propagation Letters*, vol. 14, pp. 1412-1414, 2015.
14. K. A. R. G. C. Mouli, M. S. Anuradha, D. Kuppili and D. Gopi, "Analysis of rectangular and triangular microstrip antenna arrays using HFSS," *2015 13th International Conference on Electromagnetic Interference and Compatibility (INCEMIC)*, Visakhapatnam, 2015, pp. 25-31.