DOUBLE RIDGE HORN ANTENNA DESIGN FOR MICROWAVE X-BAND APPLICATIONS

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Abstract- **The double ridge horn antenna is a versatile and efficient antenna that is well suitable for a wide range of microwave applications due to its high performance and reliability. The microwave applications are satellite communication, radar systems and microwave imaging. The antenna consists of a flared horn with two ridges along the inner walls, which creates a more complex electromagnetic field and enhances the radiation pattern. In this Design FR-4 Epoxy Substrate is used because of Good Electrical Properties such as low dielectric constant and low loss tangent. The Ansys HFSS software tool is used to design the double ridge horn antenna in the frequency range 4-8GHz and 8-12GHz to analyse the performance of the antenna comparisons are made with the different set of frequency range.**

I. INTRODUCTION:

DOUBLE RIDGE HORN ANTENNA:

In anechoic chambers, the Double Ridge Horn Antenna is most frequently used to evaluate an antenna from the S Band to the Ku Band. because of its consistent performance over a large frequency range. The ridge structure is added to the waveguide segment and the horn antenna, giving the waveguide the characteristics of a ridge waveguide. A coaxial feed joint, a waveguide portion, a horn section, and double ridge make up the double ridge horn antenna's structure. DRHA's design has been improved by adjusting the ridges to lessen edge diffraction. Higher operating frequency is where the DRHA is applied by Trendley in telecommunications, radar, and other sensing applications. The DRHA is primarily employed in weather sensing for critical military applications.

EXISTING METHOD

The electromagnetic waves are generally transmitted and received over the antennas. The Double Ridge Horn Antenna have several advantages and reliable performance in a wideband frequency range. The Double Ridge Horn Antenna consists of a waveguide feed, horn shaped antenna and ridges. The E-plane section is divided into two parts namely Feed part and the Horn part. The feed path contains the transition of coaxial waveguide, which consists of a coaxial line with impedance. The horn section consists of a rectangular waveguide with a gradually opened cross section and two exponentially tapering ridges.

Ridge waveguide is formed by introducing the ridge structure into the normal waveguide based on the initial antenna structure. A wedge-shaped structure is introduced into the feed structure, The H-plane sidewall is replaced with a metal grid. The structure of final antenna with radiation characteristics and good matching is obtained. After redesigning the transition between the coaxial and waveguide, there is no splitting or deterioration in the axis pattern in the entire frequency band (18-54 GHZ) AND THE Voltage Standing Wave Ratio (VSWR). A Double Ridge Horn Antenna is designed and the various parameters are measured. The advantages of this DRHA is it have minimal mechanical errors and widely used in millimetre wave applications

PROPOSED SOLUTION

The Double Ridge Horn Antenna is used in radar systems, telecommunication networks. The splitting of radiation is completely solved and

it provides an effective and feasible feature in the microwave frequency band. In lower frequency ranges, the radiation pattern of the both E and H planes were seen to be distorted, the radiation pattern distortion will be solved and the radiation is observed. The performance of this antenna in the range of half bandwidth is also measured for the better performance of the antenna. Then the physical parameters of the antenna such as VSWR, Gain, Radiation pattern and performance were measured. The physical geometry is used in the design, the physical size of the structures and the material qualities from which they produced are all the factors that limit the double ridge horn antenna performance. The double ridge design is used in this research for its bigger size, wider bandwidth than other antenna types. The essential parameters are calculated optimizing in a way that ensures low power consumption.

II. DOUBLE RIDGE HORN ANTENNA DESIGN:

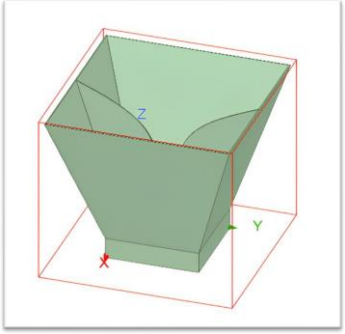


FIG 2.1 3D VIEW

In Fig 2.1 The 3D view of the double-ridged horn antenna shows the ridges, electromagnetic field distribution around the antenna.

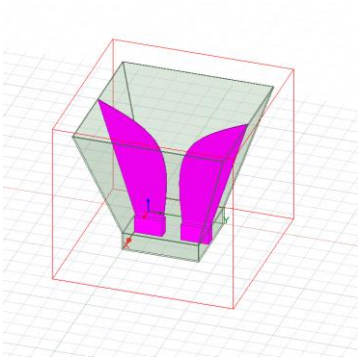


FIG 2.2 RIDGE INSIDE THE ANTENNA

In Fig 2 . 2 Shows the Ridges in the double ridge horn antenna create two parallelwaveguides within the horn.

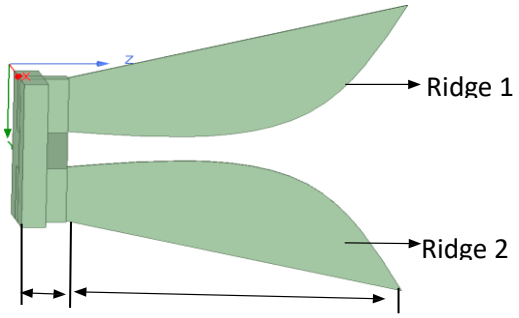


FIG 2.3 CROSS SECTION OF DRHA

In Fig 2.3 Shows The cross-section of a double ridge horn antenna refers to the viewof the antenna if it were cut perpendicular to its axis, revealing the internal structure of the antenna.

III.RESULTS:

FREQUENCY RANGE OF 4-8GHz:

FIG 2.1.1 S PARAMETER

This Figure 2.1.1 shows that the S Parameter value of DRHA is -34.41 in the frequency range of 4-8GHz.

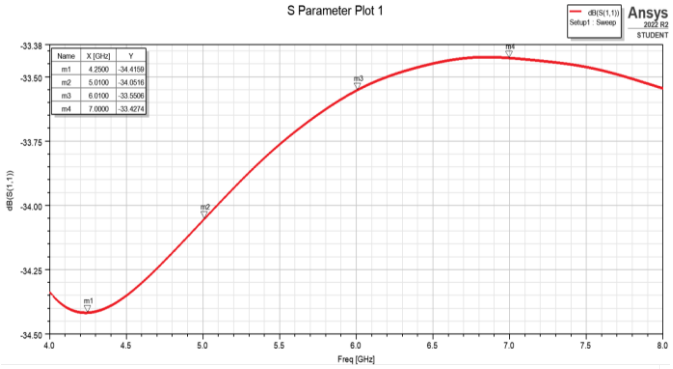
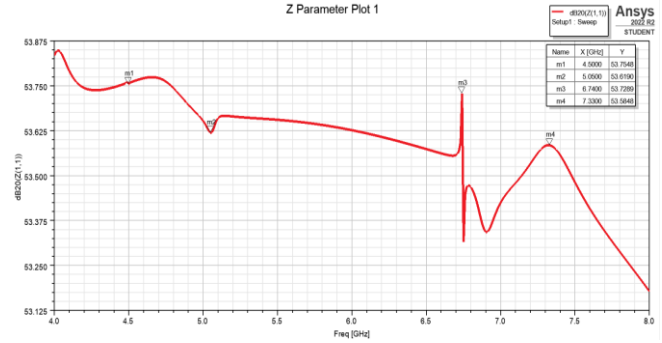


FIG 2.1.2 Z PARAMETER

This Figure 2.1.2 shows that the Z Parameter value of DRHA is 53.75 in the frequency range of 4-8GHz.



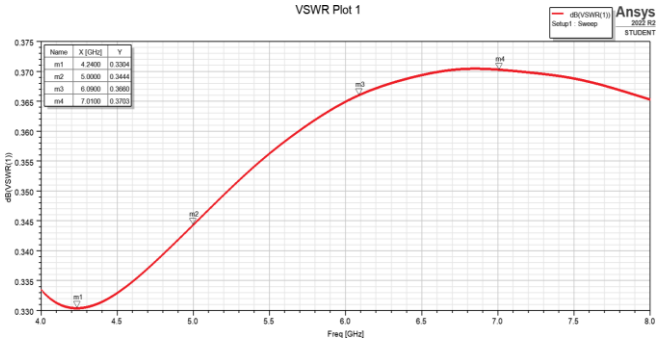


FIG 2.1.3 VSWR

This Figure 5.1.3shows that the VSWR value of Double Ridge Horn Antenna is 0.33 inthe frequency range of 4-8GHz.

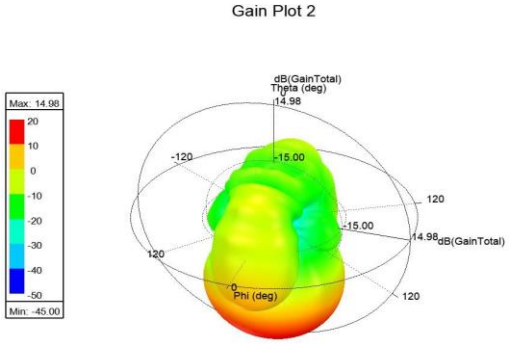


FIG 2.1.4 GAIN

This Figure 2.1.4 shows that the gain value of Double Ridge Horn Antenna is 14 in the frequency range of 4-8GHz.

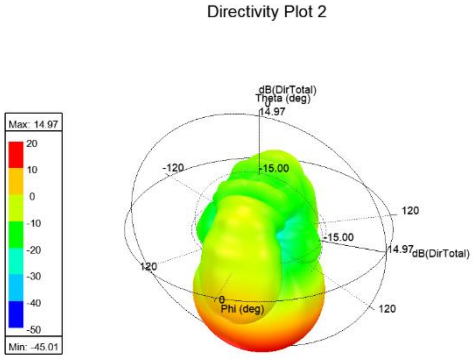


FIG 2.1.5 DIRECTIVITY

This Figure 2.1.5shows that the directivity of Double Ridge Horn Antenna in the frequency range of 4-8GHz.

FREQUENCY RANGE OF 8-12GHz:

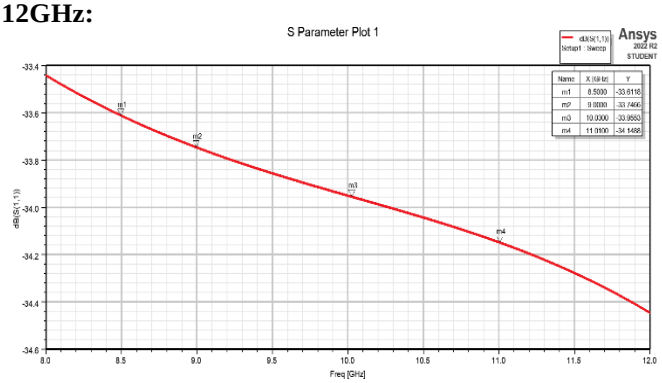


FIG 2.2.1 S PARAMETER

This Figure 2.2.1 shows that the S Parameter value of DRHAis -33.61 in the frequency range of 8-12GHz.

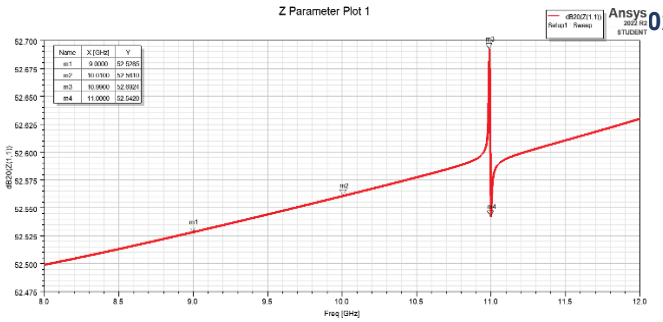


FIG 2.2.2 Z PARAMETER

This Figure 2.2.2 shows that the Z Parameter value of Double Ridge Horn Antenna is 52.52 in the frequency range of 8-12GHz.

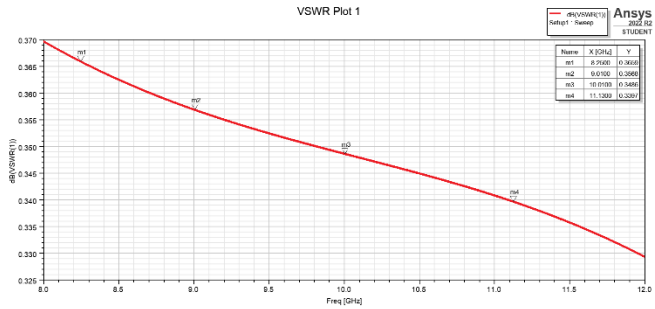


FIG 2.2.3 VSWR

This Figure 2.2.3shows that the VSWR value of Double Ridge Horn Antenna is 0.36 inthe frequency range of 8-12GHz.

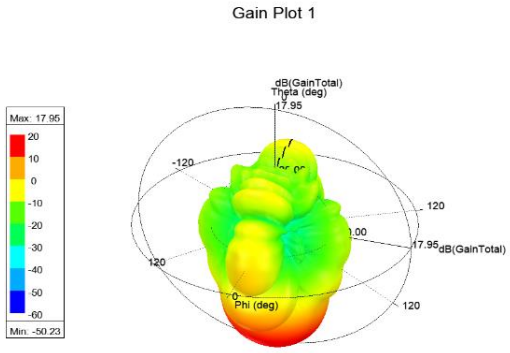


FIG 2.2.4 GAIN

This Figure 2.2.4 shows that the gain value of Double Ridge Horn Antenna is 17.95 in the frequency range of 8-12GHz.

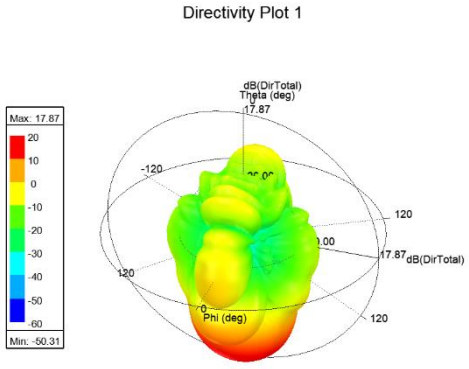


FIG 2.2.5 DIRECTIVITY

This Figure 2.2.5shows that the directivity of Double Ridge Horn Antenna in the frequency range of 4-8GHz.

IV. DRHA PARAMETER TABLE

QUANTITY	VALUE (4-8 GHz)	VALUE (8-12 GHz)
Max U	2.506474 W/sr	4.962837 W/sr

Peak Directivity	31.399760	61.260579
Peak Gain	31.510402	62.395115
Peak Realized Gain	31.498024	62.366322
Peak System Gain	31.498024	62.366322
Radiated Power	1.003129 W	1.018050 W
Accepted Power	999.607173 mW	999.538536 mW
Incident Power	1.000000 W	1.000000 W
System Power	1.000000 W	1.000000 W
Radiation Efficiency	1.003524	1.018520
Total Efficiency	1.003129	1.018520
System Efficiency	1.003129	1.018520
Front to Back Ratio	1113.643115	2198.758647

V. CONCLUSION:

In this study, FR-epoxy substate was used to develop a double ridge horn antenna, and characteristics parameters were examined in the 4-8GHz and 8-12GHz frequency ranges. The antenna is utilised in microwave applications like radar systems and satellite communication. The supplied frequency is raised to 8–12GHz in order to boost gain and decrease VSWR. The obtained gain value for 8 to 12 GHz is 17.95 dB, while the VSWR value is less than 1. The radiation efficiency in this design is 5. The antenna is really tiny. As a result, it does not require additional space and can quickly be converted to work with microwave applications. Gain, VSWR, and directivity measurements yielded values of 17.95dB, less than 1, and 17.87, respectively.

REFERENCES:

[1]V.Logeswari,P.Kokila,T.G.Dharani,V.Parameswari,Punitha.S ‘‘Design and Geometrical Analysis of Various Antennas for RF Application” vol.6,no.3,Dec.2021.
[2] J. Kerr, ‘‘Short axial length broad-band horns,’’IEEE Trans. Antennas Propag., vol.AP-21, no. 5, pp. 710–714, Sep. 1973.
[3] C. Bruns, P. Leuchtmann, and R. Vahldieck, ‘‘Full wave analysis and experimental verification of a broadband ridged horn antenna system with parabolicreflector,’’ in Proc. IEEE Antennas Propag. Soc. Int. Symp. Held Conjunct, Jul. 2001, pp. 230–233.
[4] C. Bruns, P. Leuchtmann, and R. Vahldieck, ‘‘Comprehensive analysis and simulation of a 1-18 GHz broadband parabolic reflector horn antenna system,’’ IEEE Trans. Antennas Propag., vol. 51, no. 6, pp. 1418–1422, Jun. 2003.
[5] C. Bruns, P. Leuchtmann, and R. Vahldieck, ‘‘Analysis and simulation of a 1-18-GHz broadband double-ridged horn antenna,’’ IEEE Trans. Electro-magn. Compat., vol. 45, no. 1, pp. 55–60, Feb. 2003.
[6] M. Abbas-Azimi, F. Arazm, and R. Faraji-Dana, ‘‘Design and optimisation ofa high-frequency EMC wideband horn antenna,’’ IET Microw., Antennas Propag.,vol. 1, no. 3, pp. 580–585, Jun. 2007.
[7] B. Jacobs, J. W. Odendaal, and J. Joubert, ‘‘An improved design for a 1–18 GHzdouble-ridged guide horn antenna,’’ IEEE Trans. Antennas Propag., vol. 60, no. 9,pp. 4110–4118, Sep. 2012.
[8] C. Wang, E. Li, Y. Zhang, and G. Guo, ‘‘Ridged horn antenna with adjustablemetallic grid sidewalls and cross-shaped back cavity,’’ IEEE Antennas Wireless Propag. Lett., vol. 15, pp. 1221–1225, 2016.
[9] S. Buzzi and C. D’Andrea, ‘‘Massive MIMO 5G cellular networks: Mm-wavevs.µ-wave frequencies,’’ ZTE Commun., vol. 2017, no. 6, pp. 41–49, 2017.
[10] B. Panzner, A. Jöstingmeier, and A. Omar, ‘‘A tiny double-ridged horn antenna for subsurface radar applications,’’ in Proc. IEEE Eur. Conf.Antennas Propag., Apr. 2013, pp. 1322–1325.
[11] K. V. Hoel, M. Ignatenko, S. Kristoffersen, E. Lier, and D. S. Filipovic,‘‘3-Dprinted monolithic GRIN dielectric-loaded double-ridged horn antennas,’’ IEEE Trans. Antennas Propag., vol. 68, no. 1, pp. 533–539, Jan. 2020.
[12] H. W. Tian, W. Jiang, X. Li, Z. P. Chen, and T. J. Cui, ‘‘An ultrawideband andhigh-gain antenna based on 3-D impedance-matching metamaterial lens,’’ IEEE Trans. Antennas Propag., vol. 69, no. 6, pp. 3084–3093,Jun. 2021.
[13] S. Sarjoghian, Y. Alfadhl, X. Chen, and C. G. Parini, ‘‘A 3-D-printed high- dielectric materials-filled pyramidal double- ridged horn antenna for abdominal fatmeasurement system,’’ IEEE Trans. Antennas Propag., vol. 69, no. 1, pp. 64–73, Jan. 2021.
[14] B. Jacobs, J. W. Odendaal, and J. Joubert, ‘‘Modelling manufacturing tol- erances in 1–18 GHz double-ridged horn antennas,’’ in Proc. Eur. Microw.Conf. (EuMC), Oct. 2009, pp. 1484–1487
[15] C. Bruns, P. Leuchtmann and R. Vahldieck, "Full wave analysis and experimental verification of a broad band ridged horn antenna system with parabolic reflector", Proc. IEEE Antennas and Propagation Soc. Int. Symp., vol. 4,2001
[16] M. Abbas-Azimi, F. Arazm and J. Rashed-Mohassel, "Sensitivity analysis ofa 1 to 18 GHz broadband DRGH antenna", Proc.

IEEE Antennas and PropagationSociety Int. Symp., pp. 3129-3132, 2006.
[17] M. Botello-Perez, H. Jardon-Aguilar, and I. G. Ruiz, "Design and simulation of a 1 to 14 GHz broadband electromagnetic compatibility DRGH antenna", Proc.2nd Int. Conf. Electrical and Electronics Engineering, *pp*. 118-121, 2005.
[18] H. Xu, Y. Zhou, E. Li, H. Liu, Q. Wang and Z. Zong, "Design and simulationof ultra-wideband double-ridged horn antenna", Proc. Int. Conf. Microw.Millimeter Wave Tech., pp. 950-952, May 2010.
[19] F. F. Dubrovka and A. J. Sushko, "Improvement of characteristics of UWB double ridged horn antennas", Proc. 5th Int. Conf. Ultrawideband Ultrashort Impulse Signals, pp. 45-47, Sep. 2010.
[20] Y. Zhou, E. Li, G.-F. Guo, T. Yang and L.-S. Liu, "Design of millimeter wavewideband transition from double-ridge waveguide to coaxial line", J. Infrared Millimeter THz Waves, vol. 32, no. 1, pp. 26-33, Jan. 2011