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To cite this article: Hetal M Pathak and Shweta N Shah 2021 *J. Phys.: Conf. Ser.* **1921** 012011

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Volumetric Analysis of GTEM Cell for Wide Frequency Application

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Abstract. In modern communication era, there are many electronic equipment all around us. The Electromagnetic Interference of other surround electronic equipment will enhance the level of noise to degrade the performance of System. In real life, this is necessary to test any equipment before it came to market. For Industrial as well as small scale for Domestic activity GTEM cell is designed for larger and smaller size of volume. Smaller volume GTEM is designed for 1-9.5 GHz while larger volume GTEM is designed for 9.5 to 18GHz frequency. As per the requirement of an EUT dimensions the cost effective and compact GTEM cell are Simulated and Analyzed.

1. Introduction

In today's public life majority of electronic architectures and applications are used as a heartbeat. We all are well aware with major Portable Electronic Devices (PED), wireless and communication devices smart automobile sensing system, smart mobile systems, defense robots etc. all around us. Tremendous development in electronics products leads to increase electronics pollution due to field interference problem. The extensive usage of these intentional and unintentional sources which degrades the performance of the system.

The continued development of our advanced information society results in highly techno driven world. There for it is necessary to conduct research and development of all RF emitting electronic and communications equipment to use safely in our daily life. But with the exponential growth of newer devices EMI/EMC is also important to be cross verify for high frequencies communication [1]. However, with the development of newer devices EMI/EMC is also important to be cross verify for high frequencies. This has motivated to design GTEM cell for convenient and cost-effective dimensions.

The GTEM cell was developed from the TEM cell and is essentially a tapered coaxial waveguide, which provides uniformity of EM fields in a shielded environment. The concept behind the GTEM cell design was to eliminate the restriction on upper frequency limit of the TEM cell. The GTEM cell can be operated at frequencies from DC to several GHz and the main volume of a GTEM cell consists of only one section of a pyramidal transmission line. It has an inner conductor or septum and outer conductor have the same length, the travel time along each conductor is equal [3].



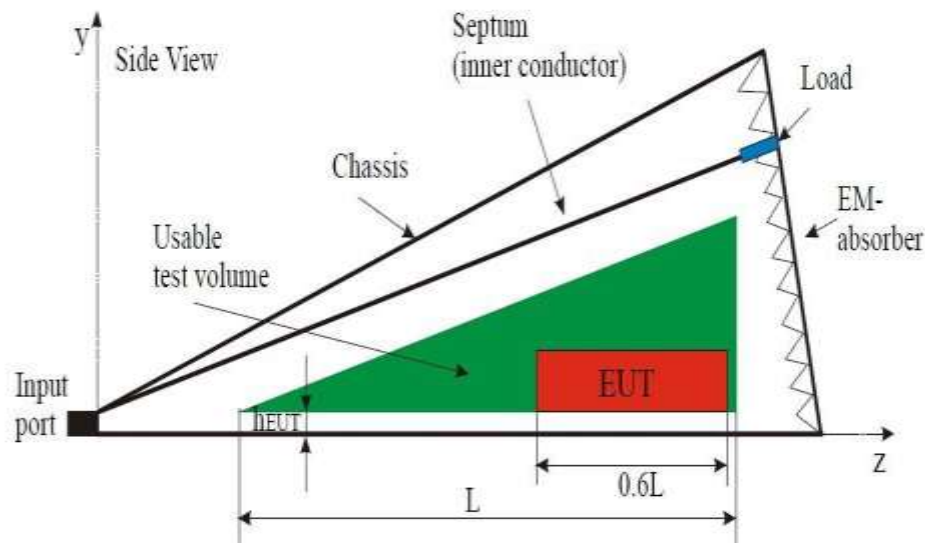


Figure 1. GTEM Cell: Basic Configuration with Matching Network and Terminating Impedance [6]

In this current Modern Electronics era Transverse Electromagnetic (TEM) cell are mostly available with their expanded version for High frequency known as Gigahertz TEM. They are developed to produce line to field and Field to line coupling to create balance Transmission Line Structure [2]. The GTEM cell is a pyramidal quadratic transmission line with a characteristic impedance of $50\ \Omega$ and is tapered with the coaxial connectors on a precise apex, as shown in Figure 1.

In GTEM cell an EM wave travels from the source to the $50\ \Omega$ quadratic shielded transmission line and to the hybrid termination without reflection or field distortion of the TEM wave. The major concern for GTEM is Electromagnetic compatibility (EMC) problems. They lead to think the design and development of GTEM for emission and Immunity measurement for low and Frequency RF emitters. The real concern is the size of GTEM required to be Optimized [2].

2. Experimental design, material and methods

The Objectives of GTEM cell design are listed as follows:

- (1) To maximize the cross-sectional testing areas for EUT
- (2) Operate at Maximize Usable Frequency
- (3) Reduce Impedance mismatch of the cell or Voltage Standing Wave Ratio (VSWR) by connecting load resistances in parallel
- (4) Enhance the uniform electromagnetic fields or eliminate the EM field distortion by using RF absorbers connected at output terminal

The dimensions of an asymmetric transmission line: GTEM are calculated from the coaxial transmission line equations. A coaxial transmission line Capacitance and Inductance are also depend on the parameters a and b [7] Where a is the inner conduct radius and b is the outer conduct radius b per unit length.

$$C = \frac{2\pi\epsilon_0}{\ln\frac{b}{a}} \text{ F/m} \quad (1)$$

$$L = \frac{\epsilon_0}{2\pi} \ln \frac{b}{a} \text{ H/m} \quad (2)$$

Characteristic Impedance Given By

$$Z_0 = \sqrt{\frac{L}{C}} \quad (3)$$

By using the above formula GTEM cell dimensions are calculated. From the Dimension GTEM cell is design for both bigger and smaller volume. Designed GTEM is simulated using ANSYS HFSS software.

Larger size GTEM is designed for 2950*1480*1610mm volume. It is designed using ANSYS HFSS software as shown in figure 2. The S_{11} for Larger GTEM cell simulation was shown in figure 3.

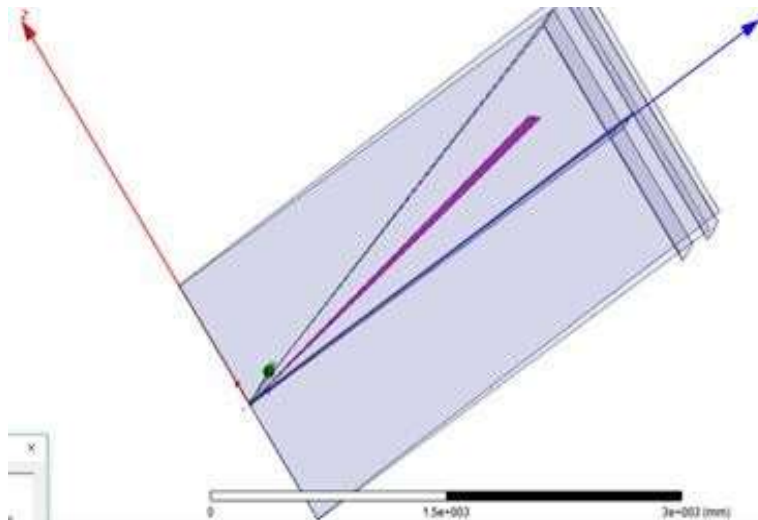


Figure 2. Larger volume GTEM (9.5Ghz-18GHz) cell

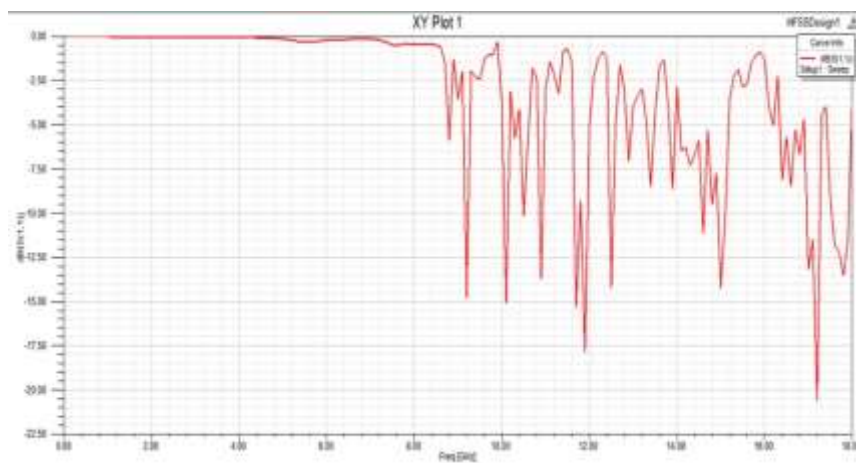


Figure 3. S_{11} for Larger GTEM cell

Modern ICs which engage in extraordinary complexity and clock frequency pose vast challenges for product design engineers in developing electronic appliances to comply with product EMC test [5].

Smaller size GTEM is designed for 510*260*180mm volume. It is designed using ANSYS HFSS software as shown in figure 4.

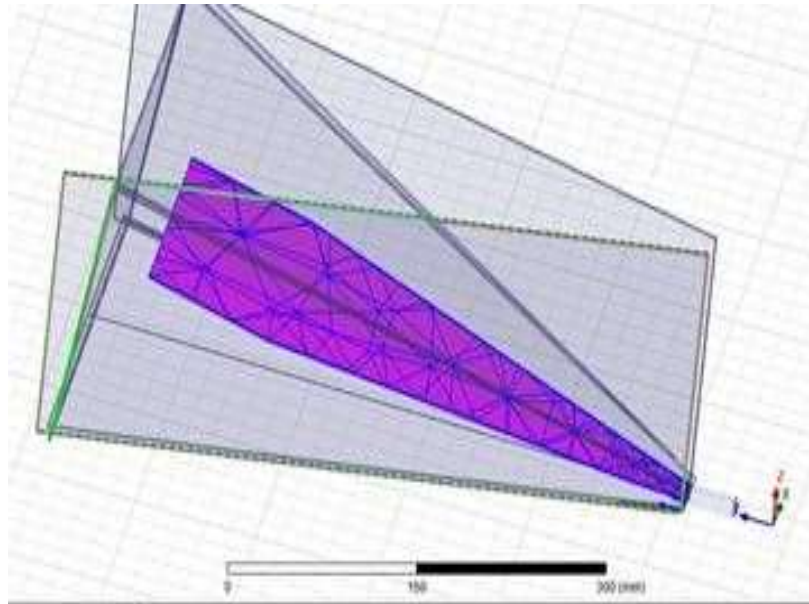


Figure 4. Smaller GTEM designed in HFSS

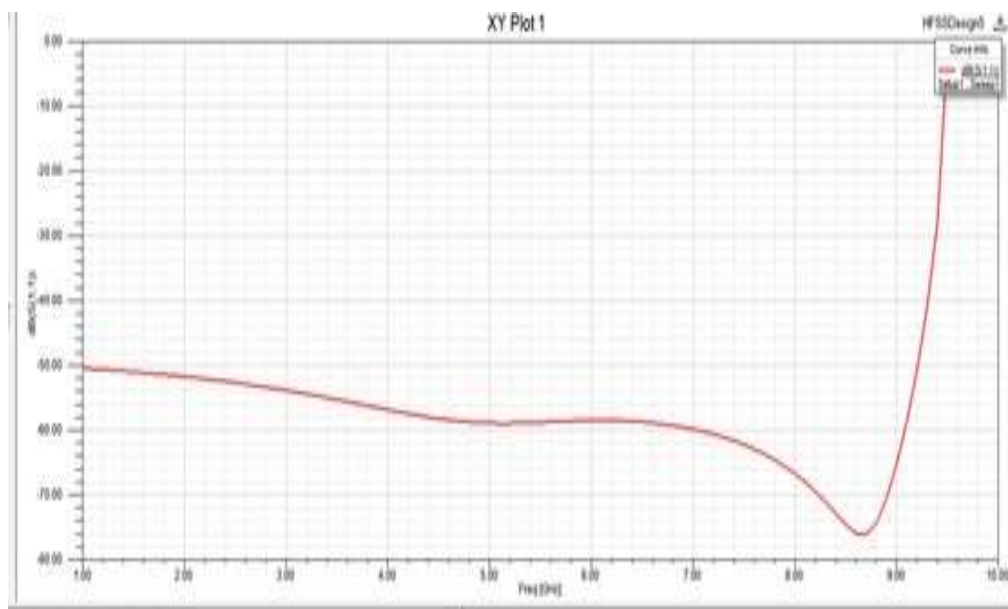


Figure 5. S_{11} GTEM (1-9.5GHz) with al septum- Mica at 11 degree 1.5mm thickness at termination

From the above analysis, Larger GTEM cell is used for 9.5GHz to 18GHz frequency, while smaller GTEM is designed for 1GHz to 9.5GHz frequency range as shown in figure 5.

3. CONCLUSION

The Smaller Size GTEM shows more compatible results for 1-9.5 GHz while Larger Size GTEM shows extended frequency outcome up to 18GHz. As per the requirement of frequency for EUT the GTEM should be Chosen and provide better Immunity and emission results with cost effectiveness.

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