# Design and Development of Triple Mode Waveguide Horn Antenna Using 3D Printing Technology

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Three dimensional (3D) printing technology based antenna structures have many promising areas for potential applications such as the feed sources for satellite payloads and ground terminals. The 3D printed technology has emerged as a technology of interests for low-cost manufacturing and light weight electronic devices. This method is an additive technology in which objects are built up in many very thin layers.

In this work, we demonstrate a light weight 3D printed triple mode circular waveguide horn antenna with corrugated chokes and its simulation and measured results. The antenna was originally designed using aluminum which serves as a reference antenna for the comparison purposes in addition to the full wave analysis (Ansys HFSS Version 15.0) results. The aluminum based horn antenna's simulation results were earlier reported in [*S. K. Sharma, S. Rao and L. Shafai, "Handbook on Reflector Antennas and Feed Systems, Volume I: Theory and Design of Reflectors", Chapter 4,* and *L. Shafai, S. K. Sharma and S. Rao, "Handbook on Reflector Antennas and Feed Systems, Volume II: Feed Systems", Chapter 8, both published by Artech House, USA, June, 2013*]. The three excited modes are: $TE_{11}$, $TM_{01}$ and $TE_{21}$, respectively.

The antenna is manufactured by a unique combination of 3D printing process of plastic material (Polycarbonate and acrylonitrile butadiene styrene (PC-ABS)) and silver conductive ink from Novacentrix which covers 6 – 8 μm layer thickness per coating. The 3D printed system "Fortus 400mc printer" is available in the Mechanical Engineering at the San Diego State University which was used to fabricate the horn structure. The parts are produced with an accuracy of ±0.005 inch. This printing method covers applications from the prototype to mass production. ABS based horn antenna's simulated results show that this antenna can achieve a common bandwidth 7.45GHz – 8.00 GHz for all the three modes which is approximately the same for the aluminum based design.

The measurement of this 3D printed antenna shows matching ($S_{11}$ = -10dB) bandwidths of 7.2GHz – 7.8GHz for the $TE_{11}$ mode, and 7.16GHz – 7.8GHz for the $TM_{01}$ mode. The $TE_{21}$ mode is showing much wider matching bandwidth but we suspect that this is because of lossy nature (thin layer of silver ink and its conductivity) and therefore, it is currently being recoated with another sliver ink layer. Next, we plan to measure the radiation performance parameters. All these results will be presented during the conference.