Metal Fused Filament Fabrication of corrugated horns for mmWave applications

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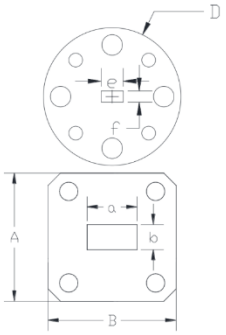
Additive manufacturing has emerged as a transformative force, offering novel possibilities for crafting intricate structures. This technology, applied to both polymers and metallic materials, introduces a paradigm shift in design flexibility. This section delves into the dichotomy of additive manufacturing, distinguishing between polymer-based [1] and metallic material-based approaches [2]. Within this landscape, this paper focuses on the potential of Fused Filament Fabrication (FFF), an additive manufacturing technique, emphasizing its suitability for constructing intricate systems as corrugated Horns Fig. 1.

Fig. 1: Conical Horns build base and corrugated using FFF

As with any technology, additive manufacturing using FFF presents its own set of challenges. Issues such as warping, the use of supports during printing, high surface roughness, and potential size discrepancies are examined. Addressing these challenges requires careful considerations, such as utilizing raft to ensure a smooth surface in critical areas like waveguide alignment and optimizing resolution to minimize roughness. Additionally, meticulous attention must be paid to the sizing of structures, considering the inherent size reduction during post-processing, a characteristic dependent on the manufacturer. The final sizes after fabrication are shown in Fig. 2.



	$\Delta x(\mu m)$
a	30
b	30
A	600
B	600
D	40
e	50
f	100

Fig. 2: FFF manufacturing errors in key dimensions

The designs discussed are grounded in [3], incorporating modifications to align with FFF manufacturing prerequisites. Specific attention is given to the Ka-band and M-band antennas. These bands are strategically chosen due to their significance in the context of Frequency Range 2 (FR2) as defined by the 3rd Generation Partnership Project (3GPP). Moreover, this selection facilitates the evaluation of FFF's performance across diverse frequency ranges. These antennas are based on two fundamental elements: the base, the main structure, and the corrugated elements. This design philosophy promotes adaptability and reusability, allowing the integration of multiple corrugations into a single base structure. These solutions are suitable for the design of complex GPHA patterns [4] or mixed designs such as [5]. The simulation results are shown in the band of interest, looking at the S11 Fig. 3 and the cross-polarization Fig. 4 in the main planes. Actual results are pending measurement.

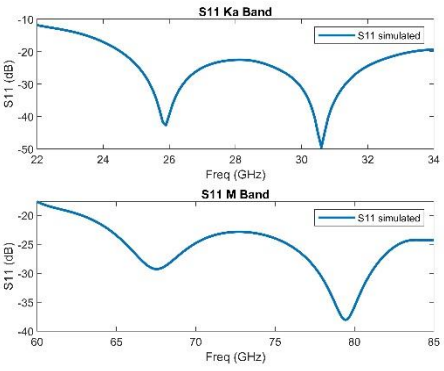


Fig. 3: Horn antenna parameter S11 for Ka and M bands

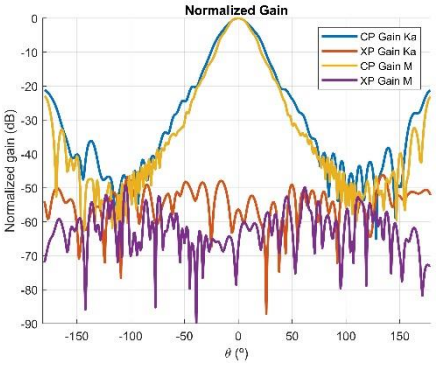


Fig. 4: Co-polar and Cross-polar gain of the devices in the Ka- and M- bands

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