Fabrication and Characterization of 3D-Printed Ku-band Frequency Scanning Slotted Waveguide Antenna Array

Kunchen Zhao, Grant Senger, and Nima Ghalichechian
ElectroScience Laboratory, Department of Electrical and Computer Engineering
The Ohio State University, Columbus, OH 43212, USA

Additive manufacturing (AM) is an attractive tool for RF device fabrication due to its rapid-prototyping capabilities and relatively low cost. Recently, researchers have shown the feasibility of 3D-printed resonant slotted waveguide array (SWA) G. P. Le Sage, IEEE Access, 4, 1258-1265, 2016). However, 3D printed non-resonant SWA arrays remain underdeveloped. The main challenges lie in the absence of a wide band feed network for the waveguide structure, termination, and fabrication limitations including conformal deposition of conductive film.

In this work, we present the design, fabrication, and measurement results of a Ku-band, 3D-printed, frequency scanning SWA antenna with an accommodating wide band power divider as the feed network. A single waveguide with 18 radiating slots is initially designed and optimized to provide a symmetric beam scan angle. Next, four of the aforementioned waveguides are configured in parallel to form the 18 × 4 array. The proposed antenna array has a beam scan angle covering -16° to +14° when operating at frequencies from 12 GHz to 18 GHz. The simulated broadside gain is 14.0 dBi at 14 GHz. The minimum and maximum realized gains are 8.1 dBi at 12 GHz and 20 dBi at 16GHz, respectively. To aid in the electroless plating process, non-radiating slots are added to the waveguide where the transverse surface current is zero. The non-radiating slots provide access for the plating solution to flow inside the waveguide without degrading the performance of the antenna.

A wide band power divider covering the entire Ku-band is designed as the feed network. Inductive walls are added and optimized to improve the impedance matching of the T-junction. Four commercial Ku-band matched loads, housed in a 3D-printed waveguide, are used to terminate the antenna. A fixture for the matched loads is also 3D printed. A fused deposition modeling (FDM) 3D printer is used to fabricate all three parts of the SWA antenna. ABS plastic is chosen as the printing material due to its mechanical robustness and high heat deflection temperature. Electroless copper plating is performed to metalize the 3D printed structures. The thickness of the platted copper were measured using a contact profiolometer. The one-port measurement and pattern measurement results will be reported at the conference. For the best of our knowledge, this work is the first non-resonant 3D printed SWA antenna.