NANODIMENSION
Electrifying Additive Manufacturing®

CASE STUDY: AEROSPACE

HARRIS' 3D PRINTED RF AMPLIFIERS COMPARABLE TO TRADITIONAL CIRCUITS

3D Printing with the DragonFly System Delivers Performance Comparable to Traditionally Manufactured Circuits, while Reducing Cost and Time

CLIENT PROFILE

Harris Corporation is a leading technology innovator, solving customers' toughest mission-critical challenges by providing solutions that connect, inform, and protect. Harris supports government and commercial customers in more than 100 countries. The company is organized into three business segments: Communication Systems, Electronic Systems, and Space and Intelligence Systems.

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BACKGROUND

Harris Corporation is a leading technology innovator, solving customers' toughest mission-critical challenges by providing solutions that connect, inform and protect. Harris supports government and commercial customers in more than 100 countries. The company is organized into three business segments: Communication Systems, Electronic Systems, and Space and Intelligence Systems. Harris Corporation and Nano Dimension worked together on a study to explore the potential use of 3D printing for radio frequency (RF) circuits for RF systems. The project included designing, simulating, and testing, a 3D printed RF amplifier and comparing it with the performance of an amplifier developed with conventional manufacturing techniques, using FR4 substrate material as a baseline. The study on the advantages of using additive manufacturing to develop RF circuits for wireless systems is part of a joint project with the Israel Innovation Authority and Space Florida Foundation, a partnership promoting research, development, and the commercialization of aerospace and technology projects.

CHALLENGE

Creating an RF circuit used for conveying information such as data, video, and voice across long distances, is typically a long, complex multi-stage process when using conventional manufacturing methods. Consequently, achieving optimum performance is an iterative process: create a design, produce the RF circuit, test its performance, improve the design, and repeat the process until an optimum design is reached. In practice, optimizing performance in this manner can be expensive and lead times are long.

SOLUTION

Using Nano Dimension's DragonFly system, Harris was able to 3D print functional RF circuits. A 101 mm x 38 mm (4" x 1.5") x 3 mm thick circuit was 3D printed in 10 hours. Nano Dimension's silver nanoparticle conductive and dielectric inks were used to create the functional electronic parts in a single print, and then, components were manually soldered to the PCB.

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TEST RESULT

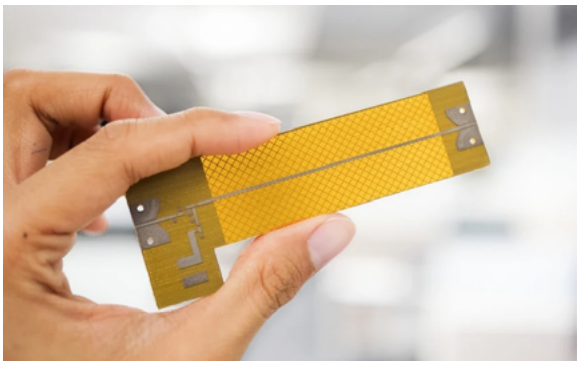
To assess the quality of the 3D printed RF circuit versus one manufactured with traditional methods, Harris used amplifier measurements that tested for small signal gain, input return loss, and output return loss.

The resulting data showed similar RF performance between the 3D printed and the baseline amplifiers, demonstrating the viability of 3D printing technology to produce a functional RF circuit with performance comparable to those developed using conventional manufacturing techniques.

- There was no noticeable difference in the input or output return loss response over the frequency range from 10 MHz to 6 GHz.

- No noticeable difference was detected in the gain of the 3D printed circuit and the conventionally manufactured amplifier. The gain difference between the 3-D printed circuit and the conventionally manufactured circuit was less than 1 dB up to 4.7 GHz and less than 1.3 dB up to 6 GHz.

With the DragonFly, circuits and systems that have rigid packaging integrated with flexible circuits can be produced in a single print, without the need for cables and connectors.



The performance of the 3D printed RF circuits was comparable with the traditionally manufactured circuits. In addition, the use of in-house 3D printed electronics to make RF amplifiers drastically reduces both the cost and time required per iteration so that RF amplifier manufacturers can iterate several versions in less time than with traditional methods. Other advantages of 3D printed electronics include the ability to save time by evaluating several design variations at one time, and fabricate complex electronic systems that cannot be manufactured by conventional means.

Arthur C. Paolella (2019) Directions in 3-D printed RF systems for space applications, Published in: 2019 IEEE Radio and Wireless Symposium (RWS).
DOI: 10.1109/RWS.2019.8754659

> *"The ability to manufacture RF systems in-house offers an exciting new means for rapid and affordable prototyping and volume manufacturing. The results of the study provide substantial motivation to develop this technology further."*
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> **Dr. Arthur Paolella, Senior Scientist,**
> **Space and Intelligence Systems, Harris Corporation**