GORE-FLIGHT®
Microwave Assemblies

PROVING INSTALLED PERFORMANCE OF AIRFRAME MICROWAVE ASSEMBLIES

White Paper

Together, improving life

Abstract

Military aircraft manufacturers have accepted the practice of replacing microwave assemblies because they get damaged during installation in airframe platforms. Damaged airframe assemblies can lead to compromised signal integrity and failures over time, especially when exposed to normal flight conditions. Failures after installation result in additional costs due to retesting, delayed production schedules, increased maintenance downtime, and ultimately microwave assembly replacement. Therefore, manufacturers need a low-risk solution that withstands the rigors of installation and reduces the cost of ownership.

Introduction

Military aircraft manufacturers have accepted the practice of replacing microwave assemblies because they get damaged during installation in airframe platforms. Damaged airframe assemblies can lead to compromised signal integrity and failures over time, especially when exposed to normal flight conditions combining rapid changes in temperature and pressure with potential contamination from fuel, oils, and fluids. Installation damage can also compromise the cable's vapor barrier, resulting in performance that can degrade unpredictably with rapid pressure and humidity change.

A recent study1 conducted for the aerospace industry showed that 29 percent of respondents said the cause of Microwave/RF cable failure or repair is due to damage during installation. This can lead to system failures, which result in additional costs due to retesting, delayed production schedules, increased maintenance downtime, and ultimately microwave assembly replacement. Therefore, manufacturers need a low-risk solution that withstands the rigors of installation and reduces the cost of ownership.

W. L. Gore & Associates (Gore) designed a simulator to evaluate the stress of installation on microwave airframe assemblies. By comparing signal integrity before and after installation, Gore can engineer assemblies that withstand airframe installation as well as the demands of the aircraft's flight envelope.

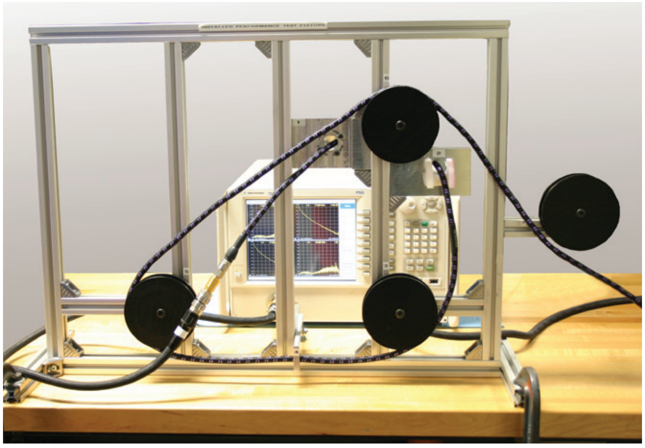
Installation Simulator Design

The simulator replicates the conditions an assembly experiences while being routed during installation in an aircraft (Figure 1).

The simulator has three main features that include the following:

- Mandrels with a diameter compliant to the claimed minimum bend radius (MBR) for the cable assembly to be tested
- Plastic and metal routing guides
- Abrasion bar

Figure 1: Installation Simulator



Test Process

Prior to installation in the simulator, new cable assemblies are tested to verify the insertion loss and VSWR over a given frequency range. For example, when testing an assembly rated at 18 GHz, insertion loss and VSWR are recorded over the range of 0.0225 GHz to 18 GHz. This information serves as the baseline to evaluate any performance change after being routed through the simulator.

Gore uses four mandrels to simulate routing an assembly around the internal structure of an airframe (Figure 2). The mandrels replicate MBR conditions that the assembly will encounter in an aircraft. This ensures the assembly is being evaluated under the worst-case scenario.

Several routing guides are used to induce torque into the assembly as it is pulled through the simulator (Figure 3). Next, the assembly is pulled through an abrasion bar to simulate routing across sharp edges or through access holes in the airframe structure (Figure 4).

Figure 2: Mandrel

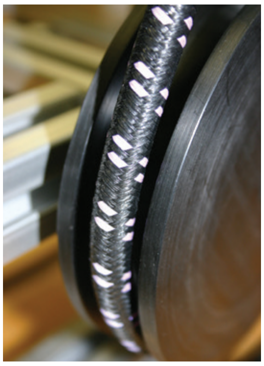


Figure 3: Routing Guides

Figure 4: Abrasion Bar

A tensile force of 20 to 40 pounds is required to pull the assembly through all the simulator features that mimic typical installation practices. The assembly is connected to a digital force gauge to measure the force applied.

Then the assembly is ready for testing. The assembly is connected to a Vector Network Analyzer (VNA) to test the insertion loss and VSWR. The results are compared to the baseline results of the assembly tested prior to installation. Depending on the results of the test, the assembly may be routed through the simulator multiple times and retested to verify its durability.

Conclusion

Independent studies and research conducted by Gore confirm that installed electrical performance is a top priority for aircraft manufacturers when installing cable assemblies in airborne platforms. Manufacturers can no longer afford the total cost associated with installing assemblies that cannot withstand the installation process and the extreme conditions of aerospace. They need assemblies that provide the same level of electrical performance after installation as when they are brand new. Furthermore, they expect assemblies to continue to perform reliably throughout the service life of the aircraft.

At Gore, we use the installation simulator to help evaluate the electrical performance of various cable assemblies. Testing such electrical characteristics as insertion loss and VSWR before and after installing an assembly in the simulator verifies its ability to withstand the rigorous challenges of installation. For example, the insertion loss and VSWR of GORE-FLIGHT® Microwave Assemblies remained consistent after being routed through the simulator multiple times.

Gore's testing demonstrates the importance of selecting the right supplier and a cable assembly with the lowest insertion loss before and after installation to ensure reliable performance over the lifetime of the aircraft.

A fit-and-forget philosophy is now a reality, providing the most cost-effective solution that ensures mission-critical system performance for military and civil aircraft operators.

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gore.com

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