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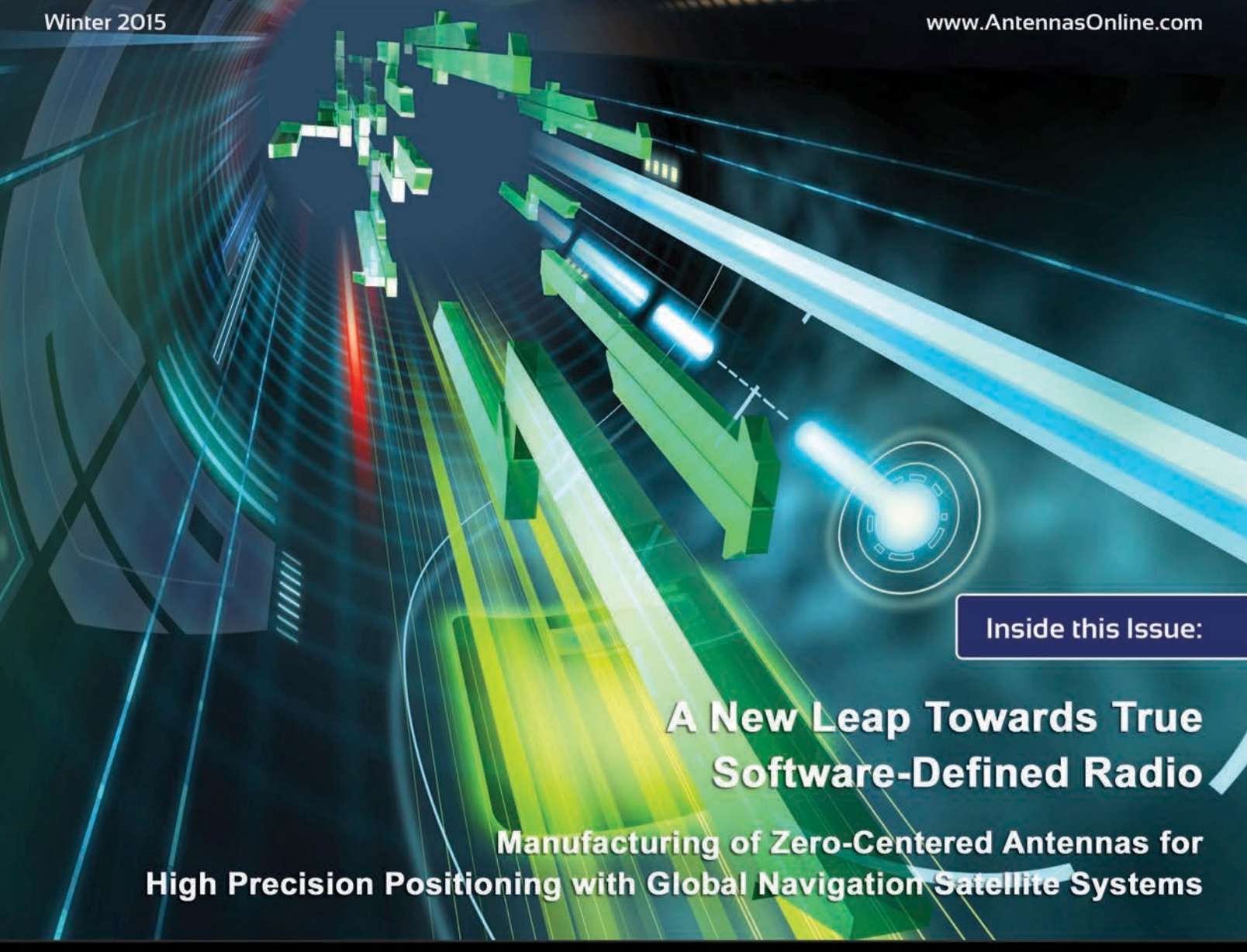

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Mission-Critical Flight Line Testing

By Robert John and Jerome Lokken, W. L. Gore & Associates, Inc.

When microwave/RF technicians are performing mission-critical testing on electronic systems in military aircraft, they are challenged to bring the precision and reliability of laboratory measurements to the flight line. Many of the locations that technicians need to reach for testing are limited in space and difficult to access. With increasing requirements to add, upgrade and maintain the multitude of electronic systems in the aircraft, the demands of mission-critical testing have become increasingly more challenging.

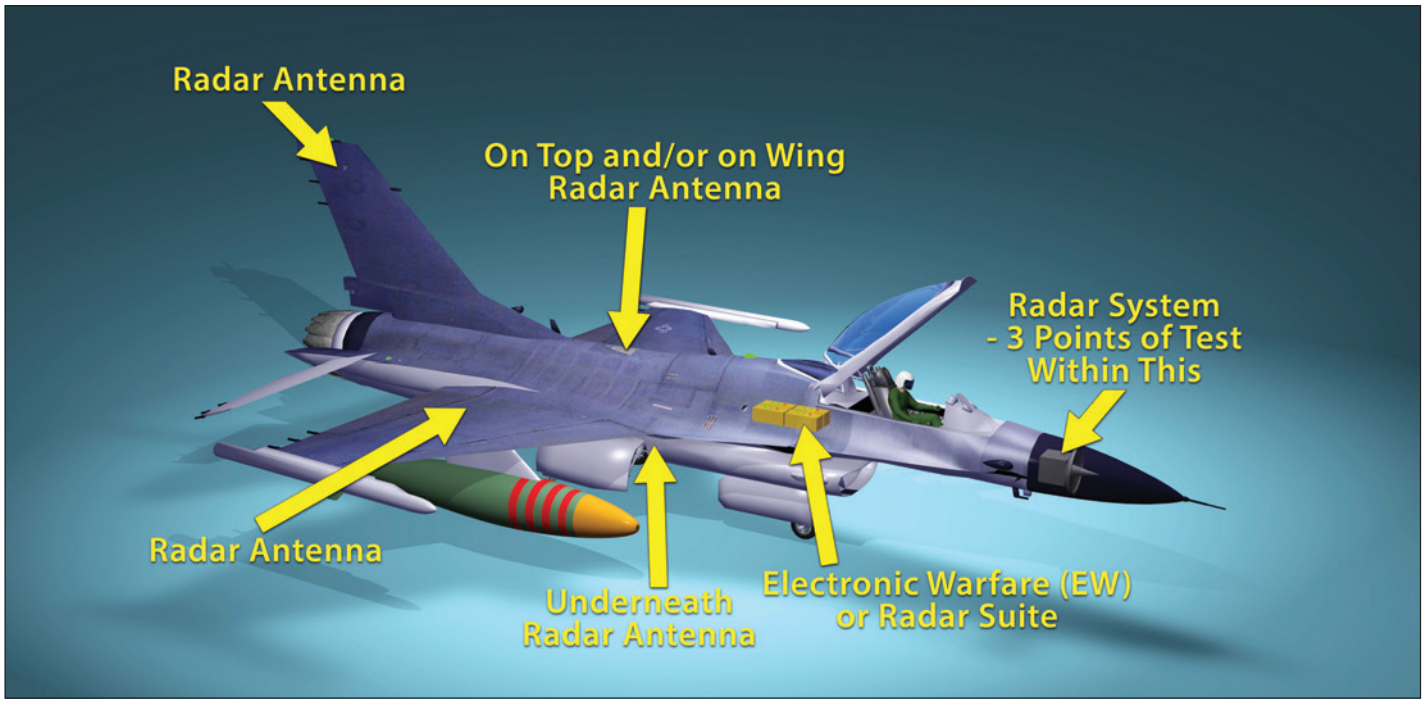

Figure 1. Typical test points in a military aircraft.

Precision Systems Require Precision Testing

With the growth in electronic warfare (EW) technologies and capabilities, precision testing of these systems is becoming even more crucial. In addition, as these complex environments get packed with electronic components, there is a necessity to make accurate and reliable microwave/RF measurements, often in hard-to-reach areas. The reliability of the test system is crucial, and critical components of these test systems are the microwave/RF test cable assemblies. These assemblies are actually the lifeline between the test equipment and the mission-critical systems under test.

The ability to reliably deliver precision measurements in mission-critical applications such as military aircraft, antennas, Radar, and EW suites in the fuselage is essential. Making accurate and reliable RF and microwave measurements in the demanding environments of flight lines requires extra durable microwave/RF cable assemblies. In addition to meeting rigorous environmental challenges including moisture, shock, vibration, mechanical stress and flexure, the cable must endure constant coiling and uncoiling as well as being stepped on, dragged or even run over by carts. Cables are often exposed to sharp edges, hinges, fuel, water and hydraulic fluids. During this exposure, cables need to be routed over and through the aircraft. Assembly lengths up to 50 feet are necessary to reach these systems regardless of their location on the aircraft.

Other examples of testing applications on an aircraft include EW / Radar suites; electronic surveillance/counter measures; Radar warning systems; missile approach warning systems; and navigation/communication systems.

Test instruments such as VNAs and PNAs, coupled with high quality microwave/RF test assemblies, will provide precise and repeatable measurements despite the challenging environment. Testing must identify problem components and should also detect intermittent failures. For example, when a pilot has identified a unit that has failed, the crew chief runs a BIT check from inside the cockpit. If this self-test indicates a bad module or component, the technician will replace it as part of the troubleshooting process. However, that component may not have actually failed. The problem could be with the test assembly and not the device under test. This could result in time wasted and unnecessary aircraft downtime, only to discover that the module or component is fine, and it is the test cable that is damaged.

Figure 2. FieldFox Handheld RF and Microwave Analyzer used during Flight Line Testing. (Image Courtesy of Keysight Technologies)

Reliable electrical cable performance makes troubleshooting easier, faster, more efficient and, most importantly, more accurate. If test equipment issues are suspected, often it's due to the cable assembly, not the testing unit itself. And if you are testing with an inferior cable, you could be shipping things that are out of spec, or delaying things that are in-spec. (Red Herring syndrome: looking for something that's not actually there.) The test cable isn't going to impact the capability of the system under test, but it will allow you to get an accurate representation of that system.

When a Cable Assembly Fails

The lack of repeatable and consistent measurements typically indicates a failed cable. Assemblies need to be stable despite the challenges they are subjected to in a flight line environment and continue to perform over time. You shouldn't have to recalibrate and retest due to poor RF assemblies. Some complex test setups can take more than two days just to calibrate. Getting to the end of that process to learn there's a defective cable in the system can be very costly.

Why Are Microwave/RF Test Assemblies Not All the Same?

The RF signal transmission through the cable assembly must remain stable with flexure. The insertion loss of unstable assemblies has been known to fluctuate by as much as several dB during flexure. Higher quality RF assemblies, such as GORE PHASEFLEX Microwave/RF Test Assemblies exhibit less than a 0.02 dB of change during the same flexure. The ruggedized construction of Gore's test assemblies provides the mechanical durability required to survive harsh environments and continue to deliver accurate and stable performance.

Performance Over Time

The microwave/RF cable assemblies used should ensure precise, repeatable measurements for the life of the test equipment.

Cables are often the last component considered when designing an electronic system. Flight line applications have environmental influences that require unique materials and mechanical properties to ensure reliable cable performance. Considering the electrical, mechanical and environmental stress that the cable will encounter in your application is crucial. Additionally, many applications have their own unique set of conditions that can stress a cable assembly. As these cables are a vital link to the test system, the ideal cable assembly should be engineered to last the life of the test equipment in any environment.

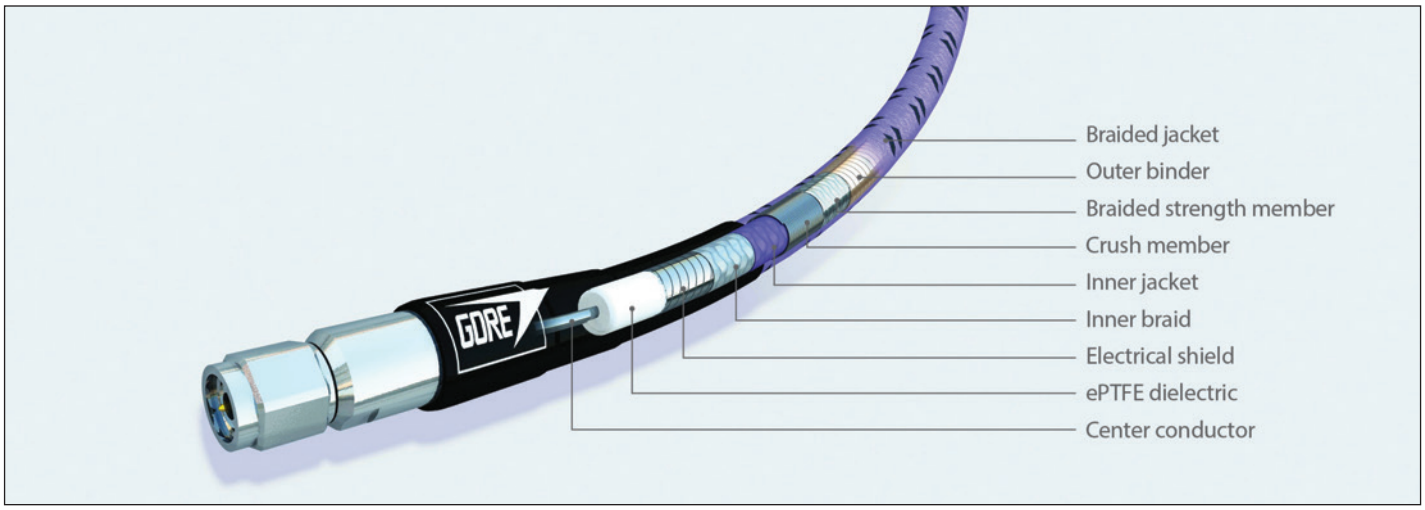

Figure 3. GORE PHASEFLEX Microwave/RF Test Assemblies cutaway reveals a construction that provides durability over time.

A recent study showed that, globally, more than 75 percent of microwave/RF cable assemblies are replaced frequently. There are a variety of reasons for why this is happening: damage during use, poor quality cable construction, connector termination issues, or failure when exposed to outdoor environmental conditions. The study found that overall, 36 percent were replaced once a year and 20 percent were replaced at least twice a year. This failure rate is not acceptable for mission-critical applications, where failure is not an option.

About the Authors

Robert M. John is an application specialist with W. L. Gore & Associates, Inc. For more than nine years, he has focused on solutions for applications requiring Microwave/RF cable assemblies. Prior to joining Gore, John was the engineering manager for a company that developed sophisticated connectors for applications ranging from consumer electronics to aerospace. During this time, he was also a member of the PCMCIA technical committee that developed standards for memory cards used in personal computing applications.

Jerome Lokken is an application specialist at W. L. Gore & Associates, Inc., where he has worked for 14 years with the Microwave Cable Assemblies group focusing on Aerospace Applications. He served for eight years in the United States Air Force and was an AIS Technician working with Automated Test Systems for Radar and EW Systems. He has extensive experience with connector design dating back to 1989, specializing in connector design for radar and EW systems.