

Testing Aircraft Electrical Bonds Ensures Safety and Reliability, Improves System Performance

Fixed and Rotary-Wing aircraft are complex assemblies consisting of various electrical and mechanical components, which are all connected to form a sound mechanical structure. While mechanical integrity is the primary concern of aircraft manufacturers and maintenance teams, sound electrical bonding is critical to insuring that all control and communications systems operate reliably. A bond is an electrically conductive joint. The bond test determines whether or not an electrical ground has been established between two points. The quality of the electrical connection between two points is sometimes useful as an indicator of the quality of the structural attachment between them. Electrical bonding of aircraft structures is important for many reasons, and should always be checked when building or maintaining an aircraft.

According to the Electrical Bonding Procedures (TM 1- 1520- 248- 23- 6), proper electrical bonds:

- protect aircraft passengers and electronic systems from lightning discharges,
- prevent the buildup of static charges and protect passengers and systems from electrostatic discharges,
- minimize RF potentials on electronic enclosures,
- provide low-impedance signal paths for electronic equipment, thereby improving system reliability and performance.

Insuring that electrical bonds in the aircraft are of the highest quality requires the use of an instrument specifically designed to accurately measure very low resistance in demanding environments, such as the TEGAM Model R1L-BR1 Bond Meter. The R1L-BR1 is a ruggedized, portable, battery-powered microohmmeter that was created for the US Army Aviation Group for ground support and maintenance activities related to the Bell OH-58 Kiowa Warrior Scout Helicopter.

Classes of Aircraft Electrical Bonds

Industry standard for the installation and repair of aircraft electrical systems (TM 1-1500- 323- 24- 1) describe six different classes of electrical bonds:

- Class A - antenna installation. This class of bond relates to the installation of antenna radiating other than radar and other similar types. Class A bonds ensure that antennas have a ground plane that does not distort the desired radiation patterns. The resistance of Class A bonds shall be less than 2.5 m Ω .
- Class C - current path return. This class of bond ensures that current path returns can adequately handle the power drawn by electronic equipment without excessive voltage drop.
- Class H - shock hazard. Class H bonds protect against shock hazard. This type of bond is used when bonding conduits carrying electrical wiring and exposed conducting frames or electronic parts and equipment. The resistance of this type of bond shall be less than 100 m Ω .
- Class L - lightning protection. Class L bonds provide lightning protection at all possible points of entry of lightning, including navigation lights, fuel filler caps, fuel gage covers, refueling booms, fuel vents, radomes, and canopies.
- Class R - RF potential. Class R bonds provide EMI protection. All electrical and electronic units or components which produce electromagnetic energy shall be installed so that there is a low-impedance path (less than 2.5 m Ω) from the equipment to the aircraft structure.
- Class S - static discharge. Class S bonds are used to prevent the buildup of static charges. All isolated conducting items except antennas greater than 3 inches, which are external to the vehicle, carrying fluids in motion, or are subject to frictional charging shall be bonded with Class S bonds. The resistance of Class S bonds shall be less than 1.0 Ω .

Bond testing

To test bonds such as those described above, an instrument capable of measuring very low resistances, such as the TEGAM Model R1L-BR1 Bond Meter needs to be used. The

Model R1L-BR1 is a digital microohm/bond meter with full scale ranges from 2 m Ω to 20 Ω . Accuracy on all ranges is \pm (0.25% of reading + 1 count) when using battery power.

The R1L- BR1 utilizes a four-wire method of measurement to determine the resistance of an electrical bond. This method allows to measure low resistance very accurately in spite of the resistance present in the connection leads.

In a four-wire configuration, two wires supply the test current to the bond under test, while the other two wires are connected to a sensitive voltmeter built inside the ohmmeter. Because the voltmeter has very high input impedance, very little current flows through these wires, making the voltage drop across these wires negligible when compared to the voltage across the bond under test. Once the R1L-BR1 makes the voltage measurement, it calculates resistance of the bond by dividing the voltage measured by the value of the test current.

The Probe Selection

To make a good connection to the structure, the right probe must be used. TEGAM offers several different types of four-wire Kelvin probes that allow making a proper connection. A Kelvin probe is one that actually makes two connections to the bond under test, one for the test current and one for sensing the voltage.

An example of this type of probe is the HTP-100 'Pistol Grip' Probes (shown in figure 1). These probes are made from impact resistant polycarbonate material, and the pistol grip allows the user to ensure that he or she makes a good connection. The pins are hardened stainless steel and rotate when pressed onto the bond under test.



Figure 1
HTP-100 'Pistol Grip' Probes

The SSP-10 Kelvin Probes (shown in figure 2) and BCP-10 Kelvin Probes (shown in figure 3) are also good choices for bond testing. The SSP-10 probes were designed for making four-wire surface resistance measurements on films and other metallic surfaces, while the BCP-10 probes were designed for making low-level resistance measurements in tight spaces. Both types of probes feature replaceable pins should the pins worn out or get damaged while in use. All of these probes come with cables measuring either 8.5 ft or 10 ft long, to test bonds where the two bonding points are up to 20 ft apart.



Figure 2
SSP-10 Kelvin Probes



Figure 3
BCP-10 Kelvin Probes

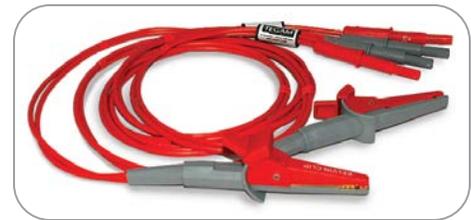


Figure 4
KAK-1M Kelvin Alligator Clips

Some bond testing applications require a probe connection to a screw. For such applications, use the TEGAM KAK-1M Kelvin Alligator Clips (shown in figure 4). The alligator clips in this set contain two contacts—one for the test current lead and one for the voltage sense lead—and make a very secure connect to screws and other hardware.

The final consideration is whether or not the bond will move at all. When performing resistance measurements on bonds that either are designed for movement during aircraft operation or use bonding straps, gently vibrating the bonded parts to ensure their tightness is recommended.

Troubleshooting and Inspecting Bonds

Should a bond's resistance not meet spec, or while performing a preventive maintenance inspection, check for the following:

- Evidence of electrical arcing. If there is any evidence of arcing, check for intermittent electrical contact between conducting surfaces that may be part of a ground plane or a current path.
- Insecure or corroded bonds. The bonds should be free from any corrosion or dirt.

- Bonds that interfere with movable parts. Bonding jumpers should be installed in such a manner as not to interfere in any way with the operation of movable components of the aircraft.
- Frayed or kinked bonds.
- Self-tapping screws. Self-tapping screws should not be used for bonding purposes. Only standard threaded screws or bolts of appropriate size should be used.
- Bonds that do not connect directly to the aircraft structure. Bonds should not be attached through other bonded parts.
- Washers of dissimilar metals. Use appropriate washers when bonding aluminum or copper to dissimilar metallic structures so that any corrosion that may occur will be on the washer.

A Safety Thought

Bond testing on surfaces of electro-explosive devices or where explosive hazards, such as propellants or volatile compounds require test instruments that will not inadvertently ignite these devices or materials. These kinds of instruments are specially certified to be intrinsically-safe. If measurements under these conditions are absolutely necessary, consider using the TEGAM R1L-E2A Intrinsically Safe Bond Meter. Being intrinsically safe means that the R1L-E2A will not under any circumstances supply enough energy to cause the ignition of hazardous gases.

About TEGAM

TEGAM, Inc. is a manufacturer of electronic test and measurement equipment and calibration standards. The TEGAM Model R1L-BR1 is designed to support the US Army Kiowa Warrior, and the Army is planning to commission the R1L-BR1 as standard ground support equipment for all Army helicopter platforms. TEGAM also has experience with other related products being fielded to support various commercial and military aircraft.

For example:

Model R1L-E2A; NSN 6625-01-527-5543: The TEGAM Model R1L-E2A is a portable, intrinsically safe microohmmeter that is required ground support equipment for the Sikorsky S-70B, S-92, and MH-60R helicopters. The R1L-E2A is currently being purchased

by US Navy for support of the USMC and USN versions of these aircraft. The R1L-E2A is also specified group support equipment for the Lockheed F-35 Joint Strike Fighter.

Model R1L-B; NSN 6625-01-350-8774: The TEGAM R1L-B is a bench-top version of the R1L-BR1 that is currently specified ground support equipment for the Boeing CH-47 Chinook and Sikorsky UH-60 Black Hawk. In both cases the US Army is taking steps to replace the R1L-B with the more rugged and complete R1L-BR1.

Model 252/SP2596; NSN 6625-01-474-6981: The 252/SP2596 LCR Meter is specified for testing the Kidde/Fenwal fire detection sensors used in many military and commercial aircraft jet engine assemblies. The 252 is required ground support equipment for the Lockheed C-130 and Bombardier Global Express.

TEGAM has experience in providing test equipments to aircraft MRO applications and to all branches of the U.S. military. We believe that our wide range of microohmmeters / bond meters offer a practical, user-friendly package that is also a durable, cost-effective solution to the day-to-day support demands of our Naval Aviation teams.

Please contact us at 440-466-6100 (sales@tegam.com) with any questions regarding your bonding needs.