SureGround™ and SureGround Plus™ Grounding Kit Qualification Report

Table of Contents

SureGround and SureGround Plus Grounding Performance

Preamble

The Andrew grounding kits are designed to meet the most severe grounding system requirements for wireless communications systems. A well designed transmission line system uses grounding kits to provide a bond between the cable and the tower / earth ground system to protect radio components from lightning transients. One grounding kit is recommended at tower top, tower bottom, at 200 ft (60 m) intervals (where applicable), and at the entrance to the equipment shelter. SureGround and SureGround Plus grounding kits were designed for fast, easy installation on HELIAX® coaxial cable. They utilize a pre-formed solid copper clip-on grounding strap for easy, snap-on installation to the cable's outer conductor and a large diameter solid copper lead for connection to the grounding system. The kit is a one-piece factory assembled ground strap which includes a two-part tape weatherproofing system. The SureGround Plus kit uses the same ground strap assembly, but includes a one piece molded weatherproofing boot.

The new SureGround and SureGround Plus Grounding Kit series were subjected to the same high level of qualification testing as all Andrew grounding products.

All testing was conducted in an independent certified test laboratory.

The following is a discussion / summary of the testing and resultant data.

Lightning Surge Testing

This test was performed to verify the ability of the product to withstand the extreme abuse of a lightning strike and still remain functional and intact.

Lightning surge testing was performed in accordance with the severe requirements of MIL-STD-1757A (component A). This testing consisted of applying damped sinusoidal type waveforms that simulate the effects of severe natural lightning. Waveforms were applied with peak current levels exceeding 100 kA peak current. Figure 1 depicts one of the actual waveforms that were recorded during the test. In all cases of applied surges, no damage was observed on the grounding kits or coaxial cables.

Figures 2 and 3 depict the test configuration that was used for evaluating Andrew grounding kits. Grounding kits were applied to the outer conductor of the coaxial cable. Various parameters such as bond resistance, microwave performance and physical characteristics were recorded before and after the applied lightning surge. In all cases of applied surges, no damage was observed on the grounding kits or the coaxial cables.

Coupling Resistance

Andrew grounding kits met and exceeded the DC resistance requirement of 1 milliohm as set forth by MIL-STD-188-124A (Military Standard for Grounding, Bonding and Shielding), Section 5.2.4 titled "Bond Resistance". The highest resistance measured at the bonding interface was 67 micro-ohms, exceeding the 1 milliohm specification. The resistance measurements were performed for four different samples of each product group, each subjected to 100 mating cycles. In all cases, no degradation of the bond resistance was observed. The DC resistance was measured using a calibrated Hewlett Packard® 34420A Micro-Ohm meter, which had better than 1 micro-ohm accuracy.

Grounding Conductor

The grounding conductor for SureGround™ and SureGround Plus™ grounding kits consists of a #6 AWG wire to meet MIL-STD-188-124A (Military Standard for Grounding, Bonding, andShielding), section 5.1.1.3.3 titled "Down Conductors",which recommends a #6 AWG wire (the cross-sectional area for a #6 AWG is 13.7 mm^2). The grounding conductor was also subjected to the same severe lightningsurge waveforms per the requirements of MIL-STD-1757A (component A).

Grounding Lugs

DC resistance between lugs and the mating material ie: copper ground bars, stranded copper conductor, galvanized steel, etc. is crucial for the performance of the grounding system as a whole. We tested the ground lugs in conjunction with a standard ground bar and 24 inches (610 mm) of the #6 AWG bonding conductor to judge performance as an assembly. Within this measurement we encompass ground bar resistance, lug to ground bar interface, lug resistance, lug to conductor crimp and conductor resistance. The performance proved to meet MIL-STD-188-124A (Military Standard for Grounding, Bonding and Shielding), Section 5.2.4 titled "Bond Resistance". That requirement is a maximum of one milli-ohm at the interface.

The grounding lugs used on all SureGround ™ and SureGround Plus™ grounding kits were tested for DC resistance using a calibrated Hewlett Packard® 34420A Micro-Ohm meter. The resistance measurements were made as shown in Figure #3. The resistance was measured before and after vibration conditioning per MIL-STD-202F, Method 204D, Test Condition A. The highest resistance recorded for this configuration, A to C connection points, before vibration was 0.755 milli-ohms, while the highest resistance after vibration conditioning was 0.753 milliohms. The largest difference of any individual sample, before to after vibration, was 0.041 milliohms. Analysis of the 0.755 milli-ohms total resistance for the grounding conductor, lugs and ground bar, yielded a distribution of DC resistance as follows:

0.690 milliohms--conductor
0.021 milliohms--crimps & lugs
0.015 milliohms--ground bar
0.029 milliohms--lug to bar interface

SureGround™ and SureGround Plus™ Environmental and Mechanical Testing

Preconditioning of Test Devices

The SureGround™ and SureGround Plus™ grounding kits were designed to operate under extreme environmental conditions. All kits were preconditioned with a "Thermal Shock" procedure, -40 °C to 85 °C for 25 one-hour cycles and then "Vibration Conditioning" per MIL-STD-202F, Method 204D, Test Condition A. At that point random samples were selected from the preconditioned population and exposed to the following tests along with virgin samples of similar products.

Icing Testing

Icing is a phenomenon which occurs under unique atmospheric conditions. The ice may cause two types of damage. It can do physical damage to the device by its weight or it may cause a moisture ingress as it thaws. This test evaluates the products ability to survive the condition.

This test was performed per MIL-STD-810E, section 521.1 (proc. #1). The test specimens were placed in a temperature chamber set to 1.66 °C. A uniform rain spray of precooled water, 5 °C, was sprayed over the specimens for one hour. The chamber temperature was then lowered to -10 °C while the spray continued. The conditions continued until 6mm, minimum of ice had accumulated on the test specimen. After this, the chamber temperature adjusted to -6.1 °C and held for a period of two hours. Following the hold at this temperature, the test specimens were returned to room temperature and examined for evidence of moisture penetration or any physical damage.

No indication of moisture ingress or damage was detected.

Blowing Rain Evaluation

Severe blowing rain is the most common source of extreme moisture exposure the product is likely to see. This test was done to simulate severe wind and rain to determine whether the product maintains its environmental integrity during periods of exposure. This test was performed per MIL-STD-810E, section 506.3, proc. #1.

Five specimens were placed in the blowing rain test setup for 30 minutes. The wind rate was 40 mph (64 kph) and the falling rain rate was 4.5 in/hr (11.43 cm/hr).

Visual inspection after the completion of the test showed no indication of a moisture ingress.

Solar Radiation Evaluation

Solar Radiation exists everywhere that the sun shines. Every outdoor product has to deal with it. The condition deals primarily with energy absorption and its effect. However, this condition should not to be confused with Ultra Violet light testing. The purpose of this procedure was to expose any thermal fracturing, melting, leaching, migration or other solar related faults This test was performed per MIL-STD-810E, proc. #11, Method 505.

Five specimens were placed in a chamber adjusted to reach a temperature of 49 °C with a radiant energy of 104 watts/ ft^2 ($930cm^2$). The specimens were placed 30 inches (76.2cm) from the radiation source. The specimens were exposed to this setup for 20 hours. The solar radiation was then turned off for a period of four hours. This completed one cycle. This cycle was repeated for a total of ten cycles. The specimens were then allowed to return to room temperature.

No anomalies were noted due to this test.

Corrosion (Salt Spray) Evaluation

Coastal areas of the world are most prone to suffer from the affects of salt spray. Any product that is to be used in these locations has to be prepared to deal with the severe effects that this environment creates. It is particularly true with electrical components that can suffer complete lose of function due to corroded connections. We performed this test to simulate the hostile environment and to judge the effect of it on the product. This test was performed in accordance with MIL-STD-1344, Method 1001.

Four specimens were suspended in a test chamber by means of cords of non-reactive material ie: plastic coated or waxed string. Two specimens were suspended in the horizonal plane and two were in the vertical plane. A five percent salt solution was forced into the atmosphere via a 0.022 in (0.55 mm) diameter spray nozzle at 18 lb/in² (12.4 N/cm²). The temperature in the chamber was maintained at 36 °C for the duration of the test. The duration of the test was 500 hours.

Visual examination of the test specimens showed no damage or deterioration.

Humidity (Thermal Cycling) Evaluation

Thermal cycling in a high humidity environment similar to those found in tropical regions can attack a product by inducing moisture ingress through cracks and seams. It can also cause moisture to migrate directly through some material. This test was done to establish whether moisture absorption and leakage would be a result of exposure to a tropical environment. This test was performed per MIL-STD-1344, Method 1002.

Three specimens were suspended in the humidity chamber at 80% to 90% relative humidity as the temperature was cycling from 5 °C to 85 °C for a period of 500 hours.

After the test procedure was complete, visual examination of the specimens revealed no evidence of physical deterioration.

Figure 1 - Applied Current Waveform (kiloamperes vs. time in microseconds)

Waveform = Damped Frequency   Peak Current = 100,000 amps
Oscillation Frequency = 16.6 kHz   Action Integral = 0.70 x 10^6 Amp^2 -sec

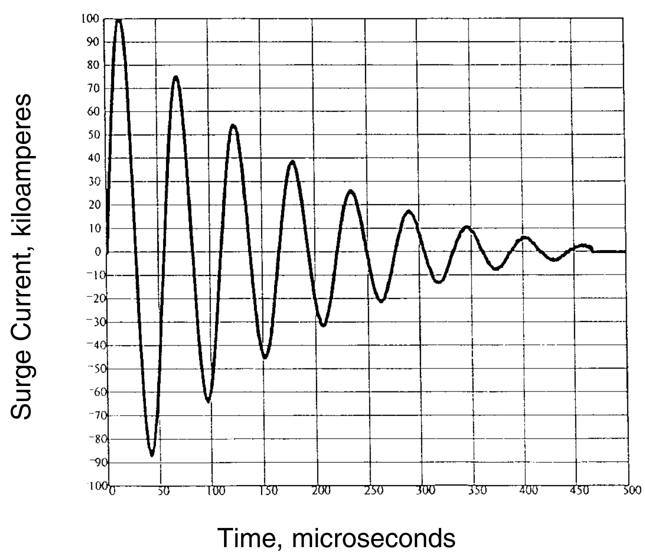


Figure 2 - Setup for Lightning Surge Testing

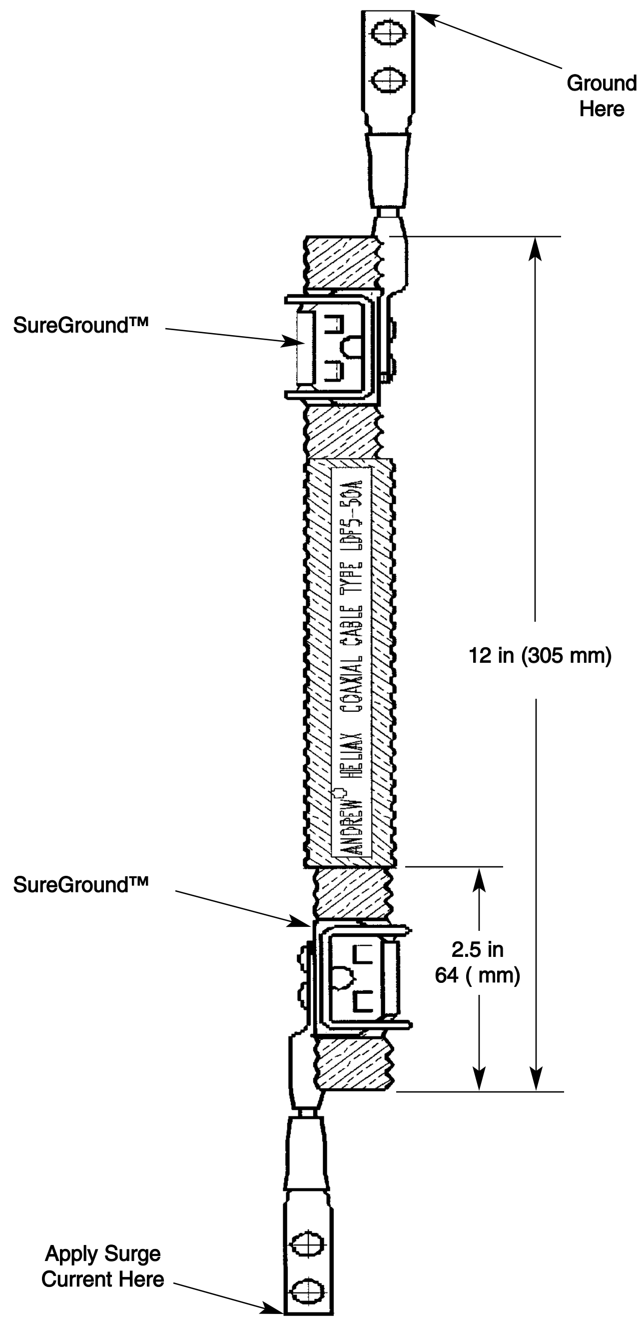
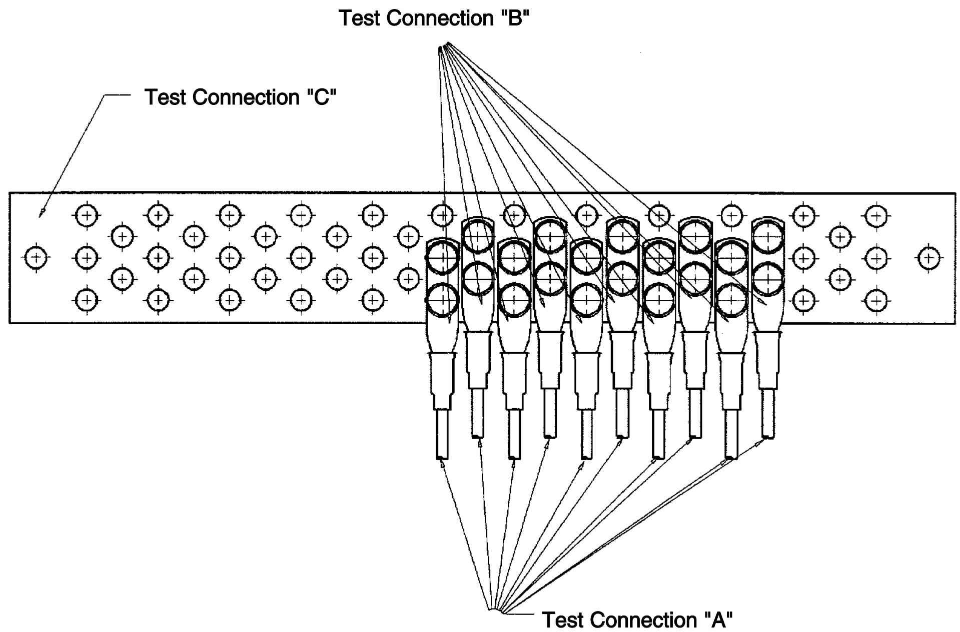


Figure 3 - Ground Lug Test Arrangement



References

MIL-STD-188-124A, Military Standard for Grounding, Bonding and Shielding.

MIL-HDBK-419A, Military Handbook for the theory of grounding, bonding and shielding of communications electronics. The handbook has two volumes: Volume #1 (Basic Theory), Volume #2 (Applications)

MIL-STD-1757A, Lightning Qualification Test Techniques for Aerospace Vehicles and Hardware".

MIL-STD-202A, Method: Vibration

MIL-STD-1344A, Test Methods for Electrical Connectors. This standard outlines corrosion and humidity testing for extreme environments.

MIL-STD-810, Environmental Test Methods and Engineering Guidelines. This military standard outlines testing for "Blowing Rain, Freezing Rain / Icing and Solar Radiation".

National Electrical Code, Article 250 "grounding"

IEC 1024-1 "Protection of Structures Against Lightning" This standard provides information for the design, installation, inspection and maintenance of an effective system for the protection of structures against lightning.

IEEE C62.41-1991, "IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits" (Recognized as an American National Standard).

BS 6651, "1991 Code of practice for Protection of Structures Against Lightning" This British Standard gives guidance on the design of systems for the protection of structures.