

Low Level Continuous Wave Lightning Test

6/23/2009

Submitted by

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Experimental License Purpose:

The purpose of this experimental license is to allow for testing in support of the FAA required aircraft Lightning Testing and Certification. This type testing is conducted as a **closed loop non-intentional radiator**, and has been performed on numerous previous occasions with no issues noted. The test is used to validate the lightning protection design on various type airframes and components. The test data is scaled and transformed to obtain estimates of the peak voltage and current transients that can be expected on the aircraft systems as specified by the following:

1. FAA issue paper SE-2, "Lightning Protection Requirements."
2. JAA document JAR25X899, Electrical Grounding and Protection Against Lightning and Static Electricity."
3. FAA issue paper SE-1, Protection from High Intensity Radiated Fields (HRIF)."
4. JAA HIRF Certification Review Item D-5 – Stage 2, Special Condition Protection from External High Intensity Radiated Fields."
5. FAA Special Condition #25-ANM-25, Boeing 747-400 & 747-400F, "Boeing 747-400 Lightning and Radio Frequency Energy Protection."
6. JAA Special Condition AAB7747-400F/02, Boeing 747-400F, "Lightning Protection Indirect Effects."
7. JAA Special Condition AAB7747-400F/01, Boeing 747-400F, "High Intensity Radiated Fields (HIRF)."

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Test Description:

The tests to be conducted are low level, swept continuous wave tests on production aircraft components. This type testing is conducted as a **closed loop, non-intentional radiator**, and has been performed on numerous occasions with no issues noted. These tests require the aircraft, or component to be located on a ground plane, typically constructed of chicken wire. A vector network analyzer, an HP 3577B or equivalent, will be used to inject low level swept CW currents, from DC to 400 MHz into the aircraft at points that represent a typical lightning attachment location. (See Figure 1 for a list of test equipment). Another connection from the aircraft will be made to the ground plane, which will represent a typical lightning exit location. The ground plane returns the current back to the network analyzer. It will sometimes be necessary to amplify the injected current using a laboratory grade 25 or 50 Watt linear amplifier. (See Figure 2 for a typical test setup). These tests are repeated with a variety of injection and exit configurations to represent various lightning attachment configurations. Testing, using widely spaced discrete frequencies would miss critical resonant frequencies.

The desired frequency range for this test is DC to 400 MHz. The sweep time will be approximately 10 seconds with a dwell time at any single frequency that will not exceed 50 mS. A typical data acquisition will require 1 to 8 sweeps. The RF drive current will be turned off between data acquisitions. The down time between data acquisitions can be anywhere from minutes to hours depending on the complexity of the test configuration changes. Various types of aircraft, which have similar shapes, sizes, and weights, may be tested using this procedure. However the test procedure, RF parameters and test locations will not change.

The tests will be conducted at two separate locations; the Boeing Facility, San Antonio, TX; and the Marana Airpark, Marana, AZ. The specific location data is listed in figure (1).

As shown in figure (2), the test set up is a closed loop non-intentional radiator. The aircraft and ground plane form a closed loop transmission line, however parasitic emissions may occur. The emission type is CW. At best, the test set up is a very inefficient antenna at higher frequencies, and Boeing believes that this test will not cause any RF interference. Boeing has been licensed to perform these tests on numerous past occasions, all were completed without any interference or other issues noted.

The inputs to the Network Analyzer are from a current probe, and through a fiber optic transmitter and optical receiver. A computer is used to read the measurements and plot the test results.

The occupied bandwidth of the emission shall not extend beyond the band limits.

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The “Stop Buzzer” is Matthew Williams, telephone, 425-266-4141.

Equipment List and Transmitter Locations

RF Equipment Used
RF Sources
Agilent/HP 3577B Vector Network Analyzer or equivalent
RF Amplifiers
RF Power Labs M125L 25 Watt CW Amplifier or equivalent
Amplifier Research 50WD1000 50 Watt CW Amplifier or equivalent
Transmitter Information
Location 1
Boeing Facility, San Antonio, TX
Within 1 KM of Lat/Lon: N 29-22-10, W 98-34-07, NAD83
Antenna Height: Highest point on aircraft is approximately 65 feet
Location 2
Marana Airpark, Marana, AZ
Within 1 KM of Lat/Lon: N 32-30-42; W 111-19-11, NAD 83
Antenna Height: Highest point on aircraft is approximately 65 feet

Figure 1

Low Level Continuous Wave Lightning Test

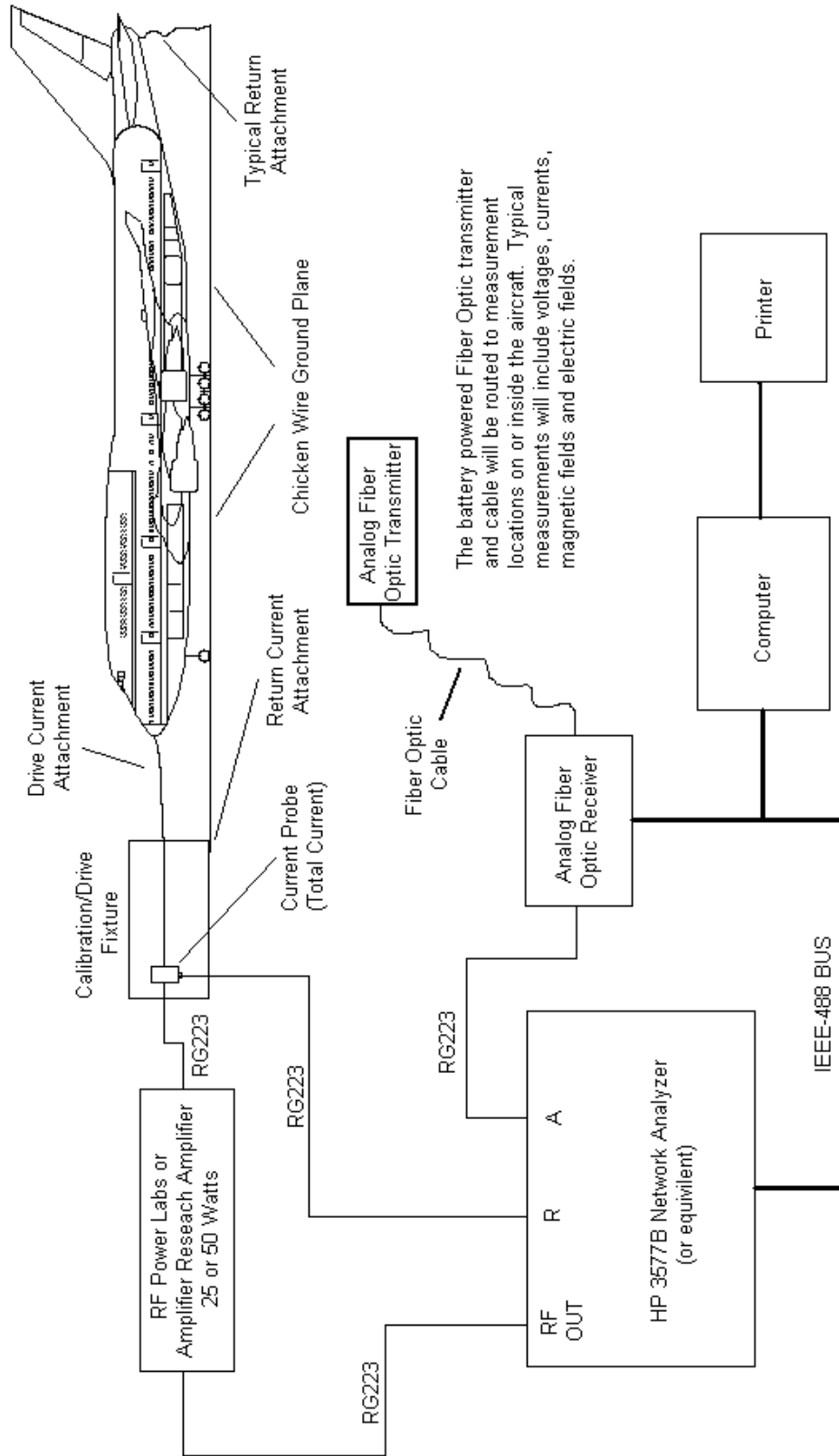


Figure 2

Low Level CW Direct Drive Test Setup for a Typical Full Scale Aircraft Test