Electronic Design

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NASA's Strategy to Lower EMI in Outer Space

EMI/EMC can be a pesky nuisance, and even disastrous, in outer space travel. NASA endeavors to lower electromagnetic interference through various testing procedures.

Outer space can be very dangerous to astronauts and space vehicles. On that front, the NASA Glenn Research Center EMI labs offer a comparison of specifications along with electronic component testing, final qualification experiment testing, and hardware testing for good shielding reliability and effectiveness.

EMI/EMC and Satellites

Satellites in outer space have a critical function in collecting data and relaying that data to ground stations on planet Earth, typically in real-time.[1] When we look closer at this important communications function, we will find that some of these RF frequencies are quite vulnerable to harmful and/or disruptive electromagnetic interference (EMI).

The NASA Antenna Test Facility (ATF) is fully capable of testing antenna radiation-distribution pattern performance for spaceflight applications in EMI environments conditioned to simulate free space. Antenna ranges are used to acquire radiation performance data via radiation pattern measurements. This chamber houses two antenna test facilities: a far-field test facility and a near-field test facility. (Image courtesy of NASA)

Electromagnetic compatibility (EMC) is necessary for spaceflight hardware designs to guarantee reliable function of spacecraft electronic systems. Not only does it prevent EMI that might compromise communications for mission-critical systems, EMC also safeguards against potential malfunctions caused by electromagnetic disturbances in the complex and harsh void of the space environment.

Thanks to the expertise of the NASA Johnson Space Center (JSC) facilities, EMI/EMC engineering development, evaluation, and simulation is available, along with certification testing for the crew, ground support equipment, and flight. This effort surrounds a vast array of systems that includes communication, biomedical tools, instrumentation, navigation devices and guidance, as well as expert computation and robotics.

Conducted and Radiated Emissions and Susceptibility Testing

The NASA JSC EMI Test Facility (JETF) offers:

- Two independent shielded test facilities with dimensions of 23 × 18 × 10 ft. and 10 × 16 × 8.5 ft.
- Larger equipment-under-test (EUT) assessments are able to be accommodated; however, they will need additional coordination.

JSC's Anechoic Chamber

Antenna testing is performed in JSC's Anechoic Chamber. The Antenna Test Facility (ATF) has one anechoic chamber and an outdoor antenna range *(see figure)*.

The JETF tests systems and subsystems in accordance with MIL-STD 461G requirements. Consultation services can be arranged as well to develop a suitable test plan that will meet any test requirements. Some specifics include:

- Shielded chambers, for conducted emissions (CE) and radiated emissions (RE) and susceptibility, have solid engineering support, qualification, and evaluation.
- The JETF supports engineering development and provides EMI/EMC evaluation and qualification.

The JETF facility also enables the testing of crew, ground support equipment, and flight, which includes communication, guidance and navigation, instrumentation, biomedical, computation, and robotics systems.

Flight Computing and Avionics Subsystems

The NASA Johnson Space Center has specialized facilities and expertise in the unique aspects of the design, development, testing, and evaluation of avionics systems and crucial architectures for astronaut space flight.

The Johnson Space Center is a beacon of expertise in the realm of aerospace technology that ranges from data handling and critical commanding architectures to comprehensive component-level analysis and testing.

EMI/EMC and NASA ISS Capabilities

The International Space Station (ISS) serves payload developers with rare research opportunities and the ability to address EMC for payloads.[14] It's critical that the payload developer incorporate exclusive EMC considerations to be compatible with the ISS and all other payloads.

The developer must understand commercial-off-the-shelf (COTS} equipment and components, used in payload designs, to certify that these items will not create EMI issues or compromise any payload performance. Payload developers must contact the ISS Research Integration Office for further information and design guidance in developing electromagnetically compatible payloads for the ISS.

The ISS environment provides unique immunity challenges. However, if the payload developer ignores these challenges, it may impact data collection and technology demonstrations.

ISS EMC and EMI requirements are spelled out in a number of ISS requirements documents:

- **SSP 30243**: Space Station Requirements, for Electromagnetic Compatibility, are located in the system-level EMC requirements. This is a tailored version of MIL-E-6051D, Electromagnetic Compatibility Requirements, Systems.
- **SSP 30245**: Space Station Electrical Bonding Requirements, a tailored version of MIL-B-5087B, Bonding, Electrical, and Lightning Protection, for Aerospace Systems.
- **SSP 30237:** Space Station Electromagnetic Emission and Susceptibility Requirements.
- **SSP 30238**: Space Station Electromagnetic Techniques, are derived versions of MIL-STD-461B, Electromagnetic Emissions and Susceptibility Requirements for the Control of Electromagnetic Interference and MIL-STD-462, Electromagnetic Emissions and Susceptibility, Test Methods.
- **SSP 30242**: Space Station Cable/Wire Design and Control Requirements for Electromagnetic Compatibility. These are very similar to DOD-W-83575: Wiring Harness, Space Vehicle, Design and Testing, General Specification, which is a unique document for the ISS. The purpose of this document is to provide a uniform methodology and specification for cabling and wiring to minimize field-to-wire coupling and crosstalk.
- **SSP 30240:** Space Station Grounding Requirements. This document contains electrical grounding and isolation requirements. The vehicle will use dedicated returns for signals and power. In addition, the vehicle will employ a distributed single ground reference system, or single point ground, to reference power and signals. This will minimize interference and any interactions with the natural plasma and geomagnetic environment, as well as maximize the crew safety.

Mitigating EMI Cost and Exposure

Keeping cost and exposure in check while performing EMI testing on large space vehicles is no easy task. There are many sources of radiation in outer space.[8,15,16] The most prominent of these include:

- **Solar particle events:** Infrequent large increases in particle fluxes are due to solar coronal mass ejections, flares, etc.
- **Galactic cosmic rays:** Present in all space environments; planetary magnetic fields provide shielding in some orbits.
- **Charged particles trapped by planetary magnetic fields.**
- **Space Plasma environment** (including atomic oxygen): Important for surface degradation in some orbits.

Summary: NASA's Lower-EMI Plan

NASA looks to minimize EMI in outer space both for the protection of astronauts and space vehicle safety. NASA's JETF is testing systems and subsystems in accordance with MIL-STD 461G. NASA also keeps cost and exposure from radiation low for large space vehicles. Payload developers must incorporate special EMI/EMC considerations while following ISS requirement documents.

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