APPLICATION NOTE

Mag-03 and Spectramag-6 used in Magnetic Hygiene Tests of Spacecraft Components

Objectives

Pre-installation EMC testing (electromagnetic compatibility) of components, and pre-launch EMC testing of spacecraft.

Instrumentation

- Mag-03MS100 three-axis fluxgate magnetic field sensor
- Spectramag-6 data acquisition unit

Application

Spacecraft manufacture and quality control.

Background

EMC requirements stipulate three conditions for equipment or a system:

1. It does not interfere with other systems or equipment.
2. The system is not susceptible to the emissions of other systems or equipment.
3. Interference is not caused internally within the equipment that would cause it to malfunction.

Magnetic hygiene of components is important onboard spacecraft. Space and weight are limited, so ground-based solutions such as keeping equipment apart or using shielding are difficult to implement.

It is not possible to reduce the magnetic signature completely, as certain equipment will always produce a magnetic field; for example transformers and inductors. Highly sensitive equipment like magnetometers is placed on booms to reduce the effect of the spacecraft's signature.

The magnetic signature of a spacecraft can also affect its attitude. The field of the spacecraft can interact with the geomagnetic field, creating a torque which tries to align the spacecraft's field with the Earth's, altering the spacecraft's position [1].

Method

In order to carry out these tests accurately, it is important to be in a magnetically quiet environment. Ideally this is 15-20m from other sources of magnetic interference. The equipment should also be located in a stable environment that presents limited variations of temperature or exposure to sunlight.

The test set-up involves using the Mag-03MS sensors as a gradiometer, connected at a distance to a Spectramag-6 unit. The two Mag-

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03s are fixed parallel to each other, set apart at a distance that is dependent on the size of the equipment under test. The alignment of the sensors is important to prevent errors in the gradient calculation. The choice of mounting material is also important: the best material to use is the plastic PEEK, as it is non-magnetic but also has minimal thermal expansion, which will limit any movement in the position of the Mag-03 sensors with any changes in temperature.

Using the Spectramag-6 software, the Differential/Gradiometer mode is a selectable option when two Mag-03s are connected. The mode allows one sensor to be used to measure the background field, which is then removed from the field measurements of the second sensor. This allows only variations local to the second sensor to be displayed. It is also possible to set the test pass/fail specifications within the software. Entering the maximum field intensity allowed for the test will display a pass or fail banner on the screen during the test procedure. The limit will also appear on the graphical display of the time domain data, allowing the user to compare test results to the allowed limits.

To achieve the required distance separation between the Mag-03 and the equipment under test, an elevated cradle or (non-magnetic) rails are used to support the equipment. The tests are carried out by moving the equipment along the rails over the second sensor. The Spectramag-6 software will indicate whether the equipment has passed or failed on the screen. It is important to run the tests with the equipment switched on and off, and to repeat the tests in various orientations to ensure the magnetic hygiene of the equipment in all directions.

Reference

[1] Fortescue, P., Stark, J., Swinerd, G. (2003) Spacecraft systems engineering. 3rd edn. West Sussex: Wiley