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Grounding requirements of spacecraft

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FOREWORD

The standard is translated from the Chinese version of Standard on GB/T 29084-2012 released by Standardization Administration of China (SAC) under the management of State General Administration of Quality Supervision and Inspection and Quarantine. TC 425 is responsible for the translation. In case of any doubt about the contents of English version, the Chinese original shall be considered authoritative.

This standard is drafted in accordance with rules given in GB/T 1.1-2009.

This standard is proposed by China Aerospace Science and Technology Corporation.

This standard is under the jurisdiction of National Technical Committee on Space Technology and Operation of Standardization Administration of China (SAC/TC 425).

INTRODUCTION

This standard belongs to the National Standard System of China Space. The National Standard System of China Space is applicable to the formulation, revision, and management of national standards in the field of space, covering three sectors of space management, space technology, and space application and services and serving as the basis for guiding spacecraft and launch vehicle project management, engineering, space launch services, and in-orbit satellite applications.

Electromagnetic compatibility is an important part of spacecraft reliability design, and a good grounding system is the guarantee of circuit operation stability. Grounding is not only an important method of spacecraft electromagnetic compatibility but also an important method to avoid any mistaken detonation or error burning of pyrotechnics, fuel and other dangerous goods, and it also ensures the safety of personnel. Therefore, this standard plays an important role to improve the reliability and safety of spacecraft.

Grounding requirements of spacecraft

1 Scope

This standard specifies the grounding requirements of spacecraft, equipment on board, and its ground test system.

This standard is applicable to the spacecraft grounding design as well as grounding in spacecraft testing, assembling, transporting and others.

2 Bond-grounding requirements of spacecraft

2.1 Requirements of structure bonding

Requirements of structure bonding are shown as follows:

a) Spacecraft metal structures shall be bonded with each other, and the DC resistance of bonding (hereinafter referred to as bonding resistance) shall be less than 5 mΩ;

b) Conductivity composite materials (such as carbon fiber) of structural component shall be bonded with structure, and the bonding resistance shall be less than 1kΩ;

c) That between carbon fiber boards for installing equipment shall be bonded, and the bonding resistance shall be less than 10 mΩ;

d) Equipment outside of cabin shall be bonded well with spacecraft structure, and the bonding resistance shall be less than 10 mΩ;

e) The bonding resistance of interface in each cabin section of multi-cabin spacecraft shall not be more than 5 mΩ;

f) The ground stud on main spacecraft structure shall be the main spacecraft grounding stud. In cases of spacecraft ground testing, storing, transporting, transiting, filling, lifting and others, main grounding stud shall be connected with field grounding studs for signal ground or technical ground (signal reference system) by specified grounding wires (multi-strand copper wire or copper wire woven belt that the total cross-sectional area is not less than 4.7 mm^2). The bonding resistance of grounding wire and grounding stud shall be less than 1Ω.

2.2 Bonding requirements of thermal control material

2.2.1 Multilayer insulation components

Bonding requirements for multilayer insulation components are shown as follows:

a) Grounding types and bonding resistance: embed conductive organ blades in each layer of multilayer insulation components, and drill a through hole (φ 4mm) at the center position of blade for riveting. Take a piece of wire according to the requirements, weld a one-way soldering lug at two ends of wire, and connect one soldering lug with a near grounding stud. Take hollow copper rivets to rivet another soldering lug with organ blades and multilayer insulation components together so as to ensure the bonding resistance is less than 10Ω;

b) Quantity of bonding points: for multilayer insulation components that the area is less than $0.05m^2$, there shall be one grounding point at least. For multilayer insulation components that the area is more than $0.05m^2$, there shall be two grounding points at least. For long strip of multilayer insulation components, one grounding point shall be set approximately for every 500 mm;

c) Position of bonding points: the distance between grounding point and multilayer edge is about 10 mm.

2.2.2 Secondary surface mirror (OSR sheet)

The metal part of secondary surface mirror shall be connected to structures with conductive adhesive, and the DC resistance between the metal part of secondary surface mirror and the structure ground shall be 5Ω~10Ω.

3 Bond-grounding requirements of spacecraft equipment and components

3.1 Bonding requirements for spacecraft structure to onboard equipment

To accomplish the grounding of equipment enclosure, spacecraft structures shall be bonded through equipment grounding stud & grounding wire or mounting surface & fasteners. The bonding resistance between equipment and spacecraft structure shall be less than 10 mΩ.

3.2 Grounding requirements for the primary power supply

Grounding requirements for main power are shown as follows:

a) The primary power return circuit shall be single-point grounded. Grounding points are selected generally in power distribution unit or power control unit, and single-point grounding shall be bonded with main grounding stud of spacecraft structure through grounding wires. This kind of grounding types can also be used for spacecraft with several primary power buses;

b) Main grounding studs of spacecraft structure shall be close as much as to the single grounding point. If grounding wire is copper wire, the cross section area shall not be less than $0.5mm^2$, and the bonding resistance of grounding wire and grounding stud shall be less than 10 mΩ;

c) All equipments directly powered by the primary power supply bus of spacecraft shall require that the return circuit of primary power bus is insulated with equipment enclosure, and the insulation resistance shall not be less than 1 MΩ;

d) Spacecraft structure shall not be used for carrying current for any power equipment;

e) If battery is insulated with spacecraft structure, its enclosure and spacecraft structure shall be connected in series with 50kΩ~100kΩ electrostatic discharge resistance. When the discharge resistance is disconnected, the insulation resistance between battery enclosure and spacecraft structure shall be more than 1MΩ.

3.3 Grounding requirements for power converter

Grounding requirements for power converter are shown as follows:

a) The input of power converter shall be isolated from the output, and the isolation resistance shall not be less than 1 MΩ;

b) For DC/DC converter of high frequency devices, its output return circuit shall be connected with the equipment enclosure;

c) There are three kinds of grounding type for output return circuit of DC/DC converter:

- Output return circuit shall be isolated from equipment enclosures, and the isolation resistance shall not be less than 1 MΩ. Output return circuit shall be connected together to the primary power distribution unit or power control unit so as to bonding with the main grounding stud of spacecraft. Low frequency circuit adopts single point grounding method;
- If the bonding resistance between equipment structure and main structure is less than 10 mΩ, the output return circuit can be grounded nearby through the grounding stud of equipment enclosure;
- For load with no grounding requirements (such as heater), the output return circuit may be isolated from spacecraft ground.

3.4 Grounding requirements for pyrotechnic device

The grounding requirements for pyrotechnic device are shown as follows:

a) The bonding resistance between the metal enclosure of pyrotechnic device and the structure mounting surface shall not be more than 10 mΩ;

b) The ignition power line of pyrotechnic device shall be twisted-pair shield cable, and two ends of shield layer shall be bonded through the metal shell of connector to accomplish grounding;

c) The positive and negative terminals of power line for pyrotechnic device shall be controlled through relay. To prevent electrostatic accumulation of pyrotechnic device, it is required to design 50kΩ~100kΩ electrostatic discharge resistance.

3.5 Grounding requirements for high frequency equipment

High frequency equipment usually adopts multi-points grounding method, and the input and output of primary power supply for power convertor in equipment shall be isolated. Both power converter output return circuit and signal ground shall be bonded with equipment enclosures to implement the grounding.

3.6 Grounding requirements for low frequency equipment

For low frequency equipment, if both primary power ground and signal ground in equipment are isolated from equipment enclosure, its internal DC/DC output grounding design shall be designed according to 1) or 2) requirements in 3.3 c). If equipment is grounded nearby, the grounding wire can be led out through connector, and bonded with the equipment grounding stud by connector.

3.7 Shielding requirements for low frequency weak signal cable

For transferring low frequency weak signals by shielded wires, shield layers shall be grounded generally with single point grounding method, and grounding points shall be on the side of signal source. Shield layer of connector is grounded through the metal shell.

4 Grounding requirements for spacecraft to ground test system

4.1 Requirements for grounding stud of test field

Requirements for setting grounding stud of test field are shown as follows:

a) Ground facilities of spacecraft test system shall have grounded electrode system, lightning protection system, equipment failure protection system (facility ground) and technical ground;

b) Field signal ground system shall be set with several safe and reliable signal ground studs to meet several spacecrafts grounding requirements;

c) Field equipment failure protection system shall be set grounding studs for ground test equipment grounding.

4.2 Grounding of spacecraft test field

Grounding requirements for spacecraft test field are shown as follows:

a) In the AIT (assembly, integration & test) plant, the main grounding stud of spacecraft shall be connected with the signal grounding stud of site through specified grounding wires. In the same test field, if there are several spacecrafts in testing, they shall be grounded separately, and each signal grounding stud shall be connected with only one spacecraft;

b) The technical center of launch site shall connect the main grounding stud of spacecraft with the signal grounding stud of test field through specified grounding wires.

4.3 Grounding of test equipment

Grounding requirements of test equipment are shown as follows:

a) The grounding point of power supply for spacecraft ground test system shall be connected with the facility ground (protection ground) of test field;

b) Test equipment shall be isolated from spacecraft signal interfaces;

c) Ground test power supply, excitation source, measuring instruments, control equipment and others shall be isolated from the equipment housing which shall be connected with the power protection ground;

d) The spacecraft ground power enclosure shall be insulated from input and output return circuits. Input and output circuits shall be isolated. Output return circuit shall be isolated from the control circuit of ground power supply. And the isolation resistance shall be more than 1 MΩ;

e) The enclosure of high-frequency ground equipment shall be connected with the internal power ground. If there is cable test, the protection ground shall be isolated with the signal ground.

5 Grounding requirements in spacecraft assembling, testing, storing, transporting, transiting, filling and lifting

5.1 Grounding requirements in spacecraft assembling

During spacecraft assembling, the main grounding stud of spacecraft shall be connected with the signal grounding stud by specified grounding wire. The bonding resistance shall be less than 1Ω.

5.2 Grounding requirements for spacecraft testing and storing

During spacecraft testing and storing, the main grounding stud of spacecraft shall be connected with the signal grounding stud by specified grounding wire.

5.3 Grounding requirements for spacecraft transporting

The grounding requirements of spacecraft transporting via road, railway and air are shown as follows:

a) The spacecraft shall be in container;

b) Grounding requirements of container: the metal structure of container shall be equipotential. Metal parts shall be bonded with each other, and the bonding resistance shall be no more than 1Ω. Non-metal container shall be equipped with grounding bonding studs inside and outside, and the grounding stud of spacecraft shall be connected with the container grounding stud by grounding wire;

c) The internal of container shall be equipped with grounding studs. The main grounding stud of spacecraft shall be connected reliably with container grounding stud by grounding wire.

d) Container shall be bonded reliably with vehicle;

e) Road vehicle shall be connected with the earth to have a good electrostatic discharge path.

5.4 Grounding requirements for spacecraft transferring

During spacecraft transferring, spacecraft container shall be connected with the earth to have a good electrostatic discharge path.

5.5 Grounding requirements for spacecraft filling

During spacecraft filling, the main grounding stud of spacecraft shall be connected with the signal grounding stud in filling building, and the bonding resistance shall be less than 1Ω.

5.6 Grounding requirements for spacecraft lifting

During lifting, spacecraft shall be grounded reliably. Metal hooks shall be insulated.

6 Requirements of spacecraft to launch vehicle grounding

It is required that the bonding resistance between the interfaces shall be no more than 10mΩ while mounting spacecraft to launch vehicle. This can accomplish the Equal-potential grounding between spacecraft and launch vehicle. After docking, the specified grounding wire of spacecraft shall be removed.