

How are the Electrical Equipment grounded on the ISS?

Grounding the electrical equipment is an extremely important process to provide a return path for the current. It serves the purpose of Safety, against the leakage or residual currents on the system, making it a shock-free deal in worst case scenarios.

When it comes to powering a manned satellite that orbits our planet 375kms above earth's surface, you must be wondering, 'What do they do about the protection from the usage of Electrical equipment?'



(Credits – NASA)

Power to the ISS

The International Space Station is powered differently than your familiar Alternating Current (AC) that courses through the city power grids. Electrical devices built for the ISS are designed to use the station's 120-volt DC power, different from the power for earth's portable CD players or electrical razors, that must be adapted to this unusual power system.

Being grounded is said to be good sometimes

The different types of electrical equipment on Earth runs in such a way that, there is a common return path or an additional wire, that goes into the ground from your household breaker panel. This additional wire called the 'ground wire' is connected to the earth's surface with the help of a metal rod buried in the ground. The importance of being 'grounded' is not to punish the equipment, but to protect yourself from the shock in an unfortunate set of events (ex.- Lightning, Power surges, Insulation failure, etc.)



DC has a negative point of view towards grounding

Electrical power on the International Space Station is the most critical resource as it allows the crew to live comfortably, to safely operate the station, and to perform scientific experiments. The ISS electrical system uses solar cells to directly convert sunlight to electricity, as the Sun is the only readily available source of energy. After all, it's not as though the crew can drop a power cord down and plug it into the city grid.

ISS uses a large number of photovoltaic cells, that are assembled in arrays to produce high power levels. That is the reason, Solar arrays are the most prominent and important feature of humanity's home in space. However, a spacecraft orbiting the Earth is not always on the path of direct sunlight. Therefore, the space station relies on nickel-hydrogen rechargeable batteries to provide continuous power during the 'Eclipse'. This way, all the equipment on ISS is DC powered and have a common reference point or use the negative terminal of the battery, as a grounding mechanism.

Safety from the Electricity

Considering the safety issues, it is the safest place in Low Earth Orbit (LEO), if we are only talking about the electricity and grounding part of the Power System.

The power management and distribution subsystem spread the power at 160 volts of direct current around the station through a series of switches. To meet operational requirements, DC-to-DC converter units condition the voltage from 160 to 120 volts DC to form a secondary power system to service the loads. The converters also isolate the secondary system from the primary system and maintain uniform power quality throughout the station.



The Grounding Rod of ISS

Before the ISS, electrical power systems on U.S space vehicles operated at the nominal 28 volts DC inherited from the aircraft industry. At such low voltages, the ionospheric plasma interactions are negligible and were not a consideration. The plasma at the ionosphere is nothing but a gas filled with charged particles that respond to electric fields - like the ones around the solar arrays. High-power systems such as those on the International Space Station operates at higher voltages to reduce power loss and system weight. Although the ISS may not have any problems related to internal earthing, but they have to consider the drawbacks of ionospheric contact at Low Earth Orbit.



These interactions may lead to high electric fields and arcing between the spacecraft components. Most of the adverse effects of spacecraft charging (i.e.- arcing and contamination) depends on the charging level of the spacecraft. As the charging increases more negatively (greater than 30 volts negative of plasma ground), the severity of these effects also increases. The most common issues that will take place is mission degradation and loss of contact, due to the interference from the plasma environment.

The Space Station arrays operate at 160 volts DC. When the arrays are producing power, the station structure will also tend to float to a voltage close to the array voltage. Under these conditions, to avoid the arcing over the surface from the surrounding environment, the structure has been grounded with a 'Plasma contactor'. The plasma contactor unit acts as an electrical ground rod to connect the Space Station structure to the local environment and harmlessly dissipate the charges that are over its surface. The grounding rod performs this function by converting a small supply of gas into ions and electrons and discharging this stream to space. The stream then carries with it the excess electrons that created the surface charge.

So, next time somebody asks you about, whether the equipment on the ISS is grounded or not, let them know how a 'grounding rod' in space looks like.

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