Flight Hardware Packaging Design for Stringent EMC Radiated Emission Requirements

This design can be used for any electronic package that needs to meet stringent electromagnetic interference/electromagnetic compatibility (EMI/EMC) environments.

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This packaging design approach can help heritage hardware meet a flight project's stringent EMC radiated emissions requirement. The approach requires only minor modifications to a hardware's chassis and mainly concentrates on its connector interfaces. The solution is to raise the surface area where the connector is mounted by a few millimeters using a pedestal, and then wrapping with conductive tape from the cable backshell down to the surface-mounted connector. This design approach has been applied to JPL flight project subsystems.

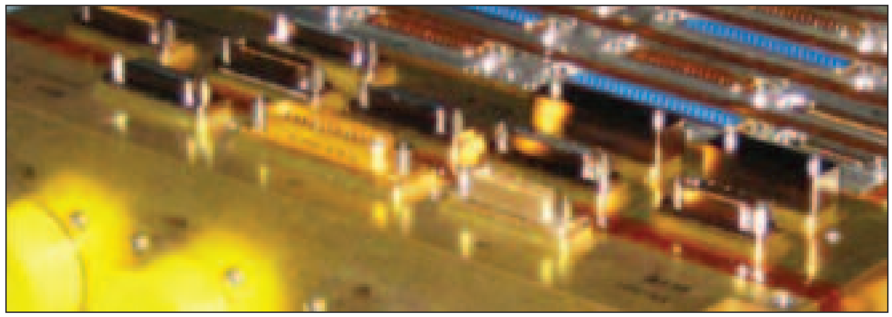

Figure 1. This picture shows the **Design Concept**, with the pedestals and the chassis as one piece of metal. The D-sub or Micro-D connector is then mounted on the pedestal. This pedestal provides a few extra millimeters for the conductive tape to make contact with the chassis.

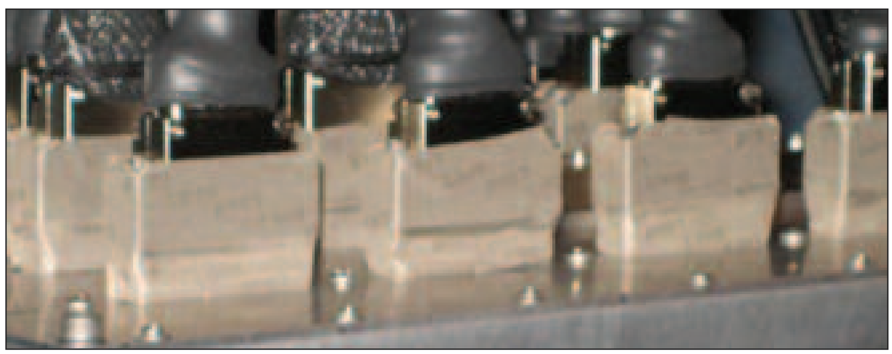

Figure 2. This picture shows the **Implemented Design Concept**. Conductive tape is wrapped starting with the pedestal, around the D connector, and ending at the cable backshell. This provides a continuous conductive enclosure that seals potential RF leakages from between the D connector and the chassis, and from between the cable plug and the connector receptacle.

The EMC radiated emissions requirements for flight projects can vary from benign to mission critical. If the project's EMC requirements are stringent, the best approach to meet EMC requirements would be to design an EMC control program for the project early on and implement EMC design techniques starting with the circuit board layout. This is the ideal scenario for hardware that is built from scratch. Implementation of EMC radiated emissions mitigation techniques can mature as the design progresses, with minimal impact to the design cycle. The real challenge exists for hardware that is planned to be flown following a built-to-print approach, in which heritage hardware from a past project with a different set of requirements is expected to perform satisfactorily for a new project. With acceptance of heritage, the design would already be established (circuit board layout and components have already been pre-determined), and hence any radiated emissions mitigation techniques would only be applicable at the packaging level. The key is to take a heritage design with its known radiated emissions spectrum and repackage, or modify its chassis design so that it would have a better chance of meeting the new project's radiated emissions requirements.

This design approach addresses radiated emissions leaking mainly from connectors. Based on a history of multiple EMC tests performed at JPL, D-connectors and micro-D connectors are known for compromising radiated emissions and causing test failures. There are two potential areas where radiated emissions can leak through: (1) the gap between the connector and the chassis (where the connector is mounted to), and (2) the gap between where the connector receptacle and the cable plug mates to. Both areas need to be shielded in order to reduce radiated emissions from leaking through these gaps. For this design, all D-connectors and micro-D connectors are mounted on an elevated surface area, known as the pedestal. The pedestal and the chassis are one piece of metal. For circuit cards that have the connector mounted on the card, this surface pedestal may not be possible. The alternative approach would be to implement a gasket to seal the gap between the chassis and the connector. Once the cables and connectors are securely mated, conductive tape is wrapped from the backshell (metal to metal contact) of each cable all the way to the raised pedestal onto the chassis, where the connector is mounted. In this process, the tape fully encloses the backshell, connector interface, and parts of the metallic raised chassis. This effectively seals any potential radiated emissions breach coming from the connectors, including from the gap between the chassis and the connector, and from the gap between the plug and the receptacle.

The novelty of this packaging design approach is to make limited changes to heritage design and increase its chance to meet a project's stringent radiated emissions requirement. Without employing a raised surface or using a pedestal, the act of using conductive tape to seal the leakages from the connectors becomes harder, because the tape may not fully enclose the gap between the connector and the chassis. Having some elevation gives that additional surface area for the conductive tape to fully enclose the gap. The alternative to the pedestal would be to implement a gasket design as mentioned in the previous paragraph.

With this approach to packaging, D-connectors and micro-D connectors that have long been considered a weak point for radiated emissions can be improved by using conductive tape and raising the surface area of where the connector is mounted. This gives enough surface area for the tape to fully enclose the gap between the connector and chassis, and between the cable plug and connector receptacle. This is a simple solution to reduce the impact of radiated emissions leakage from D-connectors and micro-D connectors.

This work was done by Charlene L. Lortz, Chi-Chien N. Huang, Joshua A. Ravich, and Carl N. Steiner of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. Refer to NPO-48440.

RF Reference Switch for Spaceflight Radiometer Calibration

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The goal of this technology is to provide improved calibration and measurement sensitivity to the Soil Moisture Active Passive Mission (SMAP) radiometer. While RF switches have been used in the past to calibrate microwave radiometers, the switch used on SMAP employs several techniques uniquely tailored to the instrument requirements and passive remote-sensing in general to improve radiometer performance. Measurement error and sensitivity are improved by employing techniques to reduce thermal gradients within the device, reduce insertion loss during antenna observations, increase insertion loss temporal stability, and increase rejection of radar and RFI (radio-frequency interference) signals during calibration.

The two legs of the single-pole double-throw reference switch employ three PIN diodes per leg in a parallel-shunt configuration to minimize insertion loss and increase stability while exceeding rejection requirements at 1,413 MHz. The high-speed packaged diodes are selected to minimize junction capacitance and resistance while ensuring the parallel devices have very similar I-V curves. Switch rejection is improved by adding high-impedance quarter-wave tapers before and after the diodes, along with replacing the ground via of one diode per leg with an open circuit stub. Errors due to thermal gradients in the switch are reduced by embedding the 50-ohm reference load within the switch, along with using a 0.25-in. (≈0.6-cm) aluminum pre-backed substrate.

Previous spaceflight microwave radiometers did not embed the reference load and thermocouple directly within the calibration switch. In doing so, the SMAP switch reduces error caused by thermal gradients between the load and switch. Thermal issues are further reduced by moving the custom, high-speed regulated driver circuit to a physically separate PWB (printed wiring board). Regarding RF performance, previous spaceflight reference switches have not employed high-impedance tapers to improve rejection. The use of open-circuit stubs instead of a via to provide an improved RF short is unique to this design. The stubs are easily tunable to provide high rejection at specific frequencies while maintaining very low insertion loss in-band.

This work was done by Joseph Knuble of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16398-1

An Offload NIC for NASA, NLR, and Grid Computing

New acceleration engine provides the functions of network acceleration, encryption, compression, packet-ordering, and security.

Goddard Space Flight Center, Greenbelt, Maryland

This work addresses distributed data management and access — dynamically configurable high-speed access to data distributed and shared over wide-area high-speed network environments. An offload engine NIC (network interface card) is proposed that scales at n×10-Gbps increments through 100-Gbps full duplex. The Globus de facto standard was used in projects requiring secure, robust, high-speed bulk data transport. Novel extension mechanisms were derived that will combine these technologies for use by GridFTP, bandwidth management resources, and host CPU (central processing unit) acceleration. The result will be wire-rate encrypted Globus grid data transactions through offload for splintering, encryption, and compression.

As the need for greater network bandwidth increases, there is an inherent need for faster CPUs. The best way to accelerate CPUs is through a network acceleration engine. Grid computing data transfers for the Globus tool set did not have wire-rate encryption or compression. Existing technology cannot keep pace with the greater bandwidths of backplane and network connections. Present offload engines with ports to Ethernet are 32 to 40 Gbps f-d at best. The best of ultra-high-speed offload engines use expensive ASICs (application specific integrated circuits) or NPUs (network processing units). The present state of the art also includes bonding and the use of multiple NICs that are also in the planning stages for future