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A LOW-MASS SOLAR PANEL WITH INTEGRATED POWER AND SIGNAL PROCESSING CAPABILITIES

Abstract

Traditional satellite technologies integrate solar panels, thermomechanical subsystems, power and data processing and harness subsystems together in a late stage of design. More recently this approach has become inefficient and its limitation can easily be overcome with modern manufacturing technologies.

The paper proposes an innovative approach to embedding power, signal processing and harness together with thermomechanical subsystem(s) and, when required, solar panels. The approach has been developed for the ARAMIS architecture for low-cost modular satellites, but it can easily be adapted to other architectures, missions and spacecraft sizes.

The proposed approach uses very thin commercial PCBs (0.2 or 0.3mm thick) as the lateral skins for honeycomb fillers.

On the one side of the honeycomb filler, the PCB is printed with copper implementing interconnections among solar cells and protection diodes. We have also developed a technology to fix solar cells directly to the PCB without the use of standard interconnectors. Protection glasses can be used normally.

On the other side of the honeycomb filler, the PCB hosts one or two commercial processors (we commonly use MSP430 family of processors, but any other device can be used instead) tightly interfaced with a Pro-ASIC-III FPGA for mutual HW/SW co-hardening of the CPU and its SW (more details on this on another paper submitted to IAC2011). The processors implement common functionalities for signal processing and data communication, such that simple analog or digital subsystems can be hosted directly on the inner surface of the same panel, using a simple plugplay approach. The harness is also printed on the same module to reduce the impact of harness on system design. Anternatively, a low-power, low-EMI RF-based data communication infrastructure can also be implemented on the same processor and module.

The inner side of the panel can also host power conversion, for an improved and more fault-tolerant interface of solar panels with the power management subsystem. A high-performance power distribution bus has also been tested, for a distributed approach to satellite power management.

We have achieved a panel of 200x200x10mm with a mass of about 120/200g (depending on what is actually implemented on the panel).

Alternatively, the honeycomb filler can be substituted with solid Aluminum for increased radiation shielding. Another alterative is also to substitute the external PCB hosting the solar cells with a carbon reinforced polymer film, to increase mechanical strength and reduce the mass up to 20g.