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A REDUNDANT POWER BUS FOR DISTRIBUTED POWER MANAGEMENT FOR A MODULAR SATELLITE

Abstract

The paper presents a novel Power Bus to be used in modular satellites, namely all those satellites which are built from a number of simple and identical modules to reduce development, manufacturing, integration and testing costs.

The idea behind the proposed Power Bus is to have power conversion (from solar panels) and power storage (in Li-Ion batteries) distributed all over several Power Management modules (the so-called "tiles") which contain, each: a solar panel; energy storage batteries with the corresponding power converters; a programmable power sink.

The proposed Power Bus is such as to allow direct connection of as many modules as required (to adapt system performance to the requirements), either in parallel (to increase current) or in series (to increase voltage) or both, while allowing a number of power management functions to be handled in a distributed way. For instance: i) accumulating the power from all solar panels towards the load(s); ii) accumulating the power to charge one or more distributed batteries; iii) transferring the unused power towards a user-selectable sink (usually on the coldest surface); iv) appropriate mixtures of the above; v) other functions like housekeeping and telemetry.

All the functions are implemented in a distributed way, with very limited centralized control (sometimes, even no centralized control), where each subsystem connected to it (namely: the solar panel with its MPPT converter; the batteries; the load(s); the power sink; the overvoltage protection) has appropriate characteristics which allow self-controlled distribution of electrical power and appropriate distributed load balancing.

System stability is guaranteed by the proposed characteristic of each subsystem in such a way that any number of modules can be connected to the bus without impairing overall performance and stability.

The performance of the bus depend on the characteristics of each module. A specific implementation is also addressed where each module has a 15x15cm2 solar panel and two Li-Ion rechargeable batteries, offering 15W continuous power and about 15Wh storage capability, allowing max 120V, 20A, 2.5kW for the load.

The proposed Power Bus can easily be made double-redundant to increase system reliability at a very limited cost. In addition, the bus is conceived to be tolerant to single faults (with at most a graceful degradation in case of one or more faults).