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11/15/94 File: PIC/SSPAPER/DANll

SOLID STATE SWITCHES FOR HIGH RELIABILITY SPACECRAFT USE

ABSTRACT

The drive to improve interplanetary spacecraft power system reliability and fault tolerance spurred JPL to develop a Solid State Power Switch (SSPS). JPL began the development of the SSPS in the late nineeen eighties to replace the traditional mechanical relay/fuse combination with high reliability solid state designs that provide distributed fault protection and load switching.

The first JPL switch was driven by the requirements of the Cassini mission to Saturn while the latest JPL design is driven by the requirements of the next generation, smaller and cheaper, spacecraft. This paper describes the different system design considerations and the specific design and implementation responses.

The Cassini spacecraft will be the first JPL spacecraft to utilize a solid state device for power distribution in place of the traditional relay-fuse combination. One hundred and ninety-two (192) **SSPS'S will be used to control numerous spacecraft loads. Additionally Cassini will be the first** JPL spacecraft to utilize the "hard power bus" concept. The hard power bus is defined as a system where a fault on a given load is transparent to the other users of the power bus. Thus, load faults on the hard power bus must be "cleared" (removed from the power bus) without triggering an under-voltage (out of regulation) condition on the other users. The fault protection and failure immunity properties of the SSPS directly provide for the implementation of the "hard power bus". The SSPS also provides the option (not possible with fuses) of re-energizing a load in the event that a self clearing fault or temporary overload condition has caused the load to "clear".

The SSPS is required to provide reliable operation throughout a long thirteen (13) year mission. A high degree of reliability is achieved by a completely redundant design and by hybridizing the design to K level requirements of MIL-STD 38534,

The SSPS is packaged in a 31 gr. hermetically sealed Kovar, 72 pin package measuring 4.06 X 5.33 X 0.63 cm. It is implemented by thick film technology and utilizes two (for redundancy) semi-custom digital gate-arrays for the command interface.

The latest JPL power switch concept is driven by the requirements of the next generation, faster, better, cheaper (and much smaller) interplanetary spacecraft. While the Cassini spacecraft utilizes a 900 Watt power system with 192 SSPS'S, the next generation spacecraft will utilize 50 to 100 Watt power systems and about 100 solid state switches. The Cassini 31 gr. SSPS is not suitable for the small volume and weight constraints of the next generation mission. Thus, a new power switching device is under development. Mixed signal ASIC technology will be used to obtain the highest possible level of integration, The goal is to package 4 independent power switches in a 15 cm^2, 20 gr. package. Additional design goals are: Flexible application, Zero OFF - state power consumption, output isolation and self contained logic power, all while maintaining the hard bus concept.

This paper describes and contrasts the design and implementation response of this two different interplanetary spacecraft.