Energy Power System for μSAT-3: Regulation, Distribution and Protection Modules

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1. Introduction

μSAT-3 is a satellite platform of 30 Kg of mass. It's in the segment of micro satellite, with general dimensions of 340 x 430 mm. The mission of μSAT-3 will be image capture from earth surface, with a resolution of 10 m/pixel. The micro satellite profile mission consist on a heliosynchronous circular orbit with an altitude of 680Km. It will have an electric propulsion system for orbital maneuvers (station keeping) and orbit functionality, which involves a pair of PPTs (Pulsed plasma Thrusters). The architecture of the EPS of the micro satellite μSAT-3 consists of 3 main blocks: Battery Charge Manager (BCM), Power Supply Module (PSM) and Power Distribution Module (PDM). The present work describes the PSM and PDM.

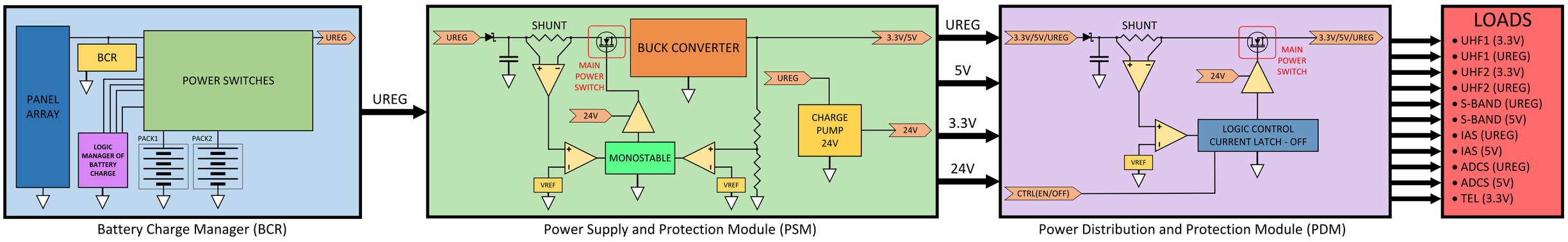

Figure 1: Energy Power System block diagram

2. Power Supply Module (PSM)

The PSM is responsible for voltage regulating of the unregulated Bus (UREG). The standard voltage levels used in digital control management systems are 3.3V, 5V. This regulation system is implemented with Buck Converter Topology and 24V with whose specifications are as follows:
Vbus(3.3V): Vripple $\leq$ 165mV (5%) Imax = 3A.
Vbus(5V): Vripple $\leq$ 250mV (5%) Imax = 3,5A.
Vbus(24V): Vripple $\leq$ 480mV (2%) Imax = 500mA.
The active protections base their operation on the continuous monitoring of current and voltage out in the converters. When any of the monitoring parameters exceeds the adjustable normal values, a main power switch that powers the inverter is turned off by interrupting the current flow. This switch remains off for a time of 500ms to 1000ms, this time is sufficient to avoid oscillations.

A typical fault problem is usually the clash of heavily charged particles in the power devices of the converters, such as Latch-up.

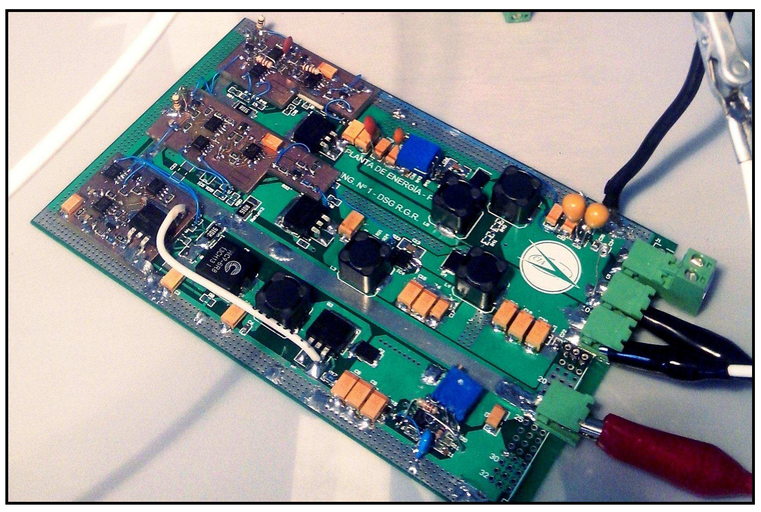

Figure 2: View of the PSM module implemented in EUROCARD format

3. Test results (PSM)

The PSM was tested in Overcurrent, Overvoltage and Short Circuit, as well as the Ripple in the Bus 3.3V and 5V, in the following oscillograms we can observe the behavior. (Test Protections: Yellow-Vout, Blue-Current).

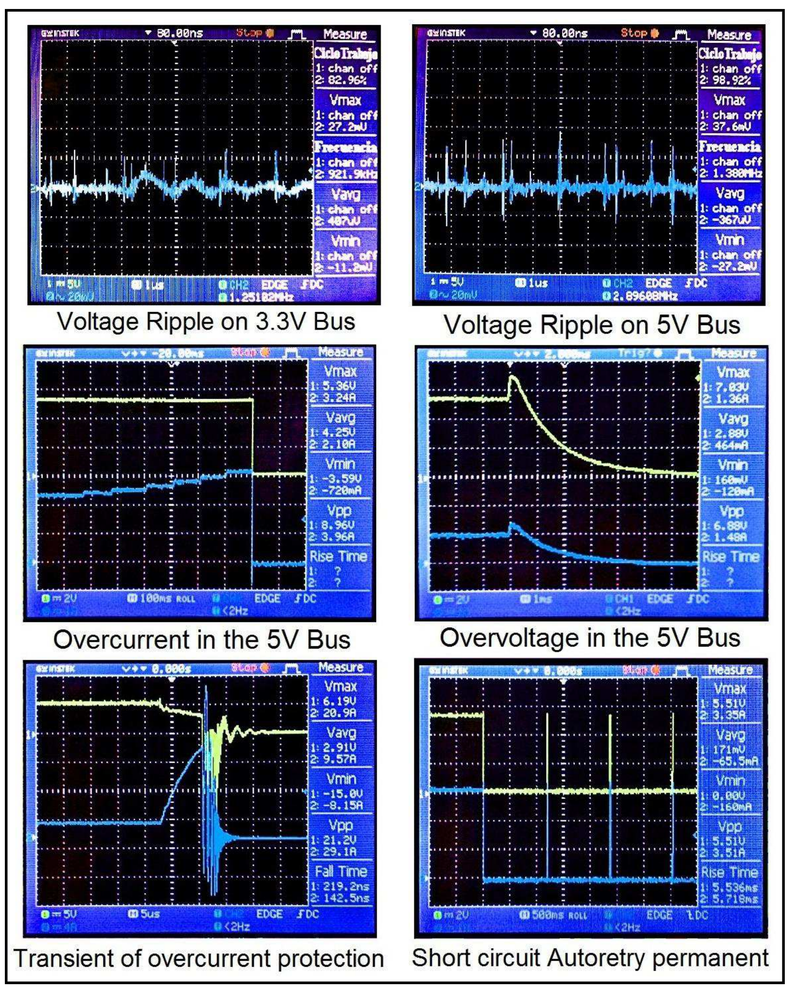

Figure 3: PSM Testing

4. Power Distribution Module (PDM)

The PDM allows the OBC to control the power that feeds each satellite subsystem. This allows isolating each subsystem in case of permanent failure. The module also carrying out telemetry of currents, voltages and power in each one of the loads of each Power Switch.

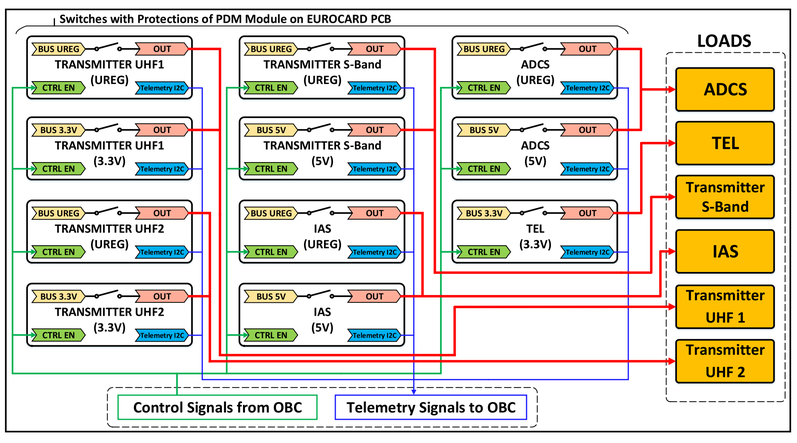

Figure 4: Energy Power System block diagram

The μSAT-3 has 12 power switches, one of them is located in the Propulsion Module to prevent large currents from returning in large wiring paths. The following diagram shows the PDM in block diagrams. Each power switch has over-current and short-circuit protections. In case of failure, it acts permanently shutting down the output, even if there is enabled signal.

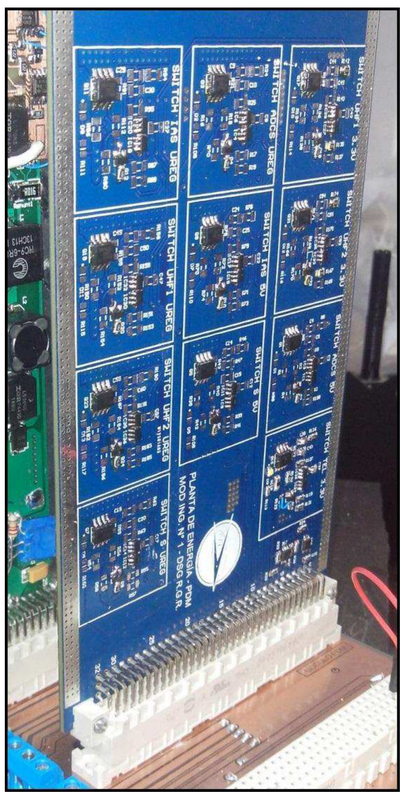

Figure 5: View of the PDM module implemented in EUROCARD format

5. Test results (PDM)

The module was tested in Overcurrent and Short Circuit on Power Switch 5V Bus. In the following oscillograms we can observe the behavior. (1-5VBUS, 2-5Vin, 3-Vout, 4-Current Switch).

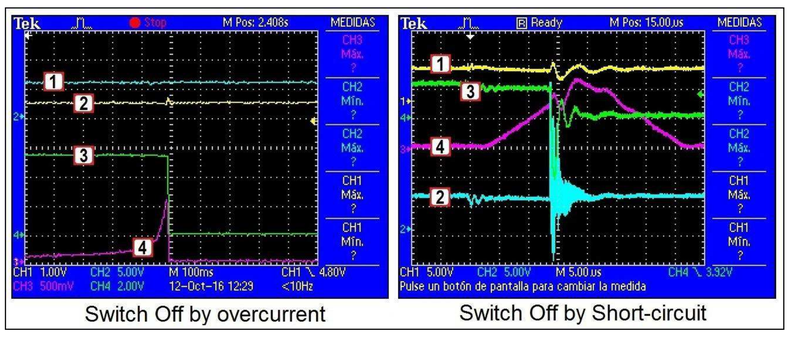

Figure 6: PDM Testing

6. Conclusions

The Voltage Buses quality has been verified with Vripple less than 2 % specified with max load, and corroborate the protections against some of the possible faults. It remains to submit the modules to space environment tests (radiation and vacuum).