THE ANALYSIS OF PSM (POWER SUPPLY MODULE) FOR MULTI-SPECTRAL CAMERA IN KOMPSAT2

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ABSTRACT:

The PMU (Payload Management Unit) in MSC (Multi-Spectral Camera) is the main subsystem for the management, control and power supply of the MSC payload operation. The PMU shall handle the communication with the BUS (Spacecraft) OBC (On Board Computer) for the command, the telemetry and the communications with the various MSC units. The PMU will perform that distributes power to the various MSC units, collects the telemetry reports from MSC units, performs thermal control of the EOS (Electro-Optical Subsystem), performs the NUC (Non-Uniformity Correction) function of the raw imagery data, and rearranges the pixel data and output it to the DCSU (Data Compression and Storage Unit). The BUS provides high voltage to the MSC. The PMU is connected to primary and redundant BUS power and distributes the high unregulated primary voltages for all MSC sub-units. The PSM (Power Supply Module) is an assembly in the PMU implements the interface between several channels on the input. The bus switches are used to prevent a single point system failure. Such a failure could need the PSS (Power Supply System) requirement to combine the two PSM boards' bus outputs in a wired-OR configuration. In such a configuration if one of the boards' output gets shorted to ground then the entire bus could fail thereby causing the entire MSC to fail. To prevent such a short from pulling down the system, the switch could be opened and disconnect the short from the bus. This switch operation is controlled by the BUS.

KEY WORDS: KOMPSAT, POWER, CURRENT, LIMITER, SYSTEM

1. INTRODUCTION

The MSC consists of the EOS (Electro-Optical Subsystem), the PMU and the PDTS(Payload Data Transmission Subsystem). The EOS is to obtain data for high-resolution images by converting incoming light into digital stream of pixel data. The PMU performs electrical and software interfaces between the MSC and the spacecraft, controls the operation of all the MSC payload subsystem by the ground station commands and reports all the SOH (State Of Health) telemetry to the spacecraft. The PDTS stores and transmits these digital image data to the ground station through X band antenna. The EOS consists of the PAN camera, the MS camera and the CC (Camera Controller). The PMU comprises of the SBC (Single Board Computer), the THTM(Thermal & Telemetry Module), the NUC(Non-Uniformity Correction Board), the APDE(Antenna Pointing & Deriving Electronics Board) and the PSM(Power Supply Module). The PSM supply all sub-system in MSC with the needed power that is regulated or not.

2. MSC PAYLOAD SUB-SYSTEM

The PMU is an on-board computer for the management, control and power supply of the MSC Payload operation. The PMU shall handle the communication with the S/C OBC for command and telemetry and the communications with the various MSC units. The PMU will perform that distributes power to the various MSC units, collects the telemetry reports from MSC units, performs thermal control of the EOS, performs the NUC function of the raw imagery data, rearranges the data and output it to the DCSU, and control the X-band Antenna LOS pointing. The PMU will consist of several sub-modules, with an architecture that supports full redundancy concept.

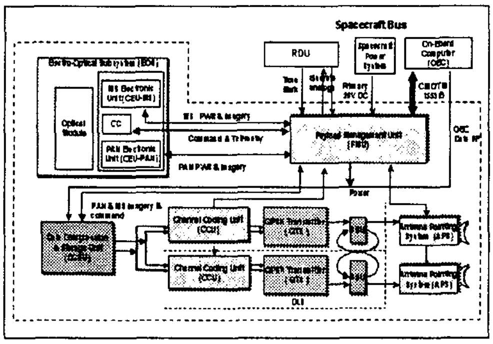

Figure 1. MSC block diagram.

As depicted in the figure 1, the SBC controls all the MSC units by means of receiving commands and data from the spacecraft via mil-std-1553B communication channel and distributing them to the proper unit at appropriate time via serial communication channel such as RS-422. The NUC is in charge of non-uniformity correction of image data. The DCSU deals with image data compression and storage. The APDE controls x-band antenna to make communication link with the ground station. The CCU is in charge of encryption, CCSDS (Consultative Committee for Space Data Systems) data encoding and randomization of incoming data stream from the DCSU. The THTM gathers the analog telemetry from all the units and sends them to the SBC and maintains the temperature of the EOS structure, optics and detectors within specified ranges.

3. POWER SUPPLY MODULE SUB-SYSTEM

The (PSM) is an assembly in the PMU which implements one component of the larger PSS. More specifically, the PSM implements the interface between channels V1 and V4 on the input, and the Sub-boards and EOS sub-systems on the output.

The PSM regulates DC power to the MSC sub-systems. Two such PSM boards will be used with additional circuitry on the Backplane form the Power Supply System for the MSC.

A functional block diagram for the PSM is shown below in figure 2.

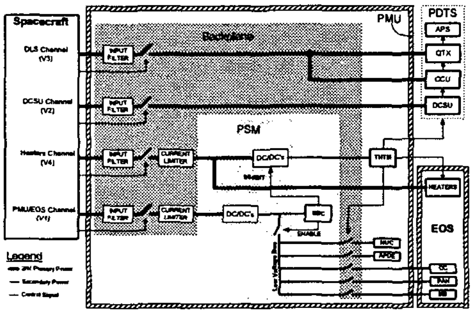

Figure 2. PSM Block Diagram

This block diagram is based on the requirements of the PSS mentioned above. There are two sets of DC/DC converters to step down and regulate the voltage (28V nominal) at the input. The upper set of converters sources all PMU/EOS outputs except for the THTM is supplied by the V1 input line and it outputs non-switched lines to the SBC and switched voltage lines to the bus.

The bus switches are shown to be controlled by the bus command signal. The lower set of converters is supplied by the V4 input and it outputs 3 non-switched THTM voltage lines as shown.

The PSM system consists of the line filter block board and the fuse block board.

3.1 The Line Filter Block

The Line Filter board is a double-sided rigid PCB that is responsible for filtering all of the operating voltages that are fed to the EOS and PMU. These operating voltages are received from the satellite's power distribution unit and are filtered in an identical method. The Line Filter board receives a total of four sets of operating voltages, each set designated for a different unit, comprised of a primary and redundant voltage, and coupled with a return line. All filtered voltages are afterwards transmitted to their destinations via sets of relays. The main function of the Line Filter board is to act as a filtration unit that filters the operating voltages that are supplied by the MSC satellite's power distribution unit to the EOS and PMU.

In general, the Line Filter board's electronics is based on a simple set of filtering blocks. Each filtering block is responsible for filtering either an operating voltage or a return line, and is identical in respect with structure.

Each operating voltage (or return line) is based on two physical lines. After filtration, the operating voltages are passed through a set of relays towards their destination.

The V1 operating voltages (primary and redundant) are fed to the power supply module (PSM) of the PMU, the V2 are fed to the external DCSU board, the V3 operating voltages are (primary and redundant) fed to the external QTX board , and the primary and redundant V4 operating voltages (heaters and telemetry) are fed to the THTM board of the PMU.

3.2 The Fuse Block

The Fuse Block board is a rigid PCB that is located on the DCSU/CCU connector panel of the PMU box. The Fuse Block board consists of a set of fuses that are used to limit the current applied with the operating voltages that are supplied by the PMU to the DCSU and CCU boards. The fuses act as a one-time protection mechanism, preventing possible over-currents from reaching the DCSU and CCU boards.

For the DCSU board, the Fuse Block board also supplies a steady leakage current in order to prevent an excessive inrush current from developing in the capacitor at the input of the DCSU board.

The Fuse Block board shall perform that provides over-current protection for the power supply lines of the DCSU and CCU, and prevents excessive inrush currents from developing at the input of the DCSU board. In the event of an over-current in one of the lines, the relevant fuse is burnt and provides a current breaking for the line. Those functions shall be implemented taking into account the redundancy requirements of the system. Both primary and redundant elements shall be implemented.

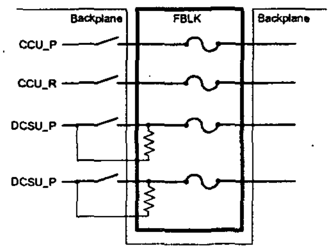

Figure 3. PSM Line filter Board

The board may be divided into two functional blocks, each block responsible for implementing a different function. The Fuse block includes the fuses for the four channels of the Fuse Block board (figure 3).
The Resistors block includes a network of some resistance those are mounted on the relay contacts of the DCSU powering lines. The purpose of these resistors is to ensure that a constant leakage current is fed to the DCSU board so that an excessive inrush current does not develop at the input of the DCSU board.

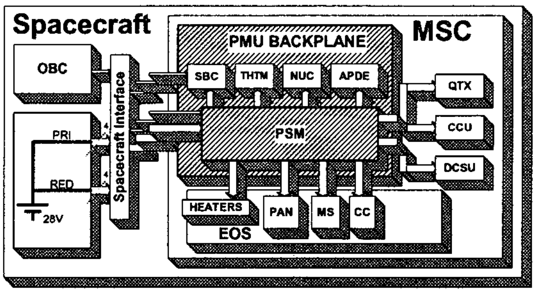

Figure 4. PSM Block diagram

The input power supply distributed to MSC over 4 channels (PMU/EOS, DCSU, DLS, HEATERS), each with redundancy (figure 4). Each channel filtered to protect satellite from MSC noise and to protect MSC from Satellite. Filters are mounted on Backplane. Each channel is switched under Satellite control. Switch status is sent back to the Satellite. Status signal is shorted to satellite's RDU ground when switch closed. All switches, except HEATERS, are off during Emergency.
The figure 5 is the used current in MSC power system. Every power channel provides over-current protection with a 10A fuse each channel provides inrush current limiting.

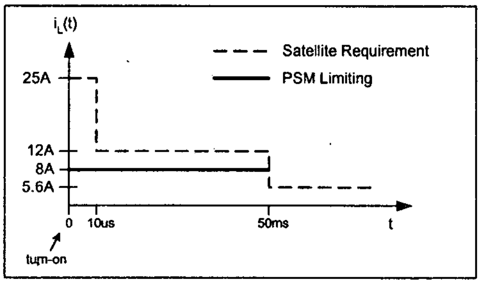

Figure 5. Used Current in MSC

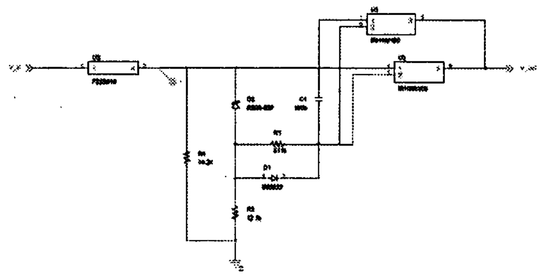

Figure 6. Current Limiter

The figure 6 is the current limiter configuration. It performs the current limiting operation. The figure 7 is the simulation result of the current limiter functional operation.

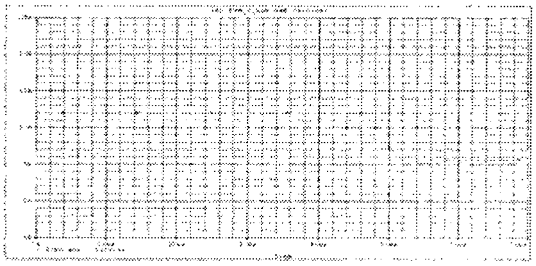

Figure 7. The Simulation Result (Current Limiter)

4. POWER CONTROL SWITCH DESIGN AND SIMULATION

The figure 8 is the output control switch. The switch will be controlled by soft-start with changing the capacitance value (C1) and the resistance value (R5).

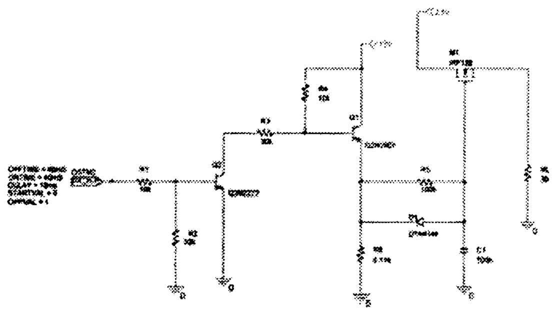

Figure 8. Output Control Switch

The figure 9-11 is the simulation result of the output control switch (figure 8) with changing the capacitance value of C1. As the figures, the start signal is controlled softly by the capacitance value.

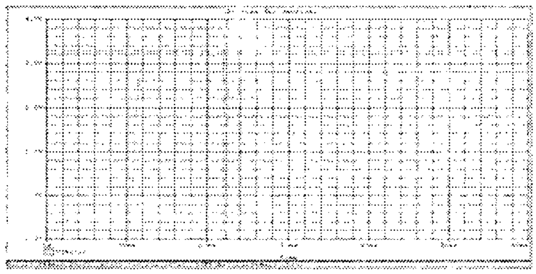

Figure 9. The Simulation Result (C1 = 10nF)

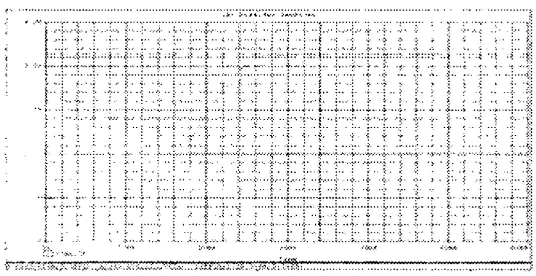

Figure 10. The Simulation Result (C1 = 100nF)

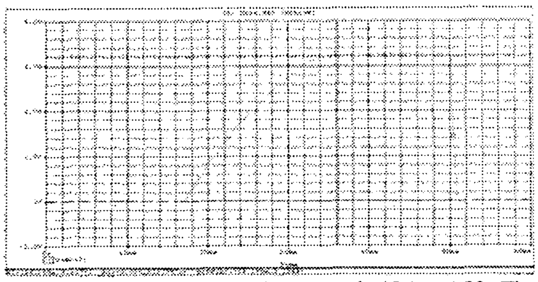

Figure 11. The Simulation Result (C1 = 150nF)

5. PSM GROUND SYSTEM BLOCK DIAGRAM

The figure 12 is the ground configuration of the PSM sub-system. That concept reduces the noise by the power of PSM. The PSM board has the high power and high current system, so ground concept is very importance for other sub-system's efficient operation.

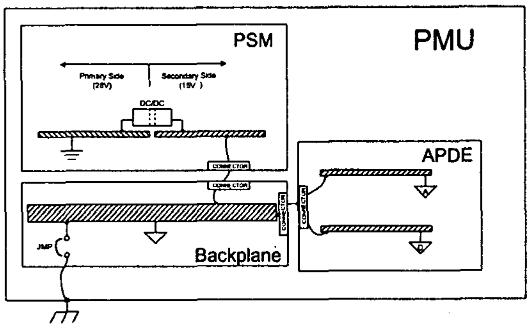

Figure 12: PSM Ground Concept Block diagram

6. CONCLUSIONS AND FURTHER WORK

In this paper, the KOMPSAT-2 electronic-payload power system is described in terms of the H/W configuration and the function operation.
This satellite payload system must need the high confidence and stability than other electronic system. The development of the MSC power electronic sub-system will be based on advanced design methods and tools, and will make use of novel advanced components and technology, in order to reduce size, power consumption, noise, weight and enhance performance
This paper also shows the stable power system-design through the various design results and simulations.
In the future, it is needed that the multi-purpose and large electronic payload system in satellite must have the high confidence, the big power capacity, the low noise and the small size. This design concept of the efficient power supply system will be used successfully.

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