Abstract: The Goddard Modular Smallsat Architecture (GMSA) is developed at NASA Goddard Space Flight Center (GSFC) to address future reliability along with minimizing cost and schedule challenges for NASA Cubesat and Smallsat missions.

The Goddard Modular Smallsat Architecture (GMSA) is developed at NASA Goddard Space Flight Center (GSFC) to address future reliability and cost challenges for NASA Cubesat and Smallsat missions. The GMSA PSE consists of five cards: Power Switches Board (PSB), PSE Processor and Adaptor Board (PSE-PAB), Battery Charge Regulator (BCR), Power Distribution Unit (PDU), and Actuator Board (AB). The GMSA C&DH includes the Analog and Digital Processor (ADP) and the Analog to Digital Converter (ADC) which are connected to the PSE cards and the Power Switches Board (PSB) through the I2C interface. The GMSA C&DH is implemented as a two board solution based on a Microsemi RTG4 Field Programmable Gate Array (FPGA) implementing a soft core processor. The C&DH can be configured to implement a variety of serial communication interfaces including RS-422, I2C, SPI, SpaceWire and general purpose input/output (GPIO) to provide the connectivity required for GMSA.

Conclusion

The PSE and C&DH subsystems that are currently under development will provide the miniaturization, flexibility, and reliability required for GMSA. Once completed, these development will position GSFC to develop cubesat and smallsat science missions that can operate reliably in harsh radiation environments for durations exceeding one year.

Robust, Radiation Tolerant Command and Data Handling and Power System Electronics from NASA Goddard Space Flight Center

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GSFC: Goddard Space Flight Center
C&DH: Command and Data Handling
PSE: Power System Electronics
COTS: Commercial-off-the-shelf
I2C: “Inter IC” or I²C bus (or IIC bus)
LRO: Lunar Reconnaissance Orbiter
MMS: Magnetospheric Multiscale
NASA: National Aeronautics and Space Administration
PDU: Power Distribution Unit
PSB: Power Switches Board
PSE: Power System Electronics
RS-422: RS-422 “High Speed Communication”
SPI: Serial Peripheral Interface
SpaceWire: SpaceWire open communication interface
cFS: Core Flight System
C&DH: Command and Data Handling
BP: Backplane Board
BCR: Battery Charge Regulator
AB: Actuator Board
PSB: Power Switches Board
PSE: Power System Electronics
I2C: Inter IC Bus
GMSA Battery
GMSA C&DH
GMSA PSE BCR
GMSA PSE PSE stack
6U Smallsat with Magnetic Boom Concept
6U Smallsat Model Design
GMSA PSE 10cm x 10cm Card
1U GMSA PSE stack
1U 10cm x 10cm Card (9Wh/64)
AB: Actuator Board
BCR: Battery Charge Regulator
BP: Backplane Board
C&DH: Command and Data Handling
COTS: Commercial-off-the-shelf
DET: Direct Energy Transfer
FW: Flight software
GMSA: Goddard Modular Smallsat Architecture
GPIO: General purpose input/output
GMSA Processor and Adaptor Board Block Diagram

6U Smallsat and C&DH Concept

Background

Within the National Aeronautics and Space Administration (NASA), interest is shifting from large-scale science missions such as the Lunar Reconnaissance Orbiter (LRO) or the Magnetospheric Multiscale (MMS) to faster and cheaper missions. Within industry and academia, many small missions have to date employed commercial-off-the-shelf (COTS) components in lieu of mostly radiation-tolerant or radiation-hardened parts. To enable higher reliability science missions that can operate at least one year in potentially harsh radiation environments, avionics which include command and data handling (C&DH) system and Power System Electronics (PSE) must have predictable reliability that goes beyond the capabilities of currently available COTS components. While there are a number of COTS components that can withstand a total ionizing dose (TID) of tens or hundreds of Grays, this is not universal. Furthermore, there remains concern regarding tolerance to and mitigation of single-event effects (SEE).

The Goddard Modular Smallsat Architecture (GMSA)

To meet this need for higher reliability small missions, NASA Goddard Space Flight Center (GSFC) is developing the Goddard Modular Smallsat Architecture (GMSA). Addressing improved reliability along with minimizing power, mass, volume, cost, and schedule constraints, GMSA is a modular, flexible, and extendable small satellite implementation approach that can accommodate spacecraft subsystems designed both internally within NASA and externally by industry and academia. Initially targeted for 6U (10cm x 20cm x 30cm) satellites, GSFC is developing GMSA Power System Electronics (PSE) and Command and Data Handling (C&DH) subsystems.