Concept of Mission Operations For MemSat

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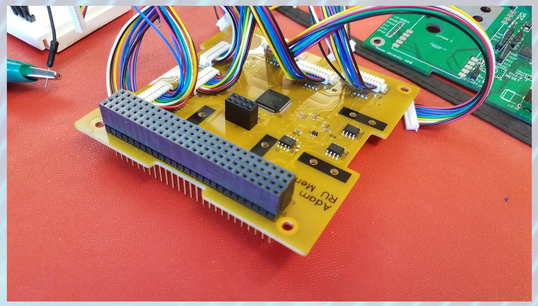
Sponsors: NanoRacks LLC., Keysight Technologies, Rowan University, NASA, NASA New Jersey Space Grant Consortium

Overview

- **MemSat** is Rowan University's first Nanosatellite being developed to test new commercially available resistive memory in the Low Earth Orbit (LEO) environment.
- The purpose of this **CON-OPS** (Concept of Mission Operations) is to establish the framework of operations of all major aspects of the MemSat.
- **MemSat Experimental Payload** provides an overview of the science & experimental objectives of MemSat.
- **System Architecture** provides brief descriptions of the various components and systems of the MemSat.
- **Mission Architecture** provides brief descriptions of the various segments and elements of the mission.
- **Operation Description** provides an overview of the schedule-driven operation approach that will be used to implement the mission
- **Pre-Deployment and Early Operations** provides the scenarios of selected processes to illustrate major aspects of the operations concept while MemSat is being integrated with our flight provider.
- **Normal Operations provides** scenarios of selected processes to illustrate major aspects of the operations concept once deployed from the International Space Station.
- **Integration and Testing** provides a description of the facilities and operations approach that will be used for Integration and Testing.

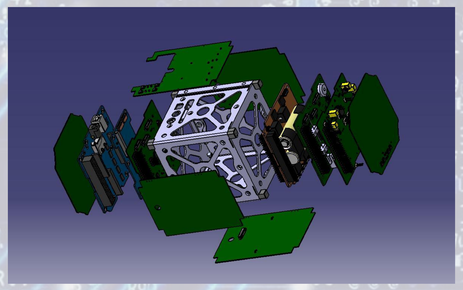
MemSat Experimental Payload

- MemSat's payload is primarily a scientific experiment. Its purpose is to evaluate a payload of several different memory types and their robustness in the harsh environment of Low Earth Orbit (LEO).
- Resistive memory is an alternative form of memory that has recently become commercially available. Compared to the traditional Field Effect Transistor (FET) based memory, resistive memory has lower power consumption, is competitively priced, and is potentially more radiation resistant.
- The experiment will write identical data to arrays of resistive memory as well as traditional EEPROM, and then observe which memory performs better.
- Performance of memory will be determined by number of bit flips and sent down to our Ground Station



System Architecture

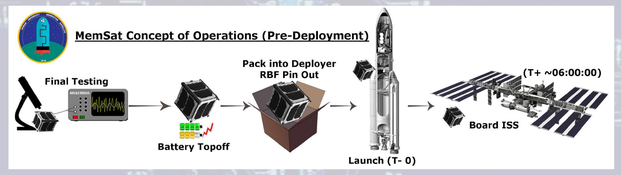
- MemSat's physical structure is 1U-style CubeSat, and consists of the outer frame of the satellite, its antenna, the motherboard, electrical power supply (EPS), transceiver, beacon, primary payload, secondary payload, and solar panels.
- C&DH (Command and Data Handling) is performed by a COTS motherboard from Pumpkin. C&DH communicates with the other various subsystems using SPI, I2C, and UART communication protocols.
- Power is generated via solar cells on the 6 external faces of the satellite. Energy is stored and distributed by a COTS EPS from GomSpace.
- Messages between MemSat and ground are communicated using the Silicon Labs Si4467 highly integrated transceiver IC.
- Physical stabilization of the MemSat is employed by a passive stabilization system using hysteresis rods to align satellite with Earth's magnetic field.
- Ground station receives data from the MemSat, the data is stored on a local computer and is then interpreted.



Exploded View of MemSat

Mission Architecture

- Phases of the mission are as follows:
  - **NanoRacks Delivery**: MemSat will be brought to NanoRacks for final integration, testing, and hand-off.
  - **Integration and Test**: all flight hardware is physically connected, and software tests are performed
  - **Pre-Deploy**: For almost all stages from the time of hand-off to NanoRacks to the time of being released from the ISS, MemSat is required to remain in a power-off state.
  - **Early Operations**: MemSat is deployed into orbit from the ISS, health check operations are performed, when these checks pass, then begins Normal Operations.
  - **Normal Operations**: when system health and orbital conditions are sufficient enough, the satellite will begin performing it's experiment.
- Provisions for launch and deployment of MemSat are coordinated by NanoRacks, LLC., aided by the International Space station, and funded in part through NASA's ELaNa program.
- MemSat is currently scheduled to launch May 20th, 2018.



Integration & Testing

- The satellite stack from the bottom up is as follows: Pumpkin Motherboard (with pluggable processor module installed), GomSpace EPS, Primary Payload, Secondary Payload, COMMS board.
- X, Y, Z side solar panel boards are fastened to the outer sides of the chassis, and their respective buses are connected directly to the EPS.
- One of the solar panel boards houses the antenna.
- For the testing required, engineering models (non-flight hardware), were implemented alongside flight models.

Temperature Testing Apparatus

Vacuum chamber

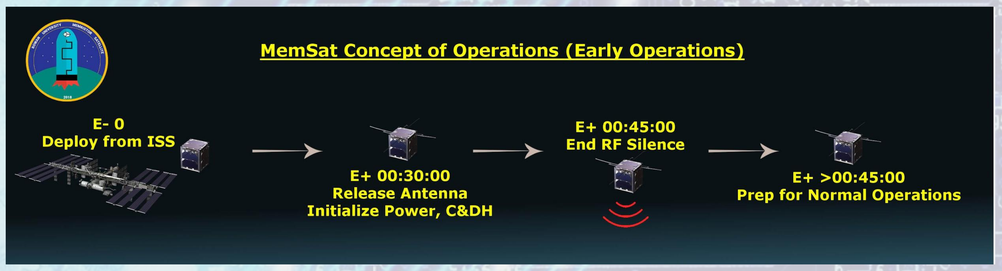
Flat Sat testing

Operations Description

- The primary experiment performed by MemSat will provide a comparison between memristive memory and traditional FET memory.
- Radio communication sends packets of data of the experiment and health to the ground station.
- Health checks are performed routinely.
- Power-on operations include initializing GPIO pins and flight processor hardware peripherals, running health checks, and sending a command to the EPS to turn on power rails for the payloads and beacon.
- C&DH with query the EPS for the battery voltage and enter the corresponding operational scenario.

Pre-Deployment & Early Operations

- Before MemSat is loaded into the deployer, MemSat team will be able to run some final tests and top off the charge on the EPS battery.
- After final verification and battery charging, the MemSat's remove-before-flight pin will be removed and only power inhibits will remain in place.
- After deployment from the ISS, Early Operations begin. The physical deployment will release the inhibits, powering on the EPS. After E+ 30 minutes, the antenna will be released, health checks will be performed.
- When health checks are sufficient, MemSat will enter Normal Operations.



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