MRT CubeSat Development

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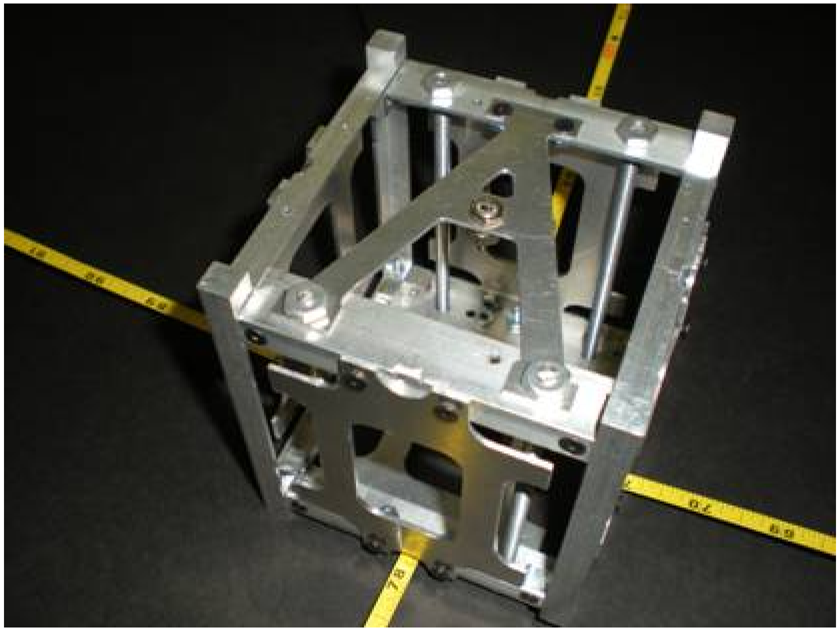
About the Microgravity Research Team

- Success measured by experience gained by its members.
- Volunteers meet after classes and on weekends.
- Multidisciplinary- all students are invited to participate.
- Students develop experiments that stem from their own research interests.
- Formerly know as the Get Away Special Team.
- Contributes to Utah State University’s reputation as the university that has flown more experiments into space than any other university in the world.

Sputnik: Project Goals

- Create a platform for future scientific missions
  - Establish radio communication and transmit data
  - Monitor component temperature to establish a basis for future component selection
- Minimize costs involved in satellite production
- Provide team members with experience and learning opportunities.



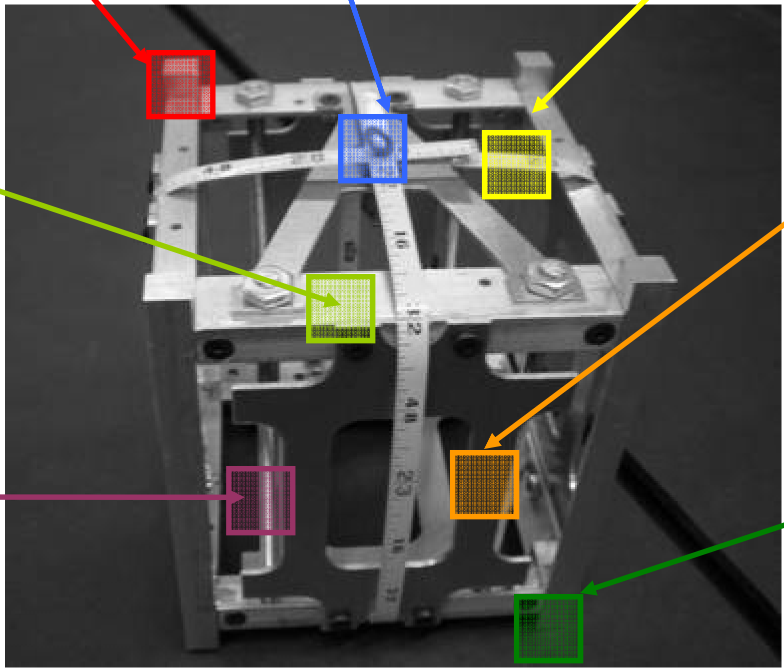
Sputnik: Structural

Rail
- Cross members fit externally
- Wiring through posts

Deployment
- Glow plug/fishing wire
- Glued antenna holes
- Detection available

Antenna
- Tape measure
- Curve aids deployment

Cross member
- Grooves stabilize and protect antennas
- Mounting points

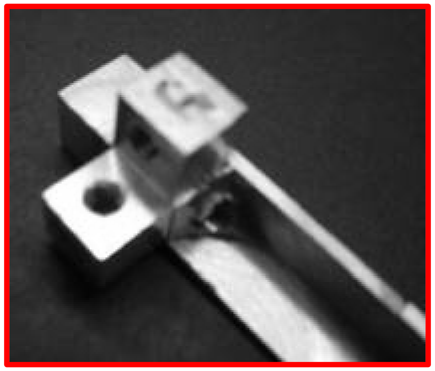


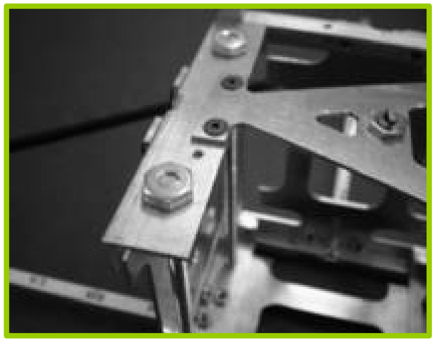
Solar Panel Mounting
- Grooved
- Fits two panels

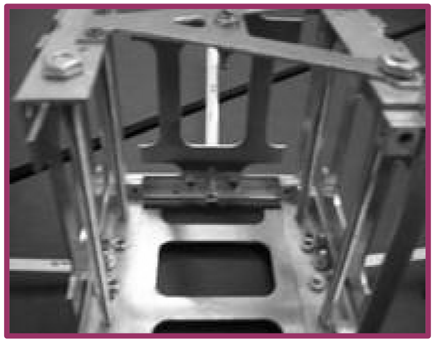
Board Columns
- Threaded
- Add strength
- Easy to make

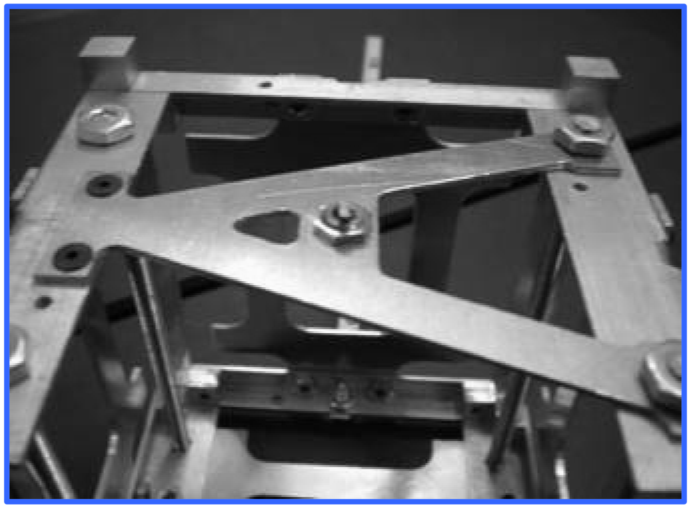
Separation
- Spring plungers
- Switches

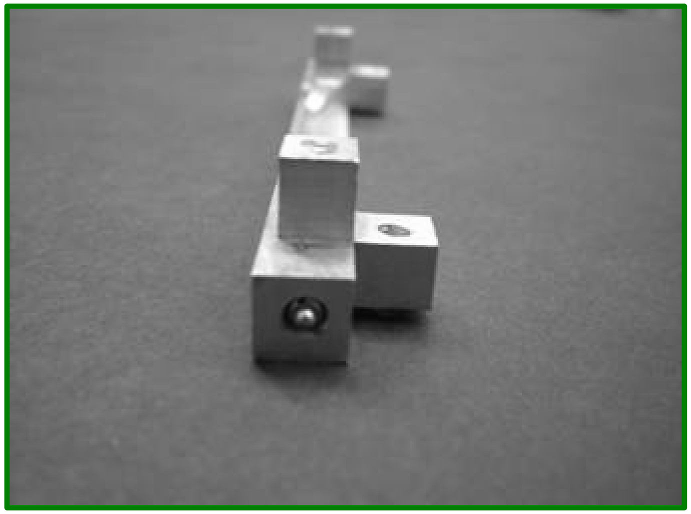
Sputnik: Structure Pictures

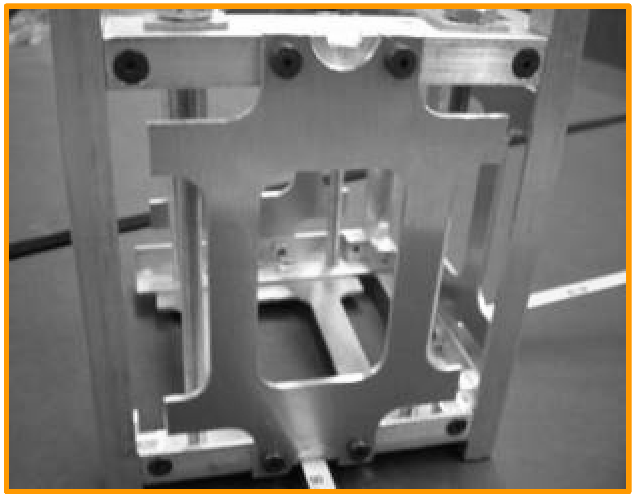












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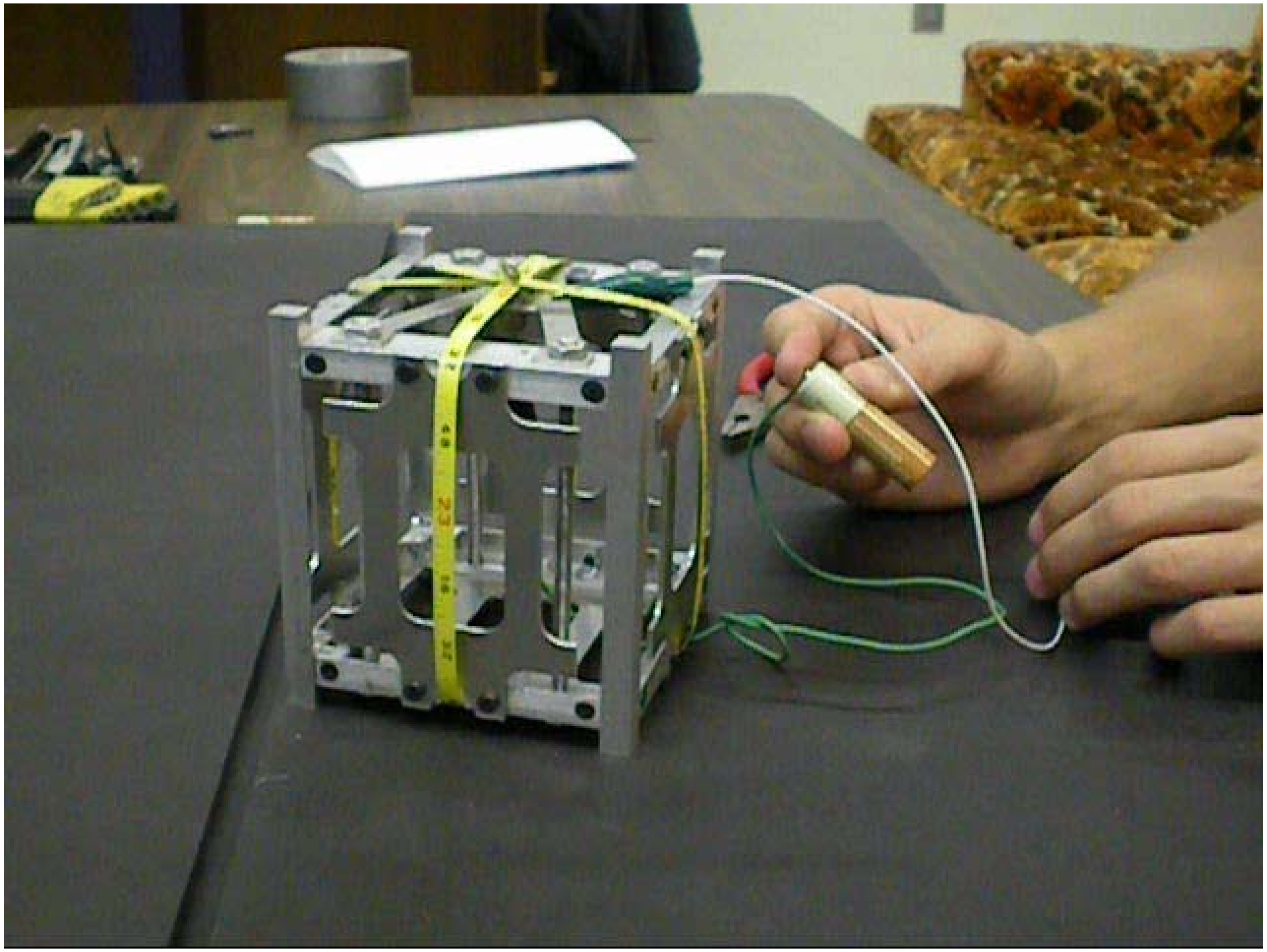
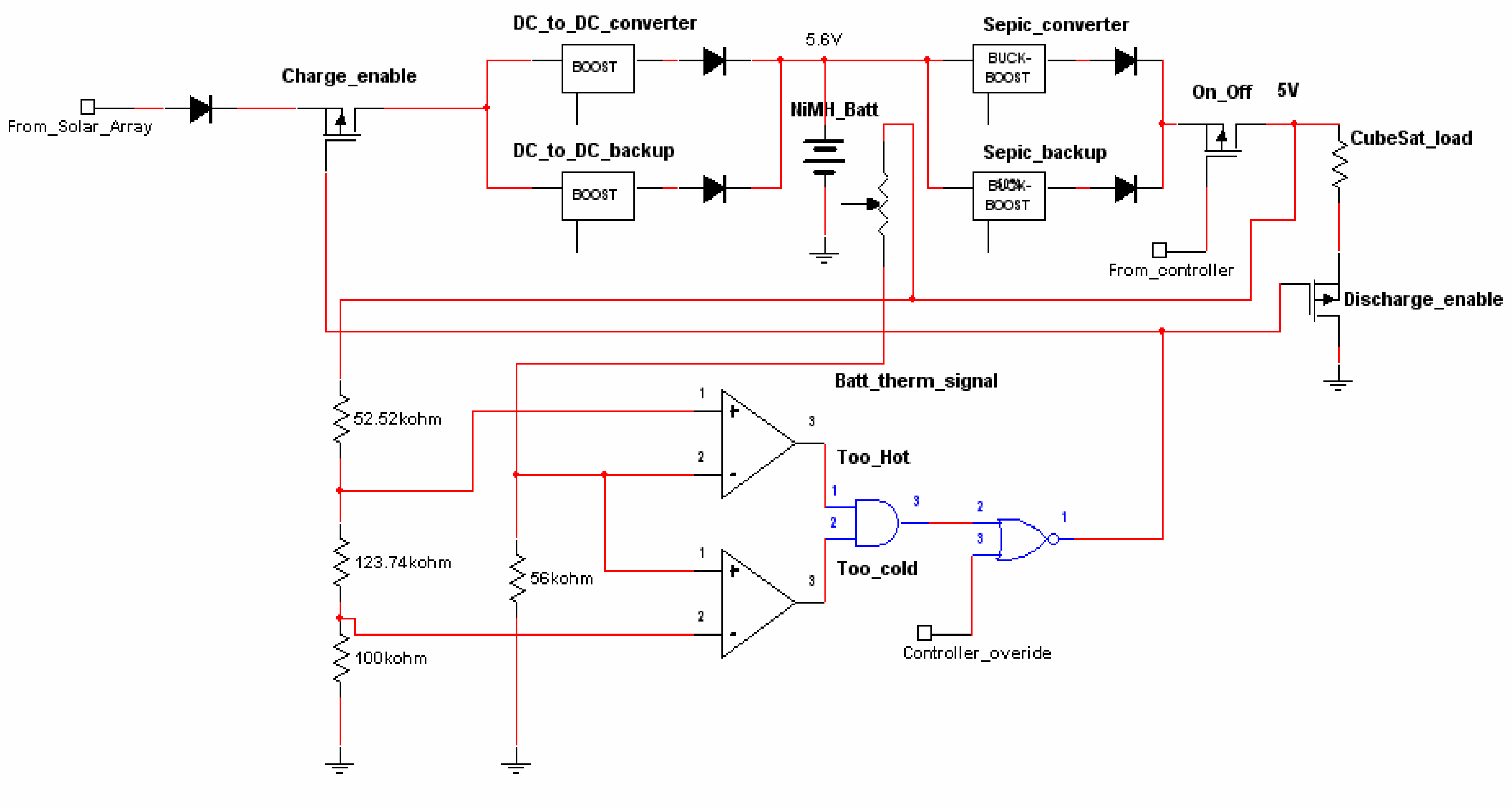
Sputnik: Deployment



Sputnik: Subsystem Power Requirements

Components	I(min)	I(max)	Duty Cycle	I(avg)	Power (@5 V)
Modem/Radio	50 mA	400 mA	6% (max) 94% (min)	71 mA	355 mW
Housekeeping	1 µA	50 mA	6% (max) 94% (min)	3 mA	15 mW
C&DH	150 µA	150 mA	100% at max (worst case)	150 mA	750 mW
Payload	1 µA	250 mA	6% (max) 94% (min)	15 mA	70 mW
TOTAL:	~51 mA	850 mA		239 mA	1.2 W

Sputnik: Power Schematic



Sputnik: Power Schematic

- Only two signals from microcontroller: charge/discharge enable override and on/off control.
- No battery charging when temperature above 45 Celcius or below 0 Celcius.
- Dual junction solar panels. Six panels connected in parallel produce 4 volts. Maximum current produced before significant voltage drop occurs is around 550 mA.
- Batteries: 4 Panasonic HHR210AH NiMH cells (4.8V nominal, 1900 mAh)
  - High and low temperature charge and discharge capability
  - Long life
  - Energy density
  - Cost
  - Accept permanent charge of 1/20 C without damage.
- Simple and effective charging
  - No fast charge controller
- Max 641 DC/DC step-up converters used in parallel for redundancy.
- All of the components are either space rated or can be made space rated with the exception of the batteries.
- The batteries were set up and tested under non-space conditions for performance.

Sputnik: Batteries

Battery:	Cell Voltage	Capacity	Temp Range	Mass	Technology
HHR120AA	1.2 V	1220 mAh	-20º to 65º C	23 grams	Ni-MH
HHR70AAAJ	1.2 V	720 mAh	-20º to 65º C	13 grams	Ni-MH
VHTAA	1.2 V	1150 mAh	-10º to 55º C	24 grams	Ni-MH

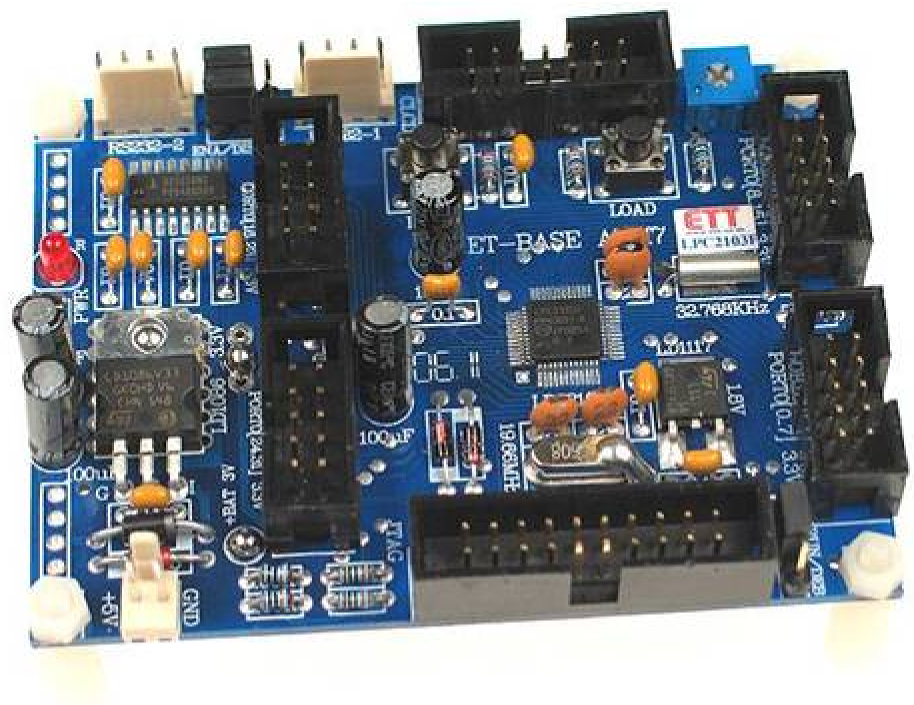
Why Ni-MH batteries?

- They have higher energy density than Ni-Cd
- They are easier to charge than Li-ion
- They have a longer charge-cycle life than Li-ion
- They have more heritage in space
- They are more reliable

Sputnik: Microcontroller

Features:

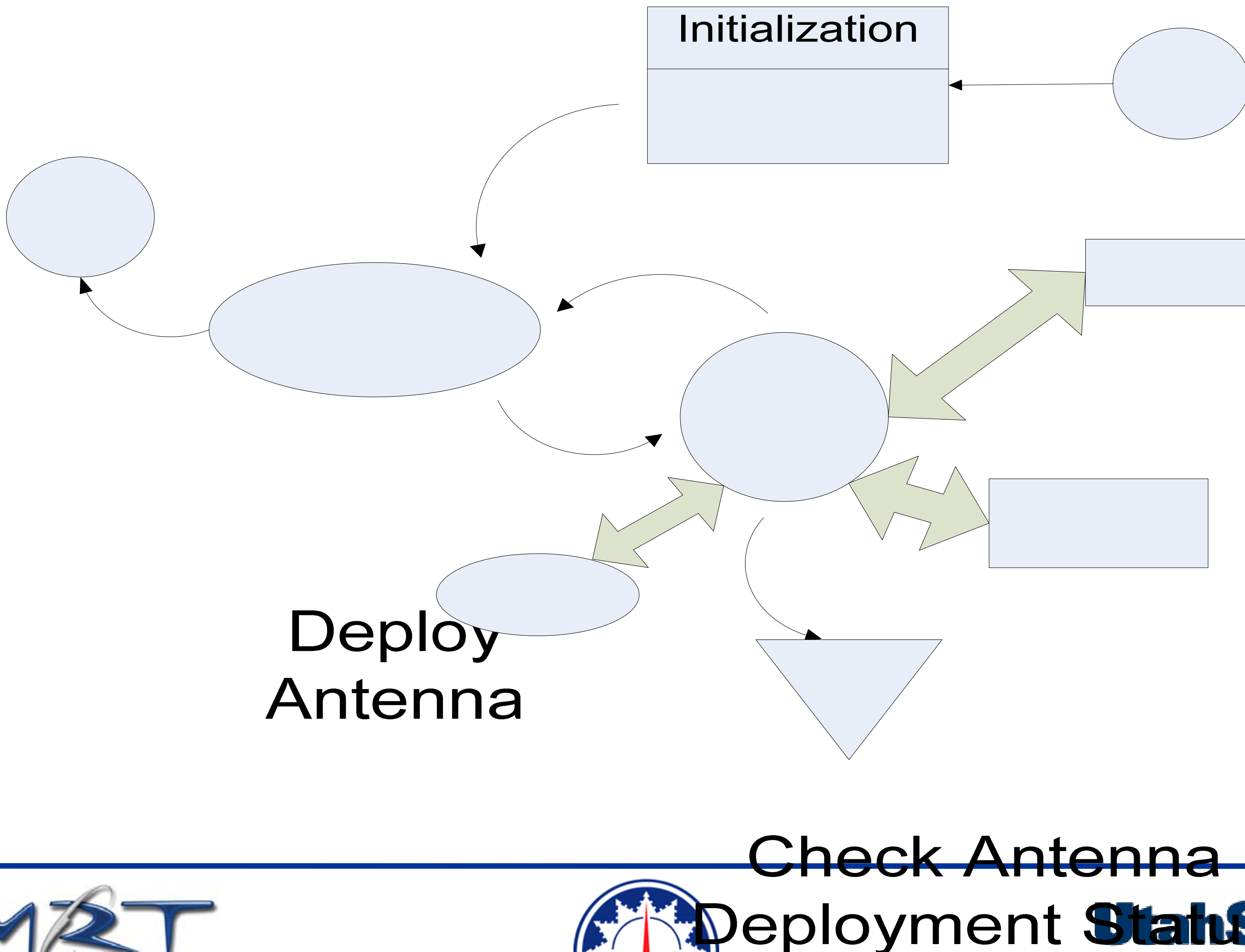
- Real-time clock
- Low power consumption
- 2 UARTs
- 2 SPI busses
- 2 RS232 ports
- 3.3 V supply pins
- 32 General I/O
- 82mm x 62mm x 25mm
- 20 MHz operating frequency
- 32 KB of flash memory
- 8 KB of RAM



ARM2103

Microcontroller Board

Sputnik: Software Flowchart



Sputnik: Software Solutions

Operating System: freeRTOS

- Small memory usage (less than 236 bytes)
- Simplifies interrupts
- Free!
- Modifying to port to ARM7 microcontroller

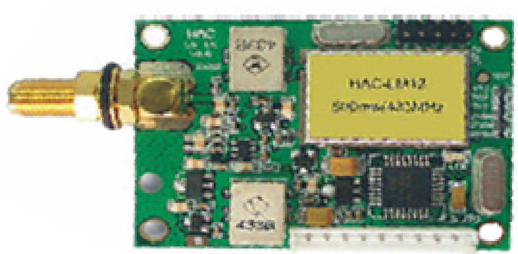
IDE

- KARM compiler for ARM processors
- C programming language
- Flash-magic (Used for programming hex file to chip via RS232 port)

Sputnik: RF Modem Specifications

For Prototype only (will not be used):

- Power Output: 500mW@5V, up to 1W max
- RF Effective Rate: 1200/2400/4800/9600/19200/38400bps
- Receiver Sensitivity: -124dBm@1200bps, -118 dBm@9600bps
- Communication Mode: Half-duplex
- Frequency Band: 433MHz(Default), 400MHz~470MHz(customized)
- Channel: 8(Default), 16/32 (customized)
- Default Interface: COM1: TTL/UART, COM2: Non-Standard RS232 or RS485
- Customized Interface: COM2: Standard RS232 or RS485



Sputnik: Science

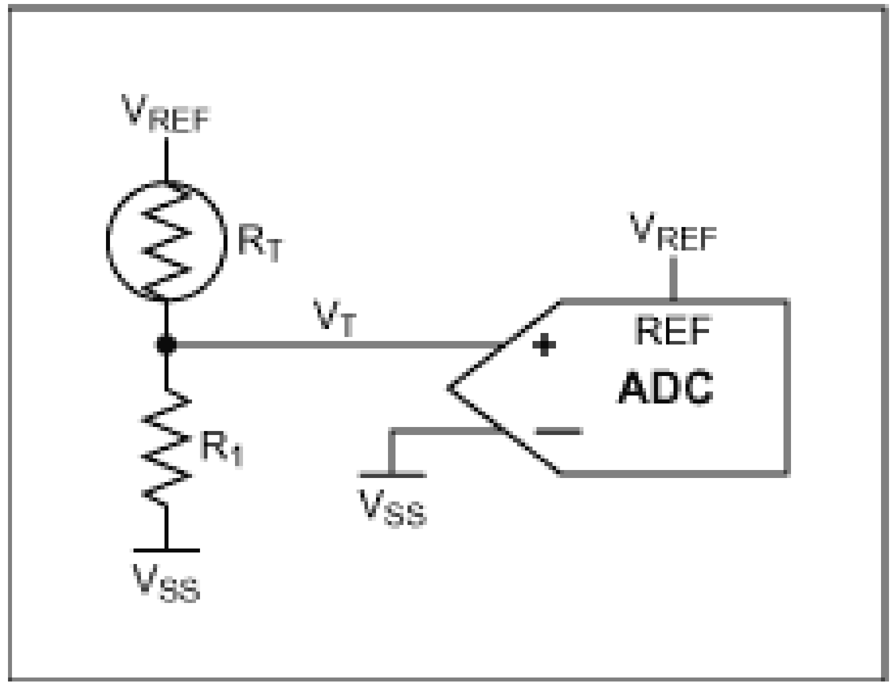
Circuit to use the Thermistor

-Rt = Thermistor resistance

-R1 = 250k ohms

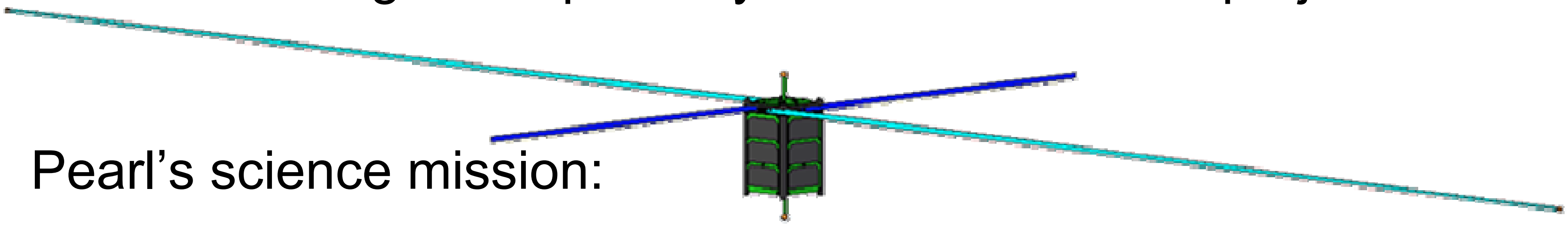
-Equation for Rt:

R1 *[(2^n/ADC) - 1]



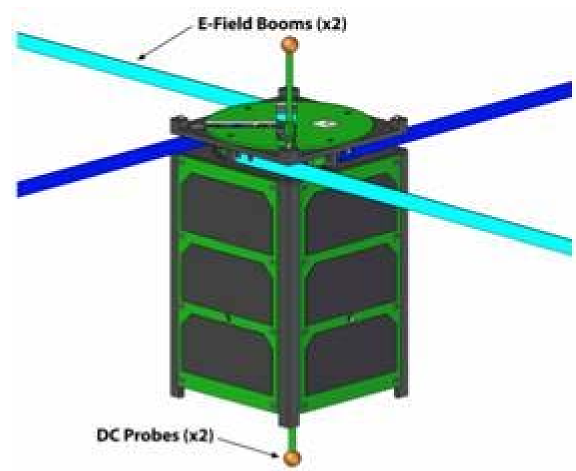
What we’re working on now: Pearl

MRT is working with Space Dynamics Lab on this project.



Pearl’s science mission:

- Take electric field measurements in the ionosphere
- Measure plasma density



Pearl is a spin stabilized 1.5U CubeSat. To make its scientific measurements it must deploy 2 two-meter booms and 2 DC probes.

The End

Questions?

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