"Volksat" A picosat project (Draft 2)

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Abstract

Some months ago, on the amsat-bb email list, Cathryn Mataga, (ke6i) made the suggestion of a "simple sat." Keep the complexity down and hence increase reliability. Hers was not the only plea made on this list, the suggestions was made to make a simple on/off style of controller, simple one up/down transponder, simple power system. In other words, "Keep It Simple Stupid" (KISS). The idea has a lot of other benefits. First off, it allows us to keep the mass down, it reduces the power budget, they will be simple and inexpensive to build and it allows these to be cranked out on an near assembly line basis. Perhaps allowing us to quickly get near 24/7 coverage in the sky.

The "Volksat"

The "volksat" will consist of the following:

1) aerogel high capacitance power supply
2) one common ni cad pack
3) one 15kHz wide 2m up to 440MHz down linear transponder
4) one command and control receiver.
5) a simplified controller.

1 Aerogel Risks/Benefits

Aerogel technology as the sole power supply is untried in space. Aero-gels have been approved for use in the cabin environment of the space station, and aero-gels have flown in other satellites, (Mars Rover) but not as the power supply.The aero-gels will have to be potted, or they will vent to space. On the other hand, an aerogel fails in open mode, hence the sat will still be usable even if one of the packs opens up. Note that the present plan is to use 3 aerogel packs in parallel. Even if all three failed, the satellite ought to be still quite usable in sunlight.

Since aerogel carbon storage capacitors are unproven in a vacuum, testing in high altitude balloons and/or sounding rockets will be made if the opportunity arises.

2 2m/440 MHz linear transponder

This will be designed to translate a 10uv signal at the up link antenna on 2m into 125mw output. At a 300 mile orbit, this would provide a plenty strong signal. The transponder will automatically be turned off by the controller when in eclipse, leaving only the command and control receiver listening.

3 Command and control

This will be designed to be a separate receiver, not built into the linear transponder. This is to provide in a secure and reliable fashion our legal requirement to be able to turn off the satellite as needed. It will run at all times off of the aero gels.

4 Controller

The controller will be a low cost micro controller with a known flight history on spacecraft. It will have the boot in ROM and will boot securely into a known state with all transmitters off. There will also be the ability to load additional code as needed, at 300baud into an on board EEPROM. Telemetry will be sent to the ground at 20wpm cw using in-band modulated tone. The following information will be sent to the ground:

1. battery voltage
2. solar array voltage
3. charge current
4. storage capacitor voltage
5. voltage regulator output voltage
6. Current on voltage regulator output
7. one byte will be sent that will flag TX on/off, low power/high power mode, battery on/off.
8. All cw values will be sent in order as 3 hex nibbles, framed by a starting "HI" and "HI" sent in morse. Data would appear as "HI000000..." With the first value being battery voltage in volts.

Preliminary Power budget

- 300 mW output 2M to 440mhz transponder - 500 mW
- micro controller unit - 75mW

- tlm transmitter (CW keyed oscillator in d/l passband) - 50 mW
- Command and Control receiver - 50 mW

Total 675 mW

Available power from one 10 * 50 F 2.5 V capacitor aerogel storage unit and one 5v output switching supply = 0.3 WH (based on observations on a working model)

Assuming a 90 minute orbit, with 45 minutes in daylight and 45 minutes in darkness and we require 0.75 * 675 = 0.501 WH power. Using two 10 capacitor storage units would provide 0.6 WH. Using three storage units would provide 0.9 W and provide a generous reserve power source.

Preliminary estimated dimensions

The satellite will be a 20cm x 20cm x 20cm cube. Each aerogel pack will be roughly 8.5 cm wide by 11.5 cm long by 8 cm high. Transponder will be roughly 4cm wide by 2cm high by 6cm long. Command receiver should be roughly similar size to Transponder. Microcontroller would be 4cm wide by 2cm high by 8cm long. Each of these in their own box. One alinco bar magnet 15cm long by 1cm thick by 2cm wide (or similar) (for static magnetorquing)

Mechnicals

All boxes will be made from 6061 T6 alumnium plate. All screws will be mil spec stainless steel. There will be a middle deck plate with everything bolted to it. The controller board will be buried as deep inside the s/c as we an to minimize radiation hits. All wiring will be teflon insulated, silver plated copper. All connectors will be mil spec. nickel or cadmium plated fittings are acceptable. No dissimilar metal shall be mated in connectors. Most connectors will be common mil spec "D" type connectors. SMA or SMB connectors will be used for RF connections. SUB-D and MDM connectors may be used if available cheaply.

Preliminary mass budget

The aerogel packs will be heavy due to the potting, we are estimating 2 KG. The one ni cad battery will be 1/2 KG. The rest of the satellite will be on the order of 1.5 KG. Total estimated mass will be 4KG. Transponder has roughly cm wide by 2cm high by 6cm long.

Antenna

The antenna will consist of one piano wire per side, for a total of 6. Exact configuration TBD.

Link Budget

TBD.

Thermal Budget

TBD