Firefly Comms Plan

November 30, 2009
Firefly Operational View

UMES POCC
Pocomoke City

Science Team

Internet

11/30/2009
• MicroHard MHX-425 UHF Transceiver.
• 2W transmit power.
• Deployable half-wavelength dipole antenna with reactive balun.
• Meteorological satellite service frequencies in the 400.15 – 402 MHz band.
• UHF dish on the ground (baseline is NASA/WFF 36 dB gain UHF dish).
• MicroHard ground radio (matched to MHX-425) connected to UHF dish.
Firefly Comms Configuration

Volume 1: Instrument

- Ant/GGB mini-board
- Optical/ VLF Front End
- Photometers
- Dashed = Gravity Gradient Boom (GGB)

Volume 2: Instrument

- GRD front End
- Photometers
- Optical/VLF Front End
- Experiment Power Regulator board
- Grd electronics
- Scintillation-based gamma-ray detector

Volume 3: Spacecraft

- FMB/MHX-425
- EPS w/Batteries
- GPS/magnetometer
- EPR
- ECB 0
- ECB 1

Flight Mother Board and radio
Power system
Subsystem board
Experiment Power Regulator
Experiment Control Boards

1U Spacecraft Bus Layout

Sub-system Board: magneto-torquer ctrl, deployer ctrl, Exp Pwr switching, GPS, magnetometer
Comm ant/balun, VLF ant, GGB deployment
Optical diode electronics, LNA, filters, etc.
Photo-diodes & collimators

Transceiver plugged into FMB
WFF link margin calculation shows link margin of at least +9.3 dB at 5° elevation:

**Method 1:**
Transmitter gain (2W) = 33 dBm = 3 dBW  
SC losses = 3 dB, SC Antenna Gain = 1.4 dB  
Free Space Loss = 151 dB (max slant range 1889 km at 5 deg elevation of tracking antenna)  
UHF antenna at WFF gain = 36 dB with 15dB LNA, UHF antenna at WFF losses = 4dB  
MHX-425 receiver sensitivity at 115.2kbps = -107dBm  
Total: 33-3+1.4-151+36-3+15+107 = 35.4dB, 20 dB required -> **15.4 dB margin worst case.**

**Method 2: (using antenna G/T – more accurate)**
Downlink frequency 401 MHz, ground antenna size 18.3 m, Ground antenna G/T 6.9 dB/K  
Data modulation Bi-Phase; carrier modulation PCM-PSK/PM, Data rate 0.1152 Mbps  
Transmitter power 2 W (33 dBm), spacecraft passive losses 3 dB, spacecraft antenna gain 1.4 dB  
Spacecraft EIRP (min) 31.4 dBm  
Altitude 430 km, elevation angle 5 degrees, slant range 1889 km  
FSPL -150.0 dB, atmospheric loss 1.0 dB, Received power -119.6 dBm  
Ground antenna gain (effective) 35 dBi, ground station passive loss 3 dB  
Received power at feed -87.6 dBm, System noise density -170.5 dBm/Hz, Carrier to noise 82.9 dB  
Bit-rate level 53.6 dB-bps, Required Eb/No 20 dB, Required carrier to noise 73.6 dB-bps  
-> **margin 9.3 dB worst case**

**Method 3 results in 11.3 dB link margin worst case**

11/30/2009
• NTIA forms filled out with all available information.
• Missing information for NTIA forms requested from MicroHard; awaiting response.
• Once forms fully filled out, will review with GSFC Spectrum Manager and file request for frequency licensing.
• Antenna deploys autonomously 30 minutes after ejection from P-POD.
• Transceiver enters sleep/sniff mode until receives ground transmission.
• As backup, turn transceiver on and transmit when expect to be near ground station, possibly using GPS location.
• If no ground contact within 3 days (TBC), reboot transceiver.
• Up to twice daily ground-station overpass for data downlink.
• Weekly command uplink (more frequent if and as needed).
• Flight software designed for autonomous operations, self-diagnostics provides single-event upset (SEU) recovery.
✓ Pre-Experiment Integration & Test – Passed

Checkout of comm link between MHX-425 ETU and MHX-425 ground radio ETU

• Slave radio (on Pumpkin development board with other Firefly Spacecraft ETUs and Firefly Flight Software version 1)
• Master radio (on MicroHard development board)
• Purpose was to check out the flight software command and telemetry interface and validate the form fit and function of the radios

• Spacecraft Flight Software Acceptance Test – NLT February 2010
  • Check out all spacecraft flight hardware, and flight software with experiment ETUs (Experiment Control Board (ECB) and Experiment Power Regulator (EPR))

• Pre-Environmental Comprehensive Performance Test (CPT) – NLT March 2010
  Firefly in final flight configuration and tested with remote ground station
  • Comm link will include test with at least 0.5 km between ground dish and satellite with attenuation between ground station antenna and receiver to simulate orbital slant range.

• Environmental Test – NLT April 2010 at WFF
  • Vibration
  • Thermal vacuum & thermal balance
  • CPT (between and after each environmental test)

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