FUNcube from AMSAT-UK

Launch and Early Operations
FUNcube from AMSAT-UK

- The FUNcube project - overview
- Current status
- FUNcube-1 hardware
- Dnepr launch from Yasny Q1 2013
- Early operations
- Educational outreach and amateur radio schedule
FUNcube project overview

• Construct and launch a 1U CubeSat to include an amateur radio transponder and to provide educational outreach to inspire students in STEM subjects

• To retain / enhance the expertise required within the UK

• To encourage and provide hardware to other small satellite groups

• To pursue launch opportunities on behalf of the AMSAT membership
Current Status

**FUNcube-1**
Flight model in thermal vacuum / vibe tests.

**FUNcube-2**
3 FM boards delivered to Clydespace (Scotland) for UKube-1 3U CubeSat

Orlando 2012

David Bowman  G0MRF
**FUNcube-1 Hardware**

CCT board. AMSAT-UK
Transponder. AMSAT-NL
2m Amplifier AMSAT-UK
Power system Denmark
Structure ISIS (Netherlands)
Antenna system ISIS

Solar panels:
Solar cells Germany
Aluminium mounting Israel
Assembled in Italy

United States…… ( ITAR )

Flight model
Engineering model

Orlando 2012

David Bowman  G0MRF
FUNcube-1 Hardware

RF Board  PA3WEG
Command receiver + 19kHz UV transponder
Also (end of life) FM to DSB

145 MHz Amplifier  RD02MUS1 FET
+ 4 channels of telemetry via I2C bus
**FUNcube-1 Hardware**

*Command Control + Telemetry Board*

- Xilinx CPLD command decoder
- Freescale CPU for telemetry generation
- 2 x I2C Bus
- 3.3V supply
- Average power consumption 15mW
- Peak power 33mW
FUNcube-1 Telemetry

1200BPS BPSK with forward error correction
54 Telemetry channels
Telemetry sent in 24 x 5 second frames over 2 minute period
Real time
Whole orbit data sampled every 60 sec stored for 104 minutes
‘Fast’ data sampled at 1 second intervals for 60 seconds
Text messages 9 x 200 character greetings messages
27 additional messages stored in memory

Very distinctive sound to enable easy identification.
4.3 seconds of data + 0.7 seconds of unmodulated BPSK tone (sample tlm)

Satellite also transmits a 24 bit sequence number and a 2 bit satellite identifier which allows groundstation software to
identify the satellite and route the data to a ‘data warehouse’
# FUNcube-1 Telemetry

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<th>Frame Type</th>
<th>Frame Id</th>
<th>Frame Type</th>
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<td>01</td>
</tr>
<tr>
<td>RTT + Whole Orbit</td>
<td>WO2</td>
<td>02</td>
</tr>
<tr>
<td>RTT + Whole Orbit</td>
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<td>RTT + Fitter Message</td>
<td>FM1</td>
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<td>RTT + Fitter Message</td>
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<td>RTT + Fitter Message</td>
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Launch status

FUNcube-1

Dnepr Launch from Yasny Russia
Q1 2013

FUNcube-2 sub system on UKube

Soyuz launch from Baikonur Russia
Q1 2013

Orlando 2012

David Bowman G0MRF
**Dnepr Launch - SS-18 Intercontinental ballistic missile**

- Originally set for Q4 2012 now Q1 2013
- Primary payload DubaiSat-2
  - 19 secondary micro and nanosat payloads
- Launch from underground silo.
  - Inclination 98.2 degrees
  - ‘near circular’ Sun synchronous orbit
  - Altitude 690km
Antenna deployment at L+26 minutes. Safe mode 50mW BPSK beacon
DC Power in = 3.2W  Power out = 450mW
**Amateur radio transponder + modes**

Mode UV  Inverting transponder.

- Power output 400mW PEP to include 50mW telemetry on 145.935MHz
- AGC range 43dB

- Educational mode : BPSK telemetry at 400mW
- Amateur mode : 50mW BPSK + transponder

- Satellite can auto switch from ‘educational’ in sunlight to ‘amateur’ in eclipse

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<table>
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<tbody>
<tr>
<td>Uplink passband centre</td>
<td><strong>435.140 MHz</strong></td>
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<tr>
<td>Transponder uplink:</td>
<td>435.150 to 435.130</td>
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<tr>
<td>Downlink passband centre</td>
<td><strong>145.960 MHz</strong></td>
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<tr>
<td>Transponder downlink:</td>
<td>145.950 to 145.970</td>
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<tr>
<td>Telemetry beacon</td>
<td><strong>145.935 MHz</strong></td>
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Educational Outreach
Thank you