 payload update

European Student Earth Orbiter

Introducing ‘FUNcube-4’

Graham Shirville, David Bowman, Chris Bridges (+ usual suspects)
ESA Hands on Projects

• SSETI Express XO-53, 2005
• Yes-2 Atmospheric re-entry Project, 2007
• 7 CubeSats, VEGA test flight, 2012
• ESMO Moon orbiter, Project closed, 2013
• ESEO with AMSAT-UK:
  – CDR June/July 2014
  – Launch 2015/16
ESA ESEO Microsatellite (New CAD)
For AMSAT-UK (2014)

• Follow-on mission to FUNcube-1 & FUNcube-2
• Powerful 145 - 1263 MHz FM Transponder
• VHF BPSK 1k2 Downlink Telemetry for STEM
• Outreach > FUNcube Dashboard & Warehouse
For AMSAT-UK (2014)

- Follow-on mission to FUNcube-1 & FUNcube-2
- Powerful 145 - 1263 MHz FM Transponder
- VHF BPSK 1k2 Downlink Telemetry for STEM
- Outreach > FUNcube Dashboard & Warehouse
- + Backup 4k8 comms for telemetry & file transfer for ESEO payloads (at request)
2014: Development Board Work
Eduardo & Victor, Science Without Borders Programme
Brazil > UK Uni Credits
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Eduardo & Victor, Science Without Borders Programme
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2015: Engineering Board Work
Ben Clewer & Ben Chapman, 3rd Year Undergraduates
University of Surrey
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Telemetry & Telecommand (CCT)

AT32 Computer, 60 MHz
256 KB I2C FLASH

Electrical Power System (EPS)

Unregulated 14-28V (assumed)
to Regulated 3V3, 6V, 9V
Martlesham Workshop
(AMSAT-UK / AMSAT-NL)
Local Test Frequency
BPSK 1k2, 2k4, 4k8, 9k6

Manual tweaking of voltages
Software RRC filtering
## Document change record

<table>
<thead>
<tr>
<th>Change</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>06/12/2013</td>
<td>First release</td>
</tr>
<tr>
<td>1</td>
<td>18/12/2013</td>
<td>Update as per comments received by ESA, HK_and_TC_TN_comments_JLopez.xls file.</td>
</tr>
<tr>
<td>1</td>
<td>05/02/2104</td>
<td>First update by AMSAT</td>
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<tr>
<td>1</td>
<td>22/05/2014</td>
<td>Updated after visit to Almaspace</td>
</tr>
<tr>
<td>1</td>
<td>04/06/2014</td>
<td>Second version of GET and SET telemetry points proposed together with data types. Please note these are subject to change.</td>
</tr>
<tr>
<td>1</td>
<td>22/06/2014</td>
<td>1. Clearly labeled HK required with the main OBDH in Table 3, added line regarding memory locations TBD for HK from OBDH. 2. Corrected naming convention of telemetry points in Table 3.</td>
</tr>
<tr>
<td>1</td>
<td>20/07/2014</td>
<td>Updated to clearly mark key power-related telecommands and HK telemetry to meet 56 B requirement (ref: INT-EIDA-5130) on: Page 5, plus Table 3 and Table 4.</td>
</tr>
<tr>
<td>1</td>
<td>31/05/2015</td>
<td>Edited to include: 1. Main ESEO TM points required by AMSAT communications payload. 2. Outline the transparent/router mode to provide backup functionality.</td>
</tr>
<tr>
<td></td>
<td>01/07/2015</td>
<td>Ref Doc: AS-12_0005-SYS-PLA-OBDH-AR-03.pdf</td>
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</table>
## ‘Router Mode’

<table>
<thead>
<tr>
<th>Function</th>
<th>Regular Modes</th>
<th>Router Mode</th>
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</thead>
<tbody>
<tr>
<td><strong>Tone</strong></td>
<td>1k2 Timing 0.7 s 4.333 s x 1200 bps</td>
<td>4k8 Timing 0.7 s 4.333 s x 4800 bps</td>
</tr>
<tr>
<td><strong>AMSAT Data</strong></td>
<td>256 B</td>
<td>256 B</td>
</tr>
<tr>
<td><strong>AO-40 FEC Rate</strong></td>
<td>x 2.539</td>
<td>x 2.539</td>
</tr>
<tr>
<td><strong>Post FEC</strong></td>
<td>5200 b / 1200 b = 4.333 s</td>
<td>5200 b / 4800 b = 1.083 s</td>
</tr>
<tr>
<td><strong>AMSAT Dashboard Spec. limit = 5 s,</strong></td>
<td>0 s</td>
<td>+ 15600 b / 4800 b = 3.25 s</td>
</tr>
<tr>
<td><strong>Spare time to transmit</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Mode Change:**
- From Ground
- From CAN Bus

Collect data over CAN (slow)
DOWN Transmit, UP holemaps
L-Band Receiver
David Bowman, G0MRF
FM Transceiver
David Bowman, G0MRF
FM Transceiver Testing

David Bowman, G0MRF
EM Fit Checks
Mech + RF + CCT/EPS
Next Steps!
EM Delivery to ALMAspace & ESA

Excerpt from ALMAspace & ESA Correspondence:

“...
• Delivery of the End Item Data Package (EIDP): 28/08/2015
• Review of the documentation: 31/08/2015 to 04/09/2015
• Telecom for authorization to delivery: 07/09/2015
...

Record representative 1k2 + 4k8 signals > dashboard software
Build up software modes + capability
Lather, rinse, repeat ...