Standardizing CubeSat Electrical and RF interfaces

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- Launched April 28th 2008 (PSLV)
- 3U CubeSat, no battery
- Nominal science mode ops
- 100mW 1200Bd BPSK VHF downlink, rx on handheld
- Over 80MB (!) of data captured so far, worldwide amateur radio network (>320 hams involved)
• Mechanical interfaces defined by CubeSat spec
• Electrical & RF interfaces not defined... need to do so?
• RF link to groundstation can also be regarded as an interface!

*This presentation is meant to foster discussion*
Standardization

- Main reason for the huge CubeSat success
- Standardization fosters creativity
  - Deployables, optimal use of volume
- *Somebody out there will violate it*...
- Start somewhere
- Limits choice / brings focus
Off the Shelf products

- Emerging and starting to get heritage
- Add satellite to basket (e.g. ISIS www.cubesatshop.com, Clyde space webshop)

Pumpkin FM430, courtesy of Pumpkin inc.
Clyde Space EPS, courtesy of Clyde Space Ltd.
ISIS Transceiver, ISIS – Innovative Solutions In Space BV
Compatibility

Clyde Space EPS

ISIS Transceiver

Pumpkin FM430
Electrical interfaces

- Bus subsystem interfaces
- Payload interfaces
- Power bus
  - 3V3, 5V
- Data bus
  - I2C
  - CAN?
- External electrical interfaces (charging, RBF/ABF, checkout)
• Reliable, proven
• High current handling capability
• Flexible, spare pins
• Limits board stacking possibilities
• Mating and demating... → tools available
• Mass penalty, board space
• Not all 104 pins necessary, usually local microcontroller on every board
• Electrical interface → drives mechanical interface
Flex-Rigid bus
RF interfaces - internal

- Coaxial connectors
- Cable diameter / bend radius
- Click vs torque?
- (MCX, SMCX, SSMCX or even smaller)
- Small distances, losses no issue
RF interfaces - external

- Modulation schemes: AFSK-over-FM far from optimal - requires about 15dB more signal/noise than BPSK (that’s more than 30 times the power!)
- AX.25 generally is ok, but do **not** use frames of multiple seconds long
- GENSO compatibility
- Beacons: provide a LONG / SEMI-CONTINUOUS beacon downlink if your power budget allows you to do so, short beacons with large intervals are hard to detect
- Availability of soundcard software removes the need for “legacy” modulations / protocols → software defined radio is the way to go!
• Software defined groundstation
• “Crosstagging”
• www.websdr.org
• Requirements on CubeSats will become more strict
  - Emerging commercial / scientific missions
  - Launch service providers
• Larger CubeSats or derivatives (4U, 5U, 6-pack)
• GENSO
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