

A Survey of CubeSat Communication Systems

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- “A Survey of CubeSat Communication Systems”
- By Bryan Klofas, Jason Anderson, Kyle Leveque
- Available on cubesat.org website
- Describes, in detail, communication subsystems for all CubeSats currently in orbit

Common Radio Configurations



- Purchase
- Purchase then Modify
- Custom Built

- Just buy COTS radio
- No modifications
- Microhard MHX-2400
 - A good radio if:
 - Big dish
 - Lots of extra power (1.15 W RX)
- Stensat Radio

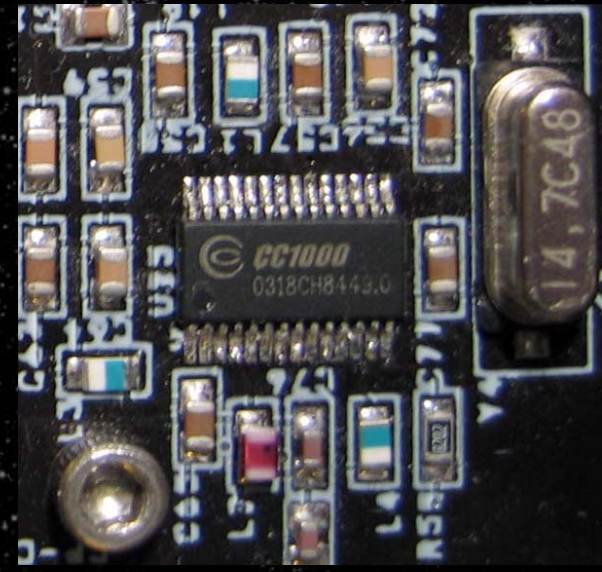


Purchase then Modify



- Purchase COTS radio
- Modify radio by:
 - Removing case, LCD, buttons
 - Adding thermal conductivity to power amplifier
 - Changing timings of handshakes
 - Change capacitors
- Usually add TNC
- Cute-1, Cute-1.7+APD, XI-IV, XI-V, QuakeSat-1, CSTB1, AeroCube-2

- Build radio entirely from chip-level components
- Great for education
- All-in-one transceiver chips available from TI, Analog Devices, RF Micro Devices
- TNCs are usually PIC
- Less successful
- CP2, CP3, CAPE1, DTU_{sat}-1



Frequencies/Power

| Satellite | Frequency | Power |
|-------------------|--------------|--------|
| AAU1 | 437.475 MHz | 500 mW |
| CanX-1 | 437.880 MHz | 500 mW |
| Cute-1 (CO-55) | 437.470 MHz | 350 mW |
| DTUsat-1 | 437.475 MHz | 400 mW |
| QuakeSat-1 | 436.675 MHz | 2 W |
| XI-IV (CO-57) | 437.490 MHz | 1 W |
| XI-V (CO-58) | 437.345 MHz | 1 W |
| NCube-2 | 437.505 MHz | |
| UWE-1 | 437.505 MHz | 1 W |
| Cute-1.7+APD | 437.505 MHz | 300 mW |
| GeneSat-1[8] | 2.4 GHz | 1 W |
| CSTB1 | 400.0375 MHz | <1 W |
| AeroCube-2 | 902-928 MHz | 2 W |
| CP4 | 437.325 MHz | 1 W |
| Libertad-1 | 437.405 MHz | 400 mW |
| CAPE1 | 435.245 MHz | 1 W |
| CP3 | 436.845 MHz | 1 W |
| MAST ⁹ | 2.4 GHz | 1 W |

Modes/Protocols



| Satellite | Protocol | Baud Rate/Modulation |
|-------------------|--------------------|----------------------|
| AAU1 | AX.25 on Mobitex | 9600 Baud GMSK |
| CanX-1 | | 1200 baud MSK |
| Cute-1 (CO-55) | AX.25 | 1200 baud AFSK |
| DTUosat-1 | AX.25 | 2400 baud FSK |
| QuakeSat-1 | AX.25 ³ | 9600 baud FSK |
| XI-IV (CO-57) | AX.25 | 1200 baud AFSK |
| XI-V (CO-58) | AX.25 | 1200 baud AFSK |
| NCube-2 | AX.25 | 1200 baud |
| UWE-1 | AX.25 | 1200/9600 baud AFSK |
| Cute-1.7+APD | AX.25/SRL | 1200 AFSK/9600 GMSK |
| GeneSat-1[8] | Proprietary | |
| CSTB1 | Proprietary AX.25 | 1200 baud AFSK |
| AeroCube-2 | Proprietary | 38.4 kbaud |
| CP4 | AX.25 | 1200 baud FSK |
| Libertad-1 | AX.25 | 1200 baud AFSK |
| CAPE1 | AX.25 | 9600 baud FSK |
| CP3 | AX.25 | 1200 baud FSK |
| MAST ⁹ | Proprietary | |

Data Downloaded



| Satellite |
|-------------------|
| AAU1 |
| CanX-1 |
| Cute-1 (CO-55) |
| DTUsat-1 |
| QuakeSat-1 |
| XI-IV (CO-57) |
| XI-V (CO-58) |
| NCube-2 |
| UWE-1 |
| Cute-1.7+APD |
| GeneSat-1[8] |
| CSTB1 |
| AeroCube-2 |
| CP4 |
| Libertad-1 |
| CAPE1 |
| CP3 |
| MAST ⁹ |

Data Downloaded



| Satellite | Amount Downloaded |
|-------------------|----------------------|
| AAU1 | 1 kB ¹ |
| CanX-1 | 0 ² |
| Cute-1 (CO-55) | |
| DTUosat-1 | 0 ² |
| QuakeSat-1 | 423 MB |
| XI-IV (CO-57) | |
| XI-V (CO-58) | |
| NCube-2 | 0 ² |
| UWE-1 | |
| Cute-1.7+APD | 0 |
| GeneSat-1[8] | 500 kB |
| CSTB1 | 6.77 MB ⁵ |
| AeroCube-2 | 500 kB ¹ |
| CP4 | 320 kB ¹ |
| Libertad-1 | 0 ⁷ |
| CAPE1 | 0 ⁸ |
| CP3 | 1.6 MB ⁶ |
| MAST ⁹ | >2 MB ¹ |

Total:

434.69 MB

Without Japanese
CubeSats

5 years

No Beacons

- Frequent Beacons allow easy tracking of CubeSats and health if no uplink
- Common Modes allow other stations to receive and forward data
- Operate ground station regularly before launch
- No good COTS solution: does somebody want to build one?
- Test early and often

Thanks



- Questions/Comments?

