

A Survey of CubeSat Communication Systems

Bryan Klofas
bklofas@calpoly.edu

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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

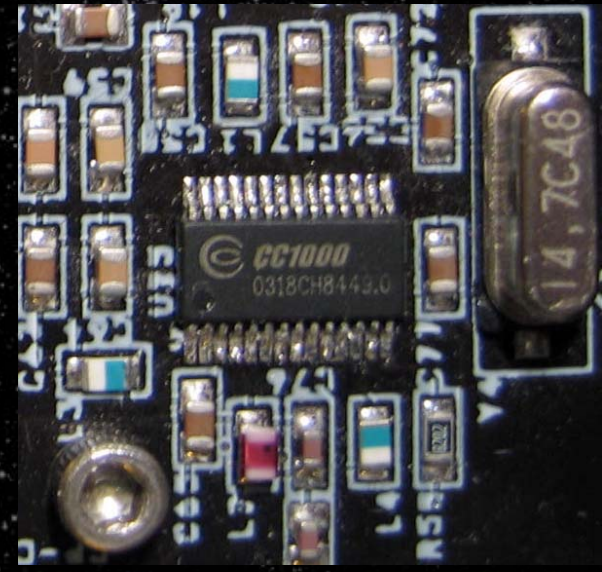


Purchase then Modify



- 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?

