



CubeSat Parts Database: NASA Usage and Kit Manufacturers

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Approach/Sources

- Discussions with PI's
- CubeSat/Small Satellite Conferences
- Mission/University Websites
- Published Professional Literature
- NASA CubeSat Developers



NASA CubeSats

- Ames Research Center (ARC) – 17
- Jet Propulsion Laboratory (JPL) – 9
- Goddard Space Flight Center (GSFC) – 9
- Kennedy Space Center (KSC) – 2
- Marshall Space Flight Center (MSFC) – 1
- Langley Research Center (LARC) – 1
- **All NASA Centers – 39 Total**
- **Launched - 13**



Microcontrollers/FPGAs

- Atmel
 - ATMEGA2560/A328 8-bit Microcontroller
 - ATmega164P
 - ARM9
- TI
 - MSP430 16-bit Microcontroller
 - OMAP3503/ARM Cortex-A8
- Microchip 32-bit Flash & Non-Flash Microcontroller
- Stamp9G20 processor
- Colibri PXA270 (Intel/Marvel ARM PXA270)
- Xilinx
 - V5QV and FX130T
- Aeroflex UT6325 Eclipse FPGA



Memories

- Numonyx P5QPCM 128 Mb Phase Change Memory
- Xilinx 32 Mb XQF32P Flash PROM
- Everspin MR4A16B MRAM
- Microchip 256 kb EEPROM
- Aeroflex 4 Mb SRAM
- Dallas 1 kb EEPROM
- Ramtron 1 Mb FRAM
- Delkin Devices MicroSD Card
- 3D Plus SDXX SDRAM



Communications

- Microhard MHX-2420 2.4 GHz Wireless Modem
- AstroDev CII Radio board
- Surrey 12-Channel GPS Receiver board



Power

- Clyde Space 3U EPS
- Clyde Space 30Wh Battery
- Buck-boost DC-DC converters
- SVGA05XX POL DC-DC converter
- LTC2309 ADC
- 1/2.5/3.3V POL
- DC-DC converter



Phone Sats

- HTC Nexus One phone
 - 1GHz Qualcomm QSD8250 Snapdragon
 - Samsung 943 KA100O015M
 - Skyworks SKY77336 GSM power amp
 - Qualcomm PM7540 power management
 - TI TPS65023 power management
 - Audience A1026 voice processor
 - Broadcom BCM4329 Bluetooth/802.11n
 - Synaptics T1007A capacitive sensor
- Arduino test board (ATMEGA 328)
- StenSat AFSK beacon radio
- 2×10^{-6} torr/-35C to 65C



Phone Sats

- Nexus S phone
 - Skyworks SKY77529 GSM/GPRS/EDGE
 - SanDisk SDIN4C2 16GB MLC NAND Flash
 - Samsung KB100DO0WM memory
 - Samsung S5PC110A01 Cortex A8 Hummingbird processor
 - Infineon 8824 XG616 Baseband processor
 - Wolfson Microelectronics WM8994 audio codec
 - Broadcom BCM4329GKUBG TE1043 WiFi
- Propeller P8X32A microcontroller support



Other

- OmniVision 2 MegaPixel CMOS camera
- AD7714 ADC
- Custom ASIC
- Passive thermistors
- LVDS/RS422 transceivers
- Analog Multiplexer
- No mention of passive grades, types etc.
- Mention of 0 to 70C and 0 to 85C graded parts
- Some assemblies are -20C to 50C



Cubesat Vendors

- www.cubesat.org
- 21 Vendors
- Wide range of subsystems to complete vertical integrated launch companies
- Microcontroller focused (8 and 16 bit)
 - TI MSP430/Silicon Labs C8051/Microchip PIC24/dsPIC33
- Only one company mentioned anything about components/parts
 - Solder & workmanship/pure-tin/EEE parts screening/obsolescence
- Two companies mention testing EMI/EMC testing
- “Reliability” only mentioned once
- One private discussion ‘consider’ automotive ‘if possible’
- Digikey
- Some temperature testing of final PBW, some only in design phase
- Performance based specs and product offerings



Conclusions

- Mature part technologies => low cost, low power
- Majority of NASA CubeSats are in development and do not have finalized parts lists
- NASA centers primarily build custom boards with a combination of COTS and high-reliability parts



Backup – NASA CubeSat Missions



NASA CubeSats (cont.)

Mission	NASA Center	Status
EcAMSat	ARC	Hardware development complete, waiting for launch opportunity
EDSN	ARC	Planned launch late 2014
GeneSat	ARC	Launched December 2006, deorbited August 2010 (no failure)
Lightsail	ARC	In development, planned launch 2016
O/OREOS	ARC	Launched November 2010, began experiencing low battery voltage and unexpected system resets in April 2011
PharmaSat-1	ARC	Launched May 2009, deorbited August 2012 (no failure)
PhoneSat 1A (Graham)	ARC	Launched April 21, 2013, deorbited April 27, 2013 (no failure)
PhoneSat 1B (Bell)	ARC	Launched April 21, 2013, deorbited April 27, 2013 (no failure)
PhoneSat 2.4	ARC	Launched November 2013, began experiencing recurring upsets in January 2014
PhoneSat 2.5	ARC	Launched April 2014, deorbited May 2014



NASA CubeSats (cont.)

Mission	NASA Center	Status
PhoneSat 2A (Alexander)	ARC	Launched April 21, 2013, deorbited April 27, 2013
PreSat	ARC	Launch failure
SporeSat	ARC	Launched April 2014, fully operational
TechEdSat-1	ARC	Launched October 2012, deorbited May 2013 (no failure)
TechEdSat-3	ARC	Launched October 2013, deorbited January 2014 (no failure)
TechEdSat-4	ARC	Unknown
BioSentinel	ARC	In development, planned launch in 2017
CeREs	GSFC	Unknown
CRaBSS	GSFC	Unknown
ESCAPE	GSFC	Proposed, not selected



NASA CubeSats (cont.)

Mission	NASA Center	Status
Firefly	GSFC	Launched November 2013, fully operational
HeDI	GSFC	In development
IceCube	GSFC	In development
MaRBLES	GSFC	Proposed, not selected
SpaceCube v2.0 Mini	GSFC	In development
TechCube	GSFC	Proposed, not selected
CHIRP*	JPL	Proposed, not selected
GRIFEX	JPL	Planned launch December 2014
INSPIRE	JPL	Hardware development complete, waiting for launch opportunity
IPEX	JPL	Launched December 2013



NASA CubeSats (cont.)

Mission	NASA Center	Status
ISARA	JPL	In development
LMRST-Sat	JPL	In development
Lunar FlashLight*	JPL	In development, launch baselined for 2017
NEAScout*	MSFC	In development, launch baselined for 2017
M-Cubed/COVE	JPL	Launched October 2011 (magnetized to E1P-2 on deployment), re-flight in December 2013 (mission success)
RACE	JPL	Launch on ORB-3 from WFF in Oct 2014
CryoCube-1	KSC	In development
CryoCube-2	KSC	In development
Shields-1	LARC	In development