

Bill of Materials for CubeSatSim v1.2 for info see http://cubesatsim.org										
Note: if you have the v1.0 PCBs, here is the BOM: https://docs.google.com/spreadsheets/d/1UQdsXe-uZ38PD8lU8TVegTDzzytF5rX3qfXSBqOa53A/edit?usp=sharing										
Note: if you have the v1.1 PCBs, here is the BOM: https://docs.google.com/spreadsheets/d/1y94Ut4Wlnf17ZC4sU9S5768G5_BMU9aPU6nHsb_djTI/edit?usp=sharing										
If you have a Google account, you can make your own copy of this spreadsheet by going under File then Make a Copy										
The colored rows which begin with "Alt" indicate alternatives. Uncheck the a choice to get the b choice										
Main Board https://github.com/alanjohnston/CubeSatSim/blob/master/hardware/v1.1/cubesatsim-main-1.2_schematic.pdf										
Ref	Item	Qty	Cost	Total	Source	Source URL	Alternate Source URL	Notes	Additional Source URL	
U10	5V boost regulator 500 mA	1	\$4.00	\$4.00	eBay	https://www.ebay.com/sch/l	https://www.amazon.com/		https://es.aliexp	
U9	NiMH CN3085 3s charger	1	\$2.99	\$2.99	eBay	https://www.amazon.com/v/	https://www.amazon.com/	Often ships from US instead of China for fast delivery		
	1x14 male breakaway header	1	\$0.47	\$0.47	Digikey	https://www.digikey.com/en/		Used for mounting 5V boost and NiMH charger and J4		
	USB-C charger with Micro USB adapter	1	\$10.99	\$10.99	Amazon	https://www.amazon.com/		Used for charging battery and powering Pi Zero		
X1	SC1464-ND 3.50mm Headphone Phone Jack	1	\$2.10	\$2.10	Digikey	https://www.digikey.com/p	https://www.newark.com/	https://www.jameco.com/z/35RAPC4BH3-3-5mm-Threaded-Right-Angle-St		
D1-D7	Diode 1N5817RLG D1, D2, D3, D4, D5, D6, D7	7	\$0.40	\$2.80	Mouser	https://www.mouser.com/	https://www.amazon.com/	https://www.newark.com/stmicroelectronics/1n5817/rectifier-diode-single		
	Remove Before Flight Tag	1	\$8.00	\$8.00	Amazon	https://www.amazon.com/	https://www.amsat.org/pr			
X1	1/8" 3.5mm Plug Audio Jack Connector	1	\$1.22	\$1.22	Digikey	https://www.digikey.com/pr	https://www.amazon.com/	Can 3D print https://www.thingiverse.com/thing:1141906		
	Alt 1a: Pi Zero WH	<input checked="" type="checkbox"/>	\$14.00	\$14.00	Adafruit	https://www.amazon.com/v/	https://www.canakit.com/	Also works with Pi Zero and Pi Zero 2 W, if without headers Pi Zero W, add		
	Alt 1b: Pi Zero W	<input type="checkbox"/>	\$10.00	\$0.00	Adafruit	https://www.amazon.com/R/	https://www.ebay.com/itm	Also works with Pi Zero		
	Alt 1b: 2x20 male breakaway GPIO header	1	\$0.95	\$0.00	Adafruit	https://www.adafruit.com/pr	https://www.sparkfun.com/	If it doesn't come with your Pi Zero W		
	16GB micro SD Card with cubesatsim image	1	\$20.00	\$20.00	Amazon	https://www.amsat.org/prod	https://www.amazon.com/	Any 16GB or 32GB card can be used with free download of cubesatsim image		
J1	GPIO 20x2 female stacking header extra tall	1	\$2.95	\$2.95	Adafruit	https://www.adafruit.com/pr		This one is different from the others		
U1-U8	Blue INA219 High Side DC Current Sensor Breakout	8	\$1.65	\$13.20	Aliexpress	https://www.amazon.com/A	https://www.amazon.com/	Blue boards are easier to find and have fewer defectives. You only need 7 if		
	6 position right angle female header	8	\$0.66	\$5.28	Digikey	https://www.digikey.com/en/		sockets for INA219 boards		
	6 position right angle male header	8	\$0.77	\$6.16	Digikey	https://www.digikey.com/en/		mounting headers to mount INA219s in sockets		
S1	Pushbutton switch, DPDT, CFP2-2RC4-AW	1	\$3.64	\$3.64	Digikey	https://www.digikey.com/pr	https://www.mouser.com/			
R11	1k Ohm resistor, 1/8 Watt, 20% tolerance	1	\$0.10	\$0.10	Digikey	https://www.digikey.com/en/				
R12	100 Ohm resistor, 1/8 Watt, 20% tolerance	1	\$0.10	\$0.10	Digikey	https://www.digikey.com/en/				
R13	220 Ohm resistor, 1/8 Watt, 20% tolerance	1	\$0.10	\$0.10	Digikey	https://www.digikey.com/pr				
R3,R4	4.7k Ohm resistors, 1/8 Watt, 20% tolerance	2	\$0.10	\$0.20	Digikey	https://www.digikey.com/en/				
LED1	Green LED 5mm clear lens	1	\$0.35	\$0.35	Digikey	https://www.digikey.com/pr				
LED2	Blue LED 5mm clear lens	1	\$0.21	\$0.21	Digikey	https://www.digikey.com/pr				
LED3	Red LED 5mm clear lens	1	\$0.15	\$0.15	Digikey	https://www.digikey.com/pr				
D8	5.1V 400mW Zener	1	\$0.26	\$0.26	Digikey	https://www.digikey.com/e				
F1	PTC resettable fuse, 1.2A	1	\$0.34	\$0.34	Digikey	https://www.digikey.com/p				
X2	Alt 2a: SMA vertical female connector	<input checked="" type="checkbox"/>	\$2.52	\$2.52	Digikey	https://www.digikey.com/en/	https://www.digikey.com/e	Either use this SMA connector or the tape measure for the antenna		
	Alt 2a: SMA 6" male to female for antenna cable	1	\$7.99	\$7.99	Amazon	https://www.amazon.com/gp		Don't need if using tape measure antenna		
	Alt 2a: SMA 433 MHz antenna	1	\$5.07	\$5.07	Digikey	https://www.digikey.com/en/	https://www.newark.com/			
	Alt 2b: Tape Measure for antenna	<input type="checkbox"/>	\$9.09	\$0.00	Amazon	https://www.amazon.com/S	https://www.amazon.com/	The antenna is either a tape measure, or a SMA antenna		
	Alt 2b: 2.5mm screw for tape measure antenna	2	\$0.38	\$0.00	Digikey	https://www.digikey.com/pr				
	Alt 3a: Main PCB with LFF installed	<input checked="" type="checkbox"/>	\$10.00	\$10.00	AMSAT	https://www.amsat.org/pr		Gerbers are available on GitHub to make your own PCBs https://github.com/alanjohnston/CubeSatSim		
	Alt 3b: Main PCB without LFF	<input type="checkbox"/>		\$0.00						
L1	Alt 3b: LFF SMD 13nH 0603	1	\$0.17	\$0.00	Digikey	https://www.digikey.com/pr				
C1	Alt 3b: LFF SMD 18pF 0603	1	\$0.22	\$0.00	Digikey	https://www.digikey.com/en/				
C2	Alt 3b: LFF SMD 16pF 0603	2	\$0.19	\$0.00	Digikey	https://www.digikey.com/en/				
R1	Alt 3b: 1k Ohm resistor	1	\$0.10	\$0.00	Digikey	https://www.digikey.com/en/				
J3	USB-C breakout	1	\$4.95	\$0.00	Sparkfun	https://www.sparkfun.com/p				
TOTAL				\$125.19						
Frame Parts https://www.thingiverse.com/thing:4333605										
Item	Qty	Cost	Total	Source	Source URL	Alternate Source URL	Notes	Additional Source URL		
Solar Cell 5.5V 160mA 90mm x 80mm	3	\$3.69	\$11.07	Aliexpress	https://www.aliexpress.com/	https://www.amazon.com/	You only need 3 if you don't put one on the bottom -Z side			
Solar Cell 5.5V 40mA 57mm x 28mm	<input checked="" type="checkbox"/> 2	\$0.89	\$1.78	Aliexpress	https://www.aliexpress.com/		Two small solar cells on either side of the camera on the -X side			
Pi Camera for Pi Zero with 6" cable	1	\$9.99	\$9.99	Amazon	https://www.amazon.com/A	https://www.amazon.com/	For taking photos for SSTV			
Solar Cell 5.5V 160mA 90mm x 80mm	<input type="checkbox"/> 1	\$2.00	\$0.00	Aliexpress	https://www.aliexpress.com/	https://www.amazon.com/	For -X side			
Solar Cell 5V 150mA 90mm x 70mm	2	\$2.00	\$4.00	Aliexpress	https://www.aliexpress.com/	https://www.amazon.com/	Choose 90x70mm "color" For +X side and +Z side			
Velcro thin clear fasteners	1	\$2.95	\$2.95	Amazon	https://www.amazon.com/gp/product/B0013AQ2PA/		With the new frame, permanent mounting of solar panels is problematic, so			
JST RCY 2 Pin Connector Plug Lead Wire 22AWG	1	\$5.98	\$5.98	Amazon	https://www.amazon.com/	https://es.aliexpress.com/	10 pack. Always make sure the polarity red/black is correct before wiring up			
Micro JST 2 pin wires and connectors	1	\$5.99	\$5.99	Amazon	https://www.amazon.com/gp	https://es.aliexpress.com/	20 pack. Always make sure the polarity red/black is correct before wiring up			
Heat shrink pieces for cables	8	\$0.16	\$1.28	Digikey	https://products/detail/alpha-wire		Cut in half and use on red and black leads for each connector, use heat gun			
GPIO 20x2 female stacking header extra long	2	\$2.50	\$5.00	Adafruit	https://www.adafruit.com/pr	https://www.aliexpress.com/	Don't buy the most common ones that are taller than these exact ones			
M2 5mm 240 pieces black standoffs	1	\$11.99	\$11.99	Amazon	https://www.amazon.com/gp		240 pieces M2.5 black			
3D Printed Frame (4 parts)	1				https://www.thingiverse.com/		If you don't have access to a 3D printer, you can order a print using this serv			
Mounting squares 1"x1"	1	\$2.49	\$2.49	Amazon	https://www.amazon.com/					
Slotted nylon screws for frame	8	\$0.22	\$1.76	Digikey	https://www.digikey.com/e					
TOTAL				\$64.28						
Battery Board https://github.com/alanjohnston/CubeSatSim/blob/master/hardware/v1.1/cubesatsim-battery-1.2_schematic.pdf										
Ref	Item	Qty	Cost	Total	Source	Source URL	Alternate Source URL	Notes	Additional Source URL	
	Alt 4a: Tenergy AA 2000mAh NiMH Rechargeable Batteries	<input checked="" type="checkbox"/> 1	\$7.99	\$7.99	Amazon	https://www.amazon.com/		For extended demos, you can use AA batteries. Make sure you get a AA batt		
BT1	Alt 4a: 3 cell AA battery holder BH3AAPC	1	\$4.34	\$4.34	Digikey	https://www.digikey.com/en/				
	Alt 4b: Tenergy AAA 800mAh NiMH Rechargeable Batteries	<input type="checkbox"/> 1	\$6.98	\$0.00	Amazon	http://www.amazon.com/		For short classroom demos, you can use AAA batteries. Make sure you get		
BT1	Alt 4b: 3 cell AAA battery holder 2479	1	\$1.62	\$0.00	Digikey	https://www.digikey.com/en/				
J1	GPIO 20x2 female stacking header extra long	1	\$2.50	\$2.50	Adafruit	https://www.adafruit.com/pr	https://es.aliexpress.com/	Don't buy the most common ones that are taller than these exact ones		
	zip tie to hold batteries	2					Any small zip tie will work			
	Battery PCB	1	\$10.00	\$10.00	AMSAT	https://www.amsat.org/pr		Gerbers are available on GitHub to make your own PCBs https://github.com/alanjohnston/CubeSatSim		
TOTAL				\$24.83						
STEM Payload Board https://github.com/alanjohnston/CubeSatSim/blob/master/hardware/v1.1/cubesatsim-STEM-1.2_schematic.pdf										
Ref	Item	Qty	Cost	Total	Source	Source URL	Alternate Source URL	Notes	Additional Source URL	

<input type="checkbox"/>	Alt 5a: Sparkfun Pro Micro	<input checked="" type="checkbox"/>	1	\$17.95	\$17.95	Sparkfun	https://www.sparkfun.com/p	https://www.digikey.com/p	Don't buy the most common ones that are 5V, it must be the 3.3V	
<input type="checkbox"/>	U1 Alt 5a: 12 pin female header for Pro Micro		2	\$0.78	\$0.00	Digikey	https://www.digikey.com/en/			
<input type="checkbox"/>	Alt 5a: 1x12 pin header for Pro Micro		2	\$0.78	\$1.56	Digikey	https://www.digikey.com/en/			
<input type="checkbox"/>	Alt 5b: STM32F103C8T6 "Blue Pill" with head	<input type="checkbox"/>	1	\$0.78	\$0.00	Amazon	https://www.amazon.com/p		STM32 boards usually need to be flashed with a bootloader which requires	
<input type="checkbox"/>	U2 Alt 5b: 20 pin female header for STM32		2	\$1.99	\$0.00	Digikey	https://www.digikey.com/en/			
<input type="checkbox"/>	U4 BME280 board Temperature/Humidity/Pres		1	\$12.99	\$12.99	Amazon	https://www.amazon.com/C	https://es.aliexpress.com/		
<input type="checkbox"/>	U3 MPU6050 9 Axis Gyro GY-521		1	\$6.49	\$6.49	Amazon	https://www.amazon.com/	https://es.aliexpress.com/		
<input type="checkbox"/>	J1 GPIO 20x2 female connector non-stacking		1	\$1.89	\$1.89	Digikey	https://www.digikey.com/pr			
<input type="checkbox"/>	R1,R2 4.7k Ohm resistors, 1/8 Watt, 20% tolerance		2	\$0.10	\$0.20	Digikey	https://www.digikey.com/en/			
<input type="checkbox"/>	C1-C3 100nF capacitor		3	\$0.23	\$0.69	Digikey	https://www.digikey.com/en/			
<input type="checkbox"/>	D1-D3 ON Semiconductor 1N5817RLG		3	\$0.40	\$1.20	Digikey	https://www.digikey.com/p	https://www.amazon.com		
<input type="checkbox"/>	D4 1N4148 diode		1	\$0.10	\$0.10	Digikey	https://www.digikey.com/pr			
<input type="checkbox"/>	LED1 Green LED		1	\$0.35	\$0.35	Digikey	https://www.digikey.com/pr		Note that LED3 is only used if Power LED not used on Main Board	
<input type="checkbox"/>	LED2 Blue LED		1	\$0.21	\$0.21	Digikey	https://www.digikey.com/pr		Note that LED4 is only used if Transmit LED not used on Main Board	
<input type="checkbox"/>	R3 1k Ohm resistor, 1/8 Watt, 20% tolerance		1	\$0.10	\$0.10	Digikey	https://www.digikey.com/en/		Note that R5, R6 is only used if Transmit LED and Power LED not used on Main Board	
<input type="checkbox"/>	R4 100 Ohm resistor, 1/8 Watt, 20% tolerance		1	\$0.10	\$0.10	Digikey	https://www.digikey.com/en/			
<input type="checkbox"/>	R9-R11 10k resistor		3	\$0.10	\$0.30	Digikey	https://www.digikey.com/pr			
<input type="checkbox"/>	STEM Payload PCB		1	\$10.00	\$10.00	AMSAT	https://www.amsat.org/pr		Gerbers are available on GitHub to make your own PCBs https://github.com/alanbj	
			TOTAL		\$54.13					
Ground Station			https://github.com/alanjohnston/CubeSatSim/wiki/3.-Ground-Station							
<input checked="" type="checkbox"/>	Item		Qty	Cost	Total	Source	Source URL	Alternate Source URL	Notes	Additional Source URL
<input type="checkbox"/>	Alt 6a: Your PC with RTL-SDR	<input checked="" type="checkbox"/>	1	\$29.95	\$29.95	Amazon	https://www.amazon.com/	https://www.ebay.com/itm	Other SDRs will work as well	
<input type="checkbox"/>	Alt 6a: SMA Antenna for 433 MHz right angle		1	\$5.33	\$5.33	Digikey	https://www.digikey.com/pr		Most low cost versions are fakes and aren't resonant at 433 MHz	
<input type="checkbox"/>	Alt 6b: Raspberry Pi 4 ground station	<input type="checkbox"/>	1	\$105.00	\$0.00	Amazon	https://www.amazon.com/			
<input type="checkbox"/>	Alt 6b: Pi 4 power supply		1	\$8.99	\$0.00	Amazon	https://www.amazon.com/			
<input type="checkbox"/>	Alt 6b: micro SD card 16 GB with FIA8v3		1	\$20.00	\$0.00	Amazon	https://www.amsat.org/prod	https://www.amazon.com	Any 16GB or larger card can be used with free download of Fox-in-a-Box v3 i	
<input type="checkbox"/>	Alt 6b: RTL-SDR		1	\$24.95	\$0.00	Amazon	https://www.amazon.com/	https://www.ebay.com/itm	Other SDRs will work as well	
<input type="checkbox"/>	Alt 6b: SMA Antenna for 433 MHz right angle		1	\$5.33	\$0.00	Digikey	https://www.digikey.com/pr		Most low cost versions are fakes and aren't resonant at 433 MHz	
<input type="checkbox"/>	Alt 6b: 7" touchscreen with speakers and sta		1	\$84.99	\$0.00	Amazon	https://www.amazon.com/gr			
<input type="checkbox"/>	Alt 6b: Wireless mouse		1	\$10.33	\$0.00	Amazon	https://www.amazon.com/gr			
<input type="checkbox"/>	Alt 6b: USB extender cable		1	\$6.01	\$0.00	Amazon	https://www.amazon.com/gr			
<input type="checkbox"/>	Alt 6b: right angle USB-C adapter		1	\$5.99	\$0.00	Digikey	https://www.amazon.com/gr			
			TOTAL		\$35.28					
Extras Useful for Deming the CubeSatSim										
<input type="checkbox"/>	Item		Qty	Cost	Total	Source	Source URL	Alternate Source URL	Notes	Additional Source URL
<input type="checkbox"/>	LED Spotlight 5W		1	\$16.99	\$16.99	Amazon	https://www.amazon.com/gr	https://www.amazon.com	Battery powered alternate one is good for portable demos	
<input type="checkbox"/>	Battery powered turntable		1	\$29.95	\$29.95	Amazon	https://www.amazon.com/		Most turntables spin too fast, but this one is slow and has 2 settings	
<input type="checkbox"/>	GLiNet GL-AR150 Mini Travel Router (Stand		1	\$29.90	\$29.90	Amazon	https://www.amazon.com/G		If you have a WiFi router, you don't need Having a portable WiFi hub tha	
<input type="checkbox"/>	USB OTG cable micro USB to USB for Pi Zero		1	\$2.50	\$2.50	Adafruit	https://www.digikey.com/en/	https://www.sparkfun.com		
<input type="checkbox"/>	Mini HDMI to HDMI Adapter for Pi Zero		1	\$2.95	\$2.95	Adafruit	https://www.adafruit.com/pr	https://www.sparkfun.com		
			TOTAL		\$76.84					
			SUM TOTAL		\$380.55					