Caveatron Bill of Materials Hardware Revision: C

Date: 2024-05-01

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Main Processor	1	PJRC Electronics	Teensy 4.1	Teensy 4.1	PJRC Store	

Notes: *The main system processor.* Available from multiple vendors. Versions with and without the pins pre-installed are available (link above is with pins). Either of the versions (with or without Ethernet) are fine.

Either of the ver Touchscreen LCD	1	BuyDisplay	N/A	LCD 3.5" 320x480 TFT Display Module, OPTL Touch Screen w/Breakout Board	BuyDisplay	Workspace Sodal Vibes 13 popula S popula
				Options: -Capacitive touch panel -16-bit 8080 40-pin header -3.3V supply -No font chip		Colleague Locator Store Competition Store Competition Start Time Off Depice York Share Truly Mail San Truly M

Notes: The display and user interface. Note that this is the capacitive touchscreen version unlike the resistive version used previously.

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Laser Rangefinder OPTION 1	1	JRT Meter Tech., Co, Ltd.	Unknown	40m – 60m Laser Distance Sensor Module	Ebay Alibaba Alibaba Alibaba Alibaba Availability changes frequently. Sites linked above has availability as of the date of this BOM	

Notes: *Used for station distance measurements.* There are several variants of this module including those that use ASCII or HEX-based commands both of which are supported by the Caveatron. Based on the datasheets I have reviewed I think any variant of this style should work. This style is the preferred LRF module and the only one for which the Rev C enclosure is designed to accommodate.

Laser Rangefinder	1	JRT Meter Tech., Co, Ltd.	Unknown	100m Laser Distance Sensor Module	Still available from some sources on Ebay or Alibaba but you will	
OPTION 2					have to search	Wast Salar

Notes: *Used for station distance measurements.* This rangefinder module uses the same ASCII protocol and power supply as option 1 above but has a longer range so can be substituted. NOTE: the current enclosure design does not accommodate this LRF so a customized enclosure would be required.

Laser Rangefinder	1	Uni-T	UT390B	Laser Distance Meter	Nearly impossible to find	No. of Concession, Name of
OPTION 3						2856 2858 2858 2859 2859 2859 2859 2859 2859

Notes: *Used for station distance measurements.* This item is long since discontinued and is almost impossible to find. Do not confuse this with the UT390B+, which is more widely available but does not have an accessible serial port, so is not useable. The UT390B+ has a bubble level in the upper left which the UT390B does not. The UT390B must be disassembled and the LCD removed to access the electronics board. The electronics and code in Rev C still support this LRF although the enclosure does not.

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Compass Module OPTIONAL BUT HIGHLY RECOMMENED	1	Witmotion	RM3100	WitMotion High-Precision RM3100 Military-grade Magnetometer Sensor	Amazon or Witmotion	

Notes: *Used to determine the azimuth angle of the Caveatron.* This is the best currently available low-cost magnetometer module option. This magnetometer has proven more accurate, reliable and with less drift than another other tested. It is optional since the Pololu IMU module below also includes a magnetometer but the Pololu magnetometer is much more noisy and less accurate, so it is highly recommended that you use this module.

Notes: *Used to determine orientation of the Caveatron and measure inclination.* The AltIMU-10 v5 is an equivalent part and can also be used (the altitude sensor is not used). The MinIMU-9 and AltIMU-10 v3 and v4 are still supported by the code and electronics but are no longer available.

Font/Graphics IC	1	Winbond	W25Q128JVSIM	W25Q128 SPI flash memory IC, 128 Mbit, quad 8-SOIC	Digikey and many other source	Part Part

Notes: Contains the fonts and graphics used for the GUI. You must use the 128Mbit 8-SOIC package version – other sizes may not work. It is soldered to the pad location on the underside of the Teensy 4.1 that is directly under the micro-SD slot and closest to the edge.

Item	Qty	Manufactu rer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Battery Pack OPTION 1	1	Dantona Industries	L37A52- 2-1-2WX	Li-Ion Battery Pack, 3.7V, 5200 mAh, 18650, wire leads with connector	<u>Digikey</u>	
Notes: Primar	y system	battery. This or	ne is the best of	choice since it is lower cost and	already has a con	nector.
Battery Pack OPTION 2	1	Tenergy	31001	Tenergy Li-Ion 18650 3.7V 5200mAh Rechargeable Battery PCB module with Bare Leads	Tenergy	
Notes: Primar	y system	battery. Identic	al size and ca	pacity to Option 1, but more ex	pensive and you m	nust add a connector.
Battery Pack OPTION 3	1	Adafruit	354	Lithium Ion Battery Pack - 3.7V 4400mAh	<u>Adafruit</u>	PKCELL ICR18650 4400mAh 3.70
Notes: Primar	y system	battery. Lower	capacity than	options 1 or 2. Has a connector	r.	

Item	Qty	Manufacture r	Mfr. P/N	Description	Suggested Vendor Link	Photo
Battery Charger Module	1	Unknown	TP5000	Lithium Ion 3.7V Charger Module	Amazon	D1 +4 82 F TN+0 SANYA RIOO B+
	require	d to make it functi				sure to get the variant with the 4 power pins all on the same side. A urge current above 1 Amp. These are usually on a red PCB but can also be
10k resistor	2	Various	Various	SMD resistor, 10k-ohm, 1%, 1206 package	<u>Digikey</u>	
		tery monitor volta, arries no significan		d for IMU power input. Avail	able from numero	ous manufacturers and vendors - the above is only 1 example. 1/4 watt or
3.3k resistor	1	Various	Various	SMD resistor, 3.3k-ohm, 1%, 1206 package	Digikey	
Notes: Resistor carries no signi			ge divider. A	vailable from numerous manu	ifacturers and ver	dors - the above is only 1 example. 1/4 watt or less is fine since this
0.2-ohm resistor OPTIONAL	1	Various	Various	SMD resistor, 0.2-ohm, 1%, 0.5W, 1206 package	<u>Digikey</u>	
Notes: Resistor	r for bat	l tery charger modu	lule. Only need	l led if you want to increase the	charge current o	of the TP5000 from the default 1 Amp to 1.5 Amp.

Notes: Power supply for Teensy. I	Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
LRF Voltage Regulator Notes: Power supply for Laser Rangefinder. Output needs to be set to 3.0V. LIDAR Voltage Regulator OPTION FOR RPLIDAR Voltage Regulator Notes: Power supply for RPLIDAR AIM8. If using the RPLIDAR S2, this cannot source enough current. LIDAR Voltage Regulator OPTION FOR RPLIDAR AIM8. If using the RPLIDAR S2, this cannot source enough current. LIDAR Voltage Regulator RPLIDAR Pololu 2123 Pololu SV Step-Up/Step-Down Voltage Regulator S7V8F5 Pololu Pololu Pololu Pololu Pololu Pololu Regulator U3V70F5 Pololu Pololu	Regulator –	1	Pololu	2119		<u>Pololu</u>	
Notes: Power supply for Laser Rangefinder. Output needs to be set to 3.0V. LIDAR AIM8 Notes: Power supply for RPLIDAR AIM8. If using the RPLIDAR S2, this cannot source enough current. LIDAR Voltage Regulator OPTION FOR RPLIDAR AIM8. If using the RPLIDAR S2, this cannot source enough current. LIDAR Voltage Regulator Notes: Power supply for RPLIDAR AIM8. If using the RPLIDAR S2, this cannot source enough current. LIDAR Voltage Regulator OPTION FOR RPLIDAR AIM8. If using the RPLIDAR S2, this cannot source enough current. Pololu Pololu Pololu Regulator U3V70F5	Notes: Power	supply j	for Teensy.	l			
LIDAR Voltage Regulator OPTION FOR RPLIDAR A1M8. If using the RPLIDAR S2, this cannot source enough current. LIDAR Voltage Regulator Notes: Power supply for RPLIDAR A1M8. If using the RPLIDAR S2, this cannot source enough current. LIDAR Voltage Regulator OPTION FOR RPLIDAR A1M8. If using the RPLIDAR S2, this cannot source enough current. Regulator Voltage Regulator OPTION FOR RPLIDAR	Voltage	1	Pololu	2118	Up/Step-Down Voltage	<u>Pololu</u>	
Voltage Regulator OPTION FOR RPLIDAR A1M8 Notes: Power supply for RPLIDAR A1M8. If using the RPLIDAR S2, this cannot source enough current. LIDAR Voltage Regulator OPTION FOR RPLIDAR RPLIDAR	Notes: Power	supply J	for Laser Rangefind	der. Output	needs to be set to 3.0V.		
LIDAR Voltage Regulator OPTION FOR RPLIDAR Pololu 2891 Pololu 5V Step-Up Voltage Regulator U3V70F5	Voltage Regulator OPTION FOR RPLIDAR	1	Pololu	2123	Down Voltage Regulator	<u>Pololu</u>	
Voltage Regulator OPTION FOR RPLIDAR	Notes: Power	supply	for RPLIDAR A1M	8. If using t	he RPLIDAR S2, this cannot so	urce enough current.	
	Voltage Regulator OPTION FOR RPLIDAR	1	Pololu	2891		<u>Pololu</u>	

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Power Switch Module	1	Pololu	2808	Mini Pushbutton Power Switch with Reverse Voltage Protection, LV	<u>Pololu</u>	
Notes: Turns	on and oj	t If system power who	en pushbutton j	nower switch is pressed and also con	trols timed auto p	power-off.
RTC Battery Holder	1	MPD and others	BC501SM	Coin Cell Battery Holder - 12mm (for CR1220 batteries)	<u>Digikey</u>	
					<u>Amazon</u>	
						ers are available from many sources with differing part
Piezoelectric	nose I ha	Uxcell	A1406240	all have nearly identical dimensions uxcell A14062400ux0199 5 Pcs		
Buzzer	1	Uxceii	0ux0199	DC 2-28V 80Db Sound Electronic Passive Buzzer Alarm Black, 22 x 4.5 mm	Amazon	

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Power Switch & Charging LED	1	Adafruit	3350	Rugged Metal Pushbutton - 16mm 6V RGB Momentary	Adafruit Amazon	

Notes: On/Off power switch and charge indicating ring LED. This one enables separate colors on the ring LED for indicating charging and charge complete. These can be found at other sources as well but if you buy from another source be sure to get the common anode version.

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USB Jack	1	GT Contact	GT114200-10	Mini USB-B C2 size Plastic	USBFirewire.	
			(RR-114200-10)	Panel Mount	<u>com</u>	
						WAY TWA LUSTSTEP WITH SOME
						GEO

Notes: *USB jack for data download, battery charging, and loading of software and calibration parameters.* This is the version with the solder pins on the inside. If you prefer a USB-micro connector, that is available as part number RR-11A200-10 and is an identical fit.

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
USB Cap	1	GT Contact	GT1C522122 (RR-1C522122)	Seal Cap	USBFirewire. com	SBFireWire.com

Notes: Waterproof cap for USB jack. This cap works for either the mini or micro USB options.

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
MicroSD Card	1	Various	Various	SanDisk 32GB Ultra microSDHC UHS-I Memory Card	Amazon and many other sources	SanDisk Ultra 32GB PSO 1 © A1

Notes: *Storage for Caveatron data.* Numerous brands and sources available. MicroSD card must be SDHC type not larger than 32 GB (smaller capacities are fine as well). SanDisk brand is preferred as they are generally the most reliable.

Teensy USB connector	1	N/A	N/A	Micro USB Male Solder Connector	Amazon and many other sources		
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Notes: For the cable to connect the exterior USB jack to the Teensy. Wires are soldered between this part and the USB jack connector pins. Note that only the D+, D-, and GND are connected on this plug. The USB power (and a second GND wire) goes from the USB jack to a plug on the main PCB.

LCD Connector Cable	1	N/A	N/A	40 pin IDE Male to Female Extension Cable, 4" (10 cm) or 6" (15 cm)	Ebay or Amazon	
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Notes: Cable to connect to LCD Touchscreen from the Caveatron main board. Cables longer than 6" would take up too much space in the enclosure while those shorter than 4" are not long enough. These are available from multiple vendors. Note that some of these connectors do not include one of the middle pins, however those are fine since that pin is not used.

JST 3 or 4 Connector 2-pin	LRF, power swit	h, and LIDAR. If yo	JST 2.54mm pitch, 5 pin, male connector ou order them prewired as in the JST 2.54mm pitch, 2 pin, male connector	Amazon, Ebay and others e photo, be sure they are Amazon, Ebay and others	e at least 100 mm in length.
JST 3 or 4 Connector 2-pin Notes: Connector used won't need one for the	Vario		JST 2.54mm pitch, 2 pin,	Amazon, Ebay and	e at least 100 mm in length.
Connector 2-pin Notes: Connector used won't need one for the		s JST-XH			
won't need one for the	d for USB data,	i i			
				them prewired as in the	photo, be sure they are at least 100 mm in length. (You
Headers 1 (6 pin position needed	in other	o or 310-87-	Socket header, 0.1" pitch, 4.2 mm insulation height, single row, 6 pins	Digikey and others	
					ed since the RM3100 has tall components. This header size is n one side and 2 pins on the other.
Socket 3 Headers 2 (54 pi positio needed	Prec-Di oin other	or 801-87-	Socket header, 0.1" pitch, 7.0 mm insulation height, single row, 24 pins	Digikey and others	To the side and 2 pins on the other.

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo				
Screen Protector	1	Supershieldz	N/A	iPhone SE and iPhone 5 Screen Protector	<u>Amazon</u>	PACINATION OF THE PROPERTY OF				
	Notes: Protection film for touchscreen. Needs to be cut to length. Most any PET screen protector film for iPhone 4, 4S, 5, 5s, or SE should work as they have the same screen width as the 3.5" LCD. Multiple yenders produce a similar product.									

width as the 3.5" LCD. Multiple vendors produce a similar product.

Laser	1	Rosco	299	Roscolux 1.2 Neutral	<u>Adorama</u>		
Rangefinder				Density Filter, 20x24"			
Optical							
Filter							

Notes: Optical filters for the LRF receiver to only accept readings from the retroreflective card. This filter only has half the optical density required, so must be folded in half when installed. Other neutral density films are fine so long as they are sufficiently dark to prevent the LRF from getting a signal from a non-retroreflective surface but no so dark that they reduce the range from the retroreflective surface.

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
LIDAR OPTION 1	1	Slamtec	RPLIDAR A1M8	LIDAR 360 Degree Laser Range Scanner, 12 m range	RobotShop	

Notes: *Scanning LIDAR sensor.* Other models that should also work but have not been tested include RPLIDAR A2M6, A2M7, A2M8, and A3. These LIDARs are triangulation-based. Available from several sources.

LIDAR	1	Slamtec	RPLIDAR	LIDAR 360 Degree Laser	RobotShop	
			S2	Range Scanner, 30 m range		
OPTION 2						
						With Many
						48)

Notes: *Scanning LIDAR sensor.* The S2 has 2.5x the range, can collect 4x the number of points per second, has a faster rotation rate, and is smaller, but is more expensive. This LIDAR is a time-of-flight LIDAR. Available from several sources. Watch out since there are several variants out there. A true unit may also be referred to as an S2 R2. Some models which are referred to as S2L are about \$100 cheaper than a true S2, but can only get about 12 m of range. There is also an Ethernet version – the S2E but you don't want that version either. Also there may be some defective units out there as the first one I received only reached 14m even through it appears to be a true S2.

Item	Qt y	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Threaded Inserts for Enclosure	10	Initeq		#6-32 Threaded Heat Set Inserts for 3D Printing (Long)	<u>Ebay</u>	
Notes: Heat set	threac	led inserts used in	3D printed enclos	sure.		
Threaded Inserts for external mounting (Optional)	1	Initeq		#1/4-20 1/4" Threaded Heat Set Inserts for 3D Printing (Short)	<u>Ebay</u>	
Notes: Heat set handle) or mou			3D printed enclos	sure for external mounting. This is	an optional part	if you plan to attach something external to the Caveatron (like a
Threaded Inserts for RPLIDAR A1M8 Standoffs For RPLIDAR A1M8 only	4	Initeq	INM2504	M2.5-0.4 M2.5 Threaded Heat Set Inserts for 3D Printing (Long)	<u>Ebay</u>	
Notes: Heat set	thread	led inserts used in	3D printed LIDA	R enclosure for RPLIDAR A1M8 st	andoffs. The sta	ndoffs that screw into these are included with the RPLIDAR.

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo					
LIDAR Window For RPLIDAR S2 only	1	JMX	N/A	3.1" Acrylic Dome	Amazon						
Notes: Windo	Notes: Window for the RPLIDAR S2. This will only work for a TOF type LIDAR. Curved windows do not work with triangulation LIDARs like the A1 series.										
LIDAR Window For RPLIDAR A1M8 only	1	Small Parts	5302441212	Acrylic Sheet, Transparent Clear, Standard Tolerance, ASTM D788, 0.118" Thickness, 12" Width, 12" Length	Amazon						
seems to be th	Notes: Transparent acrylic sheet for LIDAR window. This 0.118" transparent acrylic sheet is used for the RPLIDAR A-series windows. Requires cutting to size. Acrylic seems to be the most transparent with the least distortion and defects of the various clear plastics tested, which is important for getting good LIDAR and rangefinder readings. A flat window is required for the A-series triangulation-based LIDAR modules.										
LRF Window Material	1	Sibe Polymers	5064981212	Clear Acrylic Plexiglass 12" x 12" - 3/32" (.090)	Amazon						
Notes: Transp	arent a	crylic sheet for LRI	 F window on Ma	lin Body.							

Item	Qty	Manufacture r	Mfr. P/N	Description	Suggested Vendor Link	Photo				
Strap Attachment Hardware	1	122317	Hillman Group	D-Ring Hangers	<u>Lowes</u> <u>Amazon</u>					
Notes: Small D-rings for attaching neck strap. Available from multiple sources and similar parts likely available from other vendors.										
Neck Strap	1	DOROM	N/A	DOROM Universal Adjustable Slim Shoulder Sling Neck Strap for All Camera DSLR SLR	Amazon	Sitt				
Notes: Neck Strap. This neck strap works well, but other options are available. Recommend a nylon camera strap of 52-60" in length and about 3/8" wide in the ends.										
O-Ring Seals	4 ft	The O-Ring Store	N50.103/10	0.103" (2.62mm) Buna-N 50 O-Ring Cord Stock, 10' Piece, Black	O-Ring Store	The Paris of the P				

Notes: *O-Ring material for seals in main enclosure and LIDAR module.* This 50 durometer material is preferred over more readily available 70 durometer since it is softer and can make a tighter seal. Must cut to length and glue ends (this vendor also sells O-ring glue in small quantities.) Other vendors sell similar material.

Other Required Items:

Caveatron Rec C Printed Circuit Board

CR1220 Battery

Single row male headers, 2.54 mm (0.1") pitch

Double row female headers 2x20 (for 40 pin LCD Connector), 2.54 mm (0.1") pitch

Soldering supplies

6-32 x 1" flat head machine screws (4x)

6-32 x 3/8" flat head machine screws (4x)

6-32 x 3/8" pan head machine screws (4x)

6-32 x 5/8" pan head machine screw (1x)

4-20 x ¹/₄" thread rolling screws (10x)

M4x0.7 x 6mm (or 5mm) pan head machine screws (4x)

4-20 x ½" thread rolling screws (6x)

2-28 x ¹/₄" thread rolling screws (11x)

PETG filament for 3D printed parts

O-Ring grease

O-Ring epoxy

Size 114 O-ring (for the LIDAR-Main body interface or make your own from the O-Ring cord above)

Flexible waterproof epoxy sealant

Adhesive-backed foam

Tape (Kapton or cellophane)

Notes: For assembly and electrical interconnections between boards.