
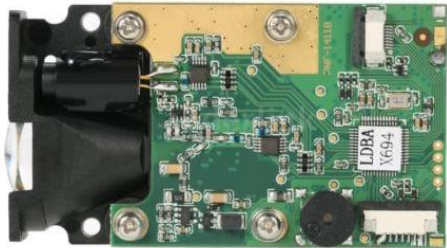



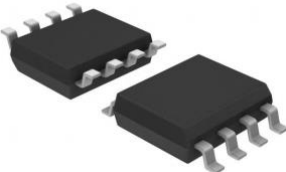





Caveatron Bill of Materials

Hardware Revision: C
Date: 2023-02-19

[illegible]



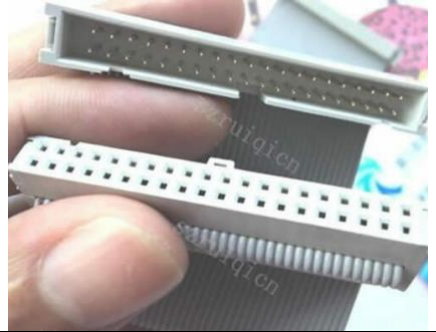
Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Laser Rangefinder OPTION 1	1	JRT Meter Tech., Co, Ltd.	Unknown	40m – 60m Laser Distance Sensor Module	Ebay Ebay Ebay Alibaba Alibaba Alibaba	
Notes: <i>Used for station distance measurements.</i> There are several variants of this 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 OPTION 2	1	JRT Meter Tech., Co, Ltd.	Unknown	100m Laser Distance Sensor Module	Still available from some sources on Ebay or Alibaba but you will have to search	
Notes: <i>Used for station distance measurements.</i> 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 OPTION 3	1	Uni-T	UT390B	Laser Distance Meter	Nearly impossible to find	
Notes: <i>Used for station distance measurements.</i> 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: <i>Used to determine the azimuth angle of the Caveatron.</i> 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.						
IMU Module	1	Pololu	MinIMU-9 v5 (#2738) Or AltIMU-10 v5 (#2739)	MinIMU-9 v5 Gyro, Accelerometer, Compass (LSM6DS33, and LIS3MDL Carrier)	Pololu	
Notes: <i>Used to determine orientation of the Caveatron and measure inclination.</i> 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	
Notes: <i>Contains the fonts and graphics used for the GUI.</i> 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	Manufacturer	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	Digikey	
Notes: <i>Primary system battery.</i> This one is the best choice since it is lower cost and already has a connector.						
Battery Pack OPTION 2	1	Tenergy	31001	Tenergy Li-Ion 18650 3.7V 5200mAh Rechargeable Battery PCB module with Bare Leads	Tenergy	
Notes: <i>Primary system battery.</i> Identical size and capacity to Option 1, but more expensive and you must add a connector.						
Battery Pack OPTION 3	1	Adafruit	354	Lithium Ion Battery Pack - 3.7V 4400mAh	Adafruit	
Notes: <i>Primary system battery.</i> Lower capacity than options 1 or 2. Has a connector.						




[illegible]

[illegible]




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	
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	
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	
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.						

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Screen Protector	1	Supershieldz	N/A	iPhone SE and iPhone 5 Screen Protector	Amazon	
<p>Notes: <i>Protection film for touchscreen.</i> 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 vendors produce a similar product.</p>						
Laser Rangefinder Optical Filter	1	Rosco	299	Roscolux 1.2 Neutral Density Filter, 20x24"	Adorama	
<p>Notes: <i>Optical filters for the LRF receiver to only accept readings from the retroreflective card.</i> 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.</p>						

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: <i>Scanning LIDAR sensor.</i> 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 OPTION 2	1	Slamtec	RPLIDAR S2	LIDAR 360 Degree Laser Range Scanner, 30 m range	RobotShop	
Notes: <i>Scanning LIDAR sensor.</i> 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 only have an 18m rated 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	Qty	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)	Ebay	
Notes: Heat set threaded inserts used in 3D printed enclosure.						
Threaded Inserts for external mounting (Optional)	1	Initeq		#1/4-20 1/4" Threaded Heat Set Inserts for 3D Printing (Short)	Ebay	
Notes: Heat set threaded inserts used in 3D printed enclosure for external mounting. This is an optional part if you plan to attach something external to the Caveatron (like a handle) or mount it to a tripod.						
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)	Ebay	
Notes: Heat set threaded inserts used in 3D printed LIDAR enclosure for RPLIDAR A1M8 standoffs. The standoffs that screw into these are included with the RPLIDAR.						

[illegible]

Item	Qty	Manufacturer	Mfr. P/N	Description	Suggested Vendor Link	Photo
Strap Attachment Hardware	1	122317	Hillman Group	D-Ring Hangers	Lowes Amazon	
Notes: <i>Small D-rings for attaching neck strap.</i> 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	
Notes: <i>Neck Strap.</i> 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	
Notes: <i>O-Ring material for seals in main enclosure and LIDAR module.</i> 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 1/2" 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.*