## **Caveatron Bill of Materials – Base Unit**

Hardware Revision: A Date: 2018-03-06

All the parts in this list have been tested with the Caveatron and integrated into the code. For some parts, alternate options are available.

| Item              | Qty | Manufacturer | Mfr. P/N | Description | Suggested<br>Vendor Link | Photo  |
|-------------------|-----|--------------|----------|-------------|--------------------------|--|
| Main<br>Processor | 1   | Arduino      | Due      | Arduino Due | Amazon                   | POWAL SERVICE IN THE SERVICE STATE OF THE SERVICE S |

**Notes:** The main system processor. Available from many vendors. Third party clones are available at lower cost but may require modification of the reset circuit by adding a capacitor and/or resistor as per this link: https://forum.arduino.cc/index.php?topic=256771.0

| Touchscreen<br>LCD | 1 | Coldtears<br>Electronics | N/A | 3.5 inch TFT LCD module<br>w/Font IC 480x320 full<br>angle Arduino DUE MEGA<br>3.2 4.3 | <u>Ebay</u> |  |
|--------------------|---|--------------------------|-----|--|-------------|--|

**Notes:** The display and user interface. This component uses a Font IC with a proprietary font/graphic library (UTFT\_GHL) that is not provided with the Caveatron code. This library can be downloaded from a link provided with the LCD module. This replaces a similar touchscreen LCD used previously (and that uses a different library – UTFT\_CTE) but no longer available. The UTFT\_CTE library is still included since it supports a 4-inch 480x320 module still being produced by Coldtears (not tested).

| Item                           | Qty | Manufacturer             | Mfr. P/N | Description  | Suggested<br>Vendor Link | Photo  |
|--------------------------------|-----|--------------------------|----------|--|--------------------------|--|
| Due LCD<br>Interface<br>Shield | 1   | Coldtears<br>Electronics | N/A      | TFT/SD Shield<br>for Arduino<br>DUE TFT LCD<br>Module SD<br>Card Adapter<br>2.8 3.2 inch<br>Mega | <u>Ebay</u>              | The state of the s |

**Notes:** Providea electrical interface from Arduino to the Touchscreen LCD.

| Laser       | 1 | Uni-T | UT390B | Laser    | Ebay,        |
|-------------|---|-------|--------|----------|--------------|
| Rangefinder |   |       |        | Distance | Amazon, or   |
|             |   |       |        | Meter    | other        |
| OPTION 1    |   |       |        |          | sources.     |
|             |   |       |        |          | Availability |
|             |   |       |        |          | changes      |
|             |   |       |        |          | frequently.  |
|             |   |       |        |          |              |
|             |   |       |        |          |              |



**Notes:** *Used for station distance measurements.* This item appears to be discontinued but can still be found online from various sources. Do not confuse this with the UT390B+, which is 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. An alternate rangefinder module has been integrated into the firmware that has wider availability and is easier to assemble into the enclosure, but has operational disadvantages. The UT390B remains the preferred rangefinder if you can find one.

| Item                           | Qty | Manufacturer                 | Mfr. P/N | Description                          | Suggested<br>Vendor Link                       | Photo |
|--------------------------------|-----|------------------------------|----------|--------------------------------------|--|-------|
| Laser<br>Rangefinder  OPTION 2 | 1   | JRT Meter<br>Tech., Co, Ltd. | Unknown  | 100m Laser Distance Sensor<br>Module | Ebay<br>Availability<br>changes<br>frequently. |       |

**Notes:** Used for station distance measurements. This new rangefinder module is very similar in size to Option 1 above, is easier to mount due to the presence of mounting holes, however, it's method of operation is less well suited to the Caveatron since it has a variable measurement time (rather than the UT390B's fixed 1 sec measurement time) and can take up to 3 sec to acquire a reading or timeout. This means that when scanning in Passage mode, you can end up with fewer reference points and a less accurate scan.

| Compass<br>Module | 1 | Pololu | LSM303D<br>(#2127) | LSM303D 3D Compass and<br>Accelerometer Carrier with<br>Voltage Regulator | <u>Pololu</u> |  |
|-------------------|---|--------|--------------------|---|---------------|--|
|                   |   |        |                    |   |               |  |

**Notes:** Used to measure azimuth and inclination.

| Item                  | Qty | Manufacturer | Mfr. P/N | Description                                | Suggested<br>Vendor Link | Photo                           |
|-----------------------|-----|--------------|----------|--|--------------------------|---------------------------------|
| Battery Pack OPTION 1 | 1   | Adafruit     | 354      | Lithium Ion Battery Pack -<br>3.7V 4400mAh | <u>Adafruit</u>          | PKCELL<br>ICR18650 4400mAh 3.7U |

**Notes:** *Primary system battery.* 

| Battery Pack OPTION 2 | 1 | Tenergy | 354 | TenergyLi-Ion 18650 3.7V<br>5200mAh Rechargeable<br>Battery PCB module with<br>Bare Leads | Amazon | SHORE PROPRIE |
|-----------------------|---|---------|-----|---|--------|---------------|
|                       |   |         |     |   |        |               |

Notes: Primary system battery. Higher capacity battery with identical dimensions and voltage to Option 1. Does not include connector unlike Option 1.

| Item                                      | Qty | Manufacturer | Mfr. P/N | Description                        | Suggested<br>Vendor Link | Photo  |
|---|-----|--------------|----------|------------------------------------|--------------------------|--|
| Battery<br>Charging<br>Module<br>OPTION 1 | 1   | Adafruit     | 259      | USB Lilon/LiPoly charger -<br>v1.2 | <u>Adafruit</u>          | O OHEM ON OHEM OF THE PROPERTY |

**Notes:** Controls the charging of the LI-lon battery pack and provides charge indication to power switch LED. Default charge current is 500 mA, but can be increased to 1000 mA by adding resistor (see assembly instruction.) An alternate part is available with a combined battery charger and fuel gauge module, but is more problematic in several ways, so this part is still the preferred option.

| Battery  | 1 | Sparkfun | TOL-  | LiPo Fuel Gauge | <u>Sparkfun</u> |     |
|----------|---|----------|-------|-----------------|-----------------|-----|
| Gauge    |   |          | 10617 |                 |                 | @ B |
| Module   |   |          |       |                 |                 |     |
|          |   |          |       |                 |                 |     |
| OPTION 1 |   |          |       |                 |                 |     |

**Notes:** *Monitors battery level.* Contains a MAX17043 battery fuel gauge IC. These are also available at other, cheaper sources such as Ebay and Amazon, but often use a counterfeit Maxim IC that does not function properly. An alternate part is available with a combined battery charger and fuel gauge module, but is more problematic in several ways, so this part is still the preferred option.

| Battery<br>Charger and<br>Fuel Gauge | 1 | Sparkfun | PRT-<br>13777 | Battery Babysitter - LiPo<br>Battery Manager | <u>Sparkfun</u> |  |
|--------------------------------------|---|----------|---------------|--|-----------------|--|
| OPTION 2                             |   |          |               |  |                 |  |

**Notes:** *Battery charge controller and fuel gauge.* This is an alternative to both the separate charger and fuel gauge modules listed above. It is capable of 1.5A charging current and provides a more accurate method for monitoring battery charge level. However, it is more challenging to mount inside the enclosure, it causes a 5-10 sec delay when booting the Caveatron, draws a small amount of power even when turned off, and does not provide an easy way to connect the charging LED on the power switch.

| Voltage Regulator – SV Pololu 2118 Pololu 2123 Pololu SV Step-Up Voltage Regulator - SV Pololu 2123 Pololu SV Step-Up/Step-Down Voltage Regulator - SV Pololu 2128 Pololu Adjustable Step-Up/Step-Down Voltage Regulator - Adjustable Regulator - Adjustable Regulator - Adjustable Step-Up/Step-Down Voltage Regulator S7V8A Pololu 2118 Pololu Adjustable Step-Up/Step-Down Voltage Regulator S7V8A  | Item         | Qty    | Manufacturer     | Mfr. P/N | Description            | Suggested<br>Vendor Link | Photo |
|--|--------------|--------|------------------|----------|------------------------|--------------------------|-------|
| Voltage Regulator – 5V  Pololu   | Regulator –  | 1      | Pololu           | 2116     |                        | <u>Pololu</u>            |       |
| Regulator – 5V Down Voltage Regulator S7V8F5  Notes: Power supply for LIDAR Module.  Voltage Regulator – Pololu Po | Notes: Power | supply | for Arduino Due. |          |                        | -                        |       |
| Voltage 1 Pololu 2118 Pololu Adjustable Step- Regulator – Up/Step-Down Voltage   | Regulator –  | 1      | Pololu           | 2123     | Down Voltage Regulator | Pololu                   |       |
| Regulator – Up/Step-Down Voltage   | Notes: Power | supply | for LIDAR Module | ).       |                        | -                        |       |
|  | Regulator –  | 1      | Pololu           | 2118     | Up/Step-Down Voltage   | Pololu                   |       |

| Item                                 | Qty     | Manufacturer     | Mfr. P/N                | Description  | Suggested                         | Photo              |
|--------------------------------------|---------|------------------|-------------------------|--|-----------------------------------|--------------------|
| Piezoelectric<br>Buzzer              | 1       | Uxcell           | a140624<br>00ux017<br>3 | Uxcell 5 Pcs DC 1-30V 90Db<br>Sound Passive Electronic<br>Buzzer Alarm Black, 30 x 6<br>mm | Vendor Link  Amazon               |                    |
| Notes: Indicat                       | or buzz | er.              |                         |  |                                   |                    |
| Power<br>Switch &<br>Charging<br>LED | 1       | Adafruit         | 916                     | Rugged Metal On/Off<br>Switch with Red LED Ring -<br>16mm Red On/Off                       | <u>Adafruit</u>                   |                    |
|                                      | power   |                  |                         | ing LED. Several colors of the LI  |                                   | <u> </u>           |
| USB Jack                             | 1       | GT Contact       | GT114200<br>-10         | Mini USB-B C2 size Plastic<br>Panel Mount  | <u>USBFirewire</u><br><u>.com</u> | WIW.USBFIRWING.Com |
| Notes: Mini-U                        | SB jack | for data downloa | d, battery ch           | arging, and loading of software  | and calibration                   | parameters.        |
| USB Cap                              | 1       | GT Contact       | GT1C5221<br>22          | Seal Cap   | <u>USBFirewire</u><br><u>.com</u> | SBFireWire.com     |

| Item                       | Qty      | Manufacturer                         | Mfr. P/N          | Description  | Suggested<br>Vendor Link | Photo  |
|----------------------------|----------|--------------------------------------|-------------------|--|--------------------------|--|
| LIDAR<br>Interface<br>Jack | 1        | Conxall/<br>Switchcraft              | 17982-<br>6SG-300 | Micro-Con-X 6 Position Circular Connector Receptacle, Female Sockets Solder Cup Gold | <u>Digikey</u>           |  |
| Notes. Jack jo             | II LIDAI | interjuce cubie. i                   | Available ITOII   | i multiple vendors.  |                          |  |
| LIDAR<br>Interface<br>Cap  | 1        | Conxall/<br>Switchcraft              | 16295             | Micro-Con-X Receptacle<br>Dust Cap   | <u>Digikey</u>           |  |
| Notes: Cap fo              | r LIDAR  | interface jack. Av                   | vailable from i   | multiple vendors.  |                          |  |
| LCD<br>Connector<br>Cable  | 1        | N/A                                  | N/A               | 40 pin IDE Connector Cable,<br>6"  | Ebay or<br>Amazon        | Designation of the second of t |
|                            |          | face Due LCD Interstretch. Available |                   |  | referred length. L       | onger would take up too much space in the enclosure. 4" can work as  |

| Item                     | Qty    | Manufacturer      | Mfr. P/N         | Description   | Suggested<br>Vendor Link | Photo  |
|--------------------------|--------|-------------------|------------------|---|--------------------------|--|
| Base Unit<br>Enclosure   | 1      | Bud Industries    | PN-1324-<br>DG   | NEMA ABS NEMA 4x<br>Enclosure, Dark Gray                              | Amazon                   |  |
|                          |        |                   |                  |   |                          | ont window and machining of the cover to add screw holes for the LIDAR D, and LIDAR Interface Jack. Available from many vendors. |
| Notes: Rail fo           | r moun | ting LIDAR module | e. Weaver TO     | 9 rail is identical but with a shi                                    | ny finish. Availal       | ble from multiple vendors  |
| Plastic Base<br>Material | 1      | Small Parts       | STPVC-<br>0093-F | PVC Sheet, Opaque Gray,<br>0.093" Thickness, 12"<br>Width, 24" Length | <u>Amazon</u>            |  |

| Item                                  | Qty     | Manufacturer        | Mfr. P/N       | Description  | Suggested<br>Vendor Link | Photo   |
|---------------------------------------|---------|---------------------|----------------|--|--------------------------|---|
| Window<br>Material                    | 1       | Small Parts         | 50649812<br>12 | Acrylic Sheet, Transparent<br>Clear, 0.06" Thickness, 12"<br>Width, 12" Length | Amazon                   |   |
| transparent w<br>Laser<br>Rangefinder |         |                     |                |  |                          | R Module. Requires cutting to size. Acrylic seems to be the most ant for not interfering with the LIDAR and rangefinder readings. |
| Optical<br>Filter                     | rangof  | indor receiver to a | nly accept ro  | adings from the retroreflective  | Card                     |   |
| Notes: Filters                        | rangeji | inaer receiver to o |                | adings from the retroreflective o  | cara.                    |   |
| Screen<br>Protector                   | 1       | iCarez              | N/A            | iPhone 5 Ultra Clear Screen<br>Protector 6-pack                                | Amazon                   |   |

**Notes:** *Protection film for touchscreen.* Also comes in a 3 pack. Needs to be cut to length. Most any 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. Available from multiple vendors.

iCarez

| Item                            | Qty   | Manufacturer | Mfr. P/N         | Description                                 | Suggested<br>Vendor Link | Photo |  |  |  |  |
|---------------------------------|---|--------------|------------------|---|--------------------------|-------|--|--|--|--|
| Strap<br>Attachment<br>Hardware | 1   | 122317       | Hillman<br>Group | D-Ring Hangers                              | Lowes                    |       |  |  |  |  |
| Notes: Small                    | 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<br>Adjustable Slim Shoulder | <u>Amazon</u>            |       |  |  |  |  |

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.

Sling Neck Strap for All Camera DSLR SLR

Assorted Fastener Hardware: Screws, Washers, and Nuts

**Notes:** For assembly. Several sizes of standard hardware required. More information in assembly instructions.

Assorted Electrical Hardware: Wire, Header Connectors, and JST Connectors.

Notes: For electrical interconnections between boards. More information in assembly instructions.

## Retroreflective Card Date: 2017-09-11

| Item                          | Qty | Manufacturer | Mfr. P/N      | Description                | Suggested<br>Vendor Link   | Photo |
|-------------------------------|-----|--------------|---------------|----------------------------|--|-------|
| Retro-<br>reflective<br>Sheet | 1   | 3M           | 580 or<br>680 | Scotchlite Reflective Film | B.C.I Imaging Supplies for 8" wide or larger sheet OR Seton for half width 4" rolls. | 3M    |

**Notes:** Retroreflective film for station card. Required to obtain positive return signal from laser rangefinder for all measurements and scans. 3M 680 film is used currently. 580 film is more readily available and is identical except for being more permanent when applied. An 8" (200 mm) wide roll is ideal but is expensive unless you are making many cards. A much cheaper half-width roll could be used as two side by side strips. Many other reflective tapes are available and may work fine but have not been tested. I would suggest a uniform material like the 3M Scotchlite as I am not sure how well the prismatic style reflective tapes would work since they might provide too strong a reflection or a non-uniform reflection that depends on where on the card you hit. But they may work fine too.

| Station Card | 1 | Small Parts | B00E8S5686            | Kydex T Sheet, P3 Velour | <u>Amazon</u> |  |  |
|--------------|---|-------------|-----------------------|--------------------------|---------------|--|--|
| Substrate    |   |             | For 12x24"<br>sheet – | Matte, 0.028" thickness  |               |  |  |
|              |   |             | other sizes           |                          |               |  |  |
|              |   |             | have                  |                          |               |  |  |
|              |   |             | different             |                          |               |  |  |
|              |   |             | part                  |                          |               |  |  |
|              |   |             | numbers               |                          |               |  |  |
|              |   |             |                       |                          |               |  |  |
|              |   |             |                       |                          |               |  |  |

**Notes:** Substrate material for retroreflective station cards. Need to be cut to about 8"x8" (200x200 mm). Kydex was chosen since it is durable, thin and flexible, comes in a variety or bright colors easy to see in the cave, and is easy to cut. The material needs to be flexible since it will need to bend to accommodate some survey station locations. Other colors and sheet sizes available from this source – recommend getting a sheet big enough for at least two cards to have a spare. Many other plastics will work but I would not recommend using anything thicker as it may not be flexible enough.