AutoRally Compute Box Instructions

Version 1.2, September 2016, Georgia Institute of Technology

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1 Getting Started

1.1 Total Time

Total estimated time to construct a complete compute box is 37 hours, not including the time to print 3D printed components which will vary significantly based on the printer used. Each step includes an estimated completion time but the actual time may be longer if you have to learn new skills.

1.2 Parts List

A complete parts list for the AutoRally platform (chassis and compute box) can be found in the AutoRally Parts List.

1.3 Tools

Tools required for the assembly of the compute box: equipment for cutting, welding, and bending metal, hex key set, Philips screwdriver set, utility knife, wire cutters, wire strippers, needle nose pliers, crimp tool suitable for all crimps, soldering iron, 3rd hand, heat gun, hot glue gun, hand saw.

1.4 Fabricated Parts

Fabricated parts include

- Compute box base, front, rear, left, and right panels
- Compute box lid and rear hinge panel
- Compute box cross brace
- GPU strut
- Camera support plate
- 2 × rectangular camera covers
- 4 × right-angle camera cover supports
- Compute box rear panel hinge
- 10 Lid connectors
- Motherboard foam padding

1.5 3D Printed Parts

Models for all components that require 3D printing are located in `models/`. These parts include the front and rear compute box mounts, RAM holder, Arduino Micro holder, battery/power supply holder, solid-state disk (SSD) holder, and graphics processing unit (GPU) holder. It is advised to use a 3D printer with support material. Print time for a complete set of chassis components is 0 hours and 0 minutes, which will vary greatly based on the printer used, and is not included in the build time estimate. Material usage for a complete set of chassis parts is 241.55 cm^3, not including support material. 3D printed parts were made on a Dimension SST 768.

2 Fabrication

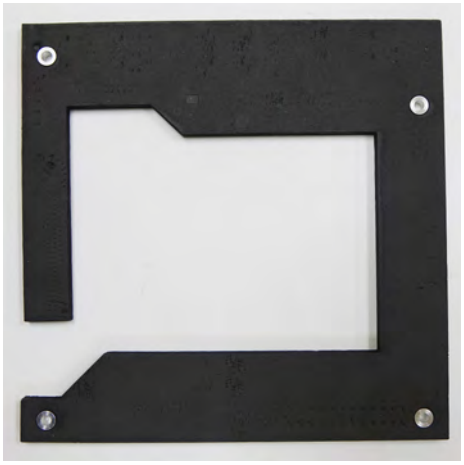
2.1 Motherboard Foam Padding

Time 0 hours 20 minutes
Parts

- 6mm-thick craft foam sheet

Instructions

a. Cut out the motherboard foam by hand or using a laser cutter. Use the .dxf file in `models/`as a stencil if cutting by hand or as input to the laser cutter.



2.2 Compute Box Lid Connectors

Time 2 hours 0 minutes
Parts

- 6" × 12", 0.25"-thick 6061 aluminum sheet
- 1 M3 × 10 mm screw

Instructions

a. Use a waterjet to cut 10 Lid connectors out of the 0.25"-thick aluminum sheet. The cut pattern for a single lid connector can be found in "Compute Box Aluminum 6061 025 Cut Pattern.dxf" in `models/`.

b. Tap the smaller hole of each Lid connector all the way through with an M3 tap.

c. Screw the M3 × 10mm screw all the way into and out of each tapped hole to clear any remaining aluminum debris.

2.3 Compute Box Panels and Internal Supports

Time 2 hours 0 minutes
Parts

- 24" × 36", 0.09"-thick 3003 aluminum sheet

Instructions

a. Cut all compute box panel and internal support parts out of the aluminum sheet using the cut patterns found in "Compute Box Aluminum 3003 090 Cut Pattern.dxf".

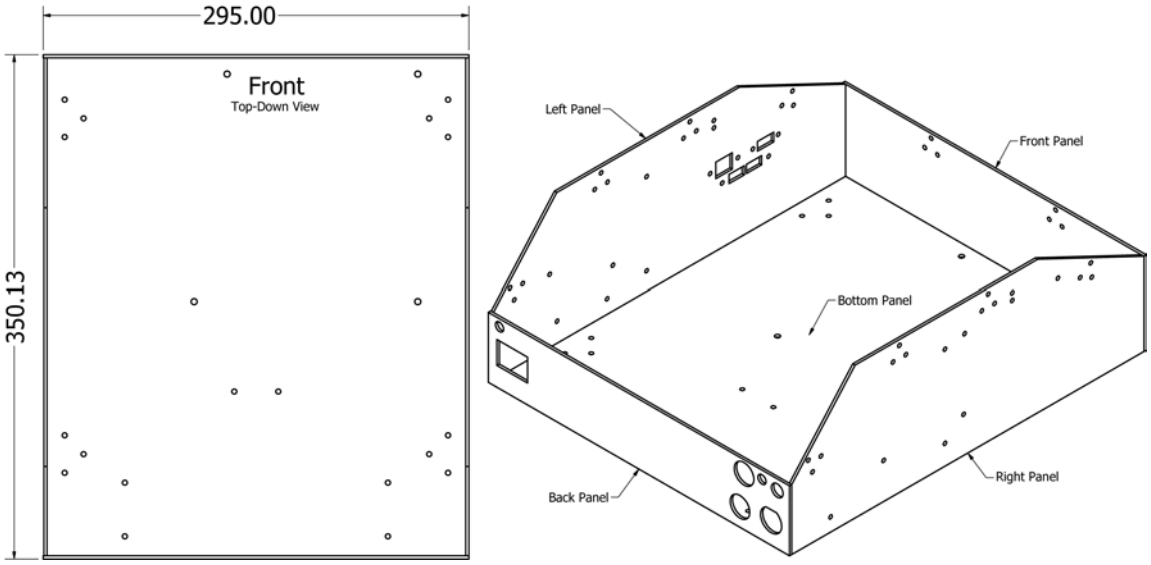
2.4 Compute Box Welding

Time 3 hours 0 minutes
Parts

- Compute box base, front, rear, left, and right panels

Instructions

a. Weld all the panels together and ensure that the outer dimensions of the box are as specified.



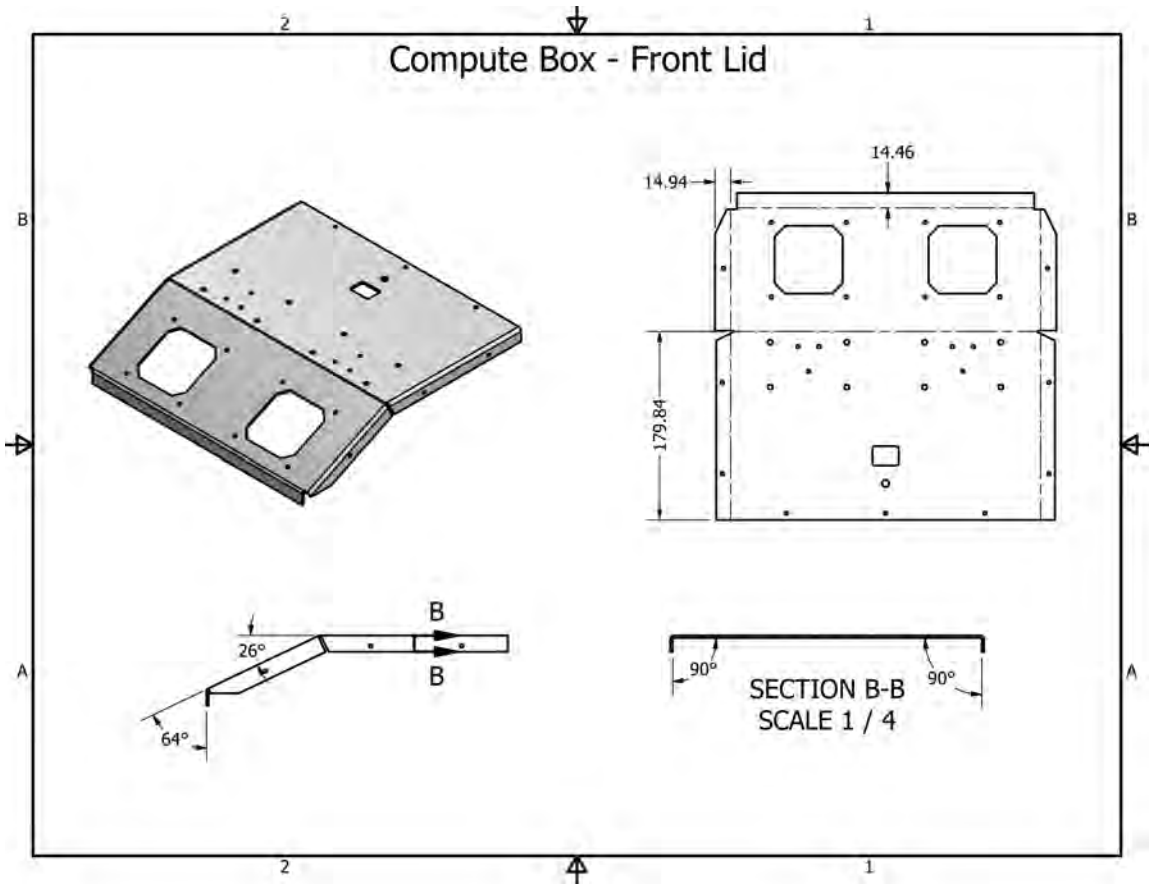
2.5 Compute Box Bending

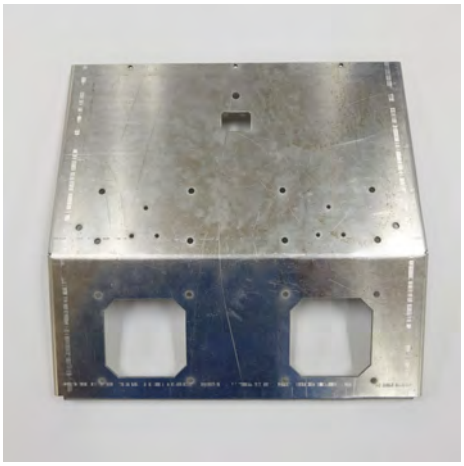
Time 1 hours 0 minutes
Parts

- Compute box lid
- Compute box rear hinge panel

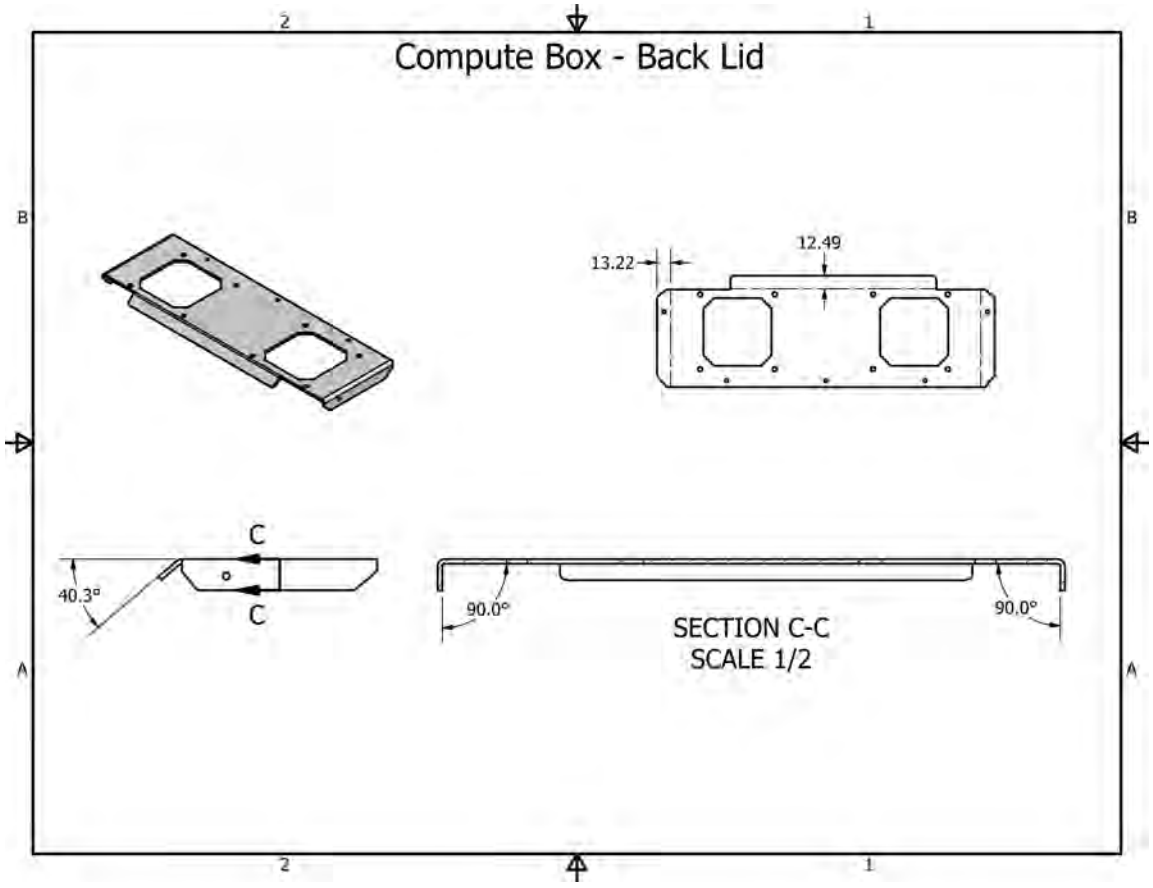
Instructions

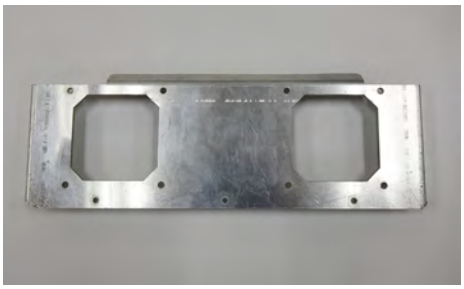
a. Bend the front lid per the following diagram



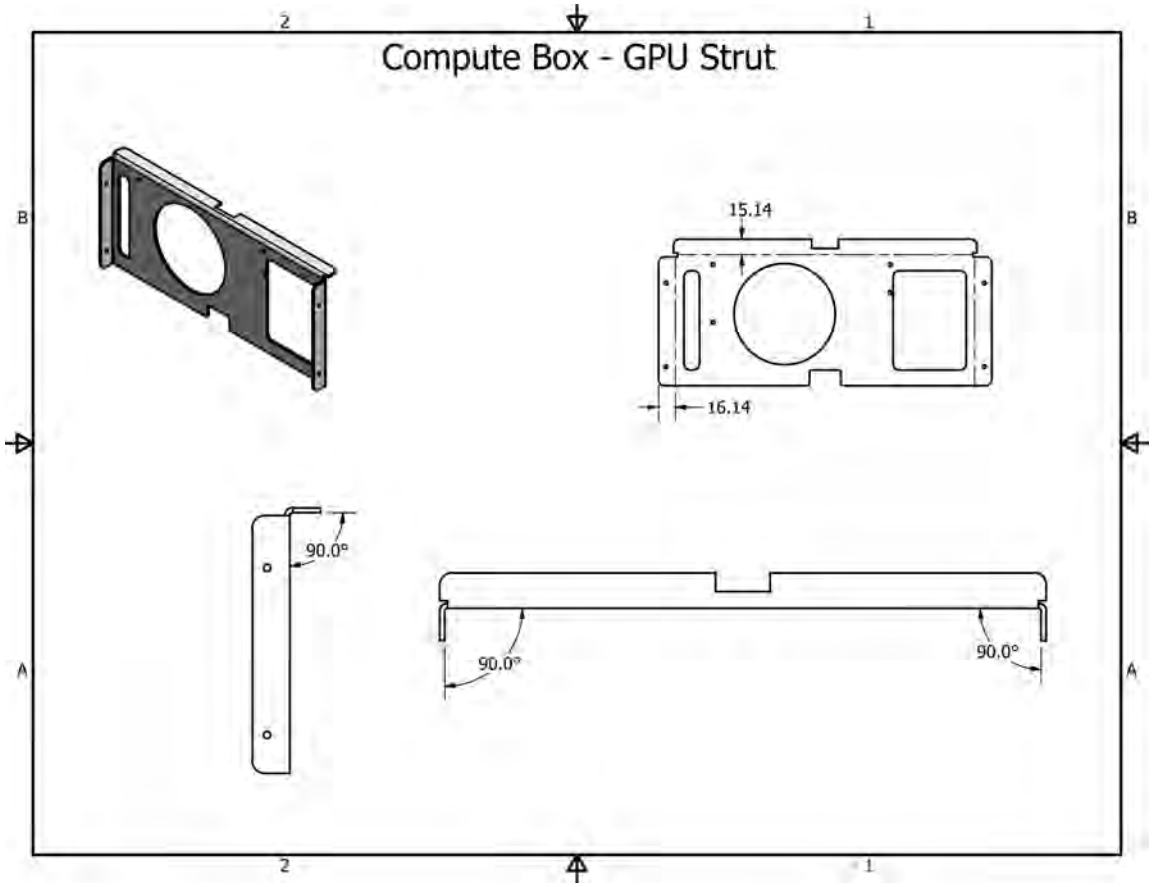


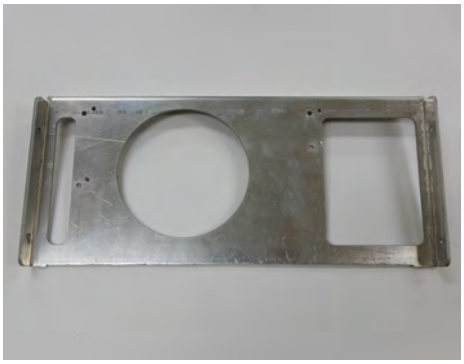
b. Bend the back lid per the following diagram



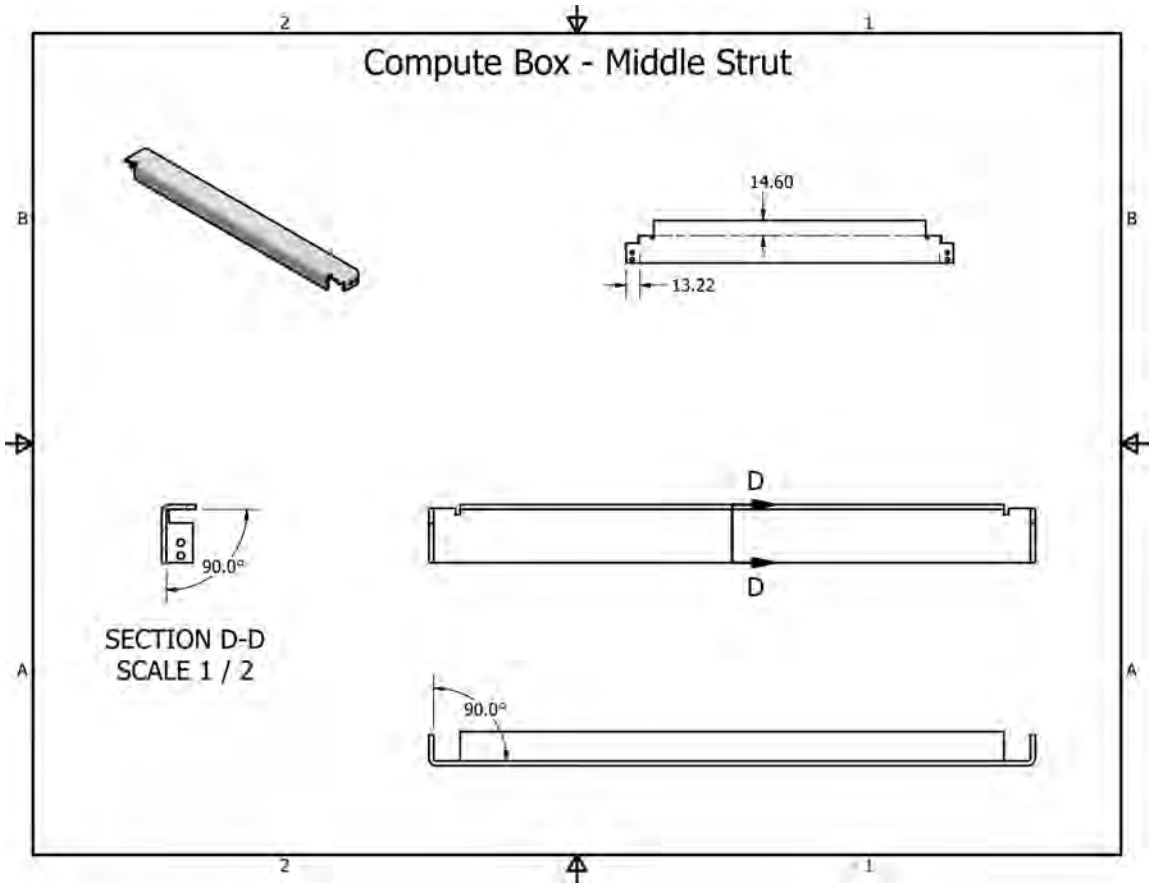


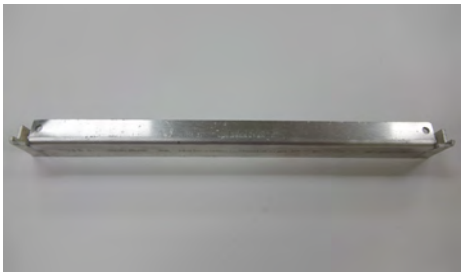
c. Bend the GPU strut per the following diagram





d. Bend the compute box brace per the following diagram





e. Test fit hole alignment and tolerances between the bent components and the welded compute box. Make any necessary adjustments to ensure that all holes are aligned.

2.6 Camera Support Plate

Time 0 hours 20 minutes
Parts

- 6” × 12”, 0.09”-thick 6061 aluminum sheet

Instructions

a. Use a waterjet to cut the camera support plate out of the aluminum sheet. Use the cut pattern found in "Compute Box Aluminum 6061 090 Cut Pattern.dxf" in `models/`.

2.7 Camera Covers

Time 2 hours 0 minutes
Parts

- 2" structural fiberglass rectangular tube
- 1" × 1" 90-degree structural fiberglass angle
- Camera support plate

Instructions

a. **These parts can be fabricated with a band saw, hand saw, or similar cutting tool.**

b. Cut two 4" lengths of 2" rectangular structural fiberglass.

c. Cut one side off of each of the rectangular tube sections, making sure to cut no more than the thickness of the wall off.

d. Cut four 4" lengths of 90-degree structural fiberglass angle.

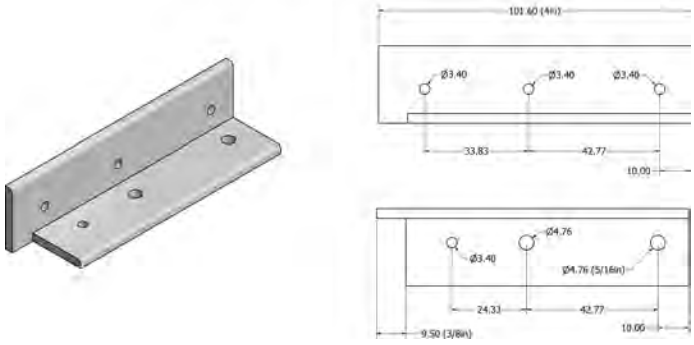
e. Mark two of the angular sections as left side pieces and the other two as right side pieces.

f. Cut a 3/8" section off of the bottom-front of each angular section. **The cut differs for the left and right sections.**

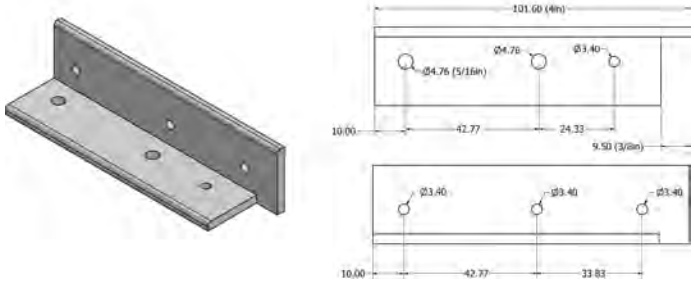
g. Clamp the angle brackets to the rectangular tube so that they sit flush. Match drill three holes through the angle brackets and through the rectangular brackets, on either side of each rectangular bracket, for a total of 12 holes.

h. Clamp the camera cover assemblies to the camera support bracket. Match drill holes in the angle brackets through the holes in the camera support plate using a 5/16" drill bit.

Camera Cover Bracket - Left



Camera Cover Bracket - Right



2.8 Fit Lid and Rear Hinge Panel

Time 2 hours 0 minutes
Parts

- Lid panel
- Rear hinge panel

Instructions

a. Align the lid with the 8 mounting holes on the base. If the holes do not align, locate the place of interference between the panels and:
   - Unbend or bend further the lid flange causing interference.
   - File off sharp edges and weld seams that are causing interference.
   - Oversize a few of the holes on the lid flanges slightly.

b. Repeat this process for the rear hinge panel.

2.9 Rear Panel Hinge

Time 1 hours 0 minutes
Parts

- 0.04”-thick, 1.25”-width unfinished steel piano hinge

Instructions

a. Use a bandsaw or hand saw to cut a piece of piano hinge with length the same as the width of the lid.

b. Clamp the hinge to the top of the lid panel such that the lid joint is pushed back against the lid as much as possible and is facing down.

c. Match drill three holes in the top part of the hinge through the three M3 holes in the lid.

d. Unclamp the hinge from the lid panel and repeat the same process for the other side of the hinge using the rear hinge panel. This time the hinge should be clamped to the rear hinge panel with the hinge joint pushed against the rear hinge panel and is facing down. Match drill three more holes in the other side of the hinge through the holes in the rear hinge panel.

2.10 Filing

Time 0 hours 30 minutes
Parts

- All fabricated aluminum parts

Instructions

a. Use a file to remove all sharp edges and remaining burrs. Pay special attention to the rectangular wire routing hole in the lid panel as well as the cutout in the top flange of the GPU strut.

3 3D Printing

Time 18 hours 37 minutes
Parts

- Models for all compute box 3D printed components are .stl files located in `models/`

Instructions

a. Print all custom compute box components:

   a) 2 × rear and 2 × front compute box mounts

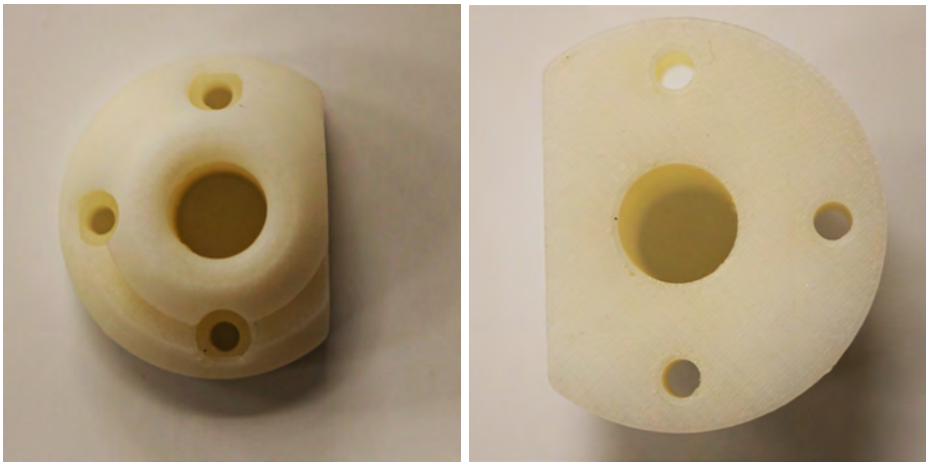


Figure 1: Rear compute box mounts

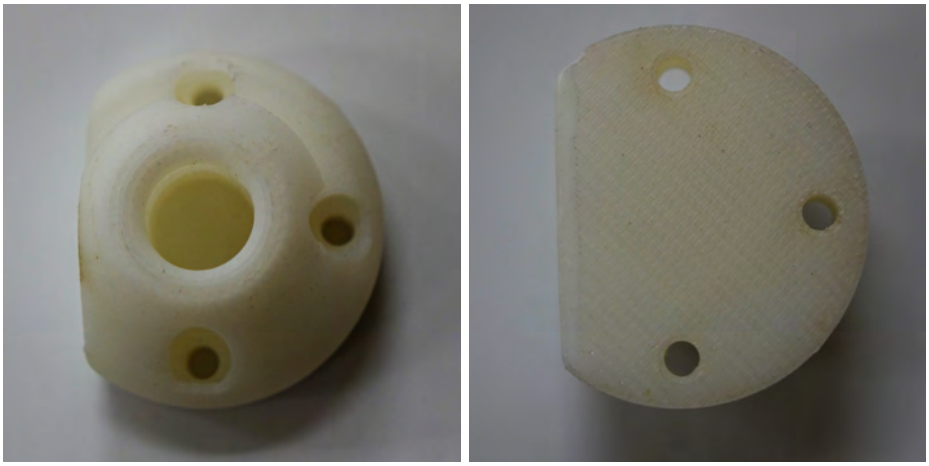
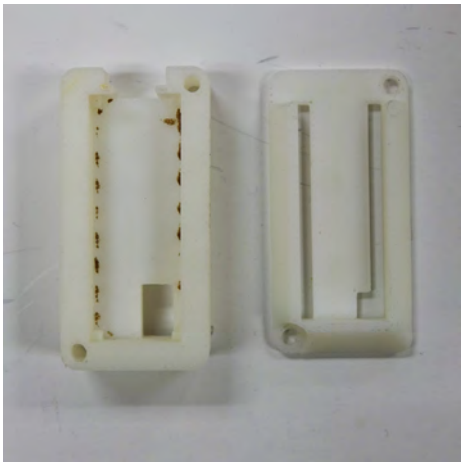


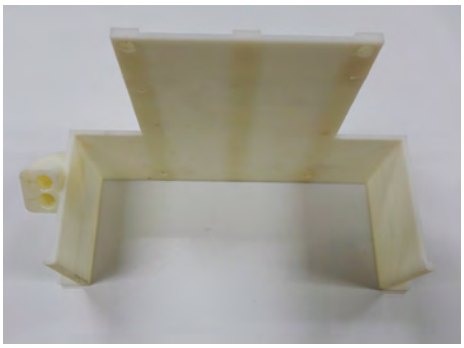
Figure 2: Front compute box mounts

b) RAM holder

c) Arduino Micro holder

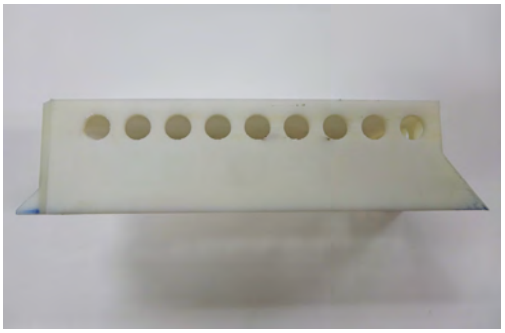


d) Battery/power supply holder



e) SSD holder

f) GPU holder




4 Device Serial Numbers

Time 0 hours 25 minutes
Parts

- AutoRally Chassis
- Hemisphere R320 GPS base (optional)
- Laptop with Ubuntu and cutecom installed
- 2 Xbee USB adapters
- UART-USB 2.0 3.3V cable
- 2 TTL-USB 2.0 3.3V cables

Instructions

a. Open a terminal on the laptop.

b. Note the existing contents of the **/dev** directory using the command `ls /dev` so that you can recognize the names of new devices as they are added.

c. Plug the chassis USB cable from the electronics box into your computer. Run `ls /dev` command and find the new item in the list. It will *probably* resemble **ttyACMx** or **ttyUSBx**.

d. Run `udevadm info --query=property /dev/ttyACMx` replacing **/dev/ttyACMx** with the correct name noted in the previous step.

e. Find the field called **ID_SERIAL_SHORT** and write down the value shown exactly. Save both the device name and the value of ID_SERIAL_SHORT for later use.

f. Repeat the process for the two Xbee USB adapters. Use a sharpie to designate one adapter the Xbee node and the other the Xbee coordinator. The Xbee node will be mounted inside the compute box, whereas the Xbee coordinator will be mounted inside the run-stop box. The Xbee modules need not be plugged into the Xbee adapters in order to get these serial numbers.

g. Repeat the process for the UART-USB 2.0 cable and each of the TTL-USB 2.0 cables. Using a sharpie mark one of the TTL-USB cables as Port A and the other as Port D. The UART-USB cable is for Port B. These are the serial numbers for Ports A, B and D for the GPS rover.

h. Repeat the process for the GPS base - Hemisphere R320. It has separate serial ports for Port A and Port B. Connect these to the laptop using a serial to USB converter and obtain the serial numbers.

i. Save the serial port numbers gathered in the steps above in a text file. They will be needed to perform configuration steps later.

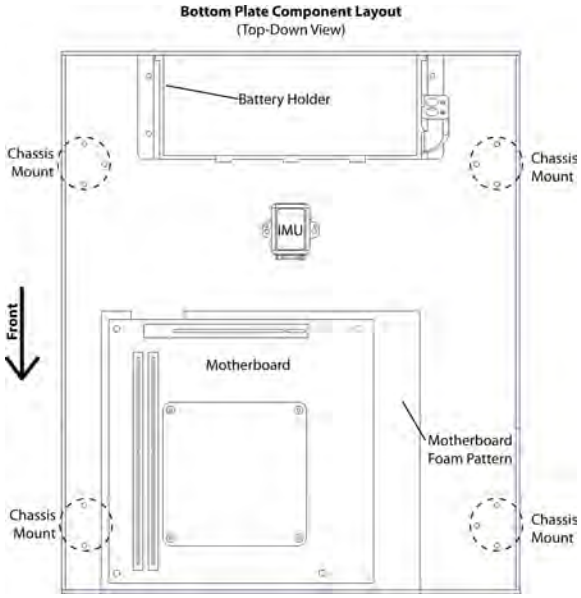
5 Compute Box Base Assembly

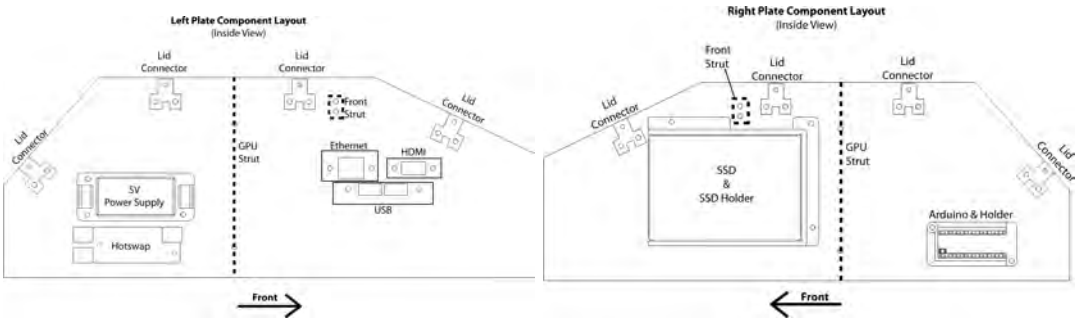
Time 1 hours 0 minutes
Parts

- Compute box base
- GPU support strut
- 10 Lid connectors
- 2 × 3D printed front chassis mounts
- 2 × 3D printed rear chassis mounts
- 12 M3 × 16mm screws
- 20 M3 × 12mm screws
- 4 M3 × 10mm screws
- 36 M3 nuts
- Motherboard
- Motherboard foam padding
- GPU
- 3D printed GPU holder
- M3 washers (quantity depends on fabrication tolerance)

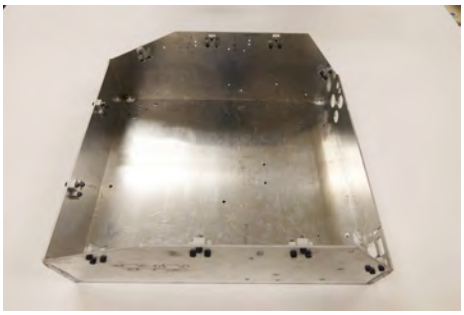
Instructions

a. Refer to the compute box layout diagrams below to determine the mounting positions of the GPU and the motherboard for this section of instructions.

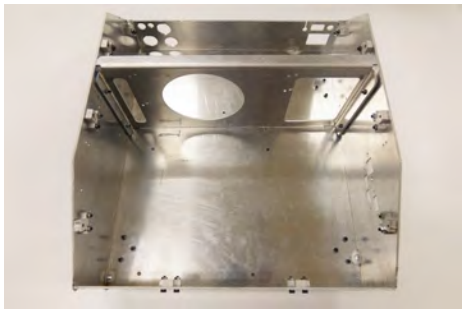




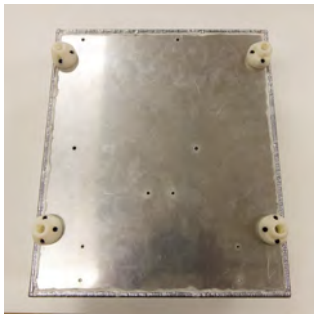
b. Using 30 M3×12mm screws and 30 M3 nuts, attach the 10 lid connectors to the appropriate holes on the inside of the compute box base.



c. Attach the GPU support strut to the side walls of the compute box base using 4 M3×10mm screws and 4 M3 nuts. **Depending on your fabrication tolerance you may need to add spacers or washers between the strut and the walls of the compute box in order to prevent movement and ensure proper alignment of the strut. It is recommended to put the motherboard, foam padding, GPU, and 3D printed GPU holder in place and check the alignment to determine the appropriate number of spacers.**



d. Attach the chassis mounts to the underside of the base using 12 M3× 16mm screws and 12 M3 nuts. The flat sides of the mounts should face outward and be almost flush with the walls of the base. **Depending on weld seam thicknesses the top outward corner of the mounts may need to be shaved down a little. Loosely screw in the mounts first and then check the alignment by attaching the base assembly to the chassis. Once alignment is confirmed, remove the compute box base from the chassis, add the nuts, and tighten the screws.** Note that the rear chassis mounts have holes that go all the way through them.




6 Compute Box Lid Assembly

Time 2 hours 0 minutes
Parts

- Hinge assembly
- Battery access panel
- Top cover
- Camera mount support plate
- 2 Edmund Optics lenses
- 2 Point Grey cameras
- 4 Camera cover supports
- 2 aluminum dust filters
- 2 fans
- 2 fan dust filters
- 2 EMI-blocking dust filter guards
- 8 metal cotter pins
- 24 metal body clips
- 18 M3×8 screws
- 8 M3×10 screws
- 8 M3×35 screws
- 6 M3×8 mm spacers with 6 mm width
- 40 M3 nuts
- 6 M3×14 mm screws
- 8 3/8” dia, 5/16” usable clevis pins

Instructions

a. Attach hinge to filter panel using 3 M3×8 screws and 3 M3 nuts with the hinge joint facing inward.

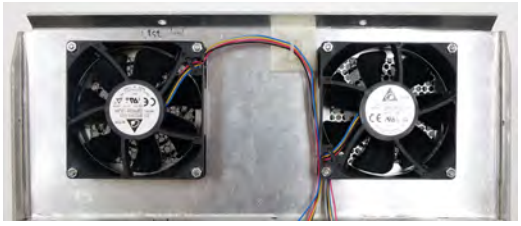
b. Attach the back panel filters to the rear hinge panel using 8 M3×10 screws and 8 M3 nuts.

c. Attach the other side of the hinge to the top cover using 3 M3×8 screws and 3 M3 nuts.

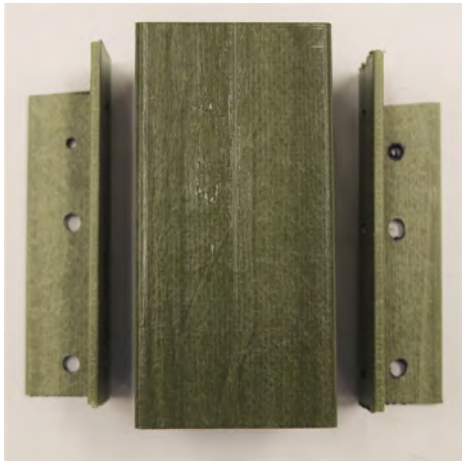
d. Insert 4 screws into each fan dust filter assembly.

e. Place a EMI filter guard on top of each dust filter assembly.

f. Insert the fan dust filter assemblies into the compute box top panel. Install fans onto the screws protruding from the fan filter assemblies with the alignment shown. Use 4 M3 nuts per fan to secure the fans to the inner side of the lid assembly.



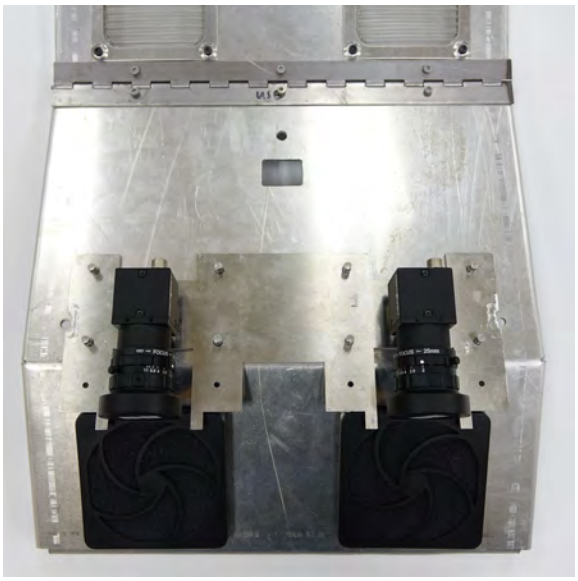
g. Attach the camera covers to the camera support plate using 6 M3 $\times$8 screws and 6 M3 nuts per camera mount.



h. Insert the 8 clevis pins into the bottom surface of the lid. Epoxy the pins to the bottom surface of the lid. These will hold the camera mount support plate and camera mount assemblies with cotter pins.

i. Install the camera lenses on the cameras.

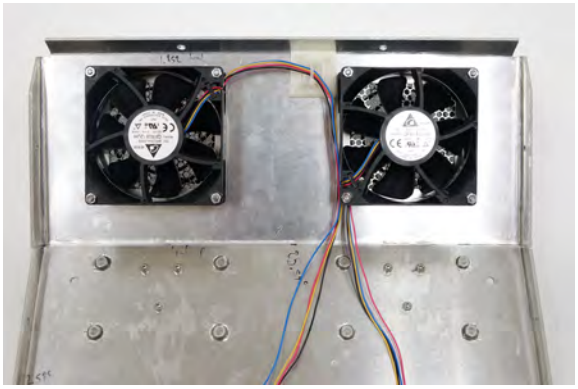
j. Push the camera mount support plate down onto the clevis pins with the protrusion pointing over the fan dust covers as shown. Insert 6 M3×14 mm screws through the camera mount holes from the underside of the lid. Place an 8mm long spacer on each screw. Seat the cameras onto the screws protruding from the spacers and tighten the screws.



k. Place the camera cover assemblies over the cameras.

l. Secure the camera cover assemblies to the lid with 3 cotter pins per clevis pin.

m. Attach one zip tie saddle to the underside of the lid as shown in the photo below. Zip tie one of the fan cables as shown in the photo.



7 Wire Assembly

7.1 Fan Wire Assemblies

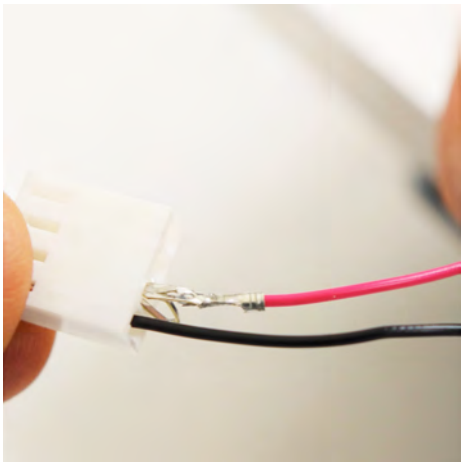
Time 0 hours 20 minutes
Parts

- 22-30 AWG female connector crimps
- 4-pin 2.54 mm female connector housing
- Compute box lid fans

Instructions

a. Cut the exposed ends of the fan leads down to approximately 3 mm.

b. Carefully crimp the female connector crimps to the fan leads. Ensure that the round "hook" is not crushed by the crimp.



c. Insert the crimped leads into the housing. The photo below shows the correct orientation of the leads with respect to the tabs on the connector housing.

7.2 Male to Male GPS Cable

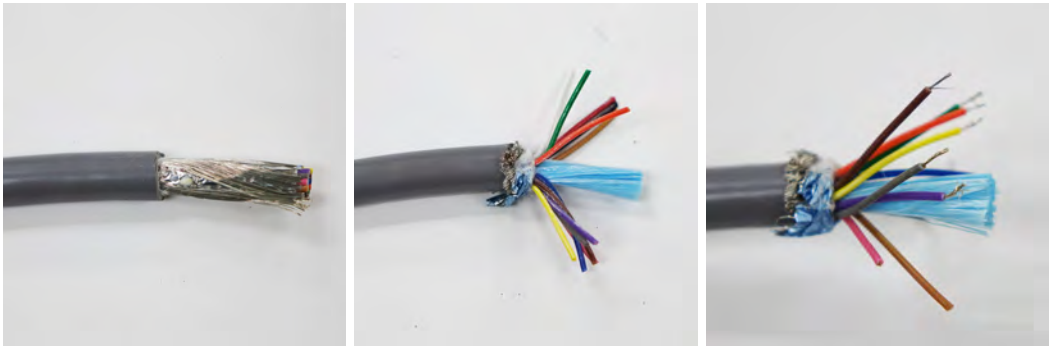
Time 1 hours 30 minutes
Parts

- 14" length of 28 AWG 12-pin data cable
- 20 HR-30 26-30AWG male crimp pins
- 2 HR-30 strain relievers
- 2 HR-30 male contact assemblies
- 2 HR-30 springs
- 2 HR-30 push-pull locking collars
- 2 HR-30 seal bushings
- 2 HR-30 back shells

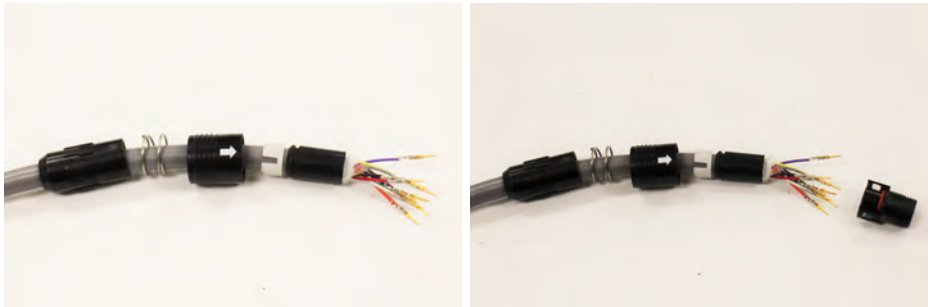
Instructions

a. **Refer to the connector-HR30_20150728 file in manuals/ for detailed diagrams demonstrating assembly procedures.**

b. Strip and remove approximately one" of insulation from both sides of the cable.



c. Slide one each of: back shell, spring, push-pull locking collar, strain relief, and seal bushing onto one side of the cable in that order. Repeat for the other end of the cable.



d. Crimp one male pin to each wire except the two unconnected (pink and light brown) wires in the image below on one end of the cable. **10 of the 12 wires will be crimped.** Repeat for the other end of the cable.

e. Referring to the diagram below, insert the crimped wires on one side of the cable into the wiring side of the contact assembly. Note that the male pin diagram is shown from the wiring side of the contact assembly. The crimped wires are coded as follows:

P1: Black

P2: Red

P3: White

P4: Green

P5: Orange

P6: Blue

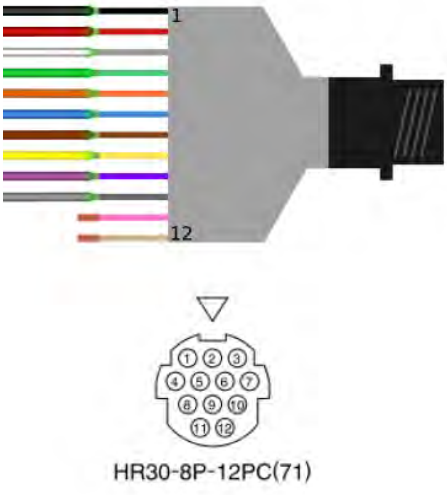
P7: Brown

P8: Yellow

P9: Purple

P10: Grey

Repeat for the other end of the cable.



f. Slide the seal bushing and strain relief up to the contact assemblies on both ends. Slide one collar and one spring over each contact assembly. **Ensure that the arrow on the collar is directly over the 3-pin side of the contact assembly.** Slide the back shell into the locking collar and twist until locked. Repeat for the other end of the cable.

7.3 Internal GPS Connector

Time 1 hours 30 minutes
Parts

- 14" length of 28 AWG 12-pin data cable
- 10 HR-30 female crimp contacts
- 10 0.1" male crimp pins
- 1 HR-30 receptacle
- 1 2×5 0.1" header housing
- 1 dust cap for HR-30 receptable
- 1 HR-30 washer
- 1 HR-30 nut
- Heat shrink

Instructions

a. Strip and remove approximately one" of insulation from the cable for the female side of the assembly.

b. Crimp one female contact to each wire except the two unconnected (pink and light brown) wires in the image below on this end of the cable.

c. Referring to the diagram below, insert the crimped contacts into the receptacle. Note that the female pin diagram is shown from the mating side of the receptacle. The crimped wires are coded as follows:

P1: Black

P2: Red

P3: White

P4: Green

P5: Orange

P6: Blue

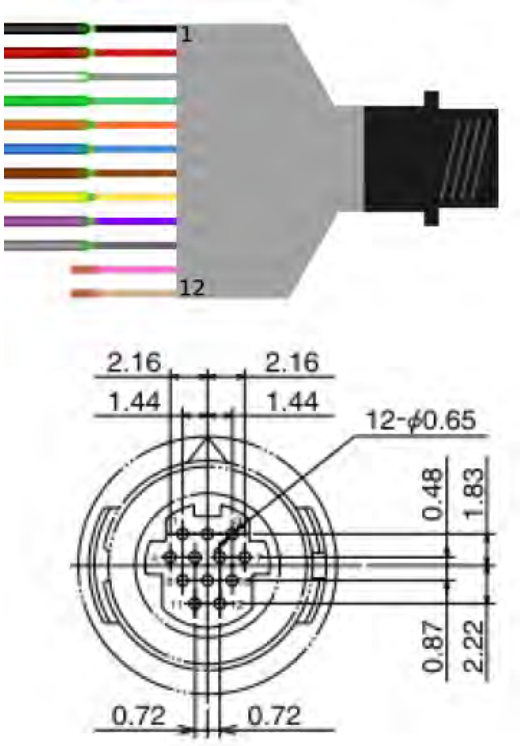
P7: Brown

P8: Yellow

P9: Purple

P10: Grey

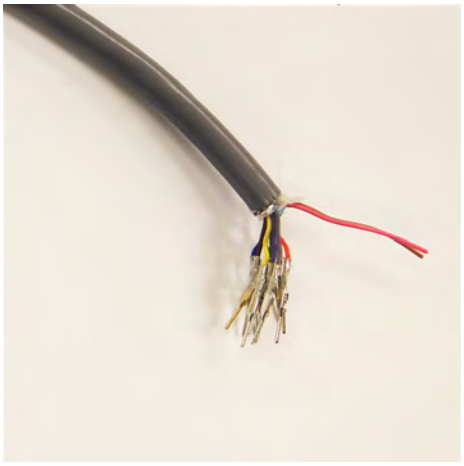
d. Put heat shrink over the exposed leads.



e. Slide the dust cap over the receptacle.

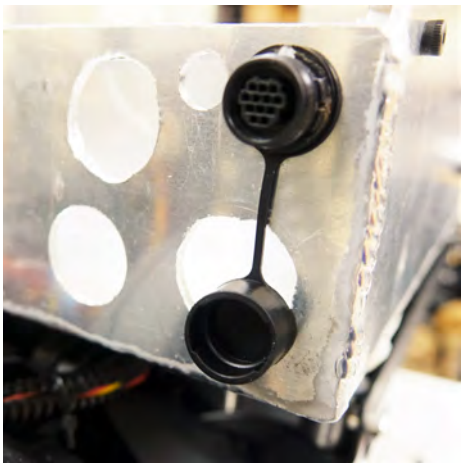
f. Strip and remove 0.5” of insulation from the opposite side of the cable.

g. Crimp one male 0.1” pin to each wire except the two unconnected (pink and light brown) wires in the image below on this end of the cable.



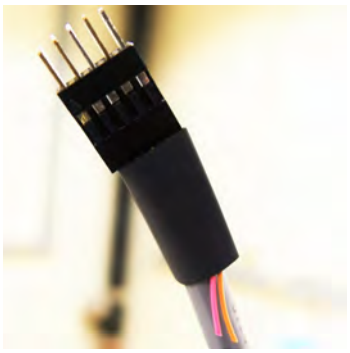
h. Put heat shrink over the exposed leads.

i. Insert the cable, male side first, through the top-right circular hole on the back of the compute box base as shown in the image below. Ensure the dust cap hangs vertically downward in front of the base as shown in the image below.

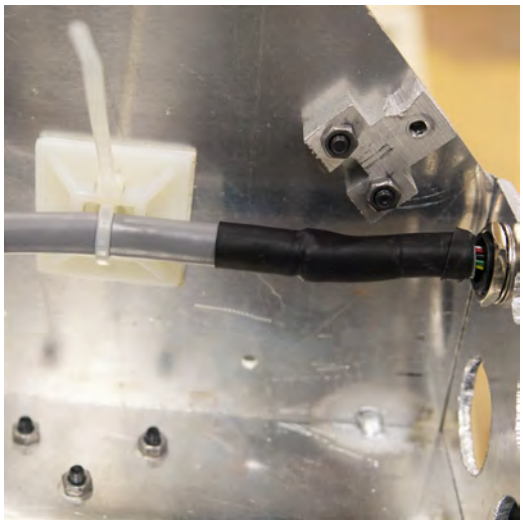


j. Push the washer and then the nut from the male side and slide them all the way to the front panel. Tighten the nut as shown in the photo.

k. Insert the 10 male pins into the 2×5 header housing. This has to be done inside the compute box. **Place and insert all the pins simultaneously into the housing. Note that the pins on the top row face upwards and those on the bottom row face downward so that the pins correctly latch into the housing.** Note that the arrow on top of the header indicates Pin 1. Pins 1 (black) to 5 (orange) are on the top row of the header. Pin 6 (blue) is on the bottom row, directly under Pin 5. Pins 6 through 10 (grey) are on the bottom row and Pin 10 is directly under Pin 1.


l. Secure the cable to the side wall of the compute box base using a zip-tie saddle and a zip-tie as shown in the image below.



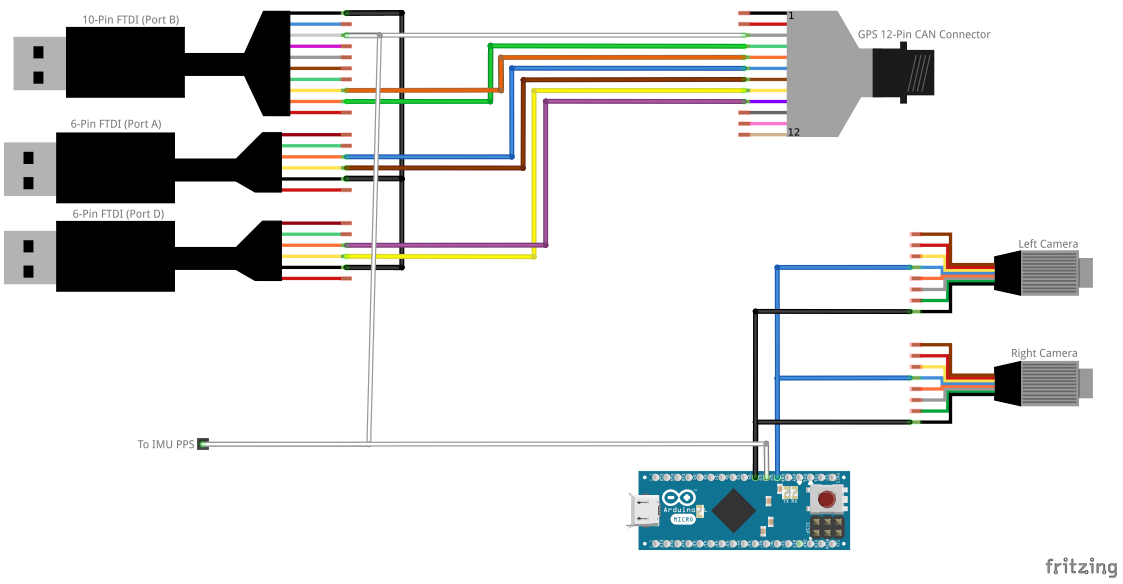
7.4 Internal GPS Breakout Assembly

Time 2 hours 0 minutes
Parts

- 1' length of UART-USB 2.0 3.3V cable
- 2 × 1' length of TTL-USB 2.0 3.3V cables
- 2 × 5 0.1" header housing
- Heat shrink
- 5" servo cable
- 10 × 0.1" female crimp contacts
- 13" 26 AWG blue wire
- 1.5" 26 AWG blue wire
- 2 female 0.1" crimp contacts and 2 1×1 header crimp housings

Instructions

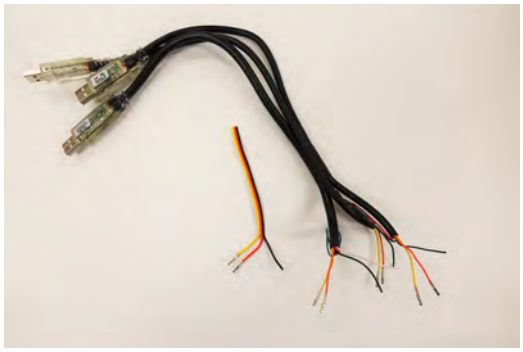
a. Refer to the diagram below, also available in `wiringDiagrams/`, throughout this subsection.



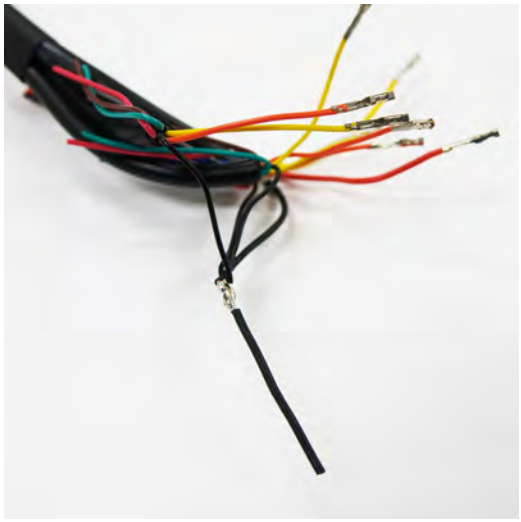
b. Cut-off approximately half of the thickness of the plastic housing of the UART- USB 2.0 cable as shown in the picture below. This is done in order to accommodate another TTL-USB 2.0 cable into the motherboard Back I/O slots.

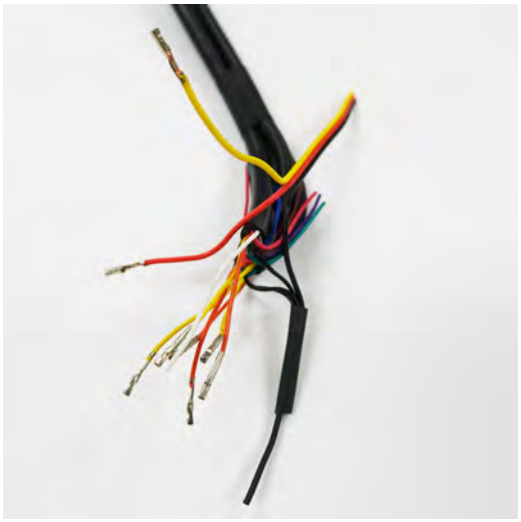
c. Strip 1.5” of insulation from the non-USB ends of each of the 3 USB cables.

d. Crimp 0.1” female contacts onto the yellow and orange wires of each of the 3 USB cables and onto the red and yellow wires of the servo cable. Refer picture below.

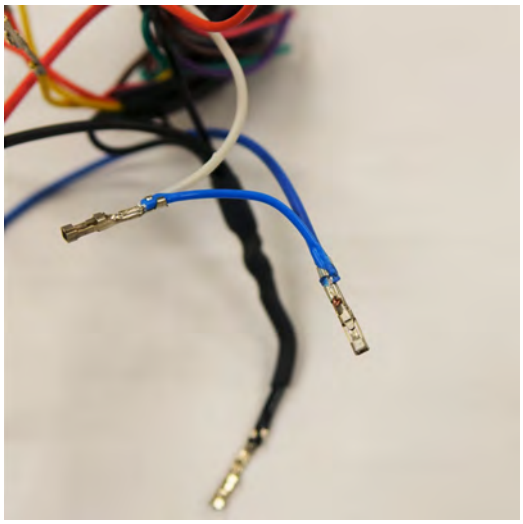


e. Splice the ground (black) wires from each of the 3 USB cables and the servo cable as shown in the picture below. Solder approximately 0.5" of black wire to the spliced ground wires of the cables. Cover the exposed conductor with a small length of heat shrink as shown in the picture below. Crimp a 0.1" female crimp contact to the 0.5" piece of black wire which ties all the ground pins together.

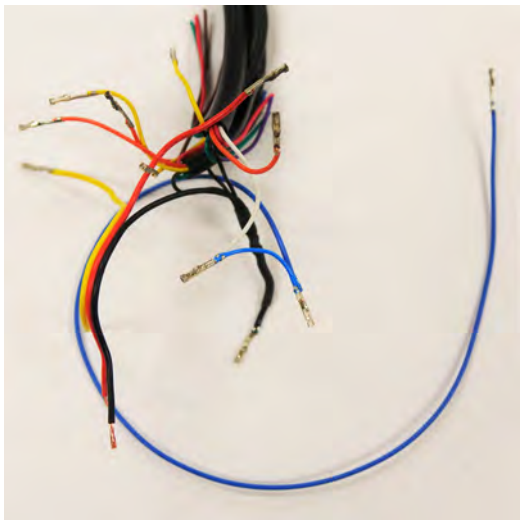




f. Crimp the white (DCD) wire of the UART-USB 2.0 cable along with the 1.5" 26 AWG blue wire into a single 0.1" female crimp contact as shown in the picture. This is for the PPS signal that will be sent to the IMU.

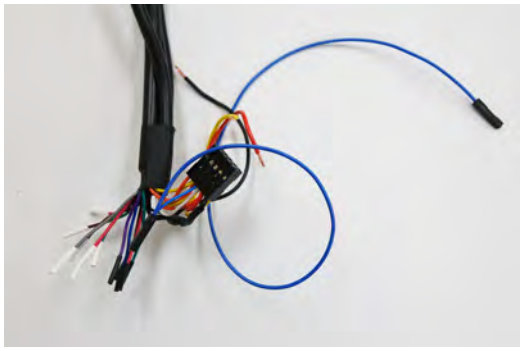


g. Crimp the 1.5” and the 13” 26 AWG blue wires into a single 0.1” female crimp contact as shown in the picture below. This is for the PPS signal that will be sent to the Arduino. Crimp a 0.1” female crimp contact onto the other end of the 13” 26 AWG blue wire. Do not insert the 13” crimped blue wire into a housing.

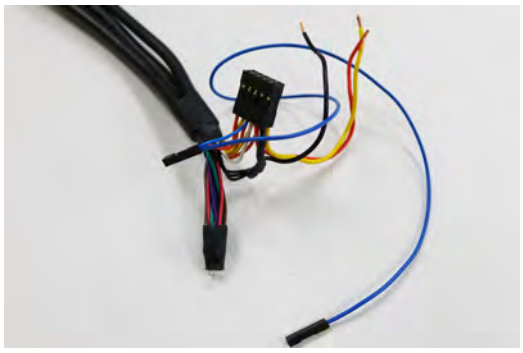


h. Insert the female crimp contacts into the 2×5 header housing. Refer to the wiring diagram in the first step in order to correctly insert the wires into the slots of the crimp housing. Note that the 2×5 connector is not shown in the diagram, but all the wires are shown. **Place and insert all the pins simultaneously into the housing. Note that the pins on the top row face upwards and those on the bottom row face downward so that the pins correctly latch into the housing.** When inserting the wires into the header, make sure that the wire order is the same as the 2×5 connector of the internal GPS connector shown in the previous section.

i. Cut small pieces of heat shrink and cover the unused wires of the 3 USB cables as shown in the picture below. This is done in order to prevent accidental short-circuits as some of these unused wires are power. Heat shrink these using a heat gun. Insert the crimped ground wire into a 1×1 header crimp housing. Insert the 1.5" blue crimped wire into a 1×1 header crimp housing.



j. Finally bundle these unused wires using a single thick heat shrink wrap as shown in the picture below.



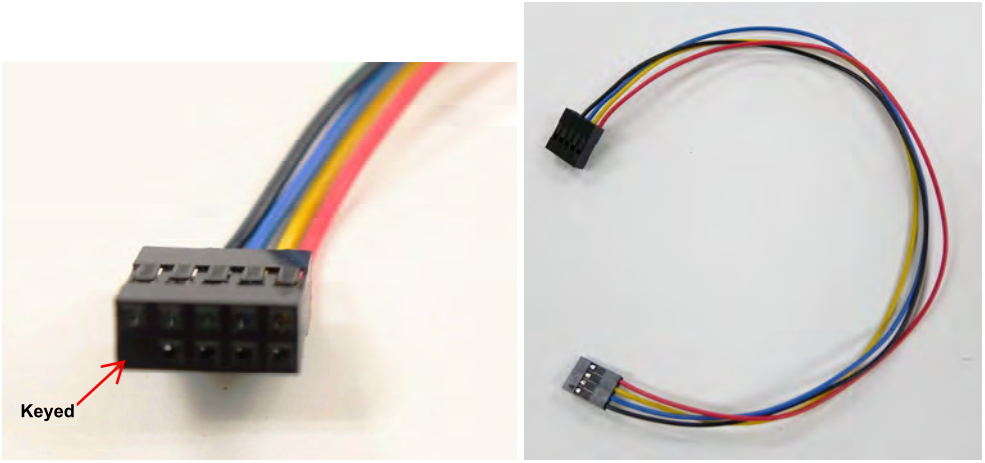
7.5 IMU Cable

Time 1 hours 00 minutes
Parts

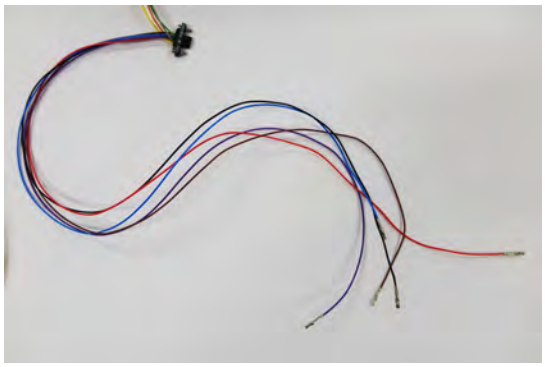
- Lord MicroStrain 3DM-GX4-25 IMU and DB9 cable with flying leads
- Stranded wire
- 12 0.1" female crimps
- 0.1" male crimp
- 1×4 0.1" header housing
- 1×1 0.1" header housing
- 2×5 0.1" header housing
- 0.1" header keying plug
- Heat shrink

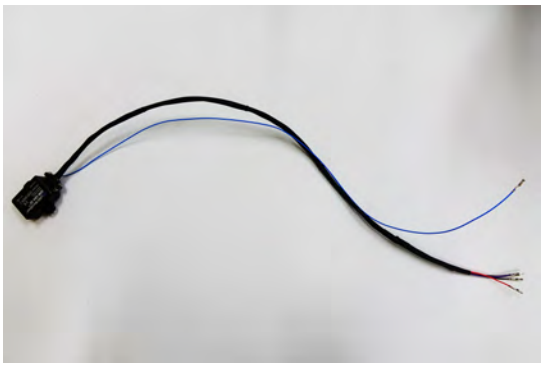
Instructions

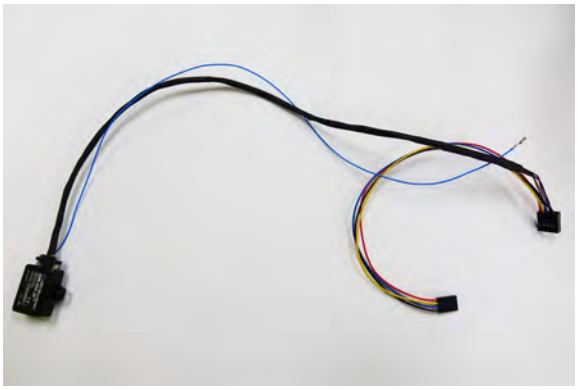
a. Cut 4 11" lengths of stranded wire. Crimp female crimp connectors to both ends of each length of wire. Insert one end of each into the 1×4 housing. **When looking at the housing from the wiring end, the order of wires from right to left is: ground, USB D+, USB D-, and Vcc.** Insert the free end of the cables into the row of the keyed header housing. **The wire nearest the closed hole should be ground. From there, the remaining wires are, in order: USB D+, USB D-, and Vcc.**



b. Crimp female crimp connectors to the black, red, violet, brown wires of the IMU cable. Crimp a male connector to the blue wire of the IMU cable and insert it into a 1×1 0.1" header housing. Heat shrink the tips of the unused leads. Heat shrink the entire set of leads **except the blue lead**, making sure to fold down the unused wires into the heat shrink so that they are not visible. Insert the crimped ends into the second (unkeyed) row of the keyed header housing. **The violet wire lead should be directly under the ground lead inserted in the previous step. From there, the remaining wires are, in order: black, brown, and red.**







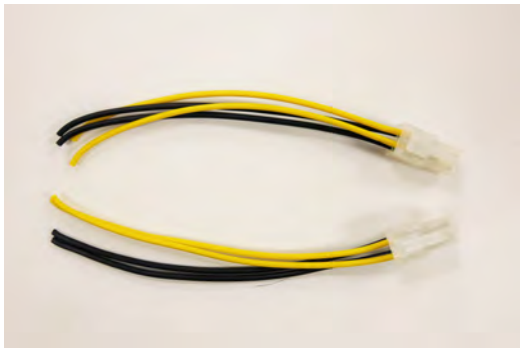
7.6 Power Switch Assembly

Time 1 hours 0 minutes
Parts

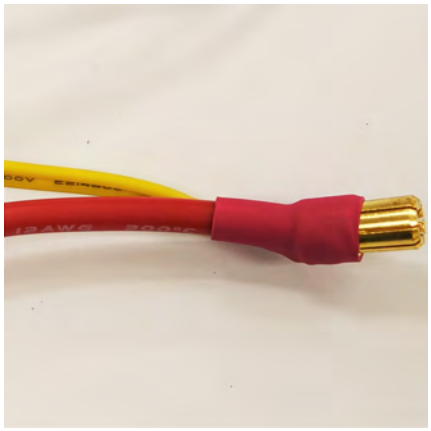
- 1 DPDT rocker switch (20A, 125V)
- 1 8” 4-pin ATX power cable included with Y-PWR power splitter
- 2 4” lengths of yellow 26 AWG wire
- 1 4” length of red 12 AWG wire + 1 very small piece
- 2 male 6.5mm bullet connectors
- 1 female bullet connector
- 3 0.1” female contacts
- 2 0.1” 1×1 header housings
- 100KΩ resistor
- Red heat shrink
- Black heat shrink
- Yellow heat shrink

Instructions

a. Cut the ATX cable in half.



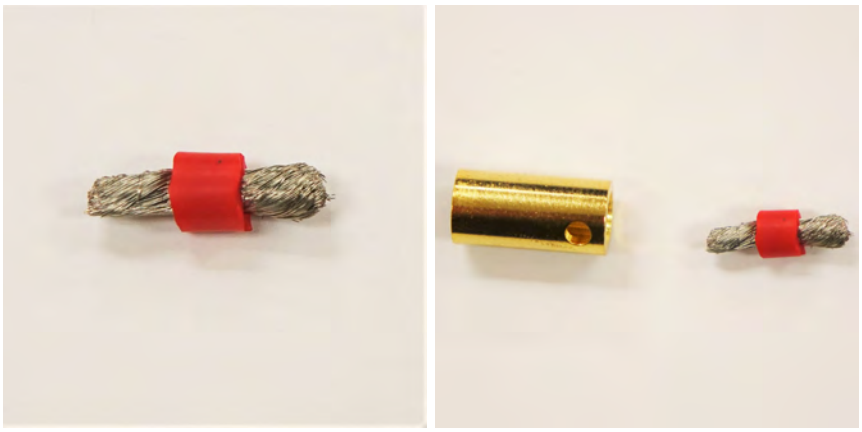
b. Solder the two positive (yellow) leads from the ATX cable together with one end of the red 12 AWG wire into a male bullet connector. Cover the exposed portion and the top half of the connector with red heat shrink. **Slip another piece of red heat shrink over the red wire but do not heat it yet.**



c. Solder the two ground (black) leads from the ATX cable into another male bullet connector. Heat shrink the exposed leads and the top of the connector with black heat shrink.

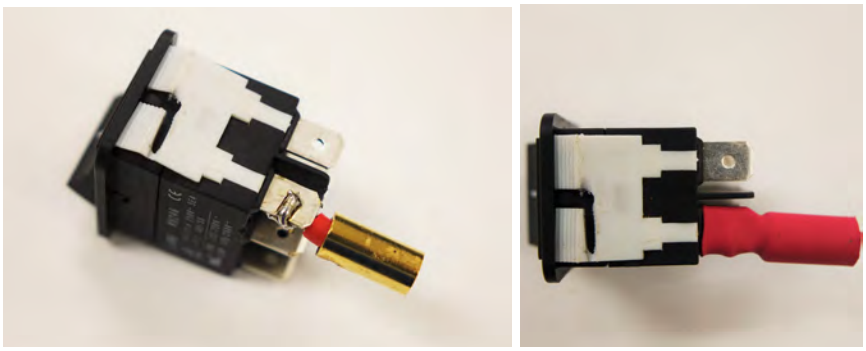
d. Crimp a female 0.1" contact to one end of each of the yellow signal wires. Insert the crimped contacts into the individual header housings.

e. As shown in the photo below, strip the insulation from both sides of the very small piece of 12 AWG red wire, leaving only a small strip of insulation separating the exposed ends. Solder one exposed end to a female bullet connector.

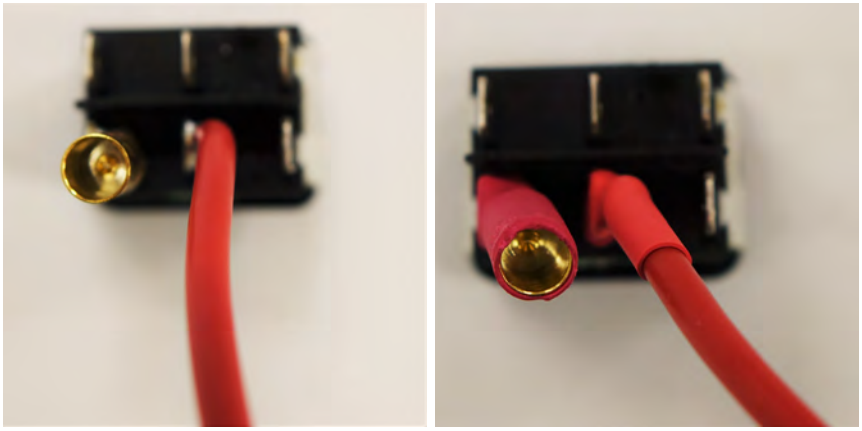


f. Note that the pins of the rocker switch are numbered. The following instructions will refer to these pin numbers.

g. Securely solder the free end of the small wire attached to the female bullet connector to Pin 4 of the switch. Cover the connector and contact with red heat shrink.



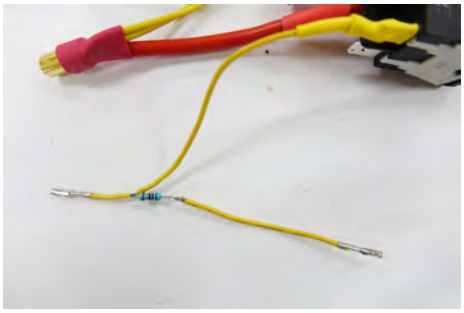
h. Securely solder the free end of the 4" length of 12 AWG wire to Pin 5 of the switch. Heat the heat shrink that was previously slipped over the red wire such that it covers the exposed end of the wire and the contact.



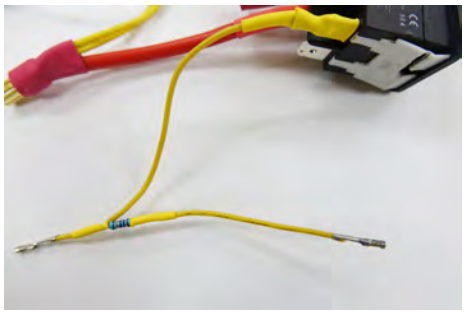
i. Solder one of the yellow wires to Pin 2 of the switch.

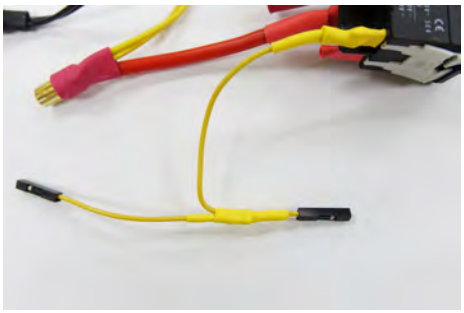
j. Solder a yellow signal wire to Pin 3 of the switch. Solder a 100KΩ resistor to the other end of the yellow wire on Pin 3. Solder one more length of yellow signal wire to the same contact of the

resistor. Solder a yellow signal wire to the free resistor contact. Crimp a 0.1” female connector to each free end of the resulting spliced cable as shown in the photos below.



k. Cover the contacts and the exposed ends of wire with yellow heat shrink. Insert the crimps into 0.1” header housings.





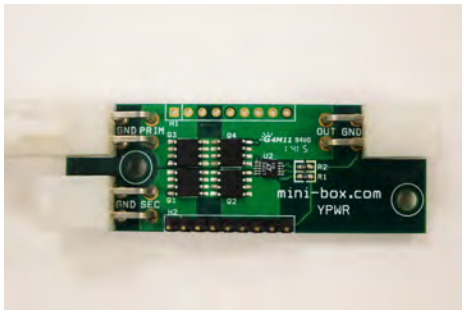
7.7 Power Y-Splitter

Time 0 hours 10 minutes
Parts

- Mini-Box YPWR splitter
- 1 row of 9 0.1” through-hole header pins

Instructions

a. Desolder and remove resistor R1 from the board.



b. Solder the header pins to the H2 header holes on the YPWR.

7.8 Splitter to ATX Power Supply Cable

Time 0 hours 20 minutes
Parts

- Reserved half of 4-pin ATX cable from previous steps.
- 5” length of 12 AWG red wire
- 5” length of 12 AWG black wire
- 2 lugs
- Red heat shrink
- Black heat shrink

Instructions

a. Solder the positive terminal wires of the reserved half 4-pin ATX cable to one end of the 5” 12 AWG red wire. Slide a piece red heat shrink over the exposed contacts and apply the heat shrink using a heat gun. Then, slide a piece of black heat shrink over the other end of the 5” 12 AWG red wire. Solder a lug onto this end of the red wire. Finally, apply the black heat shrink using the heat gun.

b. Solder the ground wires of the reserved half 4-pin ATX cable to one end of the 5” 12 AWG black wire. Slide a piece black heat shrink over the exposed contacts and apply the heat shrink using a heat gun. Then, slide a piece of black heat shrink over the other end of the 5” 12 AWG black wire. Solder a lug onto this end of the black wire. Finally, apply the black heat shrink using the heat gun.

7.9 ATX Power to GPS Isolated Power Supply Cable

Time 0 hours 15 minutes
Parts

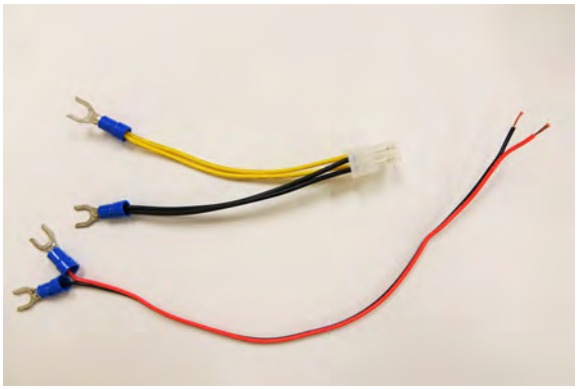
- 9” length of servo cable
- 2 lugs
- Red heat shrink
- Black heat shrink

Instructions

a. Strip-off the yellow wire from the servo cable.

b. Solder the 2 lugs to the black and red wires at one end of the remaining cable. **If your lugs do not have a plastic cover, be sure to apply heat shrink to exposed areas where appropriate.**

c. Use heat shrink to cover the exposed copper conductor of the servo cables. Refer to the lower cable assembly in the picture below.



7.10 Ground Y-Connector

Time 0 hours 15 minutes
Parts

- 2 0.5” lengths of black 12 AWG wire

- 2 female 6.5 mm bullet connectors
- 1 male 6.5 mm bullet connector
- Black heat shrink

Instructions

a. Solder one end of one piece of black wire into a female bullet connector. Repeat for the other wire and female connector.

b. Solder both free ends of the wire into the male bullet connector.

c. Cover exposed wire, the bodies of the female bullet connectors, and the top half of the male bullet connector with heat shrink.

7.11 Power Supply / Battery Holder

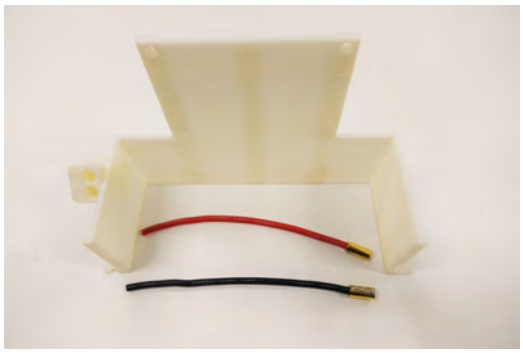
Time 0 hours 20 minutes
Parts

- 3D printed power supply holder
- 2 female 6.5mm bullet connectors
- 2 male 6.5mm bullet connectors
- 1 6" length of red 12 AWG wire
- 1 6" length of black 12 AWG wire
- Red heat shrink
- Black heat shrink

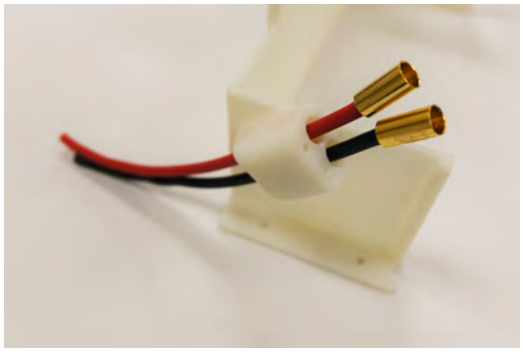
Instructions

a. Solder one end of the red wire to a female bullet connector.

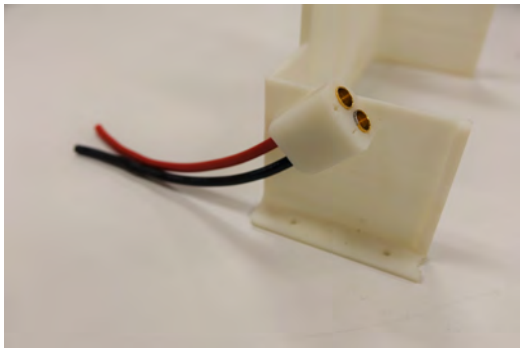
b. Solder one end of the black wire to the other female bullet connector.



c. Push the free end of the red wire through the hole marked + on the power supply holder. Push the free end of the black wire through the hole marked −. **Do not push the connectors into the holes yet.**

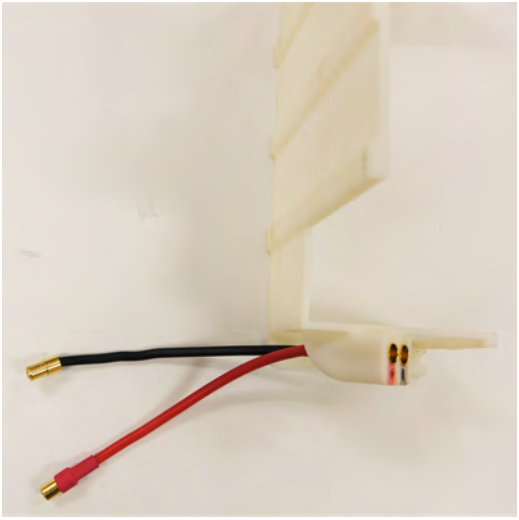


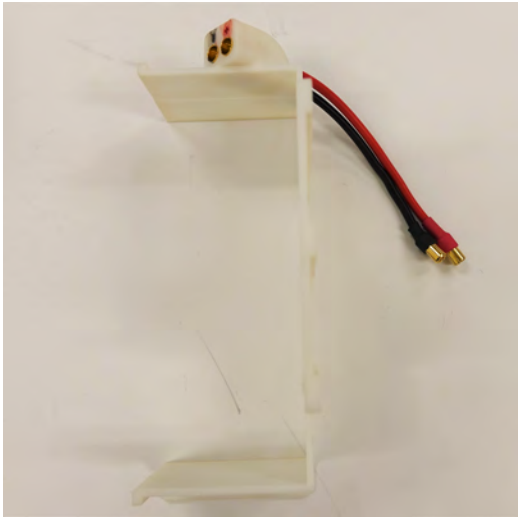
d. Place epoxy around the inside of each hole. Push the connectors into the holes to fix them in place.



e. Slip red heat shrink over the free end of the red wire. Slip black heat shrink over the free end of the black wire. **Do not heat the heat shrink yet.**

f. Solder the free ends of the wires to male bullet connectors. Cover the top halves of the connectors with heat shrink and then heat it.





7.12 Power Button, Reset Button, SSD LED

Time 0 hours 30 minutes
Parts

- 1 Power button
- 1 Reset button
- 1 SSD activity LED
- 4 6.5” length of yellow 26 AWG wire
- 1 6.5” length of black 26 AWG wire
- 1 6.5” length of red 26 AWG wire
- 8 female 0.1” crimp contacts
- 4 1×2 header housings
- Yellow heat shrink
- Red heat shrink
- Black heat shrink

Instructions

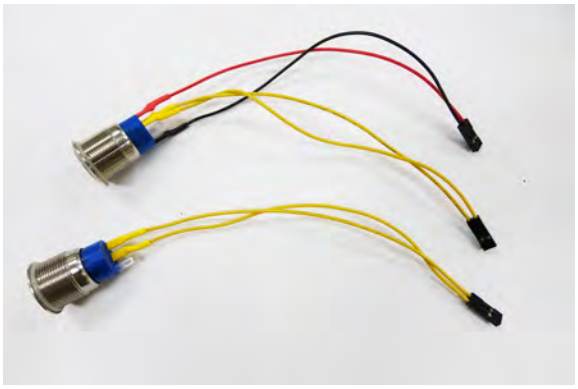
a. Crimp female contacts to the wires of the LED. Insert the crimped ends into a 1×2 housing.

b. Solder the red wire onto the positive contact of the power button. Cover the contact and exposed wire with red heat shrink.

c. Solder the black wire onto the ground contact of the power button. Cover the contact and exposed wire with black heat shrink.

d. Solder the yellow wires onto the normally open (NO) and common (C) contacts of the power button. Cover the contact and exposed wire with yellow heat shrink. Repeat for the NO and C contacts of the reset button.

e. Crimp female contacts onto the free ends of all wires soldered to the power and reset buttons. Insert the crimps into the housings.



7.13 Camera Trigger Cable Assembly

Time 0 hours 30 minutes
Parts

- 2 Hirose 8 pin GPIO cables
- 2 0.1" female crimp connectors
- 1 4×1 header housing
- Heat shrink

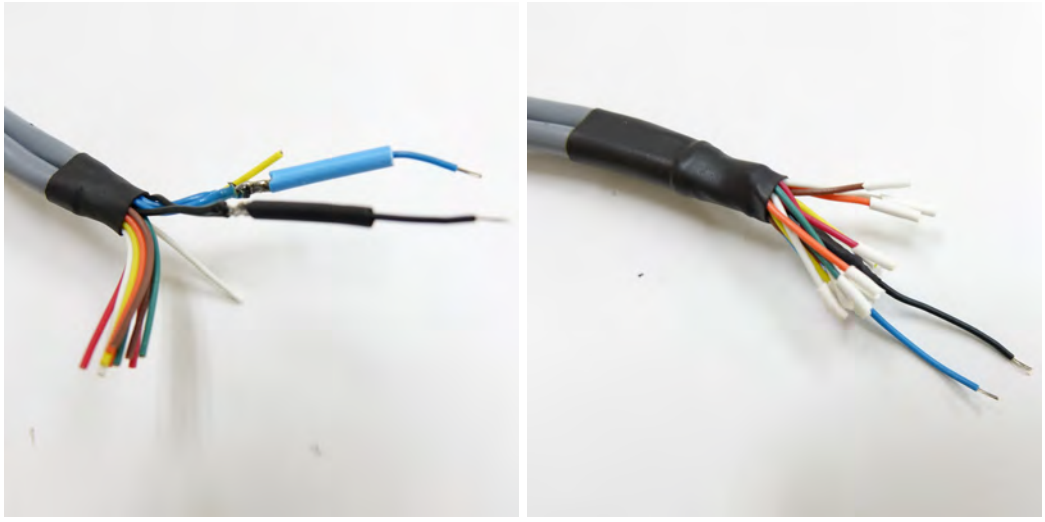
Instructions

a. Cut the GPIO connectors down to a 17" length. Remove 1.5" of insulation from the end to reveal the individual leads making up the cable.

b. Strip a small amount of insulation off of the black and light blue leads. Twist the exposed portion of the black leads of the two cables together and repeat for the light blue leads. Put a small amount of solder on the combined leads to hold them together.

c. Slip a large piece of heat shrink so that it is half across the gray portion of the cables and half across the individual leads. Individually cover the tips of the unused leads with heat shrink.

d. Cut off a 1.25" length of light blue and black wire **from another source**. Solder this onto the combined light blue and black leads to create a 1" (approximately) extension. Cover the exposed solder joints with heat shrink.



e. Cover all the unused, heat-shrink-covered leads with a single larger piece of heat shrink. Crimp a 0.1” female connector to the extended (black and blue) leads.

f. The triangle on the 4×1 header housing marks pin 1. Insert the blue lead into pin 1 and the black lead into pin 3.

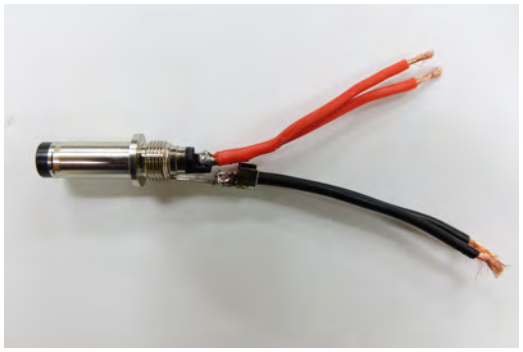
7.14 Shore Power Cable

Time 1 hours 0 minutes
Parts

- 14' long 16 AWG yellow power cable
- DC power plug 8A 2.5mm ID, 5.5mm OD
- 2 lengths of 1.75" red servo wire
- 2 lengths of 1.75" black servo wire
- 2 4mm male banana plugs
- black, yellow and red heat shrink

Instructions

a. Strip some insulation from both ends of the black and red servo wires. Solder one red servo wire to each side of the center (positive) terminal of the DC power plug. Solder both the black servo wires to the ground terminal of the DC power plug. **Ensure that the black servo wires are soldered such that, when the barrel is crimped down, there are no loose strands that could potentially cause a short circuit. Tinning the leads of the servo wires before soldering could help avoid this.**



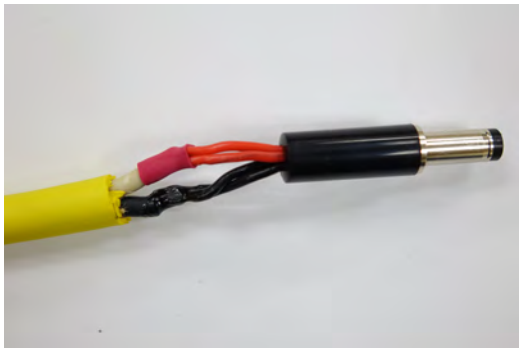
b. Cut a small piece of red heat shrink and slide it over the red servo wires. This help protect from short circuits.

c. Crimp the barrel of the power plug over the black servo wires using pliers.

d. Slide and screw in the black thermoplastic housing over the terminals up to the threading.

e. Strip one end of the 16 AWG power cable. **Be careful not to damage the insulation on the inner conductors while stripping off the outer layer of yellow insulation.**

f. Tin the leads of the 2 black servo wires and the 2 red servo wires. **Slide a small piece of black heat and red shrink before soldering to cover the exposed conductors.** Solder the 2 black servo wires to the ground conductor of the 16awg power cable. Solder the 2 red servo wires to the positive conductor of the 16 AWG power cable.



g. Strip about 1.5” of the other end of the 16 AWG power cable. Solder a 4mm male banana plug onto each of the conductors.

h. Slide short lengths of red and black heat shrink over the positive and ground wires respectively where the 4mm banana plugs are soldered. Cut a long piece of black heat shrink to cover the above assembly up to the black thermoplastic housing of the DC power plug.

i. Cut a 1” piece of yellow heat shrink and slide it over the the 4mm banana plugs such that half of it covers the yellow cable insulation and half covers the wires. Use heat gun to shrink wrap as shown.

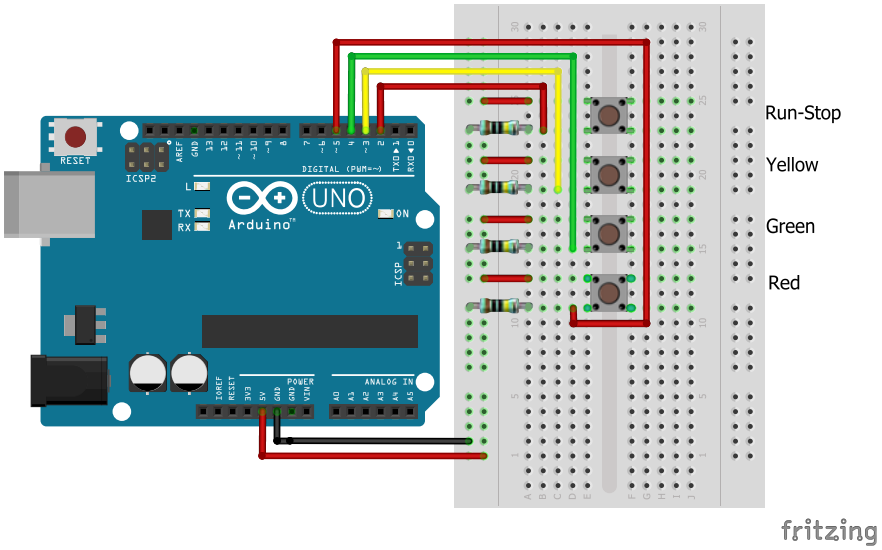
7.15 Run-Stop Button Box Assembly

Time 1 hours 0 minutes
Parts

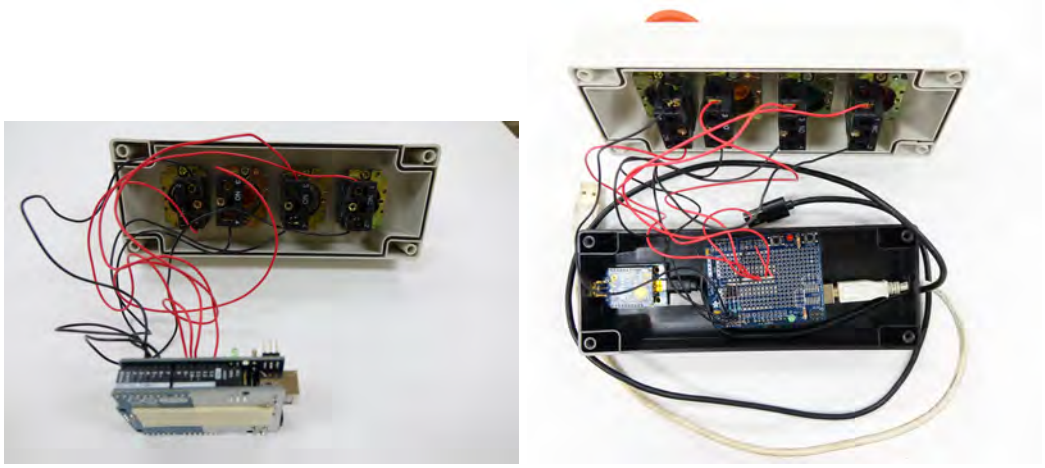
- Button box (base and lid) and included screws
- Arduino UNO
- Protoshield for Arduino UNO
- 3' mini-USB to USB cable for Xbee
- 3' USB A-B cable for Arduino UNO
- Servo wire
- Double-sided sticky tape

Instructions

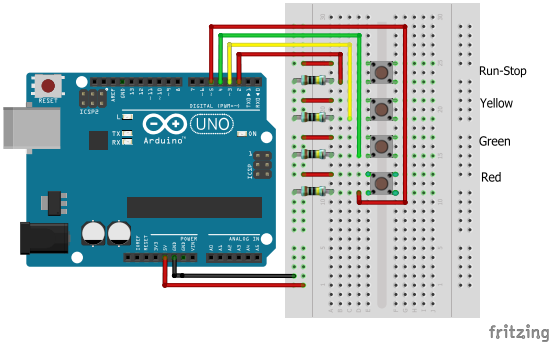
a. Drill a hole on the top (narrow) side of the base of the button box for the Xbee antenna. Ensure that the hole is drilled such that the Xbee antenna connector passes through the hole. Panel mount the Xbee using the included nut and washer. Run the Xbee USB cable through the existing hole on the opposite side.



b. Make the Arduino protoshield using the diagram shown below. Connect the protoshield to the Arduino and use double-sided sticky tape to firmly attach the Arduino to the base of the box. Run the Arduino USB cable through the same hole used for the Xbee USB cable.

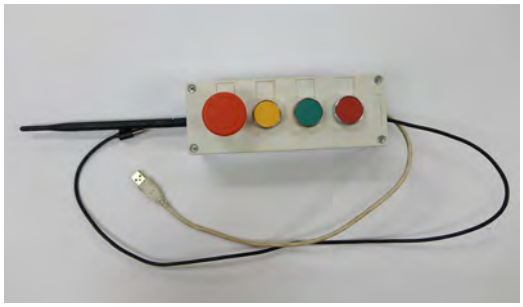


c. As shown in the diagram below, attach leads from the protoboard to the appropriate terminals of the buttons on the lid of the box.



d. Close the box by connecting the two halves and screwing in the four screws.

e. Attach the Xbee antenna to the antenna connector.



8 Installation and Routing

8.1 Power and IMU

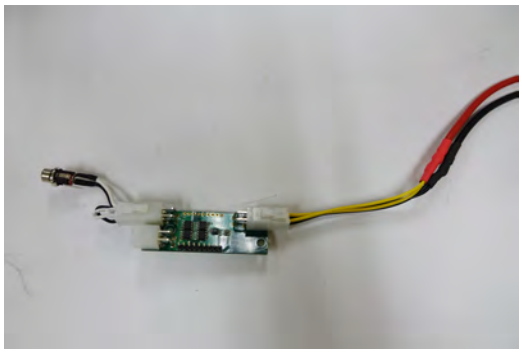
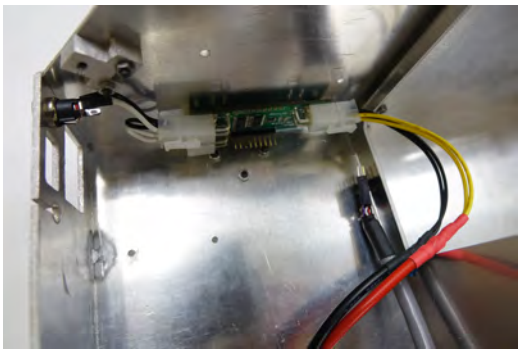
Time 1 hours 30 minutes
Parts

- AutoRally compute box base
- 2 M3×14 mm screws
- 4 M3×12 mm screws
- 2 M3×10 mm screws
- 6 M3×8 mm screws
- 14 M3 nuts
- 6 M3×4 mm standoffs
- Lord MicroStrain 3DM-GX4-25 IMU with cable assembly
- Mini-Box M4 ATX power supply
- Mini-Box Y-PWR power splitter
- 3.3V power regulator
- Y-PWR input dust cap
- Ground Y-adapter assembly
- Power switch assembly

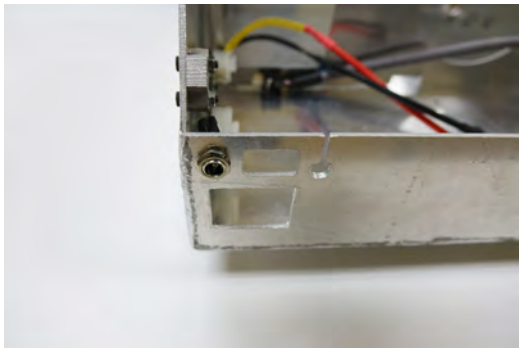
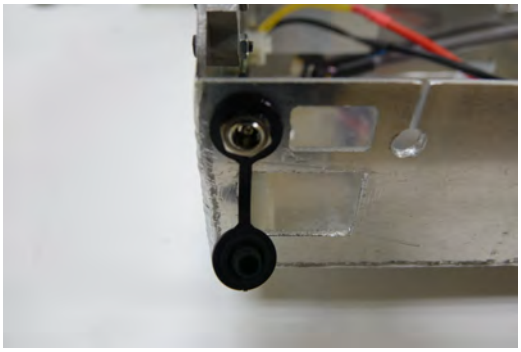
- ATX to power supply cable assembly
- Power supply to regulator cable assembly
- GPS USB breakout assembly
- 3D printed power supply mount
- 2 zip tie saddles
- 2 zip ties
- 2mm foam

Instructions

a. Attach the ATX-to-power supply cable assembly to the Y-PWR output. Mount the Y-PWR to the compute box base using 2 M3×10 mm screws, 2 M3 nuts, and 2 M3×4 mm standoffs.

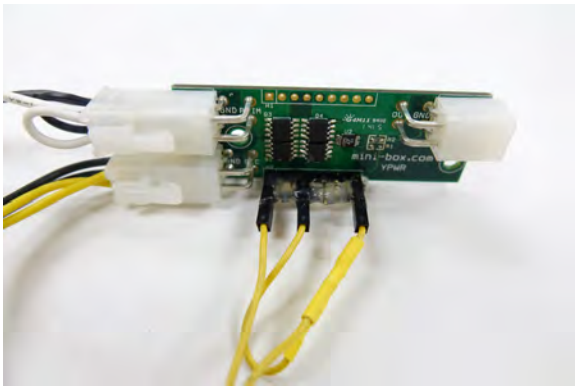
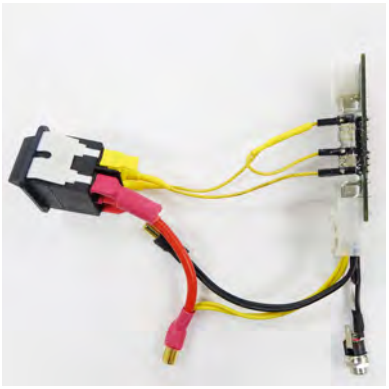



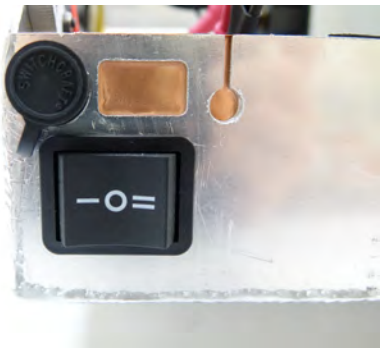
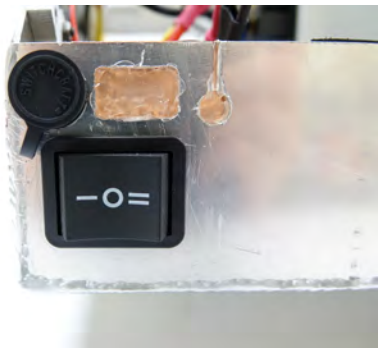
b. Panel mount the Y-PWR input, ensuring that the included washer and nut are on the outside of the compute box. The dust cap mounting hole is slightly larger than the washer. Mount it in place on the outside of the box and use epoxy to secure it.

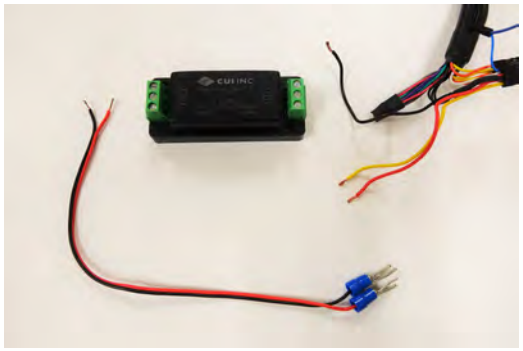
c. Attach the ground Y-adapter to the ground connector of the main power switch assembly. Install the main power switch, ensuring that the side marked || faces toward the right. **Before sliding the switch in all the way, connect the ATX connector to the secondary ATX input of the Y-PWR splitter.** Slide the switch assembly in and connect the yellow signal wires (with the resistor) of the switch assembly to pin 9 and pin 5 of the secondary header of the Y-PWR splitter (to which male headers were soldered in an earlier step). **Pin 9 is the pin closest to the output; pin 5 is marked with a dark circle.** Connect the yellow signal wire from pin 2 of the switch assembly to pin 1 on the secondary header. Use hot glue to fix these wires in place. Also place a layer of hot glue over the unused pins in order to prevent shorts.

After installing the main power switch, cover the neighboring slots the with copper conductive tape and hot glue.

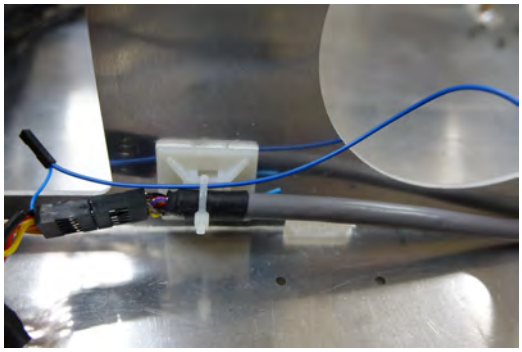



d. Plug the power and ground leads of the power supply-to-regulator cable assembly to the **VIN** and **GND** inputs on the input side of the 3.3V regulator, respectively. Plug the exposed red and yellow (power) leads of the GPS USB breakout assembly into the **+Vo** output on the right side. Plug the exposed black (ground) lead of the breakout into the **0V** output. Mount the regulator assembly to the compute box using 2 M3×14 mm screws and 2 M3 nuts.

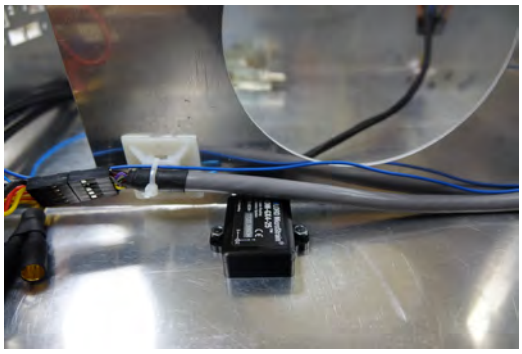



e. Plug the GPS cable into the 2×5 header on the GPS USB breakout.

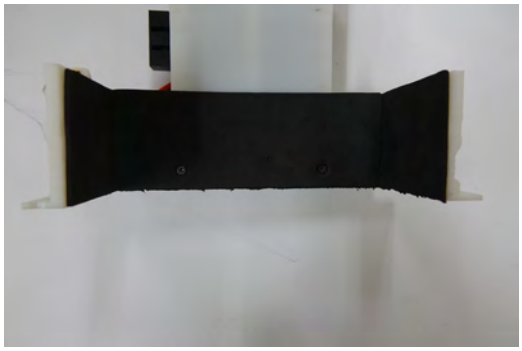
f. Place a zip tie harness of the back of the GPU support strut for the GPS cable. The cable must clear the IMU slot while still being low enough to avoid restricting airflow or interfering with the GPU. Zip tie the GPS cable as well as the blue PPS cable input from the GPS USB breakout assembly.



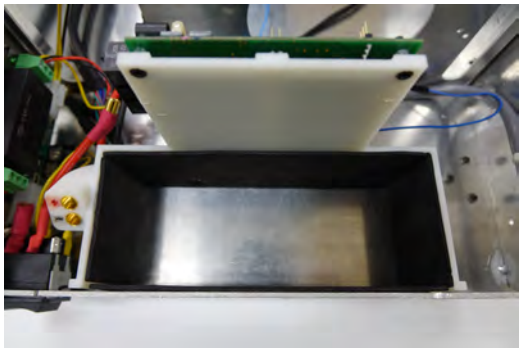
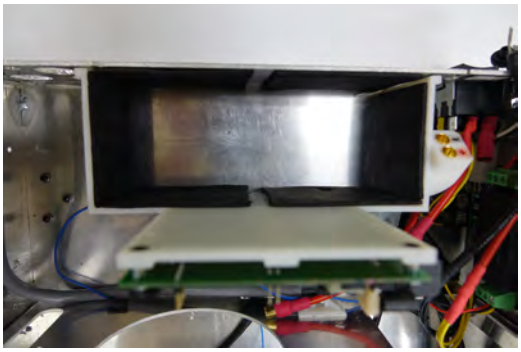
g. Slide the IMU wires through the slot in the GPU strut. Mount the IMU using 2 M3×8 mm screws and 2 M3 nuts.



h. Line the inside of the lower portion of the 3D printed power supply holder with 2mm foam. Use hot glue to attach the foam to the mount. Use one piece of foam with dimensions 6.5”×2.25” and two pieces with dimensions 2.5”×2.25”. Also cut and reserve an additional piece with dimensions 6.5”×2.25”.



i. Attach the power supply to the 3D printed power supply mount using 4 M3×12 mm screws, 4 4mm M3 standoffs, and 4 M3 nuts. Attach the 3D printed power supply mount to the compute box base using 4 M3×8 mm screws and 4 M3 nuts. **Depending on fit and finish, this 3D printed part may need to be clipped or cut slightly in the following steps.** After mounting, hot glue the additional piece of foam from the previous step on the compute box wall opposite the 3D printed power supply holder. Cut a slit down the center of the foam on both of the longer sides.

j. Connect the red (power) lead coming from the power supply to the short red input on the switch assembly. Plug the black (ground) lead coming from the power supply mount to the free input of the ground Y-adapter.

k. Place a zip tie saddle above the 3.3V regulator. Zip tie the four cables coming into and out of the regulator so they sit above the regulator, leaving just enough slack so that the lugs can safely reach the power supply.


8.2 Arduino Micro

Time 0 hours 10 minutes
Parts

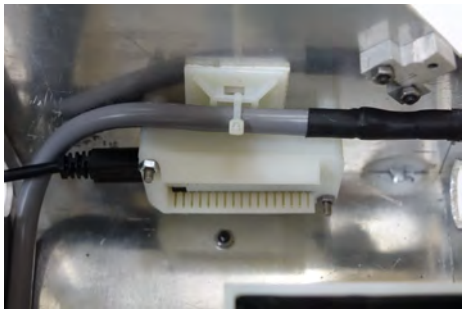
- AutoRally compute box base
- Arduino Micro

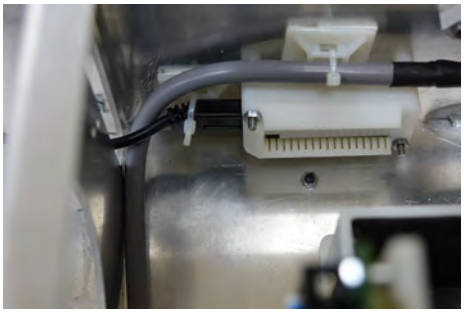
- 3D printed Arduino Micro holder
- USB cable for Arduino Micro
- 2 M3×25 mm screws
- 2 M3 nuts
- 1 zip tie saddle
- 1 zip tie

Instructions

a. Place the Arduino Micro in the 3D printed Arduino holder. Note that the lid of the holder is directional and must be mounted as shown below.

b. Mount the entire assembly to the compute box wall, near the GPS cable, using two M3×25 mm screws and two M3 nuts. The screws should be inserted from the outside of the box. Insert the USB cable into the Arduino and route the cable through the vertical hole in the GPU strut. Place a zip tie saddle against the Arduino holder, lining up the top of the saddle and the holder. Zip tie the USB connector itself to the holder.





8.3 Panel Mount Buttons and Connectors

Time 1 hours 0 minutes
Parts

- AutoRally compute box base
- Panel mount USB port
- Power button assembly
- Reset button assembly

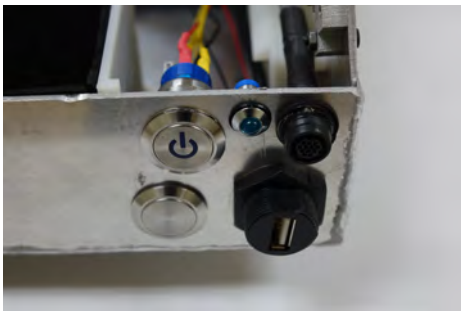
- SSD LED
- Motherboard system panel header connector (included with motherboard)
- Panel mount dual USB3 ports
- Dust caps for USB3 ports
- 2 $4-40$ screws
- 1 zip tie

Instructions

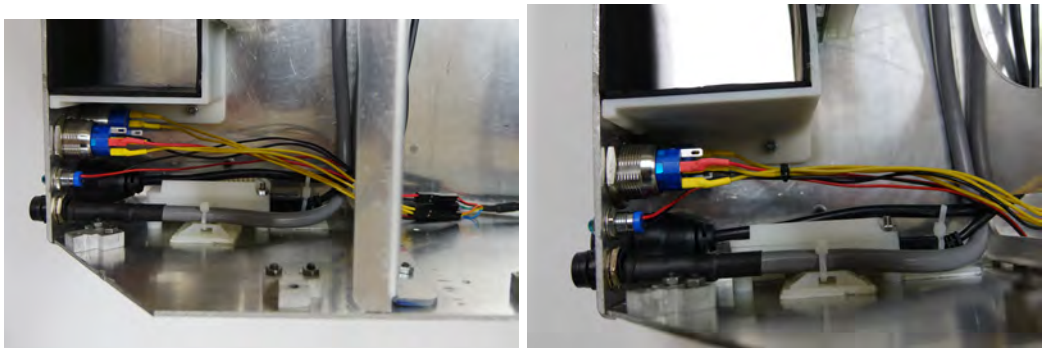
a. Install the panel mount USB using the included nut. Route the cable through the same hole as the Arduino USB cable.

b. Install the panel mount power LED. The washer and nut should go on the inside of the box. Connect the power and ground wires of the LED to the **HDD LED** headers on the motherboard's system panel connector assembly, ensuring that the ground and power wires are matched with those of the Power LED. Refer to the motherboard's user manual for the color coding of the system panel connector.

c. Install the panel mount reset button using the included nut. Repeat for the panel mount power button. Connect the leads of both buttons to the corresponding outputs of the motherboard system panel connector. Note that the power and ground leads of the power button's LED should be connected to the **Power LED** header of the system panel connector.



d. Zip tie the leads from the power button, reset button, and SSD LED together.



e. Install the panel mount USB3 connector and dust caps using 2 0.5" $4-40$ screws instead of the screws included with the panel mount USB connector. Ensure that the connector is installed so that USB peripherals are connected facing up. Also ensure that the dust caps hang vertically downward and are oriented such that the word **top** is visible on top when the dust caps are inserted into the USB ports.

8.4 SATA SSD and Motherboard/CPU Power Connectors

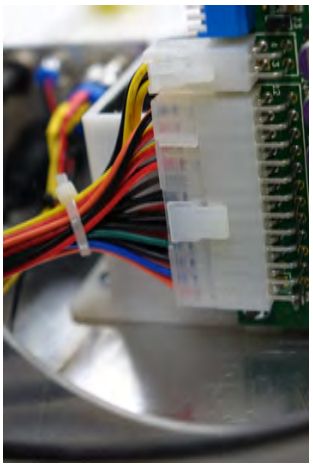
Time 0 hours 10 minutes
Parts

- AutoRally compute box base
- 24-pin ATX motherboard power cable
- 4-pin ATX CPU power cable
- 4-pin ATX CPU power cable extension
- 1 zip tie

- 4 M3×6 mm screws
- 3 M3×8 mm screws
- 3 M3 nuts

Instructions

a. Plug the 24-pin and stock (longer) 4-pin ATX cables into the power supply. Attach the shorter 4-pin cable to the longer one as an extension. Place a zip tie around the main ATX power and 4-pin CPU, bundling the leads together.



b. Attach the SSD to the 3D printed SSD holder using 4 M3×6 mm screws. Mount the holder to the compute box using 3 M3×8 mm screws and 3 M3 nuts. Route the ATX power and 4-pin CPU power cables underneath the SSD mount.

8.5 Motherboard and Computer Components

Time 1 hours 15 minutes
Parts

- AutoRally compute box base
- ASUS Z170I mini-ITX motherboard (and included accessories)
- 1TB SATA3 SSD
- 500GB M.2 SSD
- Intel Core i7 6700 CPU

- Noctua L9i CPU cooler
- Thermal paste (included with CPU cooler)
- 32 GB (16 GB×2) DDR4 RAM
- 3D printed SSD holder
- 3D printed RAM holder
- Laser cut foam motherboard support
- 4 M4×6 mm standoffs for the foam support
- 4 M4×14 mm screws
- 4 M4 nuts
- 2 M3×20 mm screws

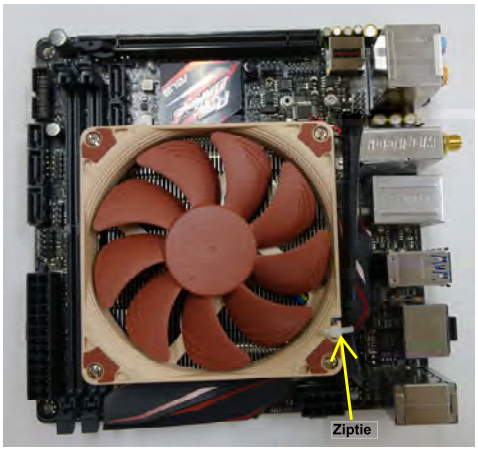
Instructions

a. Install the CPU on the motherboard.

b. Carefully place thermal paste on the CPU, making sure that the CPU surface is clean before doing so.

c. Install the CPU cooler and cooler fan and ensure that the fan lead points toward the motherboard's USB ports.

d. Plug the fan into the CPU fan header on the motherboard. Zip tie the fan lead to the plastic support of the CPU fan as shown in the photo.



e. Install both sticks of RAM.

f. Remove the two screws on the CPU fan that are nearest the RAM. The RAM holder should press fit snugly against the RAM. Install the 3D printed RAM holder and replace the removed screws with 2 M3×20 mm screws to hold down the RAM holder. **Note that the RAM holder may not fit if the RAM used is not exactly as specified in the AutoRally Parts List.**

g. Install the M.2 SSD. Use the M.2 screw kit included with the motherboard to install the drive.

h. Press 4 M4 6mm standoffs into the laser cut foam. Place the laser cut foam on the motherboard while it is upside down. Carefully turn the motherboard and foam over.

i. Place 4 M4×14 mm screws in the 4 mounting holes. Carefully put the motherboard, foam, and loose screws into the compute box and let the screws drop into the mounting holes.

j. Secure the screws with 4 M4 nuts on the **underside** of the compute box. Do not overtighten to ensure that the motherboard does not bend.

8.6 Plugging In and Routing Cables

Time 0 hours 30 minutes
Parts

- AutoRally compute box base
- SATA-3 data cable
- 3 zip tie saddles
- 3 zip ties

Instructions

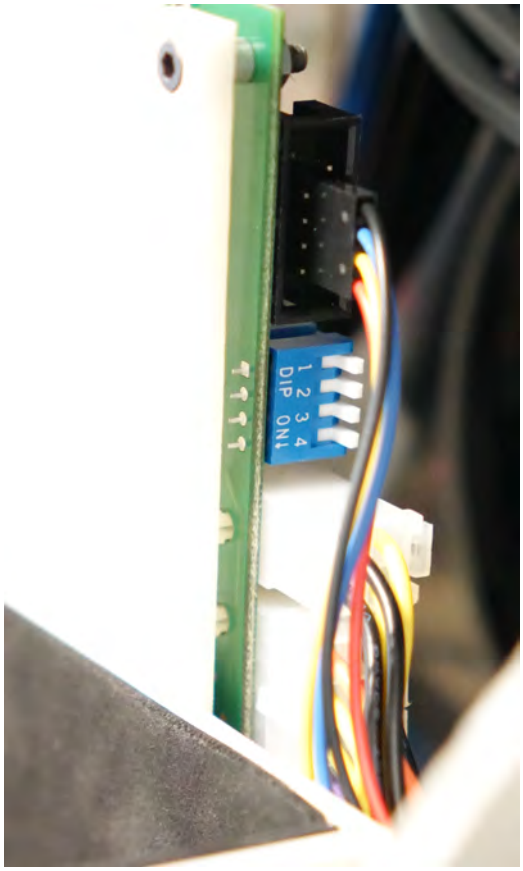
a. Clip two opposite sides of a zip tie saddle to make it approximately 0.9” on one side. Install the zip tie saddle just to the right of the slot for the IMU leads.

b. Zip tie the back panel USB cable, the side panel USB 3 cable, and the Arduino USB cable. Also include the IMU cable and the PPS signal cable **under** this set of wires. After routing, plug in the male 0.1" PPS connector to the remaining free female connector. Route the connected blue PPS lead as shown in the photo below.

c. Plug the system panel connector in to the system panel header on the motherboard.

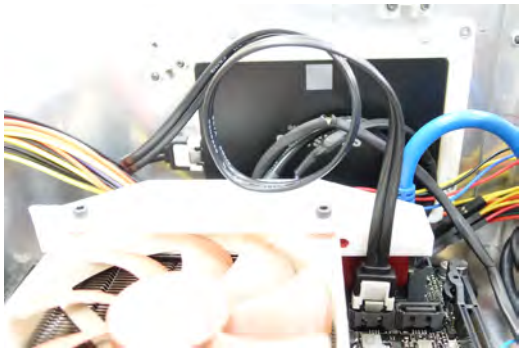
d. Plug in the Y-cable that is also attached to the IMU connector to the USB2 header.

e. Route the other part of the USB2 Y-cable to the power supply data header such that the ground wire is on Pin 2 of the top row and the power wire is on Pin 5 of the top row. Zip tie that cable to the ATX power bundle.



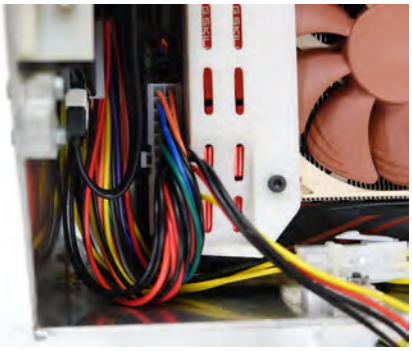
f. Plug the side panel USB3 connector into the USB3 header.

g. Plug one end of the SATA data cable into the SATA SSD. Plug the other end into the motherboard's SATA6G 3 port, looping the cable as shown in the photo if it is too long.

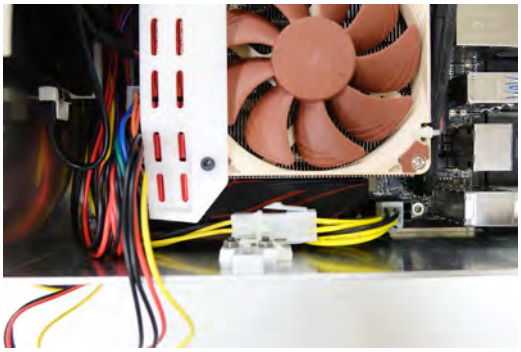


h. Place a zip tie saddle directly on the SSD. Zip tie the SATA data cable, the system panel header connector, the panel mount USB cable, and the IMU cable as shown in the photo below.

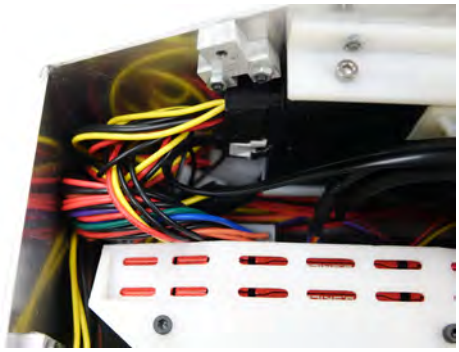
i. Route the 4-pin ATX CPU power cable under the SSD (per the previous section) and around the outside of the motherboard. Plug it into the ATX CPU power connector on the motherboard, pushing until it clicks. Route the 24-pin ATX motherboard power cable under the SSD (per the previous section) and over the 4-pin connector, loop it around as shown in the photo, and plug it into the power connector on the motherboard. Push it in until it clicks.



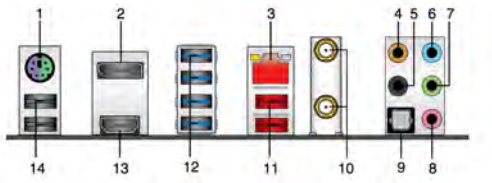
j. Place a zip tie saddle directly underneath the lid connector near the ATX CPU power connector. Zip tie the ATX CPU power cable to the zip tie saddle.

k. Plug one of the SATA power extensions on the motherboard ATX power cable into the SATA SSD. Hot glue the remaining connectors to block exposed pins. Fold up the cables and tuck them into the corner of the compute box, making sure not to stress the motherboard or the cables.

l. Referring to the diagram below, plug the 10-pin UART-USB connector from the GPS breakout into the bottom port of 14. Plug one of the TTL-USB connector into the top port of 14 and the other into the bottom port of 12. Plug the Arduino USB cable into the second port from the bottom of 12, and plug the back panel USB cable into the bottom port of 11.



8.7 XBee

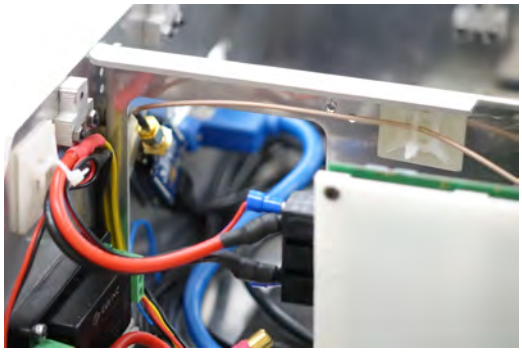
Time 0 hours 10 minutes
Parts

- AutoRally compute box base
- XBee Pro S3B
- 12” RP-SMA antenna cable
- 1 zip tie saddle
- 1 zip tie

Instructions

a. Connect the XBee into the second USB port from the top of USB tower 12 on the motherboard I/O diagram shown above. Orient the XBee module as shown in the image below. Secure the XBee to the wall of the compute box using double sided sticky tape. The reason for doing so is to avoid straining the mini-USB cable and connector from the XBee that connects into the motherboard and so that the antenna wire can pass through the cut out in the strut. Make sure that the antenna wire does not push against the edges of this cut out in order to prevent damage.

b. Route the XBee antenna wire under the flange of the strut above the top edge of the cut-out. Secure the antenna wire to the wall of the strut using a zip-tie saddle. Clip-off one end of the zip-tie saddle so that the antenna wire can be secured under the flange. Refer to the image below for location of the zip-tie saddle and routing of the antenna wire.



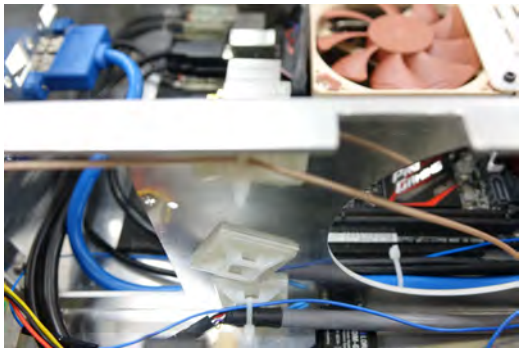
8.8 WiFi Antenna and Camera USB

Time 0 hours 15 minutes
Parts

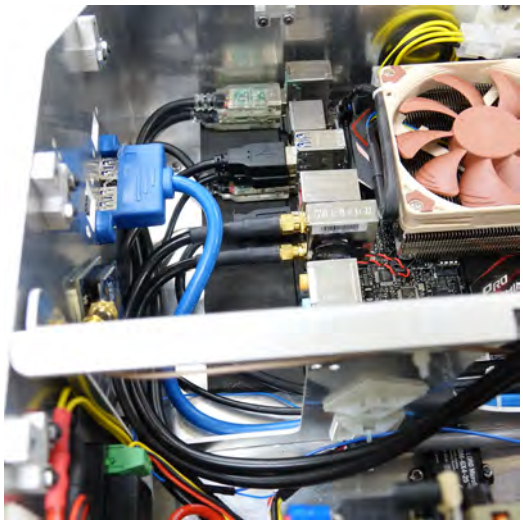
- AutoRally compute box base
- 2 2' RP-SMA extension cable
- Camera USB cables

Instructions

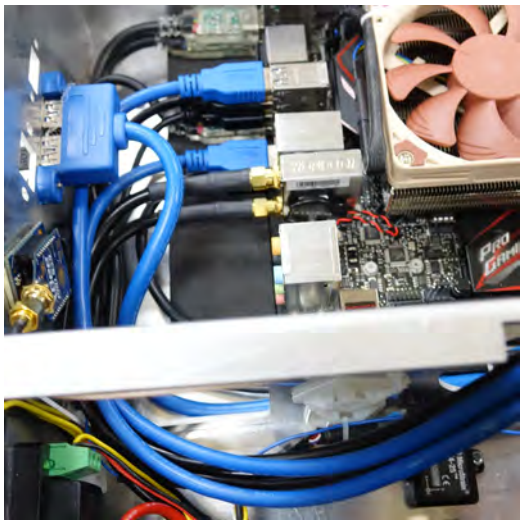
a. Attach a zip-tie saddle at an angle to the strut as shown in the image below. This is done so that the saddle is able to hold down the WiFi antenna (2' RP-SMA extension) and camera USB cables as the bend through the cut-out in the strut and are routed through the notch in the strut and out of the cut-out in the lid.



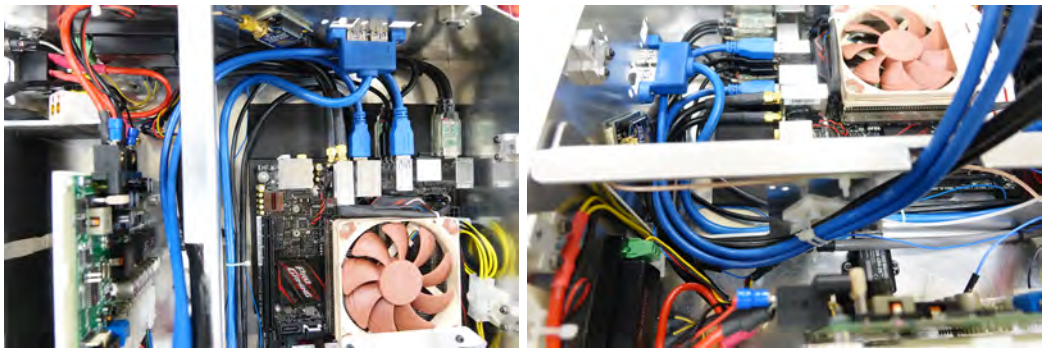
b. Install the WiFi antenna cables first. These can be bent and shaped before trying to route and connect into the motherboard. Be careful when connecting to not put too much of strain on the ports on the motherboard. These cables have to be routed under the blue USB 3.0 panel mount cable which is already in place.



c. Install the camera USB cables into the USB slots at the top USB ports of towers 11 and 12 in the motherboard I/O diagram. Route these cables under the blue USB 3.0 panel mount cable similar to the antenna cables. Refer images for routing.



d. Secure the two WiFi and the two camera USB3 cables to the zip-tie saddle using two zip ties. Also, note that before securing the cables down with zip ties, route them such that they are as close as possible to the base.



8.9 Camera Trigger

Time 0 hours 20 minutes
Parts

- AutoRally compute box base
- Camera trigger assembly
- 2 zip tie saddles
- 2 zip ties

Instructions

a. Place a zip tie saddle near the power supply on the bottom of the compute box. See the photo below for exact placement.

b. Place another zip tie saddle on the GPU support strut between the GPU fan hole and the narrower cable hole, about 1” from the top of the mount. See the photo for exact placement.

c. Take the remaining blue PPS signal lead and plug it into pin 4 on the camera trigger assembly (recall that the light blue lead is in position 1).

d. Route the camera trigger assembly under the ATX power cables as well as under the rear panel

assembly.

e. Plug the camera trigger assembly into the bottom row of the Arduino Micro. The ground (light blue) lead should be connected to the 6th pin from the back. Refer to the **AutoRally_ComputeBox_MITX** file in wiringDiagrams/ if clarification is needed.

f. Zip tie the camera trigger assembly. Note that the zip tie closer to the Arduino should hold the large heat shrink which partially covers both the outer insulation and the individual leads; it also holds the PPS signal wire.

g. Route the camera trigger cable along the top edge of the GPU support strut until it reaches the exit slot.

8.10 Panel Mount Ethernet and HDMI

Time 0 hours 10 minutes
Parts

- AutoRally compute box base
- Panel mount ethernet cable
- Panel mount HDMI cable
- Ethernet dust cap
- HDMI dust cap

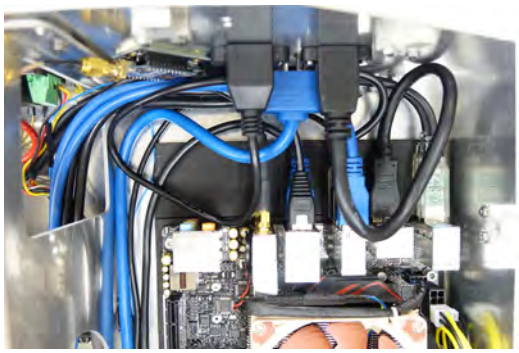
Instructions

a. Trim the two edges of the ethernet dust cap to allow it to sit flat. Specifically, make a vertical cut to remove the “A” of the logo and a circular cut near the “o” and “l”.

b. Install the panel mount ethernet port, replacing the stock screw on the side that will hold the dust cap with a $4-40$ screw.

c. Plug the HDMI cable into the motherboard. Install the panel mount HDMI port and insert the dust cap.

d. Plug the ethernet cable into the motherboard.



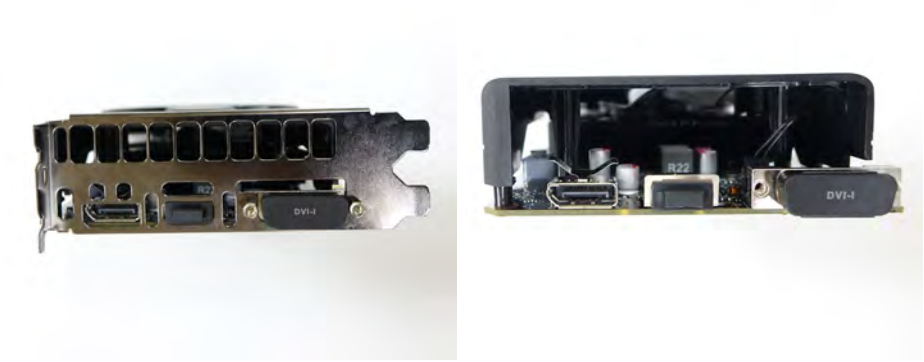
8.11 GPU

Time 0 hours 30 minutes
Parts

- AutoRally compute box base
- EVGA GeForce GTX 750 Ti GPU
- 3D printed GPU cover
- 4 M3×8 mm screws
- 4 M3 nuts
- 2 mm foam

Instructions

a. Remove the two hex screws around the DVI port. Remove the panel screw on the back of the GPU. Remove the GPU panel and then replace the panel screw on the back of the GPU. Do not replace the two hex screws.



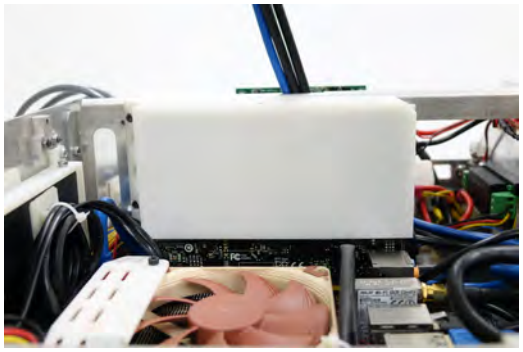
b. Bend back the grounding tab on the DisplayPort so that it no longer sticks out in front of the port.

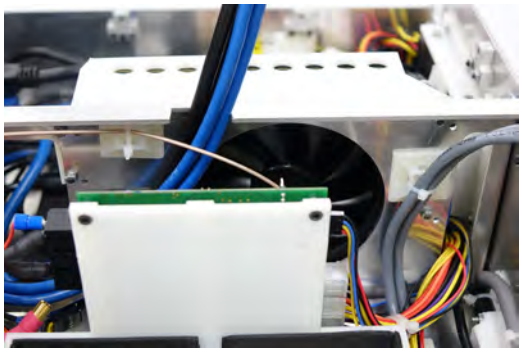
c. Cut and place 2 mm foam around the fan hole on the metal GPU support strut. Ensure that the foam does not block the GPU fan and does not interfere with the small "lip" on the plastic surrounding the fan. **Place the GPU first and mark the boundaries. Remove the GPU and hot glue the foam in place, ensuring that it does not pass the edge of the marked areas.**

d. Install the GPU.

e. Cut and hot glue a rectangular piece of 2 mm foam to the inside of the 3D printed GPU holder.

f. Slide the 3D printed GPU holder over the GPU from the top. Use 4 M3×8 mm screws and 4 M3 nuts to secure the holder to the GPU support strut.





8.12 Cross Brace

Time 0 hours 5 minutes
Parts

- AutoRally compute box base
- Metal cross brace

- 4 M3×8 mm screws
- 4 M3 nuts

Instructions

a. Install the cross brace using 4 M3×8 mm screws and 4 M3 nuts as shown in the photo.

8.13 Compute Box Battery

Time 0 hours 15 minutes
Parts

- AutoRally compute box base
- Battery
- Servo cable
- Hot glue

Instructions

a. Hot glue a 7" length of servo cable around the center of the battery to create a handle. The cable should go about 2/3 of the way down both sides of the battery. Once the glue has dried, slide the battery into place.

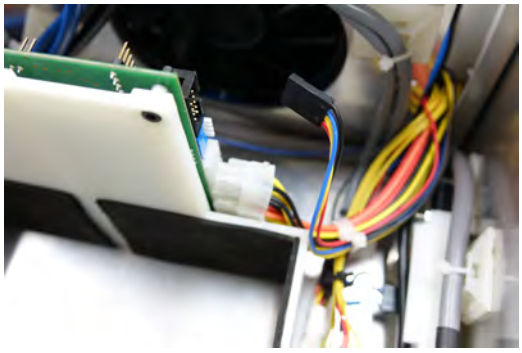
9 Testing

Time 0 hours 30 minutes
Parts

- AutoRally compute box base
- Shore power cable
- Power supply
- Battery
- Monitor
- HDMI cable
- Mouse
- Keyboard

Instructions

a. Unplug the power supply USB cable.



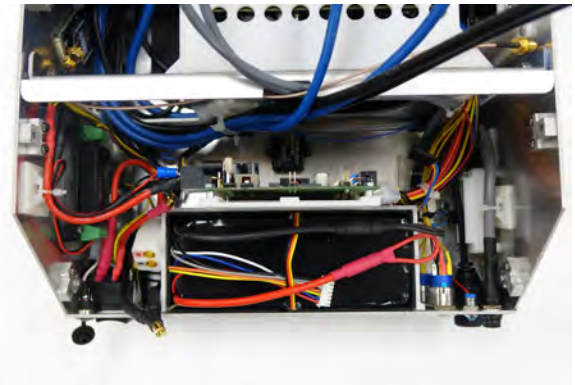
b. Unplug the 4 pin ATX CPU power cable.

c. Unplug the 24 pin ATX power cable.

d. Plug the shore power in to the plug on the back panel of the compute box. Look for the solid light on the 3.3V voltage regulator and for the flashing light on the power supply. Only continue if these two lights are evident; if they are not, review the steps above to make sure that all instructions have been followed precisely.

e. Unplug the shore power cable.

f. Place the battery into the battery holder; ensure that the protector plugs are still connected to the battery leads.



g. Ensure that the rocker switch is in position **0**.

h. Remove the ground cable protector from the battery and plug it in to the male terminal of the ground Y-adapter. Note that you should not twist the protector plug when pulling it off.

i. Remove the power cable protector from the battery and plug it in to the red male terminal. **Do NOT let the power lead from the battery touch the compute box.** Note that you should not twist the protector plug when pulling it off.

j. Once the functionality of the power system has been verified, plug in the 24-pin ATX power cable and the 4-pin CPU power cable. Unplug all USB connectors from the motherboard (leave internal USB connections to motherboard headers plugged in). Plug the HDMI cable **into the GPU** and plug in a mouse and a keyboard. Connect shore power. The power status LED on the motherboard should turn red.

k. Press the power button. Both the CPU and the GPU fan should spin up.

l. Enter the BIOS by repeatedly pressing F2 until the BIOS starts. Press F7 to go to Advanced mode. Click the Advanced tab. Click System Agent (SA) Configuration. Click Graphics Configuration and change Primary Display from Auto to **CPU Graphics**. Click Exit and then click Save Changes and Exit. Once configured, replace the HDMI dust cap back into the GPU and plug the monitor into the panel mount HDMI port.

m. Shut down the PC. Plug in all of the USB connections. Restart the PC. The Arduino and XBee should indicate that they are powered with LEDs – the other devices may not show any physical indication.

10 Install the Compute Box Lid

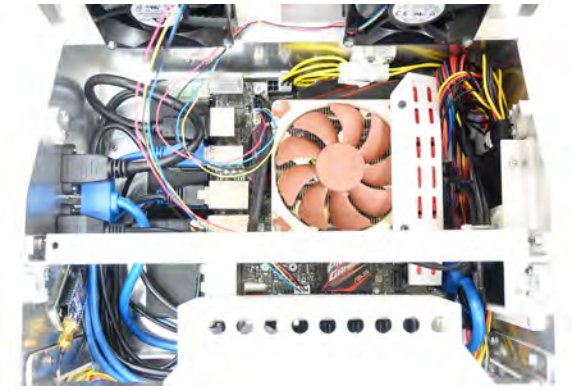
Time 0 hours 30 minutes
Parts

- AutoRally compute box base
- AutoRally compute box lid
- 1 XBee antenna
- 2 WiFi antennas
- 8 M3×10 mm screws
- 4 zip tie saddles
- 6 zip ties

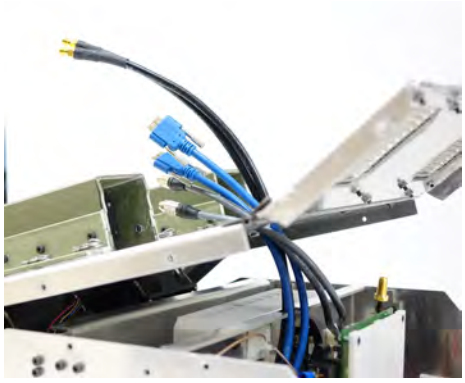
- 2 thumbscrews

Instructions

a. Plug in the fan cables to the fan headers on the motherboard. The zip tied cable should be connected to the header near the CPU fan; the loose cable should be connected to the header nearer the GPU. Refer to the photos for exact placement.

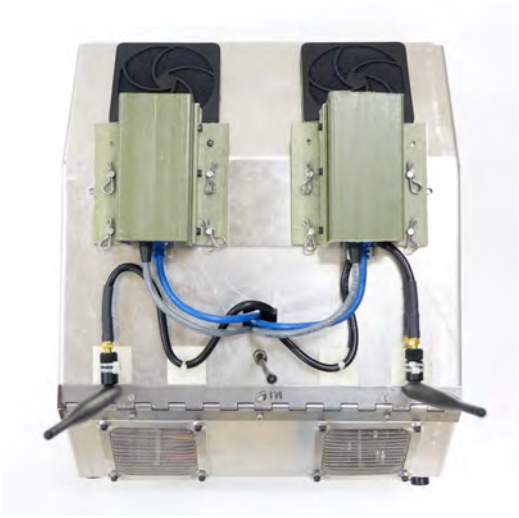


b. Pass the WiFi antennas through the rectangular cutout in the lid. Pass the camera data (USB) cables next, followed by the camera trigger cables. Finally, panel mount the XBee antenna cable.



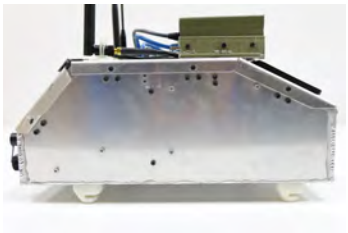
c. Place a zip tie saddle against the "lip" of the hinge, one inch in from either side of the lid as shown in the photos below. Place another zip tie saddle one more inch toward the middle from each zip tie saddle already placed, for a total of 4 saddles. Firmly zip tie the WiFi antennas to

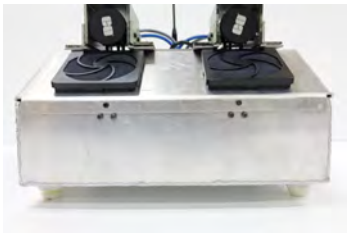
the outer saddles, ensuring that the hinged lid can still open (and remain open without being held up). Bend the WiFi cables as shown in the photos below and zip tie the cables to the inner zip ties.

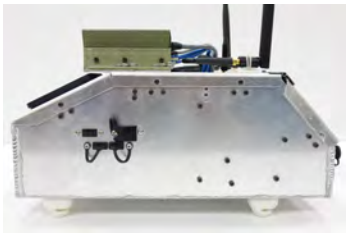


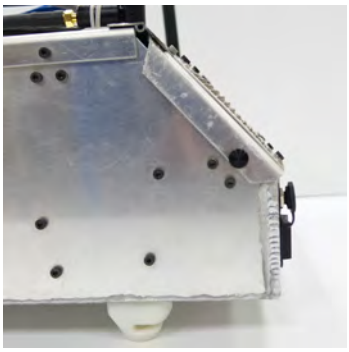
d. Plug in the camera data and trigger cables. Ensure that the camera data cables are firmly screwed in.

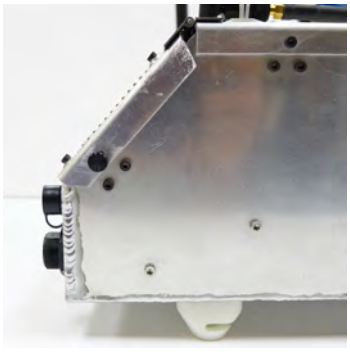
e. Screw the lid into the base using 8 M3×10 mm screws and 2 thumbscrews. This step may require some maneuvering of the lid to make all of the mount holes align depending on fabrication tolerances.











11 Integration with Chassis

Time 0 hours 25 minutes
Parts

- AutoRally compute box
- AutoRally chassis
- AutoRally body
- Male-to-male GPS cable

Instructions

a. Mount the compute box onto the chassis. Refer to the AutoRally Operating Procedures for a detailed explanation.

b. Plug the GPS box into the compute box using the male-to-male GPS cable.

c. The front body mount set should be fixed with body clips at the 2nd hole. The rear body mount set should be fixed with body clips on the last hole.


d. Use a sharpie to make marks at 1.5" from each of the windshield sides, leaving a strip of 2" in the middle about 1/4" above the windshield seam. Depending on fabrication tolerances of the camera mounts and the kind of lens used, the location and size of the cut above the seam may have to be varied slightly.

e. Hold the body above the front and rear body mount pegs. Using a sharpie, mark locations to drill holes underneath the roof for the WiFi antennas. The goal is to have the antennas sticking straight upwards after the body is mounted onto the pegs.

f. Make the necessary cuts outs in the windshield using a dremel.


g. Cut out two holes in the body to allow the WiFi antennas to pass through the both. Cut out a third hole for the XBee antenna.

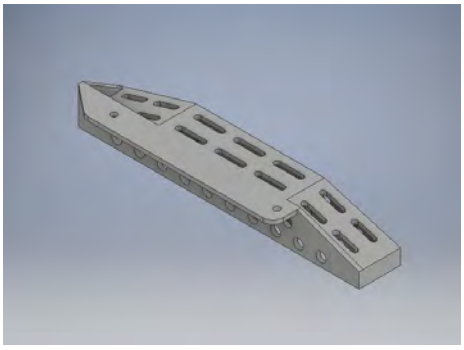



h. Test fit. Make the necessary adjustments to ensure that WiFi antennas are pointing straight upwards and camera mounts are sticking out the windshield.

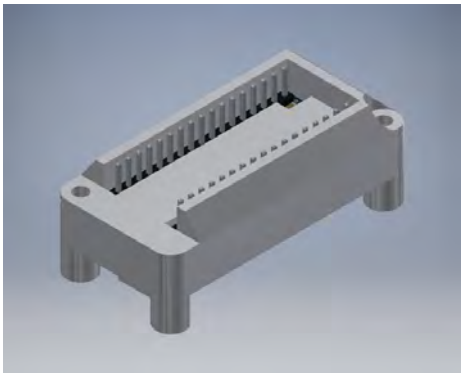
12 Appendix A: Parts

12.1 3D Printed Parts

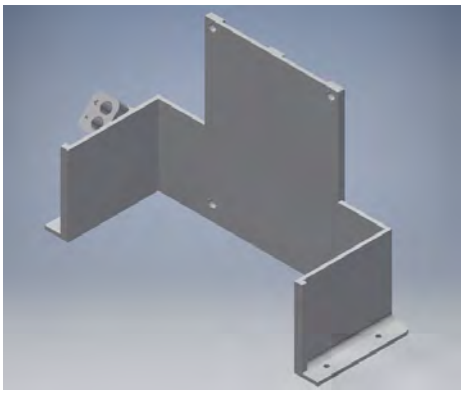
1. RAM holder



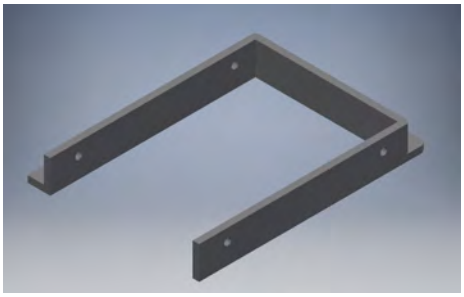
2. Arduino Micro holder



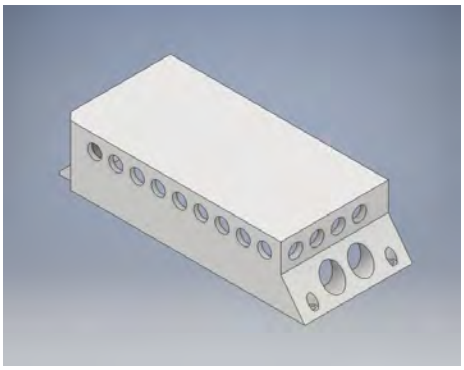
3. Battery/Power supply holder



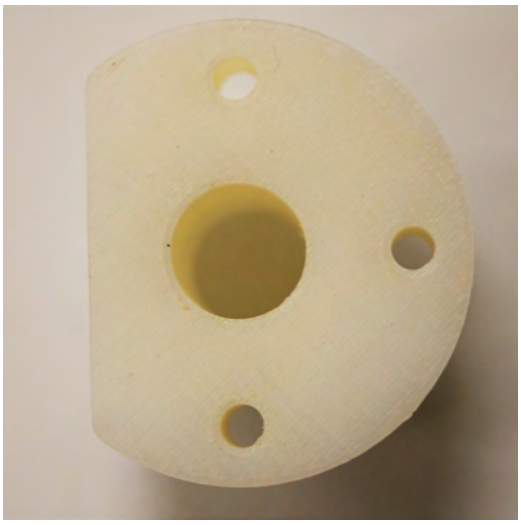
4. SSD holder



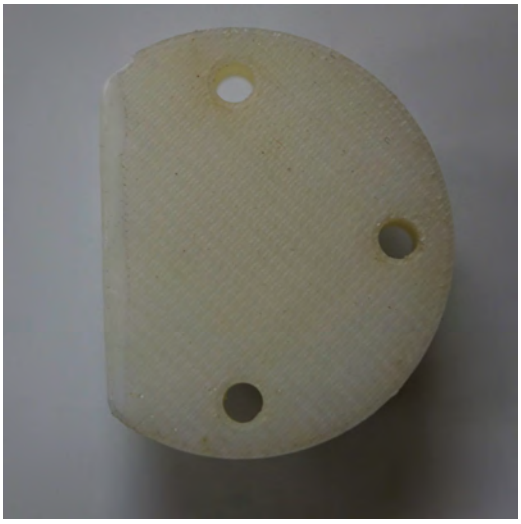
5. GPU holder



6. Front compute box mount

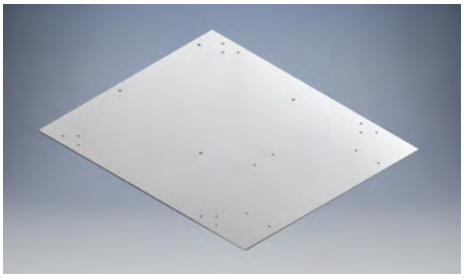



7. Rear compute box mount

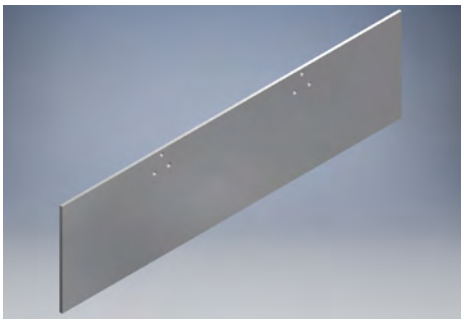



12.2 Fabricated Parts

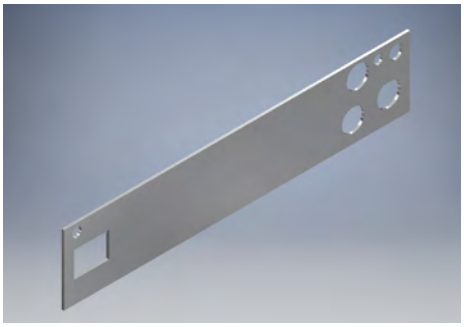
1. Compute box base



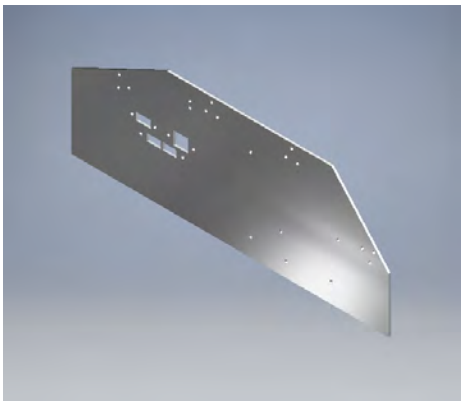
2. Compute box front panel



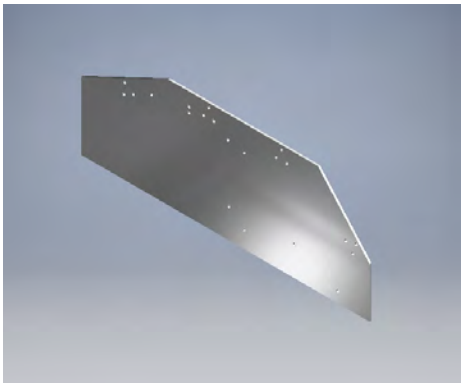
3. Compute box rear panel



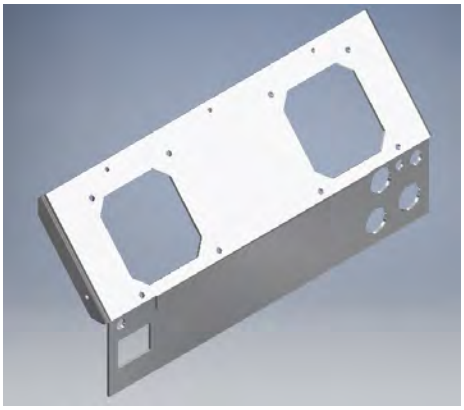
4. Compute box left panel



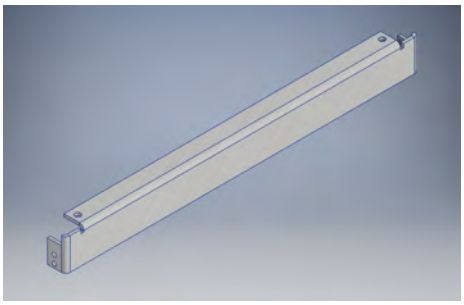
5. Compute box right panel



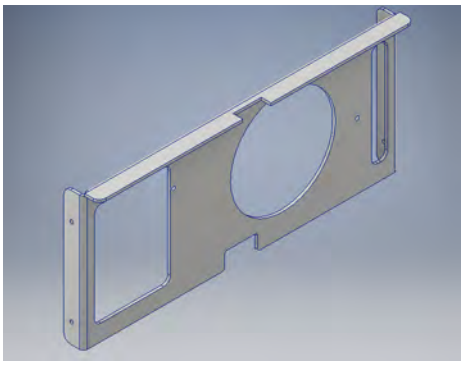
6. Compute box lid and compute box rear hinge panel



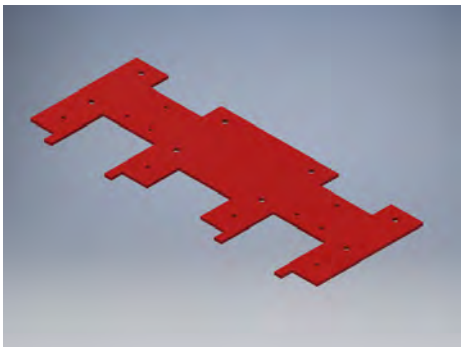
7. Compute box cross brace



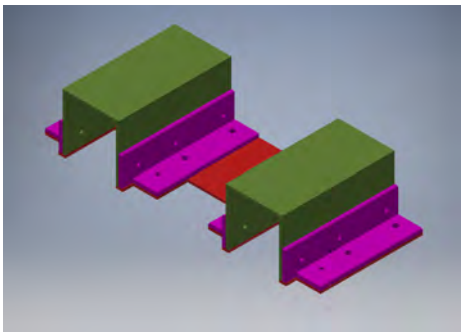
8. GPU strut



9. Camera support plate



10. Rectangular camera cover and right-angle camera cover support



11. Lid connector

12. Motherboard foam padding

12.3 Computer and Electronic Components

1. Arduino Micro

2. LiPo 11,000 mAh 6S 22.2v Battery Pack

3. Noctua NH-L9i 95mm SSO2 CPU Cooler

4. 80×25.4mm 12VDC Axial Fan

5. 4.5mm C Series Fixed Focal Length Lens

6. GeForce GTX 750 Ti GPU

7. 3.3V DC/DC Converter Isolated Power Supply

8. Panel Mount Indicator Blue LED

9. SAMSUNG 950 Pro m.2 512GB PCI-Express SSD

10. M4-ATX, 250W Intelligent Automotive DC-DC Car PC Power Supply

11. ASUS Z170I Mini ITX Intel Motherboard

12. Red Mushroom Emergency Stop NC Latching Push Button Station

13. SPDT 3A 250V Power Pushbutton

14. Intel Core i7 Skylake Quad-Core 3.4 GHz Desktop Processor

15. G.SKILL Ripjaws V Series 32GB (2 x 16GB) DDR4 SDRAM

16. SPDT 3A 250V Reset Pushbutton

17. DPDT 20A 125V Rocker Switch

18. SAMSUNG 850 EVO 2.5” 1TB SATA SSD

19. Xbee Pro 900 HP

20. Y-PWR, Hot Swap, Load Sharing Controller

12.4 Cables, Connectors and Hardware

12.5 Cables

1. Xbee Antenna

2. RPSMA 12” extension cord

3. Ethernet Cable

4. 10' HDMI cable

5. 8 pins, 1m GPIO Hirose cable

6. 30cm 11.8" ATX 4 Pin P4 M/F Connector Motherboard CPU Power Cable Adapter

7. Panel Mount USB 2.0 cable

8. 16awg yellow Power cable

9. USB to TTL Serial 3.3V Cable

10. USB to UART Cable

11. 3’ USB-mini cable

12. USB 3.0 A Female Slot Plate Adapter

13. Wifi antenna

14. Wifi antenna cable

SMA Female Reverse Polarity

SMA Male Reverse Polarity

15. USB 3.0 cable for camera power

12.6 Connectors

1. 1×1 0.1” header housing

2. 1×4 0.1” header housing

3. 2×5 0.1” header housing

4. 0.1” male crimp connector

5. 0.1” female crimp connector

6. Fan 4-pin connector

7. Fan connector crimps (Non-Gendered Contact Tin 22-30 AWG Crimp)

8. HR-30 Socket Contact 26-30 AWG Female Crimp

9. HR-30 Pin Contact 26-30 AWG Male Crimp

10. HR-30 Circular Connector Plug for Male Contacts

11. 12 Position Circular Panel Mount Connector Receptacle for Female Contacts

12. Receptacle Dust Cap

13. Black Keying plug

12.7 Hardware

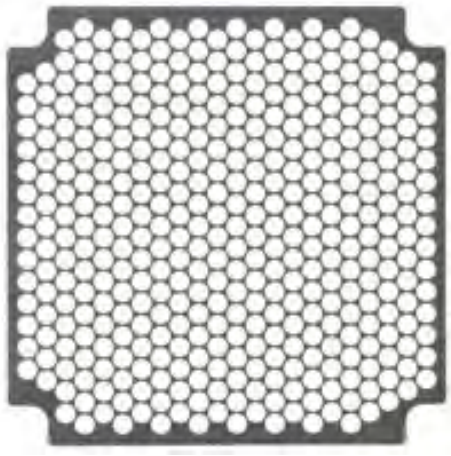
1. M4×6mm, 8mm O.D. Aluminum spacer

2. Foam 2 mm thick

3. Ethernet dust cap

4. 80mm fan cover

5. 80mm EMI filter guard



6. HDMI dust cap

7. M4 nut

8. Power jack dust cap

9. M4×14mm screw

10. USB dust cover

13 Appendix B: Revision History

Revision	Date	Author(s)	Description
1.1	July 2016	KS, MP, BG, MB, SS, JM	created, version aligns with other documentation
1.2	September 2016	BG, MB	Fixed error in GPS breakout cable in compute box diagram