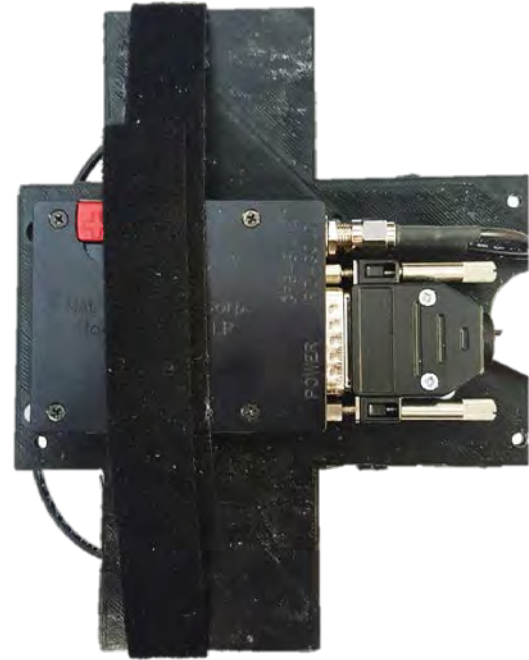


Preparation and Use of the Iridium Satellite Tracker



BE AWARE: ESD Sensitive Components!

- ESD – Electrostatic discharge

Electrostatic discharge (ESD) is the sudden flow of electricity between two electrically charged objects caused by contact, an electrical short, or dielectric breakdown. A buildup of static electricity can be caused by tribocharging or by electrostatic induction. The ESD occurs when differently-charged objects are brought close together or when the dielectric between them breaks down, often creating a visible spark.

ESD can cause a range of harmful effects of importance in industry, including gas, fuel vapour and coal dust explosions, as well as failure of solid state electronics components such as integrated circuits. These can suffer permanent damage when subjected to high voltages. Electronics manufacturers therefore establish electrostatic protective areas free of static, using measures to prevent charging, such as avoiding highly charging materials and measures to remove static such as grounding human workers, providing antistatic devices, and controlling humidity.

- Use grounding straps when handling/touching components such as the Pi, RFD 900+ modems, modems, power boards, OCCAMS, etc. and place them on the ESD rubber mat when not in use.

Overview

- The Iridium Satellite modem is used for payload tracking and remote payload commands.
- This system consists of an OCCAMS board, a 6.6Ah 3.7V battery, two antennae, and an NAL Research Iridium Modem 9602-LP.
- These slides will cover:
 - System Setup
 - Field Operation
 - Testing
 - Data Accessing
- **There are 17 steps to this build**

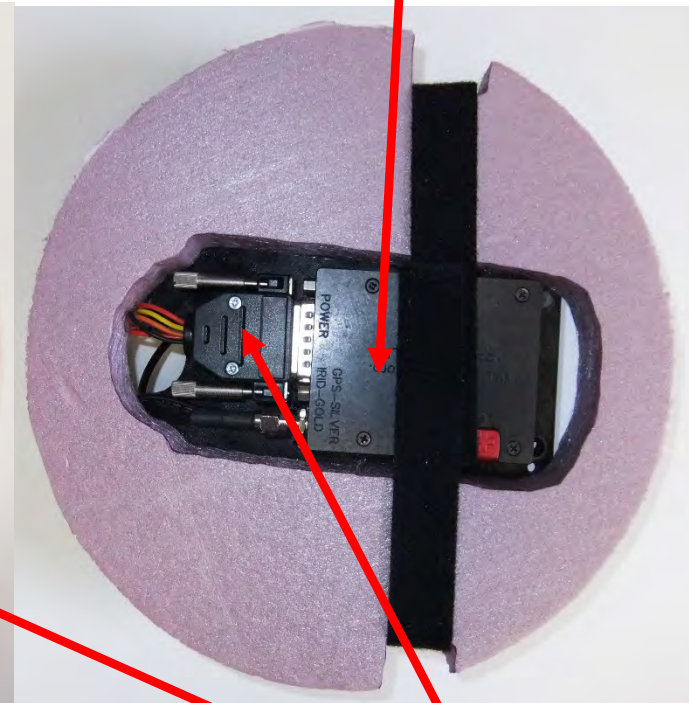
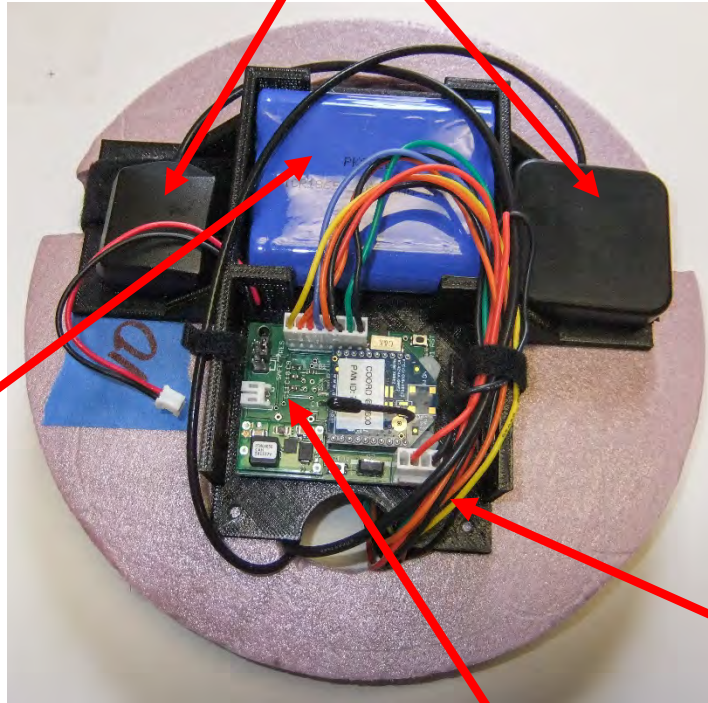
Introduction

- Iridium has two key features. The first being it's satellite GPS packet relay and the second being it's ability to relay commands from an emailed packet to the OCCAMS module.
- The Iridium system will allow us to track the balloon in real-time with approximately 30 seconds between GPS packets.
- We can send up to eight commands via email to the Iridium modem.
- The attached OCCAMS can also relay the status of the payload back down to the ground through the use of four status bits.

Assembly of Iridium Payload Introduction

A2 – NAL Antennas

A1 – NAL Iridium Satellite
Tracking Modem

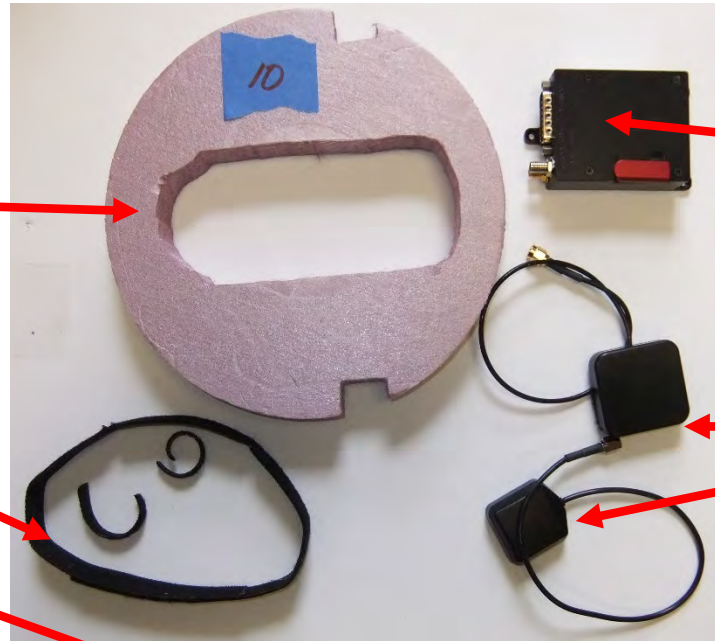


A3 – 3.7V
Battery at
6600mah

OCCAMS (Iridium)

Iridium Cable

Assembly of Iridium Payload Introduction



Iridium Foam Housing

Velcro Straps

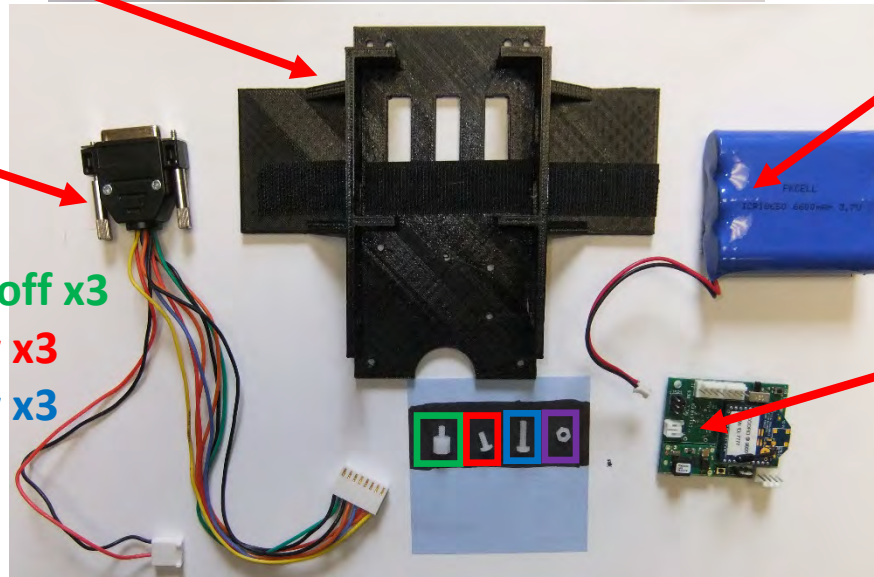
3D Printed Bracket

Iridium Cable

A1 – NAL
Iridium Satellite
Tracking
Modem

A2 – NAL Antennas

A3 – 3.7V
Battery at
6600mah



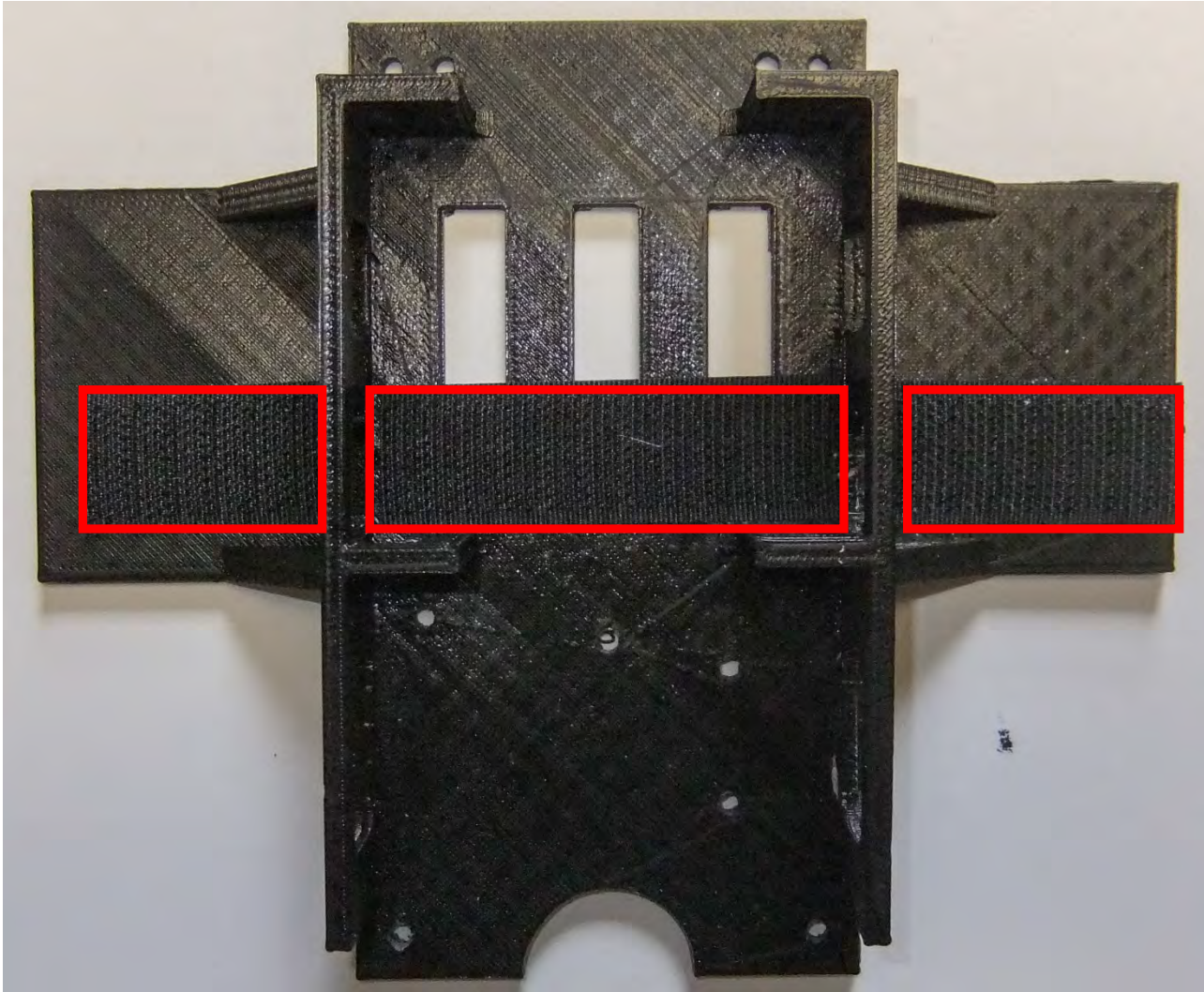
OCCAMS (Iridium)

- N1 – 1/4 inch nylon standoff x3
- N6 – 1/4 inch nylon screw x3
- N7 – 3/8 inch nylon screw x3
- N12 – Nylon nut x6

Step 0 – Verify Parts List

- Fully Assembled OCCAMS (XBEE coordinator)
- 3.7V 6.6Ah 3-cell Battery (Blue)
- GPS patch antenna
- Iridium patch antenna
- Iridium Modem 9602-LP
- 3D printed Mount
- 15-pin D connector to 8-pin and 4-pin Molex (multicolored wire harness)
- Two 1.5" Velcro mated strips ($\frac{3}{4}$ " width)
- Two 1.5" Velcro strap ($\frac{1}{4}$ " width)
- Velcro strap (~12")
- Three $\frac{3}{8}$ inch nylon screws and nuts for Iridium Modem
- Three nylon $\frac{1}{4}$ inch standoffs, $\frac{3}{8}$ inch screws and 3 nuts for OCCAMS

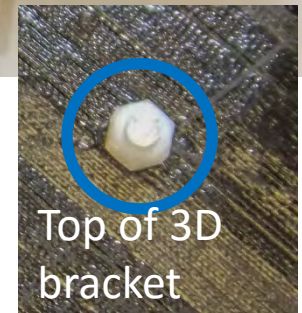
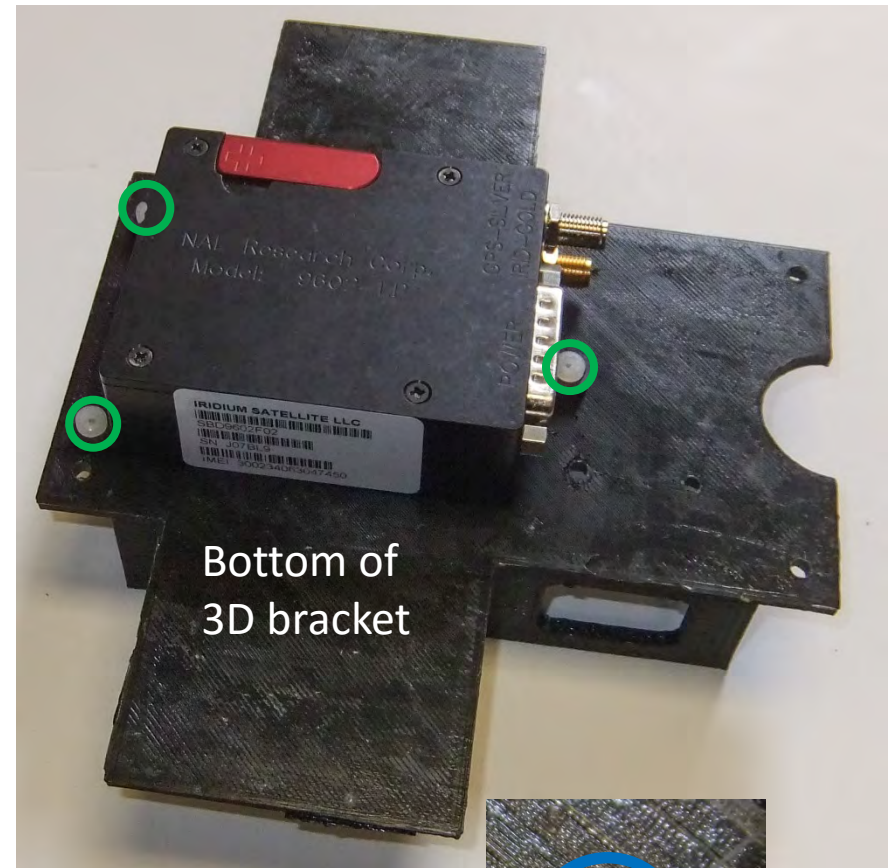
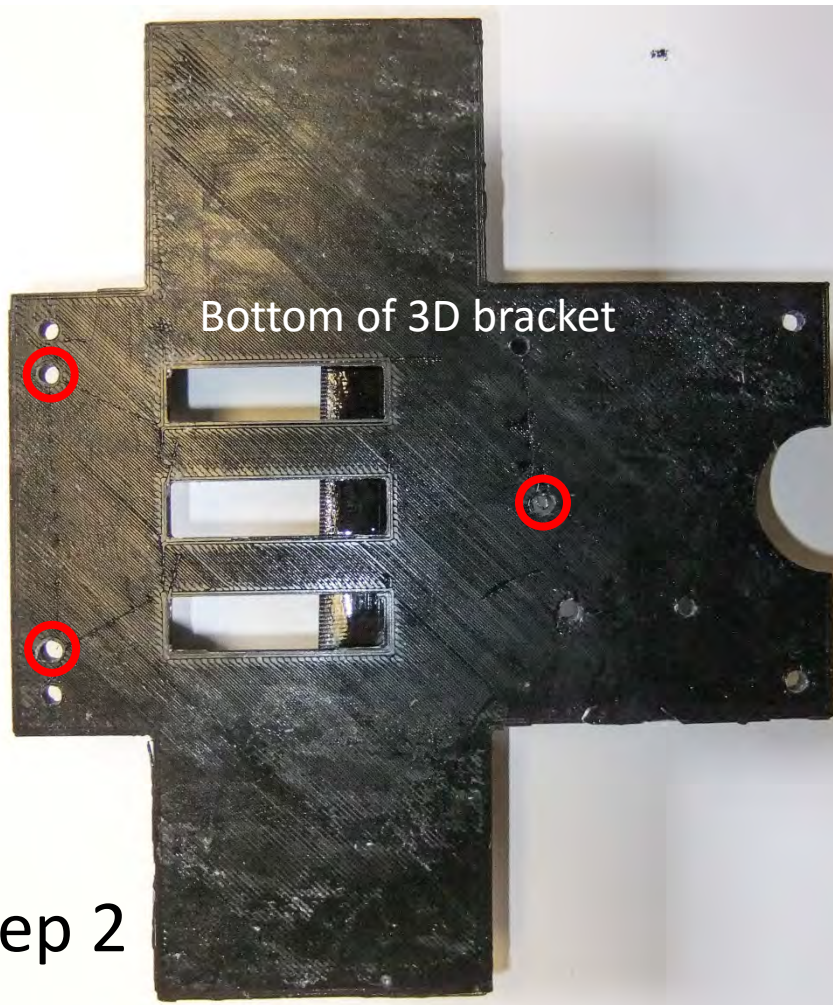
Assembly of Iridium Payload



Step 1

Place 3 strips of the sticky backed hooked Velcro onto the 3D printed bracket in these 3 locations

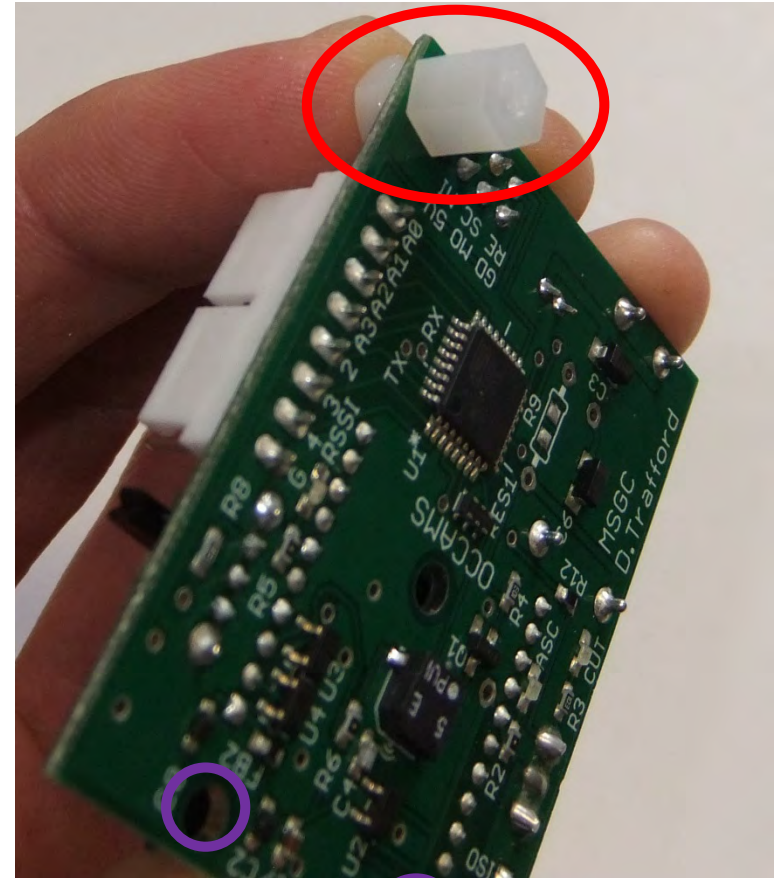
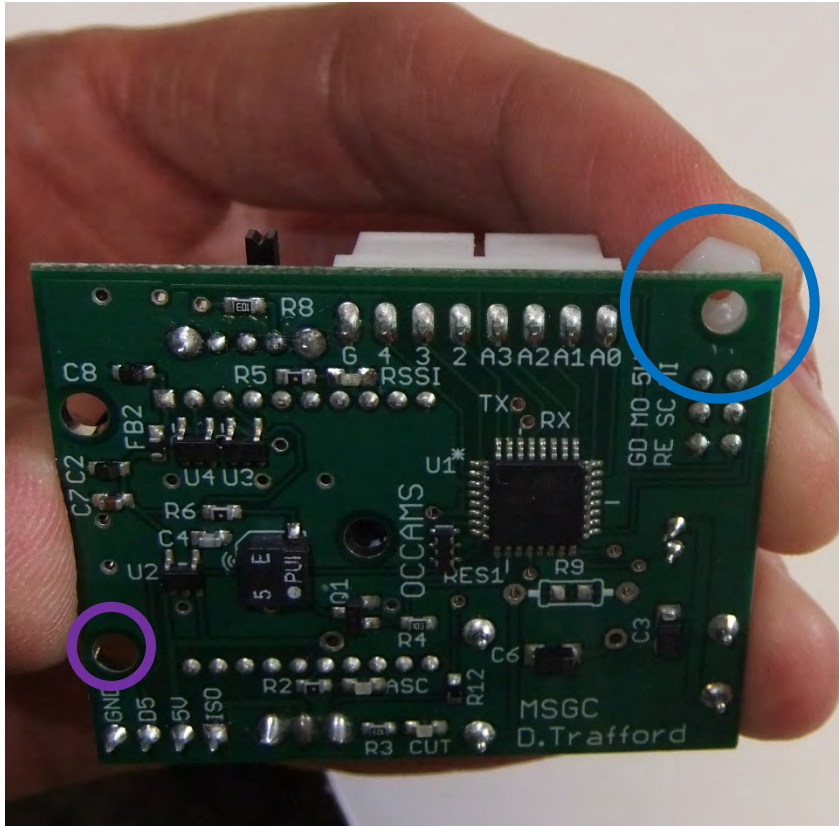
Assembly of Iridium Payload



Step 2

The Iridium modem will be mounted on the bottom of the 3D printed bracket using 3 holes. Place three 3/8 inch nylon screws through the holes and screw a nylon nut on the end of each screw from the top.

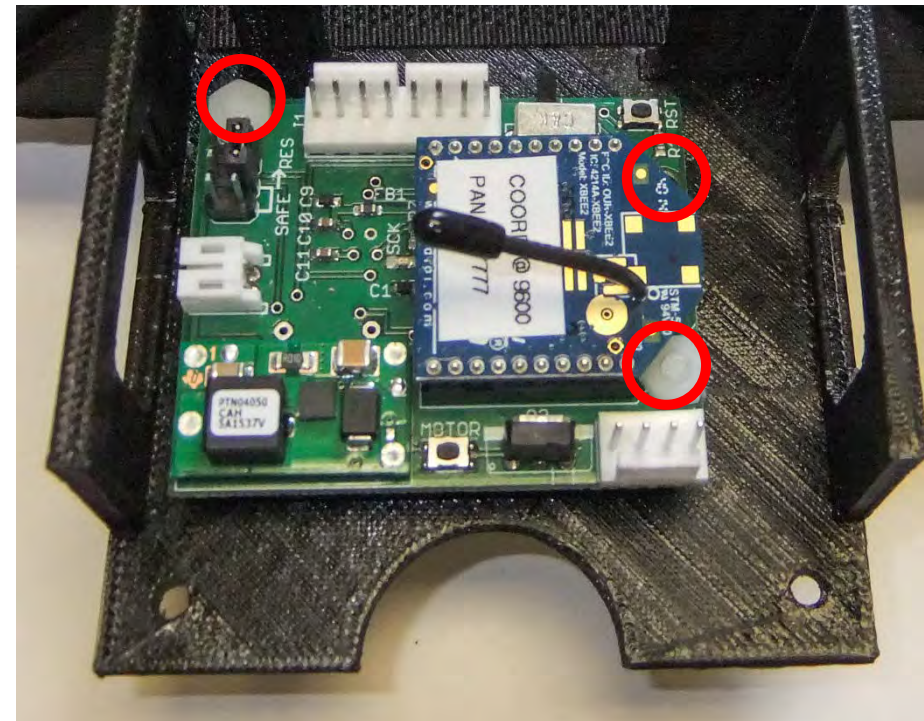
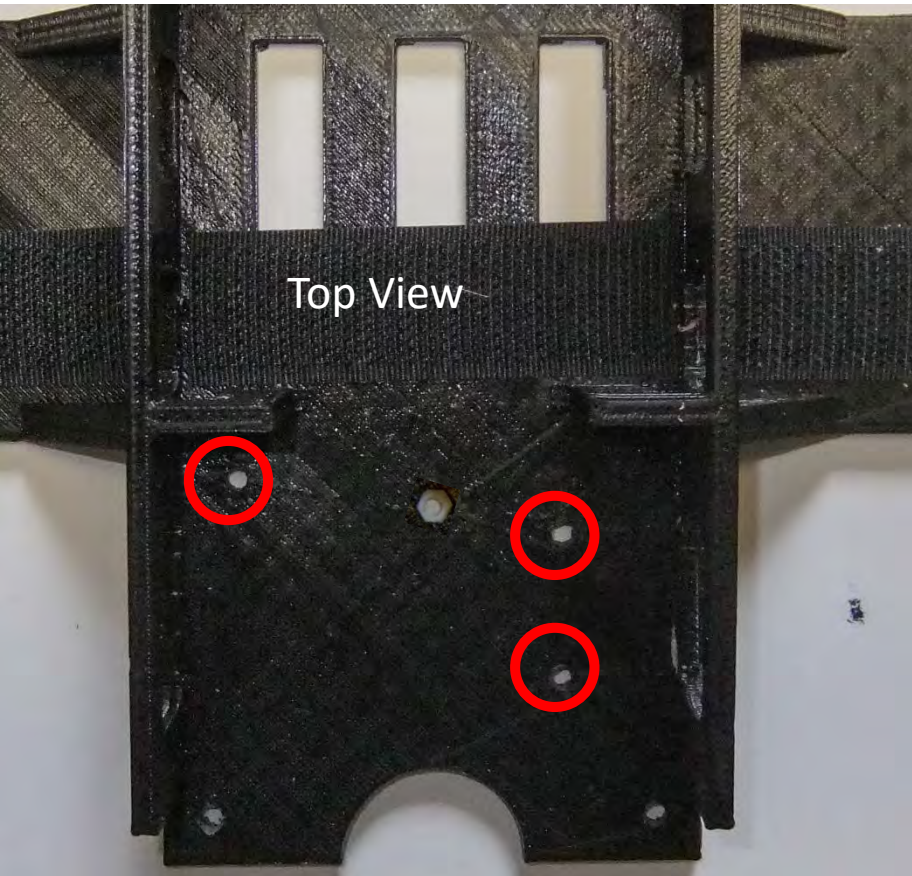
Assembly of Iridium Payload



Step 3

While holding the edges of the OCCAMS board, place a **nylon nut** over the mounting hole while holding it in place with your finger and **screw a 1/4 inch standoff into the nut**. Use this same procedure for the **two other mounting holes**. 10

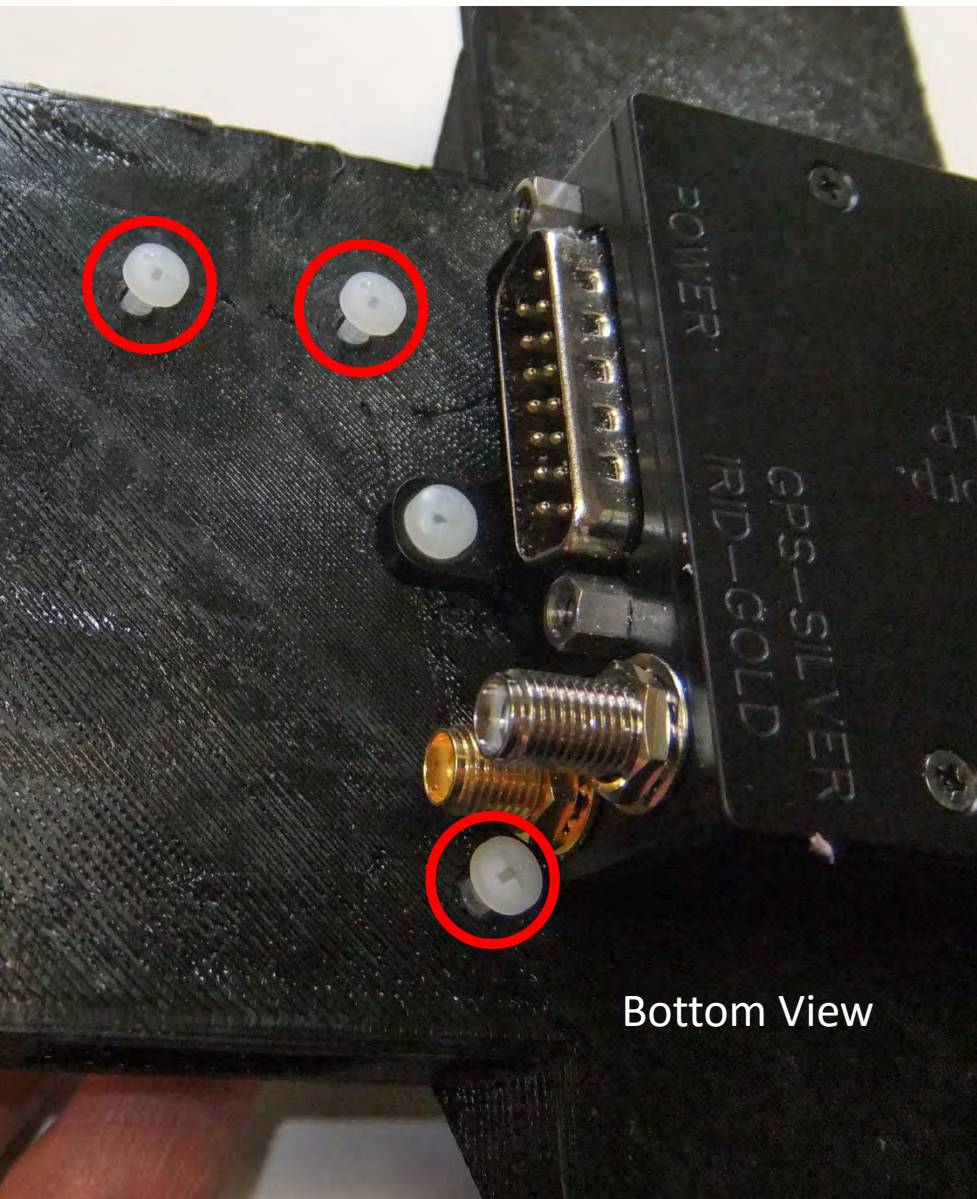
Assembly of Iridium Payload



Step 4

Place the OCCAMS board on the top of the 3D printed bracket **lining up the 1/4 standoff with the mounting holes in the 3D printed bracket.**

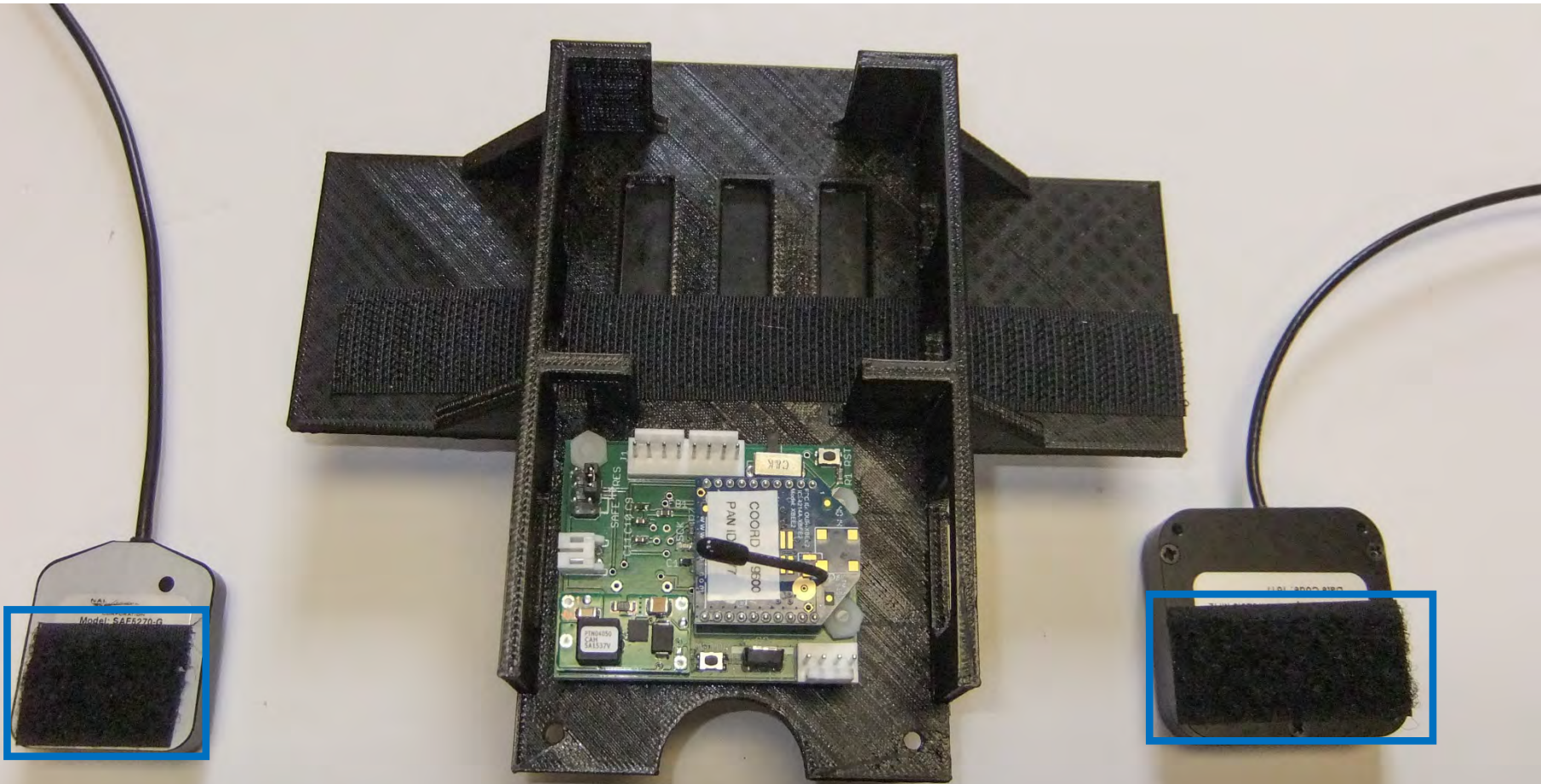
Assembly of Iridium Payload



Step 5

Insert three 1/4 inch nylon screws **through the mounting holes** on the bottom of the 3D printed bracket and screw them into the 1/4 inch standoffs.

Assembly of Iridium Payload



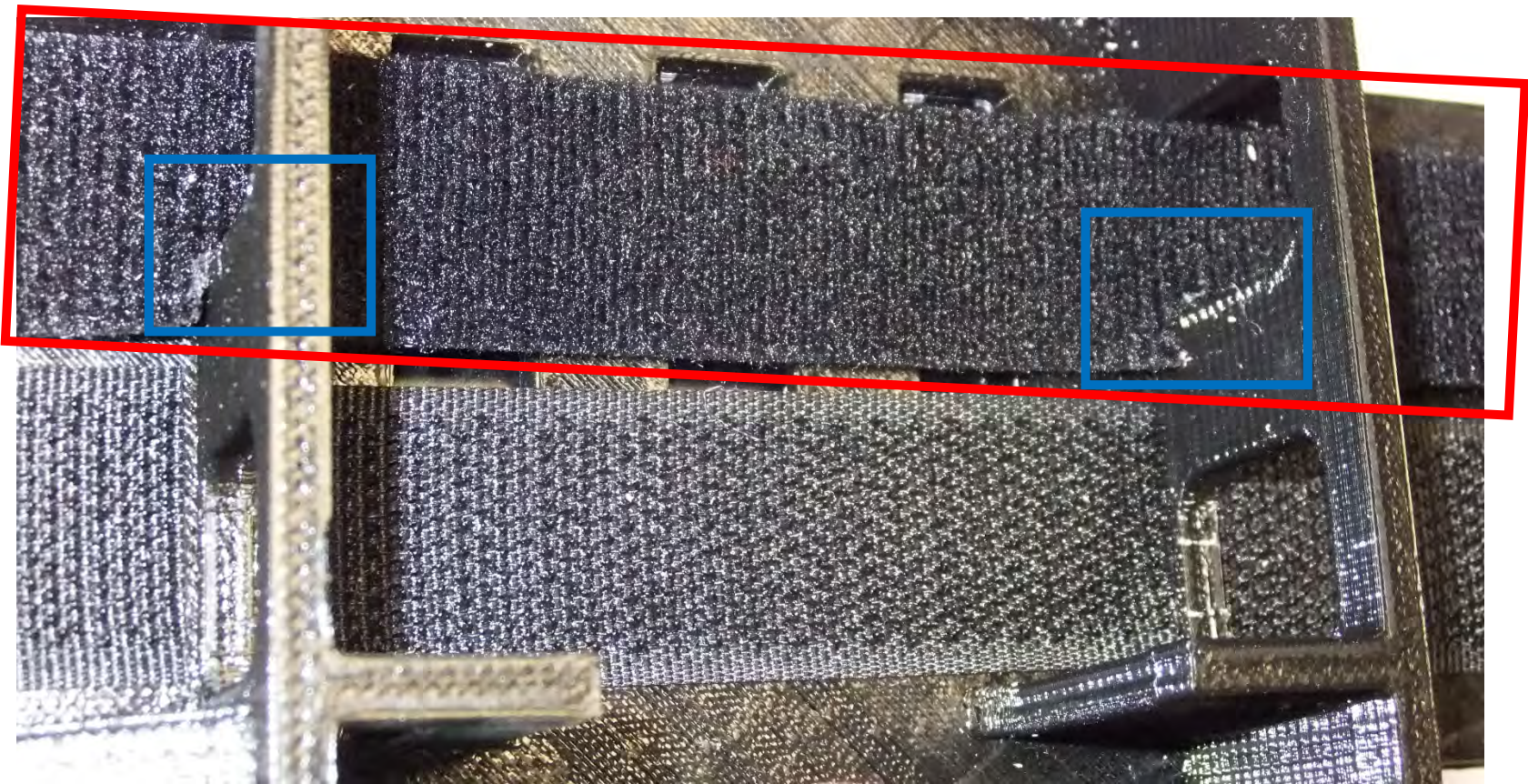
Step 6

Place the fuzzy Velcro with sticky back on the bottom of the two Iridium antennas in the location shown above.

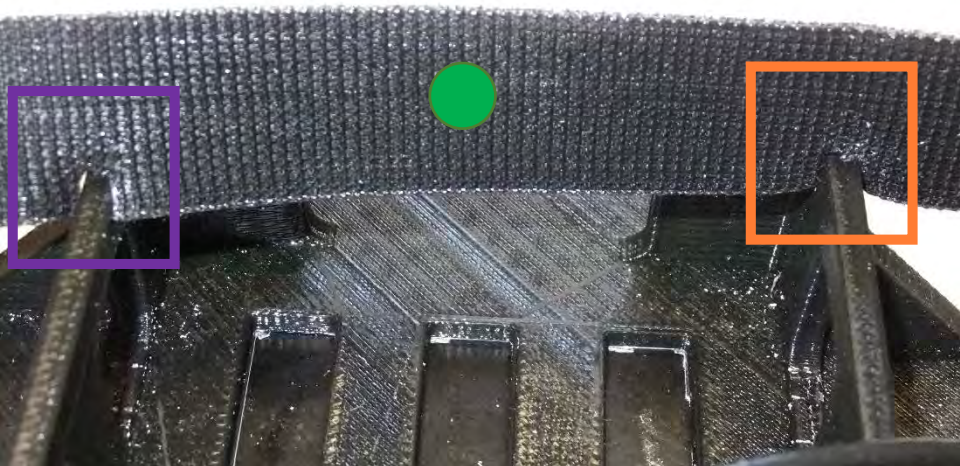
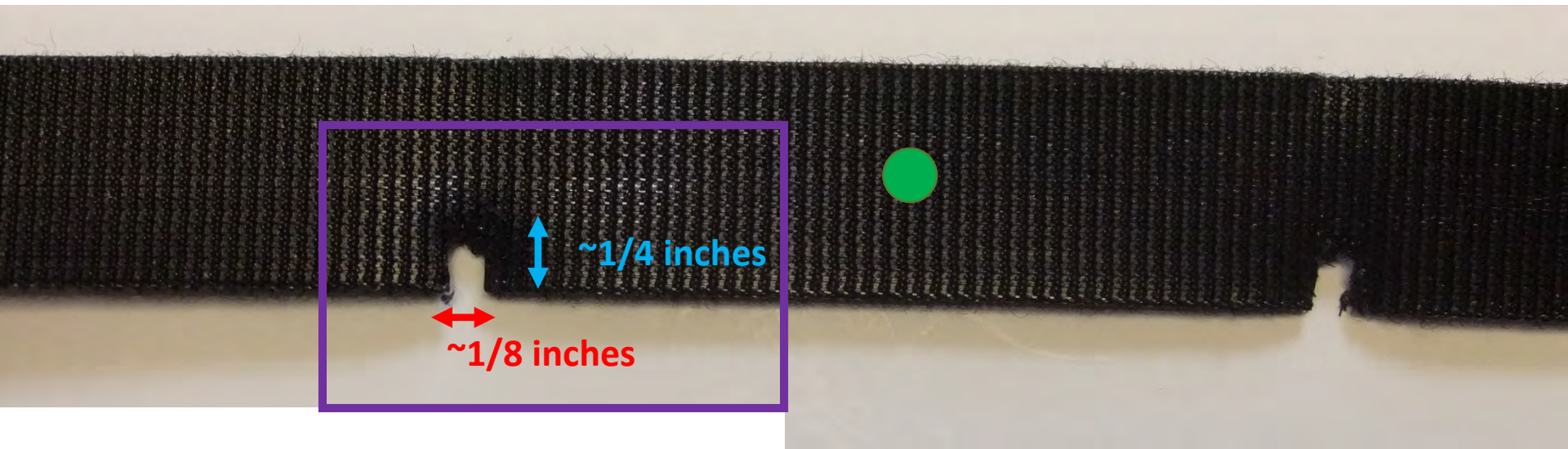
Assembly of Iridium Payload

Step 7

We need to run a ~12 inch long piece of double sided Velcro **along the bottom of the battery compartment** in the 3D printed bracket just above the hooked Velcro. To do so we must **cut out two notches** to make it sit flush on the bottom of the 3D printed bracket.



Assembly of Iridium Payload



Step 8

Take a ~12 inch long piece of double sided Velcro and **cut a notch** just off **center** with the specs above. To determine width of the second slot, place it across the raised rails of the 3D printed bracket. Cut a second notch in the Velcro **here** with the same specs.

Assembly of Iridium Payload



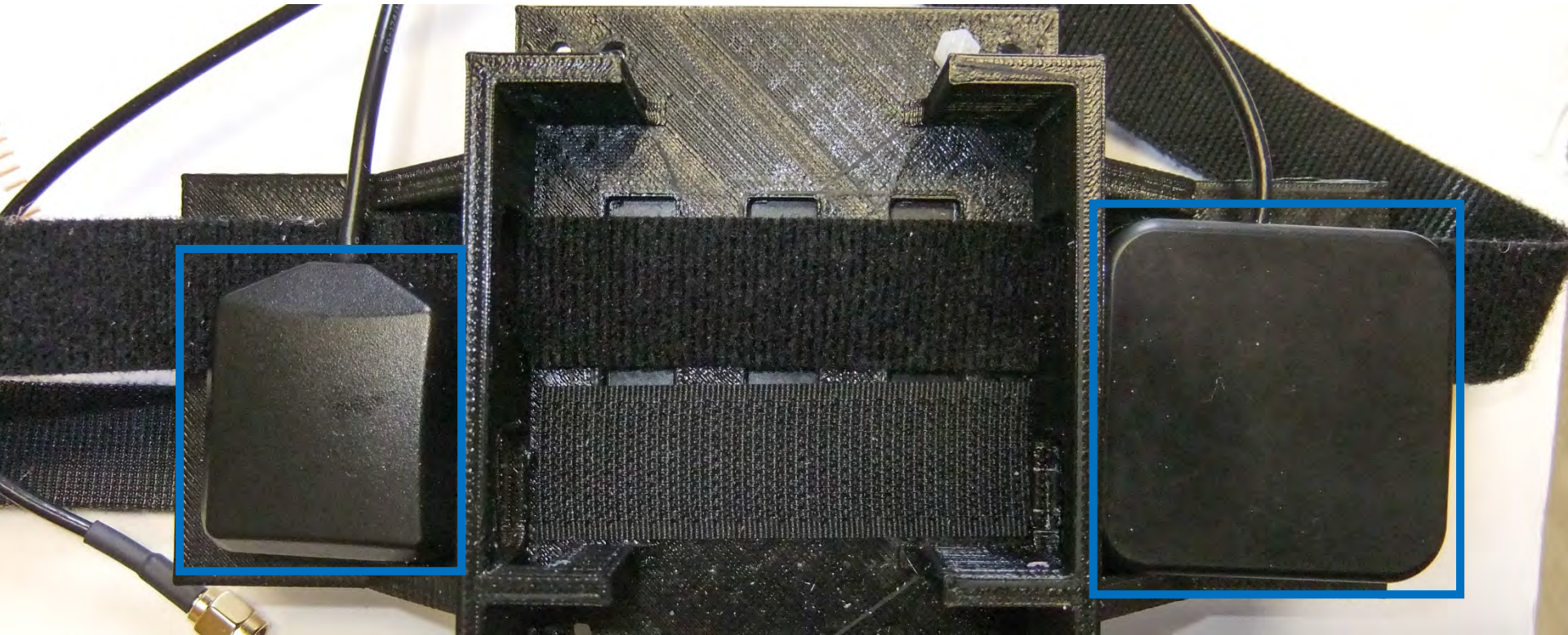
Step 9

Place the Velcro strips above the hooked Velcro with the soft fuzzy side up.

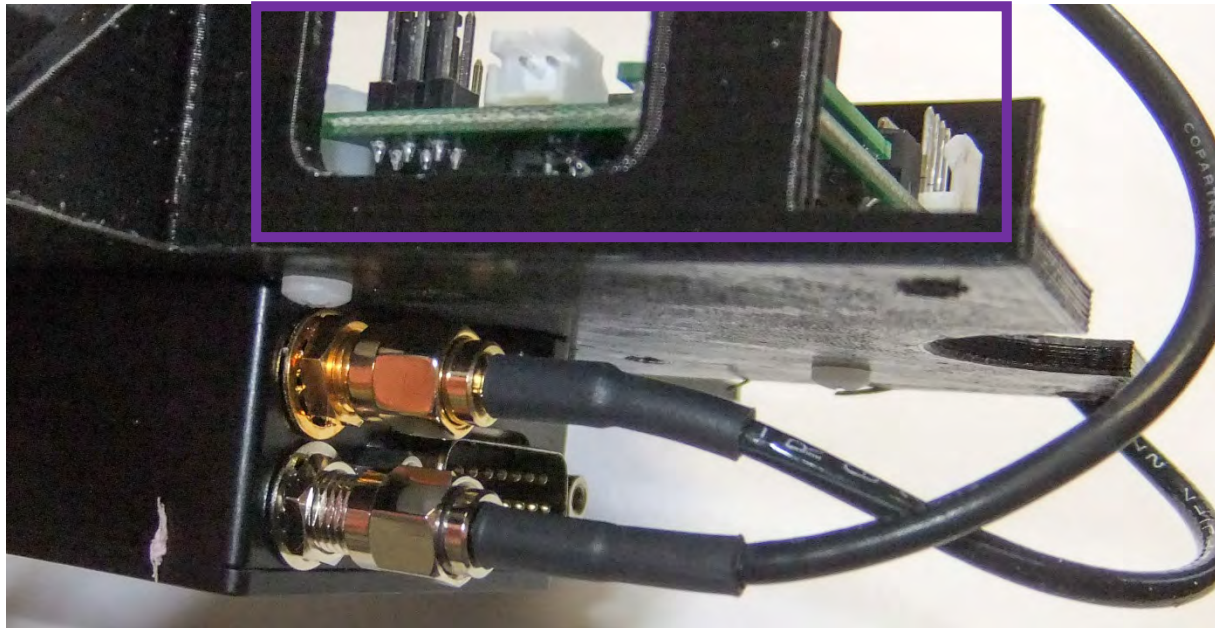
Assembly of Iridium Payload

Step 10

Place the two antennas attaching them to the hooked Velcro attached to the 3D printed bracket.



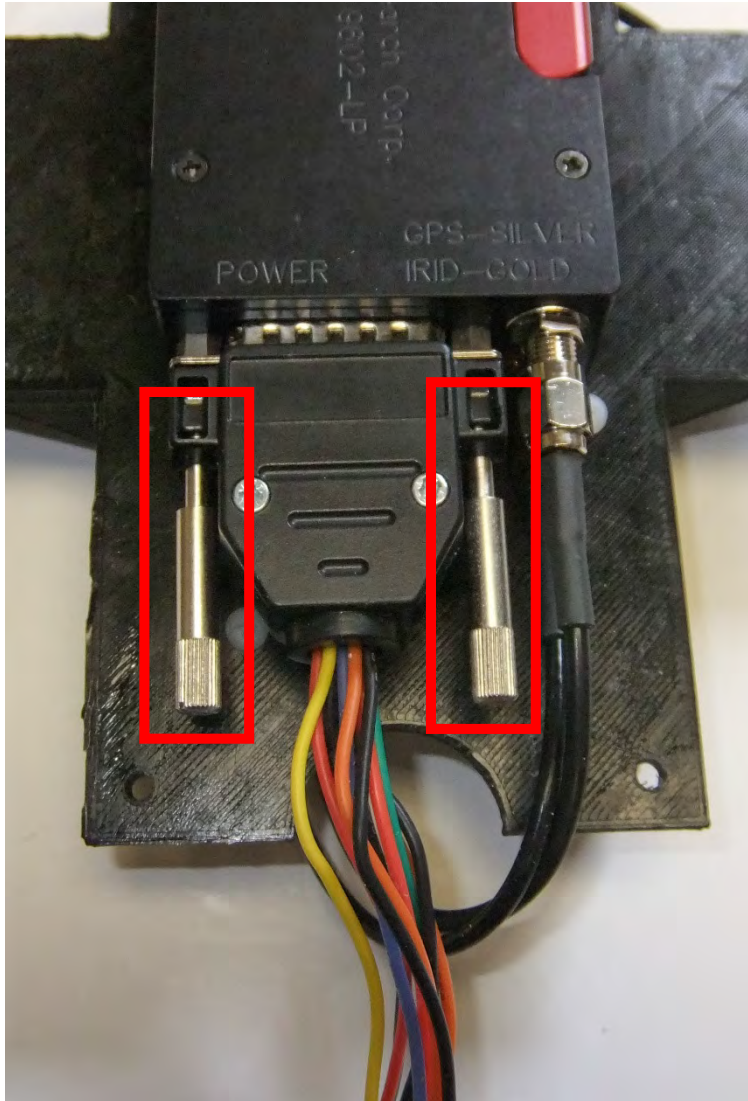
Assembly of Iridium Payload



Step 11

Wrap the cables around the **edges of the battery frame** and run them **above the OCCAMS board** and connect them to the Iridium modem. The connection on the modem match the color (gold or silver) of the wire connectors.

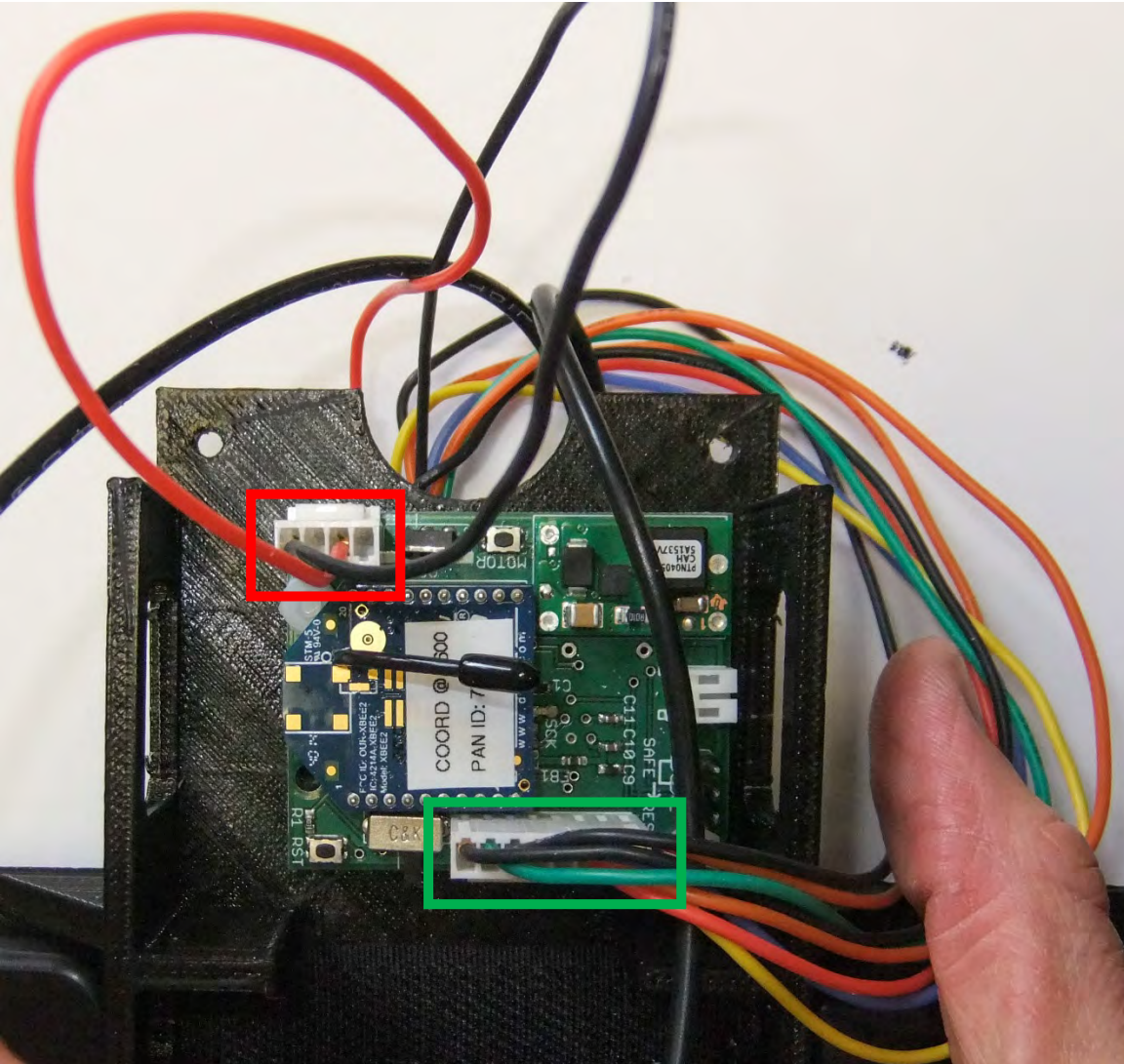
Assembly of Iridium Payload



Step 12

Plug the Iridium cable into the Iridium modem and hold in place by screwing in the **connector screws**.

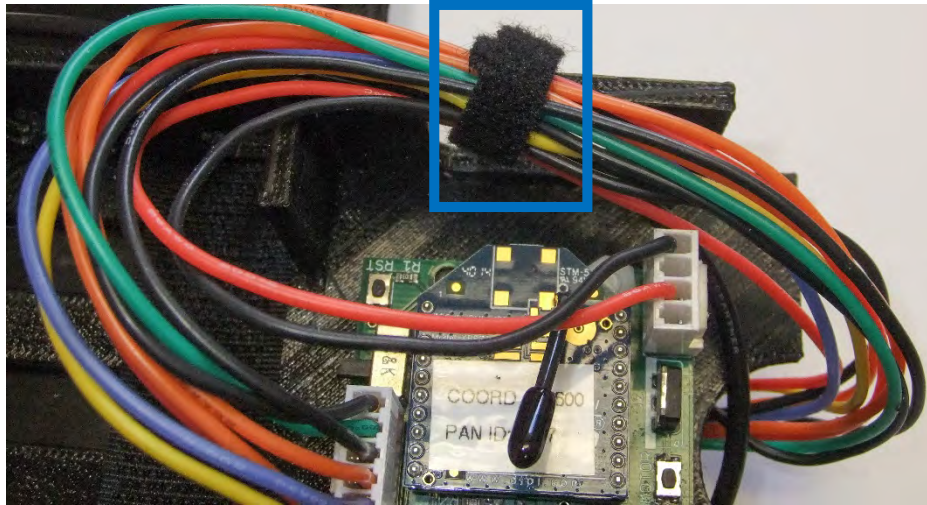
Assembly of Iridium Payload



Step 13

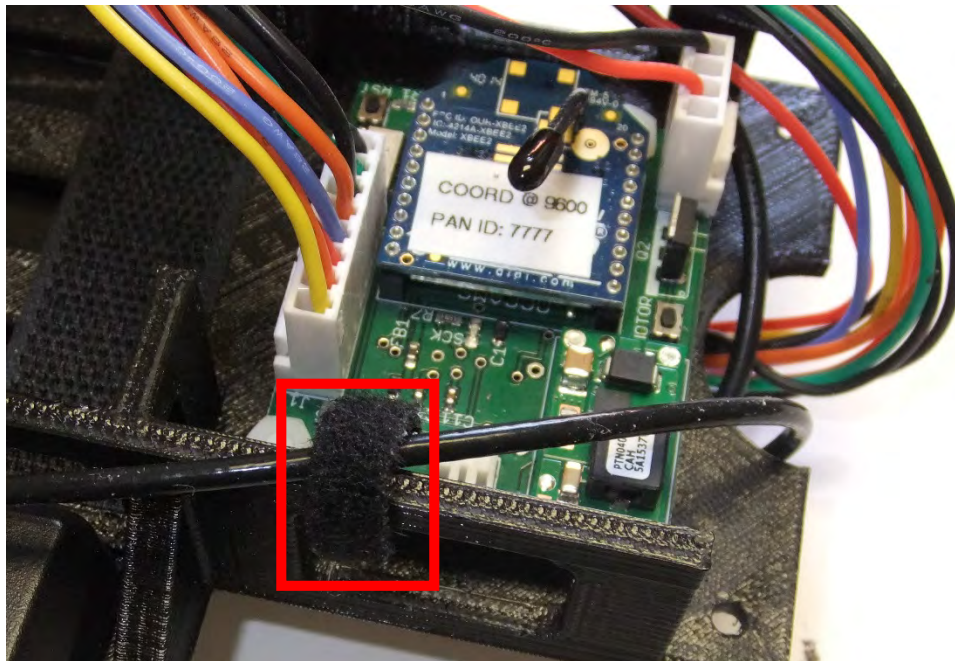
Running the Iridium cables between the antenna wires plug in the **Iridium power** and **connection harness** into the OCCAMS board.

Assembly of Iridium Payload



Step 14

Using a .25 x 2 inch double sided Velcro strip to strap the Iridium cable and antenna wire to the 3D printed bracket



Using a .25 x 2 inch double sided Velcro strip to strap the antenna wire to the 3D printed bracket

Your 3.7V 6600mAh Lithium Ion Battery Pack

Taking care of, using and safety of your 3.7V Lithium
battery packs.



Safety Notes

- Each cell can provide **0.5C** of current (1.1 A per) so all together the peak current you can draw is over 3.3 Amps. Note that these batteries are not designed to sustain such high loads, we suggest keeping any constant current draw under 0.2C or 1.3A.
- The packs come with color coded wires, and now they come with a JST 2-pin cable attached for use with our chargers! Because they have a genuine JST connector, not a knock-off, the cable wont snag or get stuck in a matching JST jack, they click in and out smoothly. The cables are rated for 2A so if you use them keep that in mind.
- The included protection circuitry keeps the battery voltage from going too high (over-charging) or low (over-use) which means that the battery will cut-out when completely dead at about 3.0V. However, even with this protection **it is very important that you only use a Lilon/LiPoly constant-voltage/constant-current charger to recharge them and at a rate of 0.25C (1.5A) or less.**
- Like most lithium-ion packs, the batteries we sell do not have thermistors built in. This is why we suggest charging at 0.2C or even less - 1A max in this case. Of course, you can charge at a lower rate - it'll just take a little longer to fill up.
- Do not use a NiMH/NiCad/lead-acid charger! Also, do not abuse these batteries, do not short, bend, crush or puncture. **Never charge or use unattended. Always inspect batteries and surrounding circuitry constantly for any damage, loose wiring, or possibility of short circuits.** As with all Lithium ion polymer batteries and with any power source - they should be used by experts who are comfortable working with power supplies

To prevent potential leaking, overheating or explosion of batteries please be advised to take the following precautions:

WARNINGS!

- Do not immerse the battery in water or seawater, and keep the battery in a cool dry environment during stands by period.
- Do not use or leave the battery near a heat source such as fire or heater.
- When recharging, use the battery charger specifically for that purpose.
- Do not reverse the position (+) and negative (-) terminals.
- Do not connect the battery to an electrical outlet.
- Do not dispose the battery in fire or heat.
- Do not short-circuit the battery by directly connecting the positive (+) and negative (-) terminal with metal objects such as wire.
- Do not transport or store the battery together with metal objects such as necklaces, hairpins etc.
- Do not strike or throw the battery against hard surface.
- Do not directly solder the battery and pierce the battery with a nail or other sharp object.
- Outer metal conduct can not contact the aluminum layer in AL laminate film, especially with electrification ,which will be “black spot ”and swelling easily.
- Do not use sharp things to hit the battery.

To prevent potential leaking, overheating or explosion of batteries please be advised to take the following precautions:

CAUTIONS!

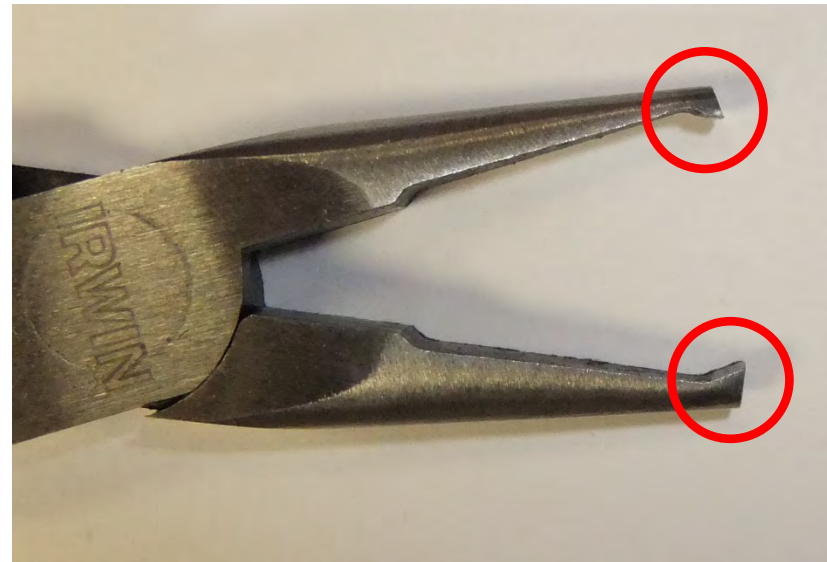
- Do not use or leave the battery at very high temperature (for example, at strong direct sunlight or in a vehicle in extremely hot weather). Otherwise, it can overheat or fire or its performance will be degenerate and its service life will be shortened.
- Do not use it in a location where static electricity is rich, otherwise, the safety devices may be damaged, causing a harmful situation.
- In case the electrolyte get into the eyes due to the leakage of battery, do not rub the eyes!
- Rinse the eyes with clean running water, and seek medical attention immediately. Otherwise, it may injure eyes or cause a loss of sight.
- If the battery gives off an odor, generates heat, becomes discolored or deformed, or in any way appear abnormal during use, recharging or storage, immediately remove it from the device or battery charger and place it in a contained vessel such as a metal box.
- In case the battery terminals are contaminated, clean the terminals with a dry cloth before use.
- Otherwise power failure or charge failure may occur due to the poor connection between the battery and the electronic circuitry of the instrument.
- Be aware discarded batteries may cause fire, tape the battery terminals to insulate them before disposal.

Taking Care of your Batteries

- Be careful plugging the batteries into the power board and un-plugging from the power board.
- Repeatedly pulling/pushing on the wires can cause them to be pulled from the connector (rendering the battery useless) and/or cause a dangerous short.
 - This can also wear out the male power connector on the power board
- We have a few tools and techniques to help keep your batteries in good shape...

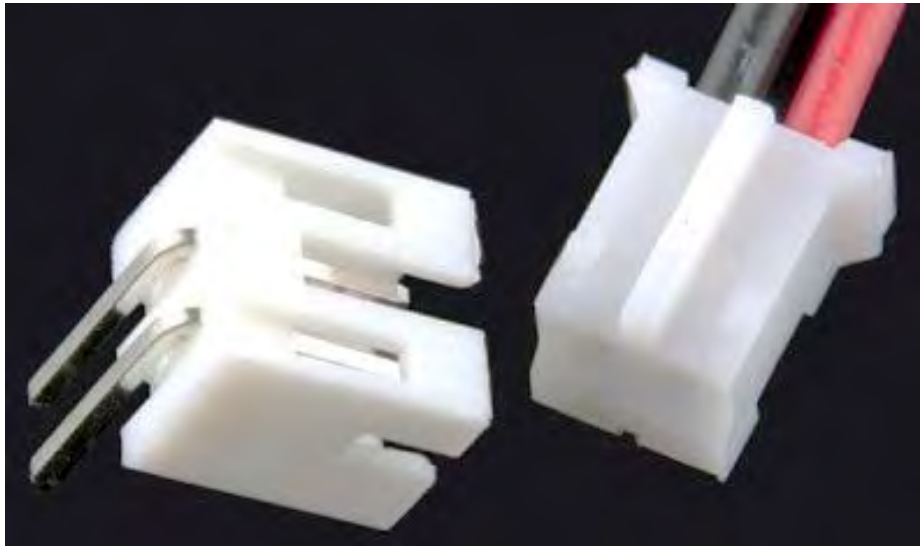
Transverse End Cutter Pliers = Great “Connector Pullers”

- The tool we will use as a “connector puller” is a transverse end cutter plier, should you need to get a replacement
 - These work well because you are able to grab the connector firmly and pull the connector out lessening the risk of slipping off the connector and damaging the wires.
 - These are not cheap! Try and take care of the one in your kit.
 - Should you buy a new connector puller, take a metal file and file down the sharp “teeth” of the plier so they don’t cut into the connector.



Connector “Gender”

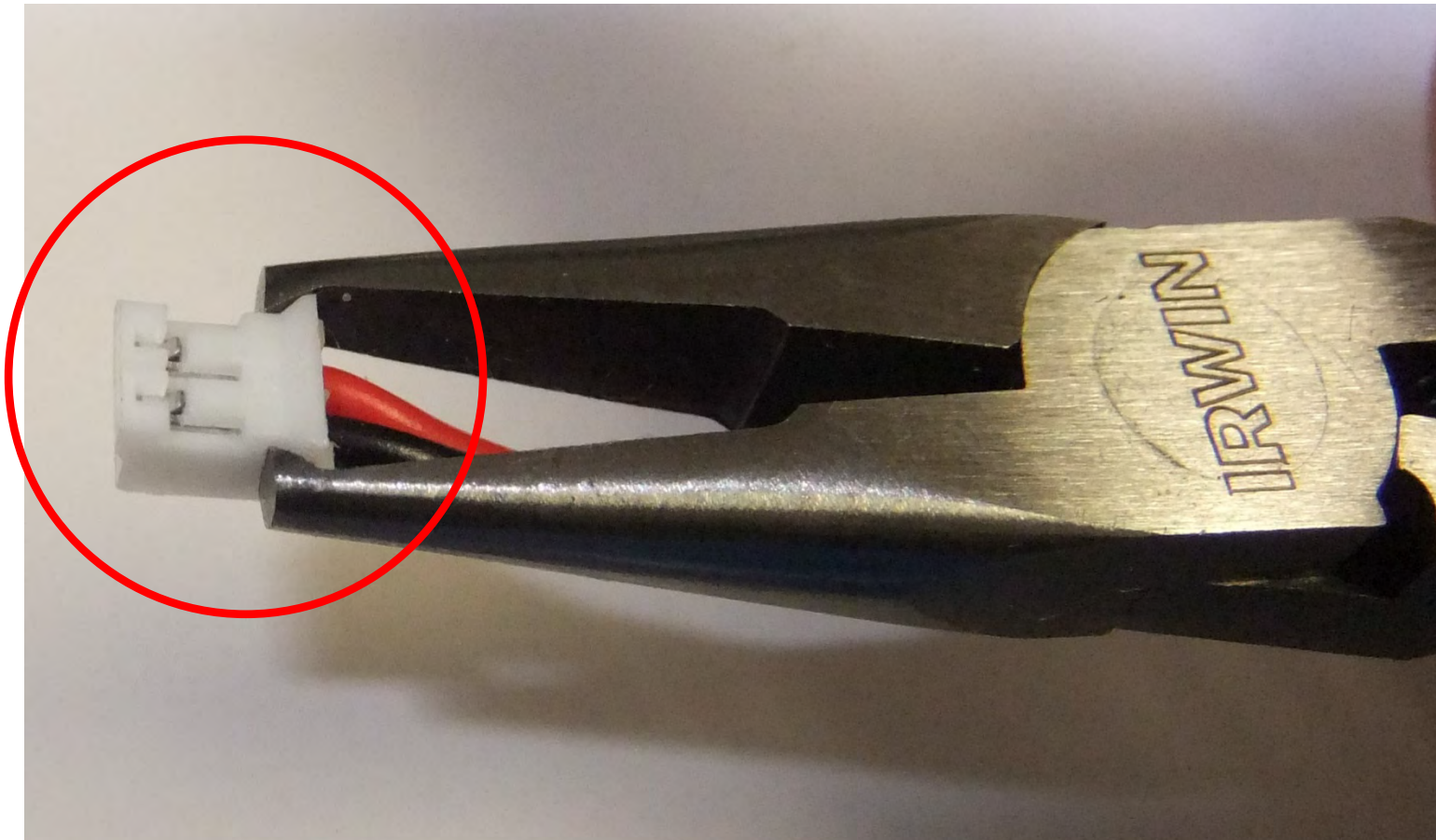
Gender - The gender of a connector refers to whether it plugs in or is plugged into and is typically male or female, respectively (kids, ask your parents for a more thorough explanation). Unfortunately, there are cases where a connector may be referred to as “male” when it would appear to be female



Male (left) and female 2.0mm PH series JST connectors. In this case, gender is determined by the individual conductor.

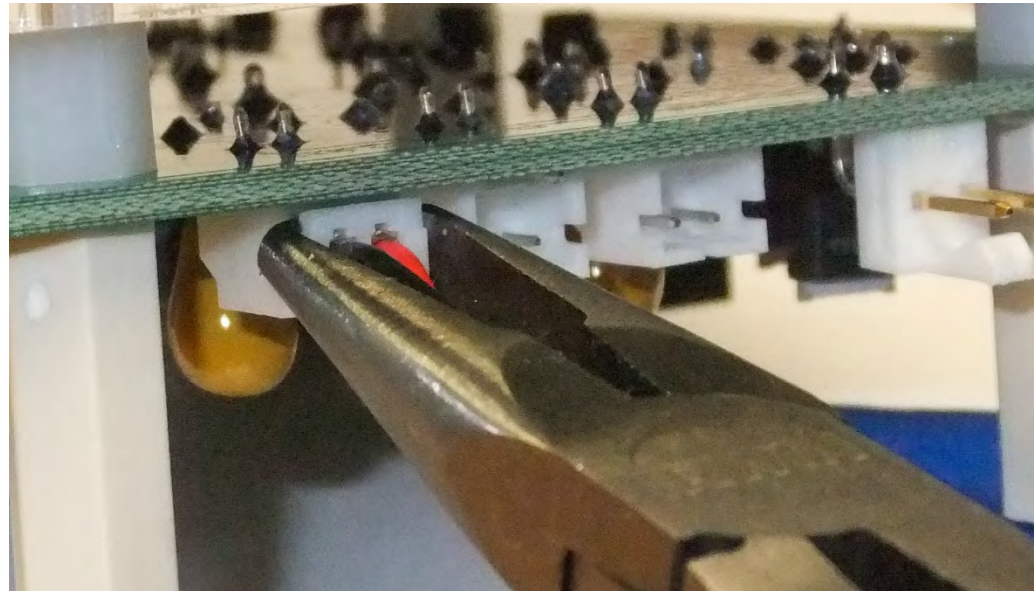
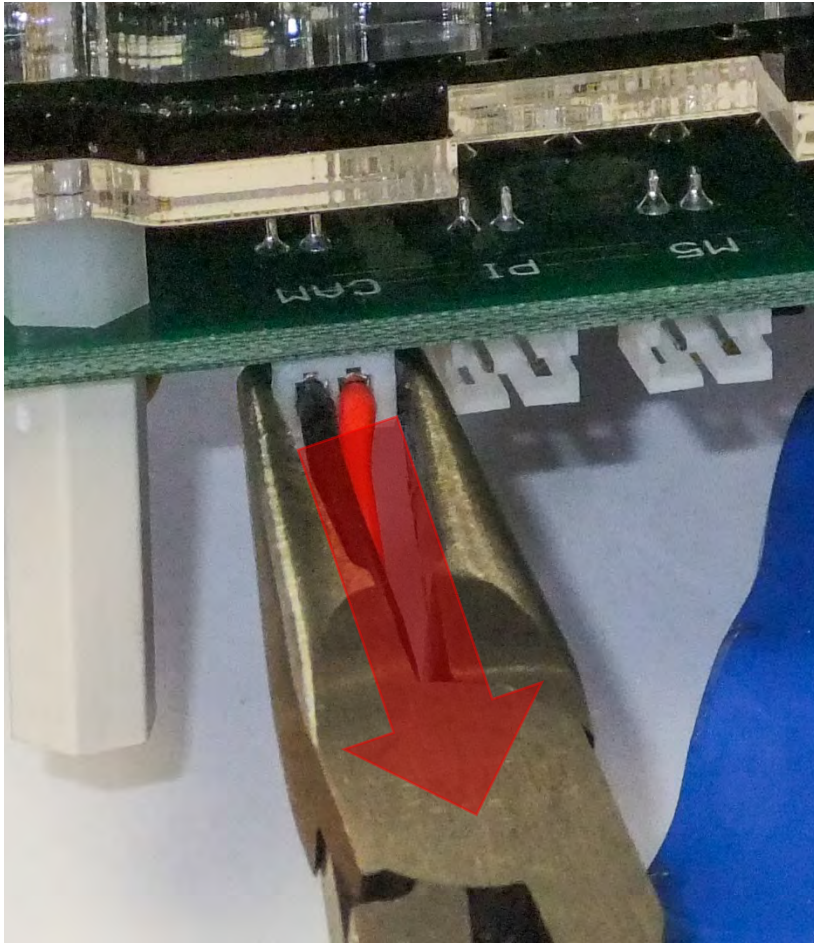
Using the Connector Pullers

You can use these to both insert the battery connectors to or remove the battery connectors from the power boards. Grab the connector right behind the connector where it flares out. Don't squeeze the connector too tight where you cut into the connector.



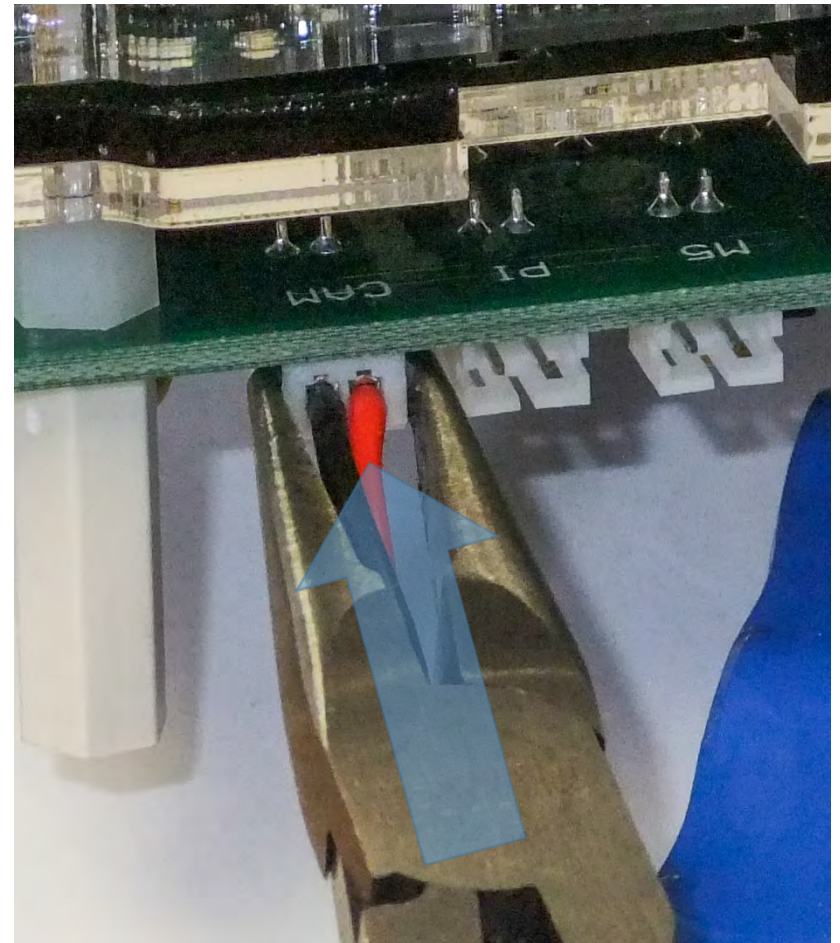
Using the Connector Pullers

To remove the battery connector, grab the connector right behind where end “flares” out and gently pull straight out. Make sure you have just the female connector which is connected to the battery wires and not the male end connected to the power board.



Using the Connector Pullers

To insert the battery connector, grab the connector right behind where end “flares” out and gently push it in. Don't push to hard as you can damage the male connector on the power board.



WARNING!!!!!!

NEVER CONNECT A MODEM TO POWER UNLESS IT HAS THE ANTENNA(S) CONNECTED TO IT!

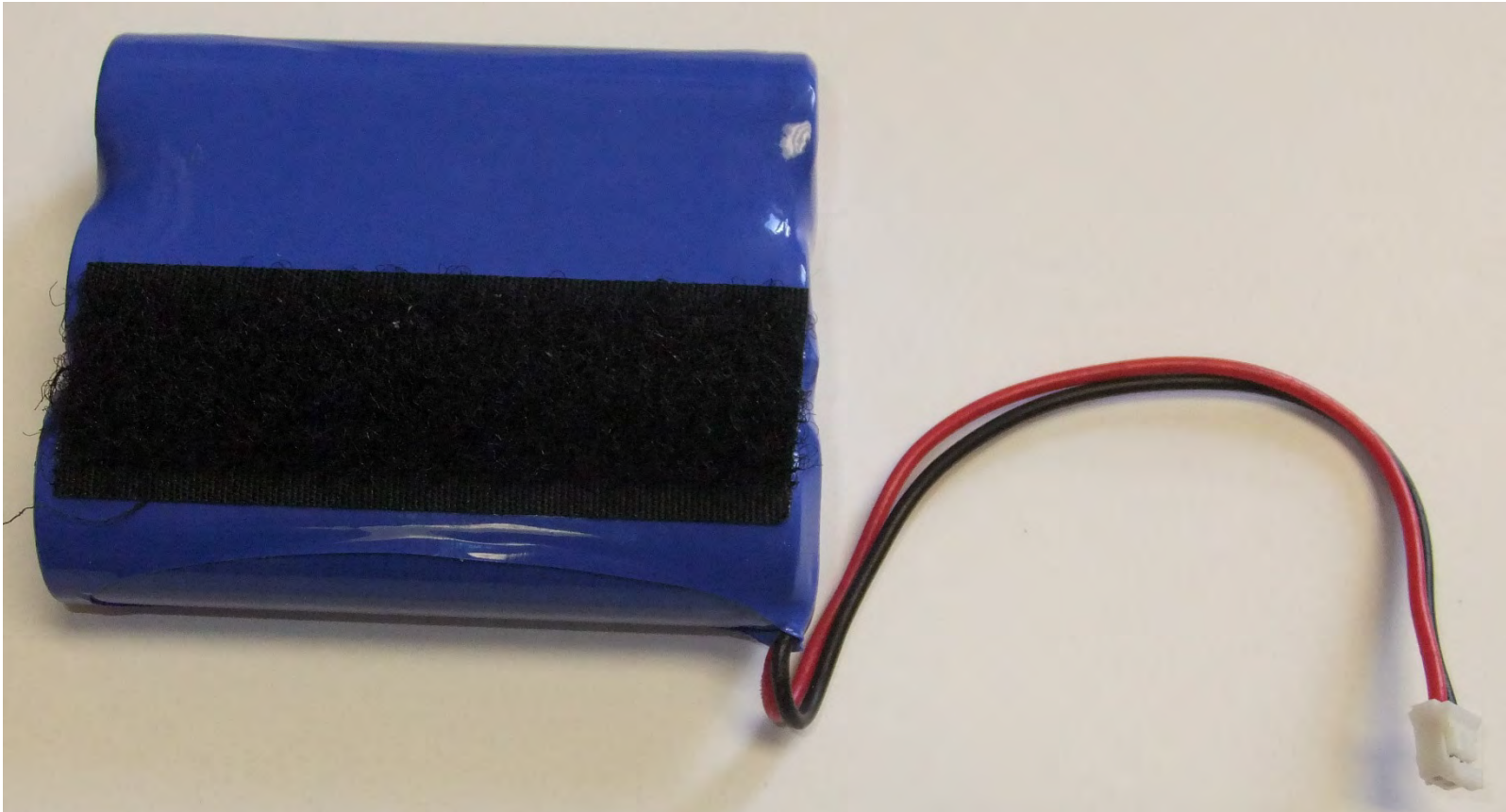
CONNECTING A MODEM TO POWER WITHOUT AN ANTENNA CONNECTED WILL DESTROY THE MODEM RENDERING IT USELESS!

NONE OF THESE MODEMS ARE CHEAP AND SOME ARE VERY EXPENSIVE (~\$700)!

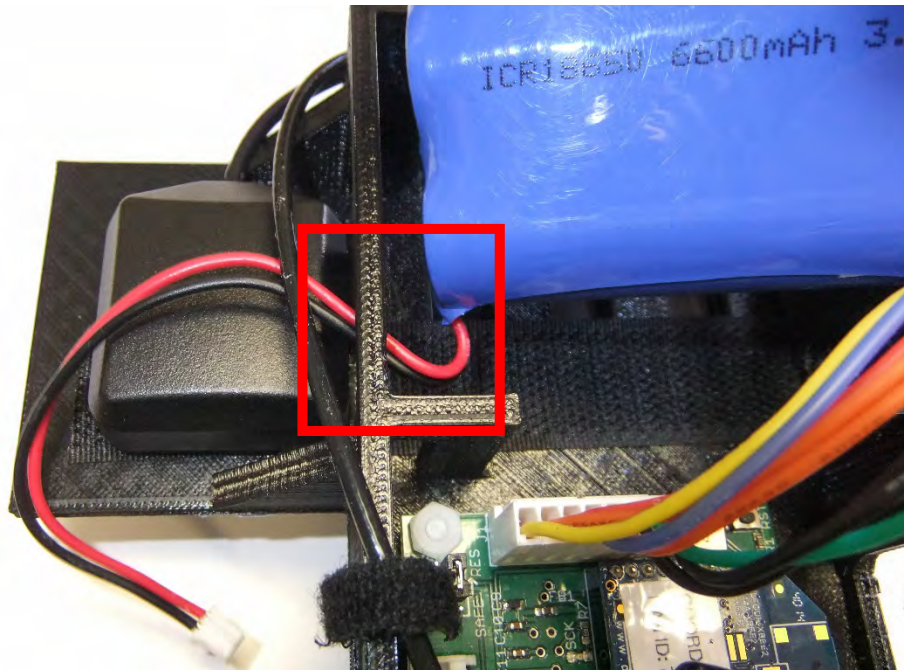
Assembly of Iridium Payload

Step 15

Place a strip of the fuzzy veclo with sticky back on the battery as shown below.



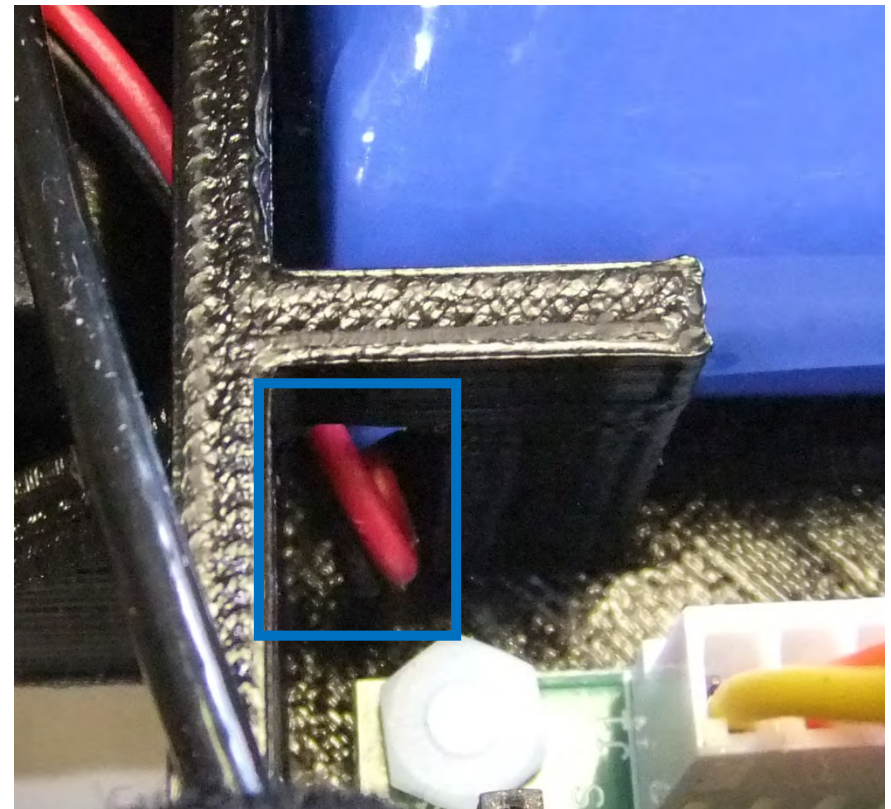
Assembly of Iridium Payload



There is a **notch in the battery housing** on the 3D printed bracket for the battery connector wire to “loop” back on itself. Make sure the wire is not kinked.

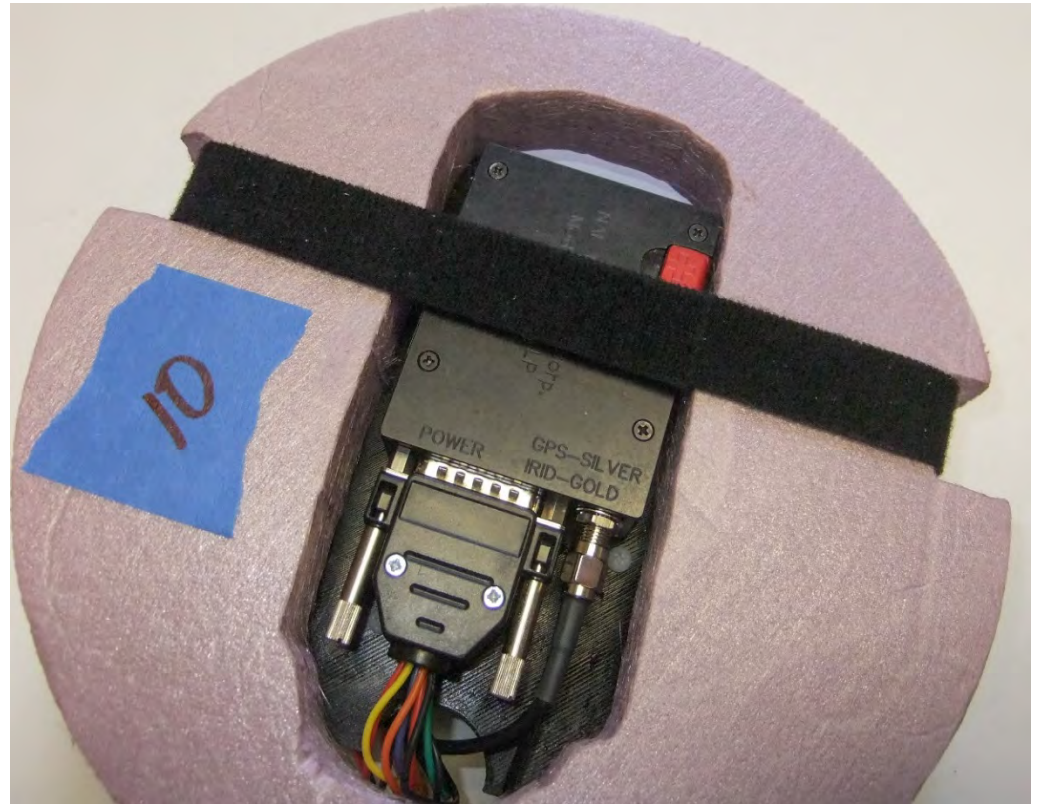
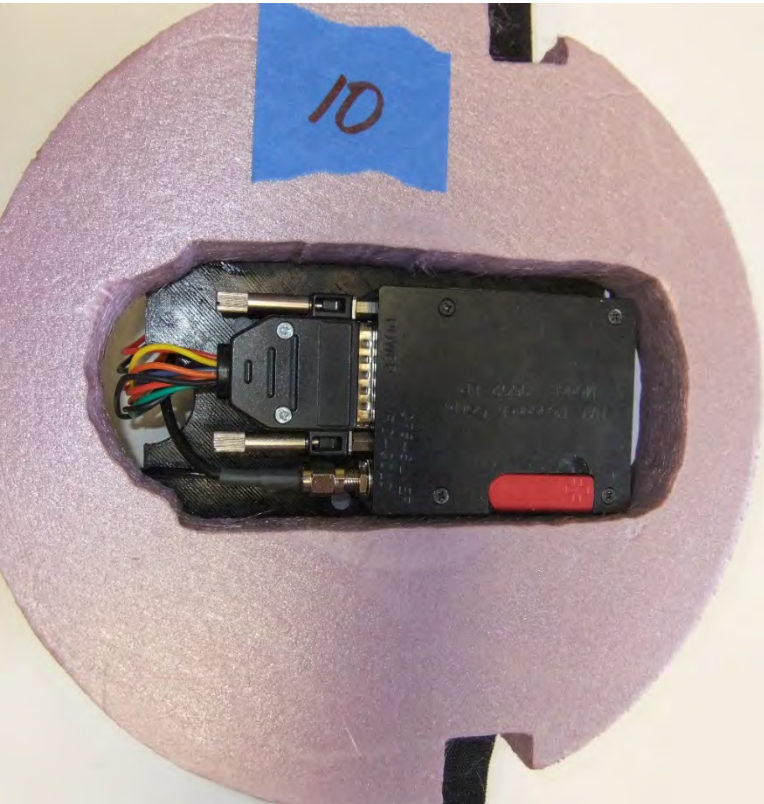
Step 16

Carefully place the battery in the 3D printed bracket. Loop the connector through the hole in the bracket **here**.

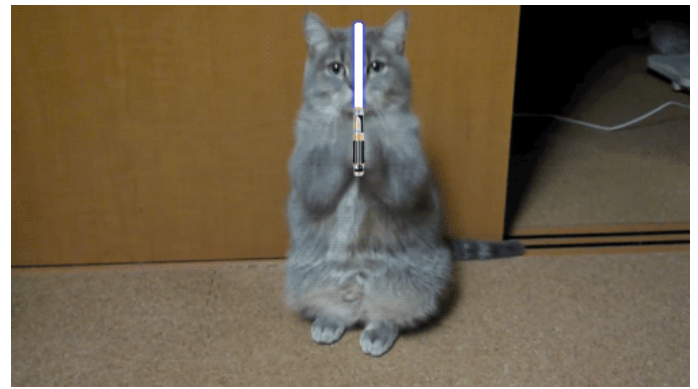


Assembly of Iridium Payload

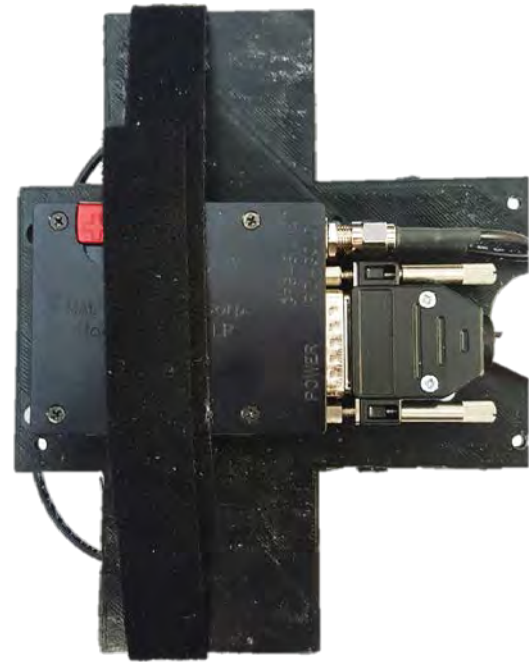
Step 17



Place the foam housing over the bottom of the 3D printed bracket and fasten with the Velcro strip.

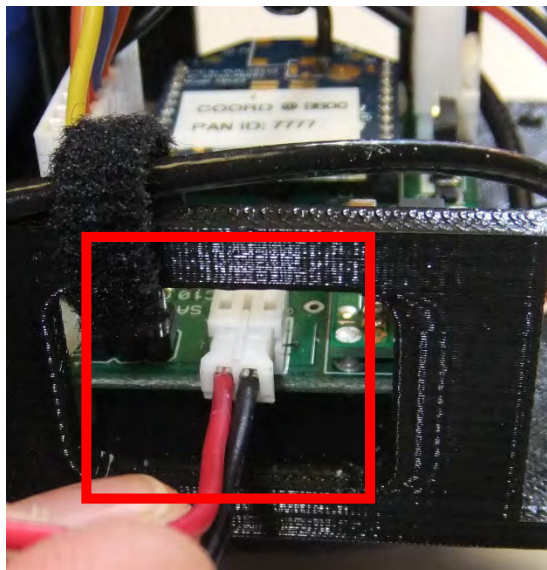


You have completed your Iridium system!



Initial Modem Power Up

- Both the Iridium and the OCCAMS board get their power from the same battery. **Plug the battery into OCCAMS** and the **green power light** on the Iridium modem should come on. Notice the SCK LED on OCCAMS is also flashing in beat with the OCCAMS audible indicator.



Iridium Modem Status LEDs

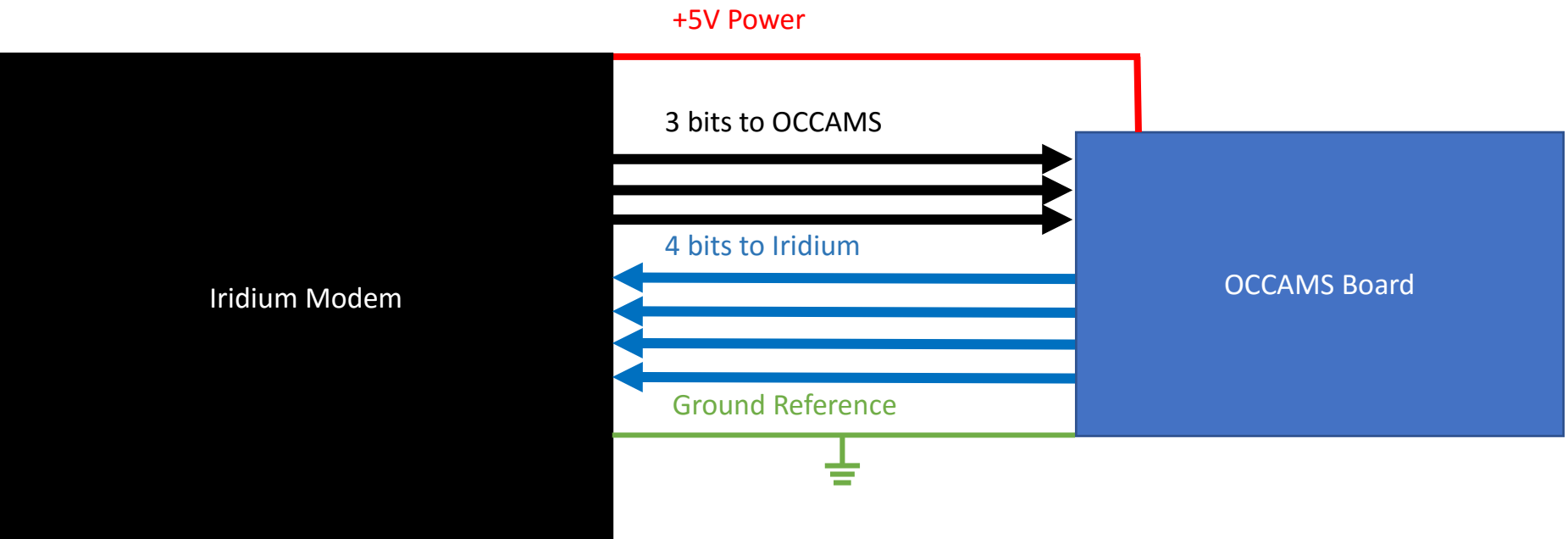
- Power
 - Indicates system is properly powered
- Iridium
 - Flashing = 1-2 bars connection
 - Solid = 3-5 bars connection
 - Off = No Connection found (0 bars)
- GPS
 - Flashing = 2D Connection
 - Solid = 3D Connection
 - Off = No GPS Fix
- Status
 - Flashing = Last attempted packet did not have a valid GPS fix or did not send
 - Solid = Last attempted packet was successful (valid GPS fix)
 - Off = Initially off until first transmission
- Emergency
 - Solid = Modem in Emergency Mode
 - Off = Modem not in Emergency Mode

GPS Data

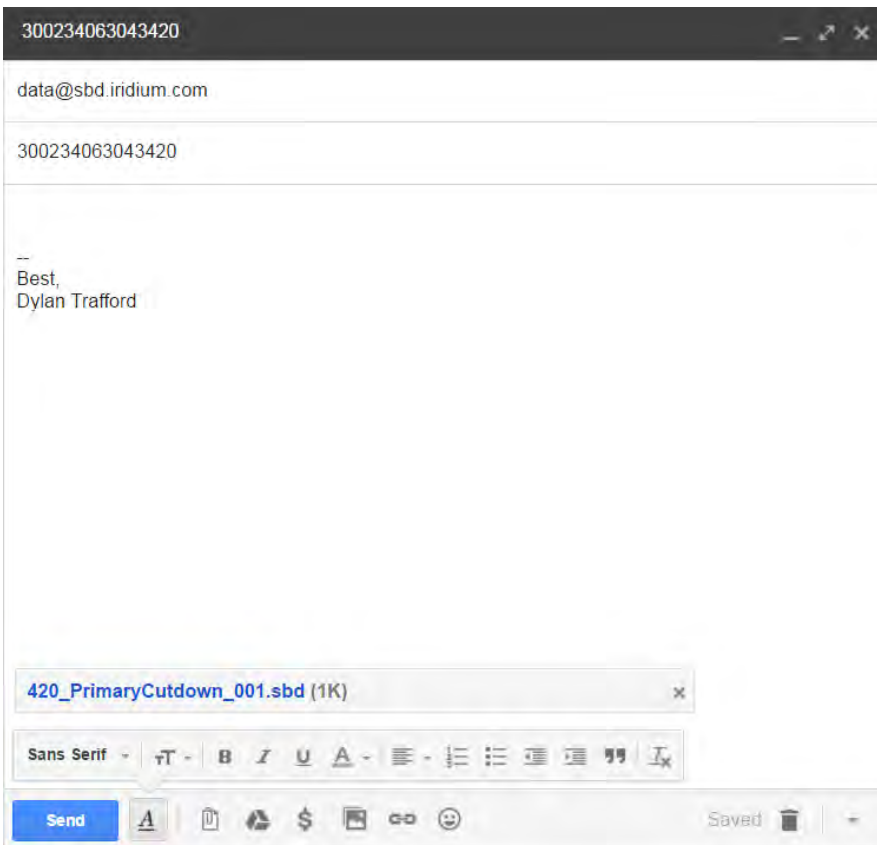
- Given that the Iridium modem at this point has a successful GPS and Iridium lock, the data should be appearing on the website.
- The GPS data is now also available for the ground station antenna array at this point through the MySQL database.
- Both the MySQL database and the tracking website are maintained by MSGC at Montana State University so nothing should be needed on your end to view or store the GPS data.
- Go to 153.90.202.26 to see your balloon's GPS flight data.

The OCCAMS Board

- OCCAMS has a 7-bit interface with the Iridium system as shown.
- OCCAMS supplies +5V power to Iridium.




Commands



- Emailed commands can be sent to change the three bits going from Iridium to OCCAMS.
- To send a command:
 - Compose an email
 - Set data@sbd.iridium.com as recipient.
 - Set the subject line of the email to the IMEI number of modem (on side of modem).
 - Attach the .sbd file of the desired command (must match the modem)

Commands (cont.)

- After the email is sent we get a response from the Iridium server.

SBD Mobile Terminated Message Queued for Unit:
300234063043420  Inbox x

 **sbdservice@sbd.iridium.com** Apr 30 (10 days ago)   
to me 

The following mobile-terminated message was queued for delivery:

IMEI: 300234063043420
Time: Sat Apr 30 18:14:35 2016

Attachment Filename: 420_SystemIdle_000.sbd
Attachment Size: 15

The MTMSN is 17, and the message is number 1 in the queue.

- Key points of information in this emailed response
 - Message was queued instead of rejected
 - Message number in queue

The message number in queue can tell us if the messages are getting through to the balloon's Iridium modem. If this queue is greater than 1, then the messages are not being transmitted from the iridium satellite network to the balloon's iridium modem and there are messages in queue.

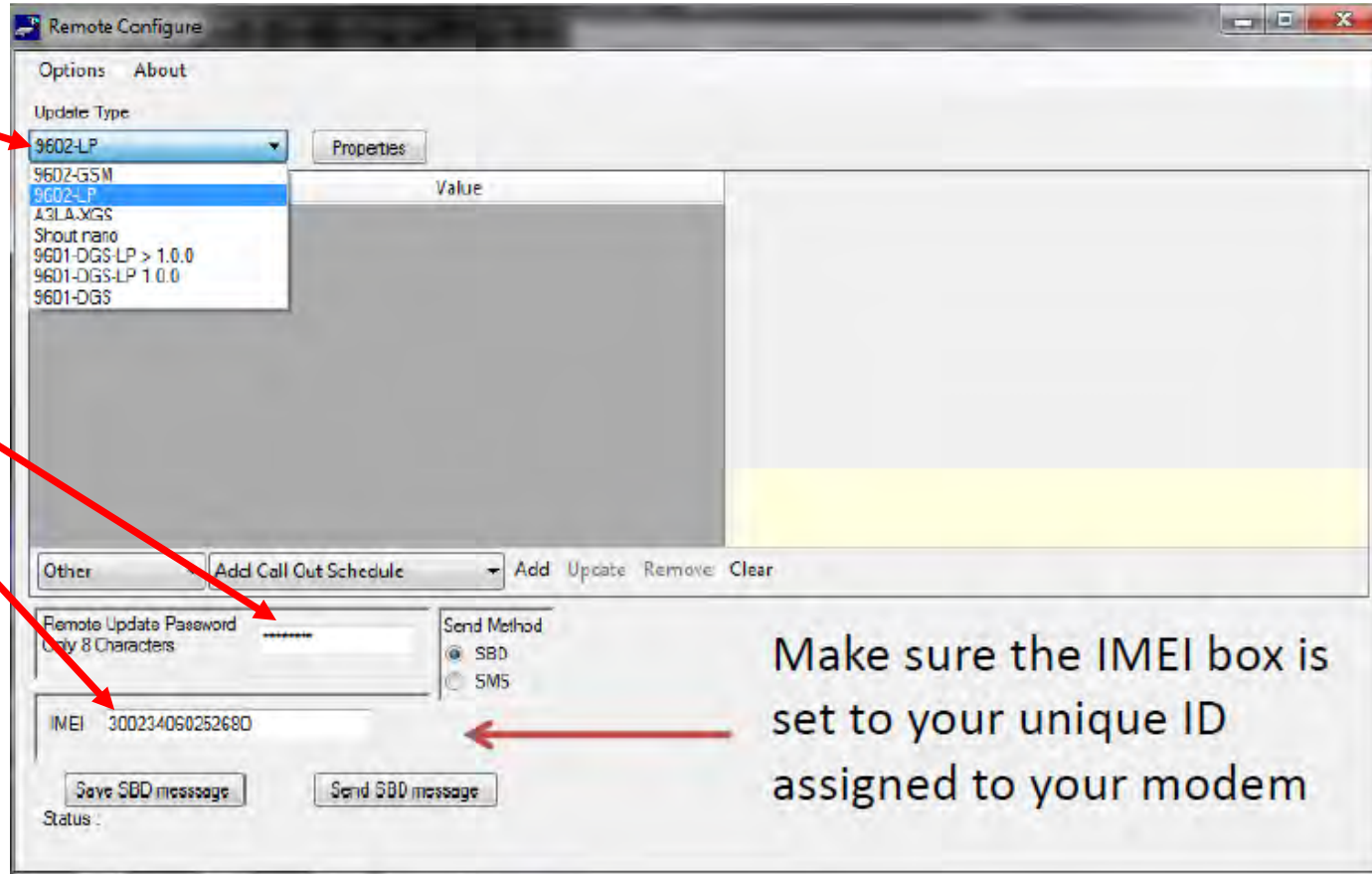
Command Creation



- Possible command currently used
 - Change output pins (eight different options 0-7)
 - Change report rate
 - Request a poll report
- All of these can be built using the Remote Configure Application downloaded from NAL Research.
- You will need the IMEI number of the modem you are trying to command. This is found on the side of the Iridium modem.

Command Creation (cont.)

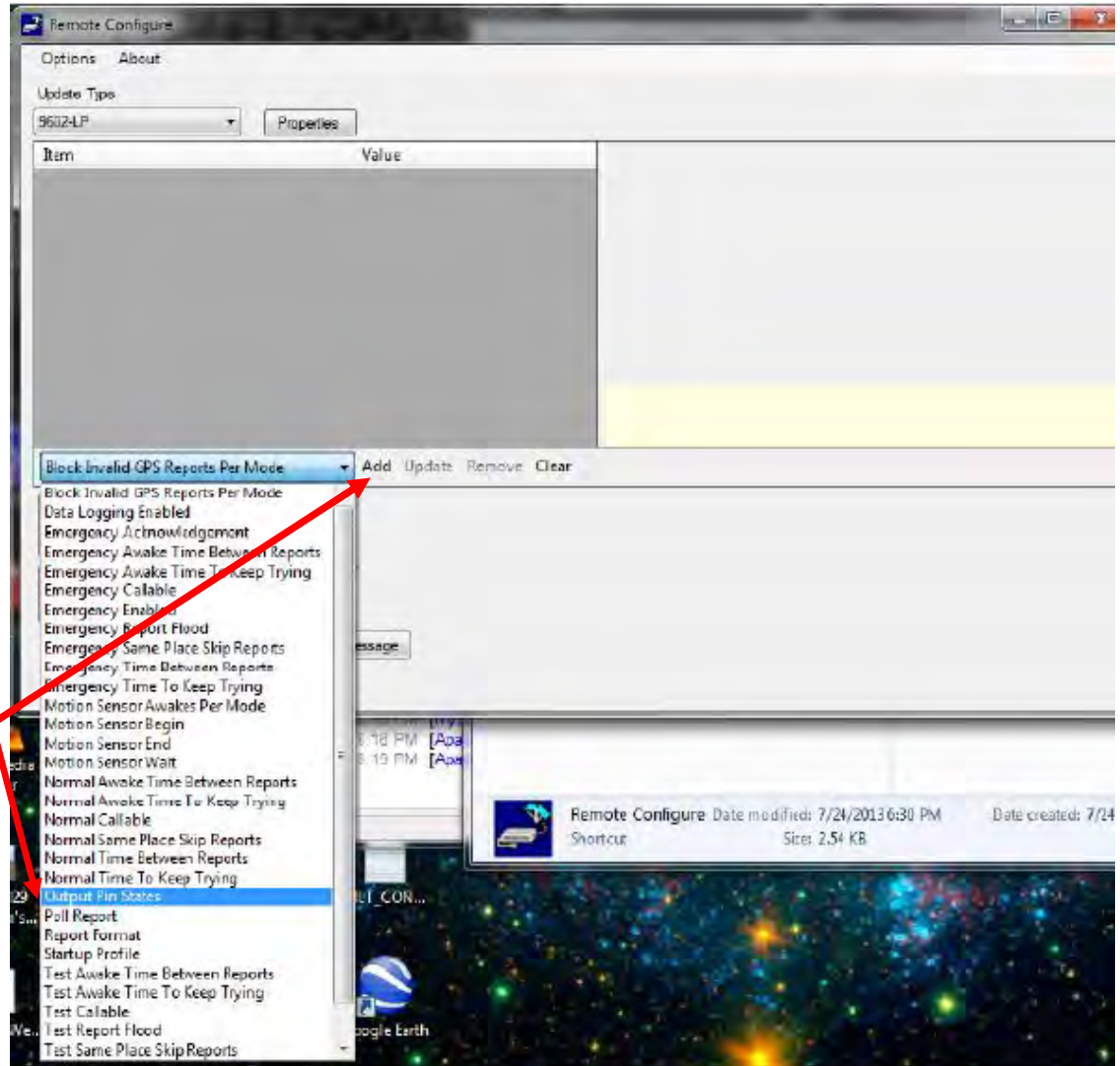
- Select 9602-LP from the Update Type
- The default remote update password is 12345678.
- Set the IMEI number to match the modem you want to command



Make sure the IMEI box is set to your unique ID assigned to your modem

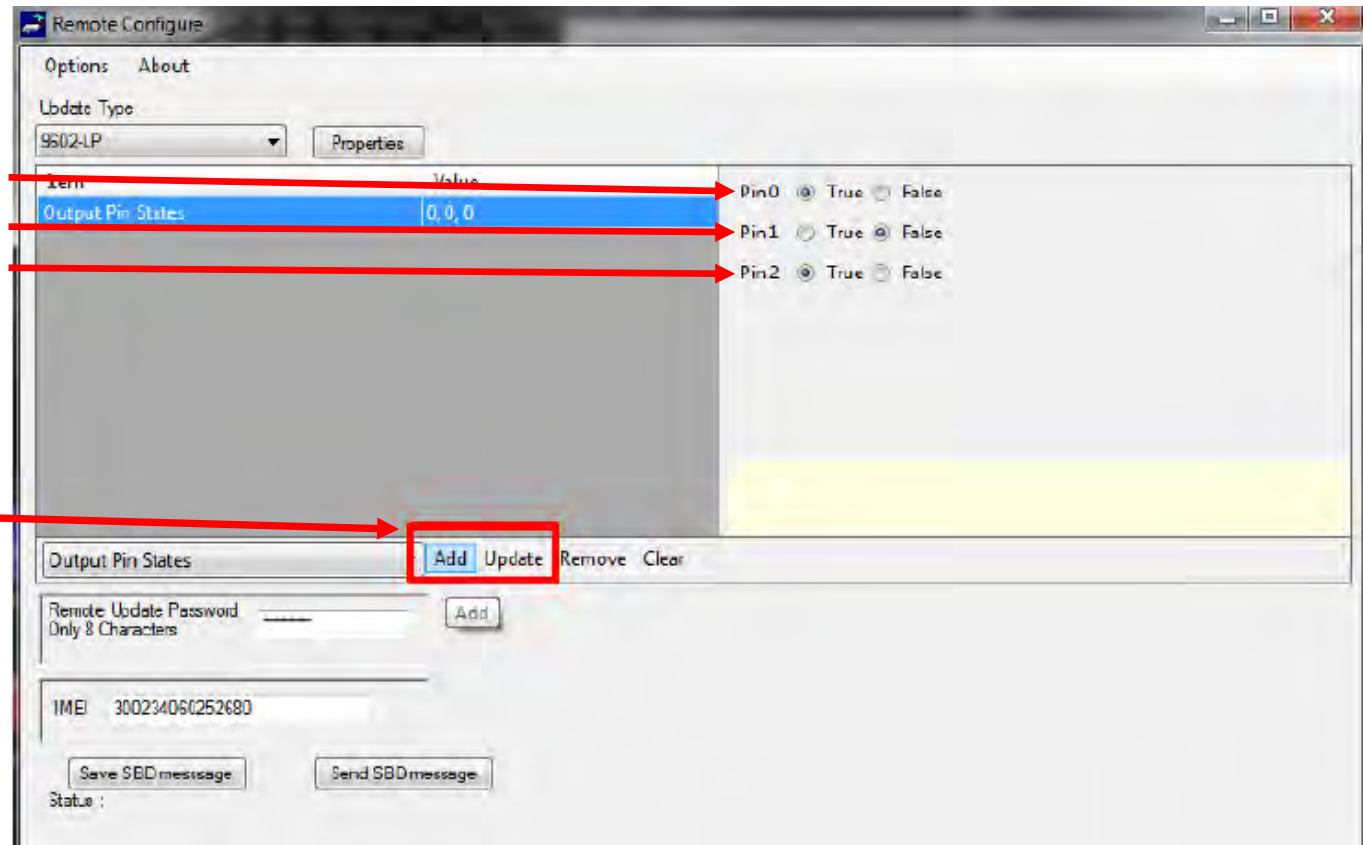
Command Creation (cont.)

- For this example, select Output Pin States from the drop down menu.
- Select *Add* to add the item to the packet.



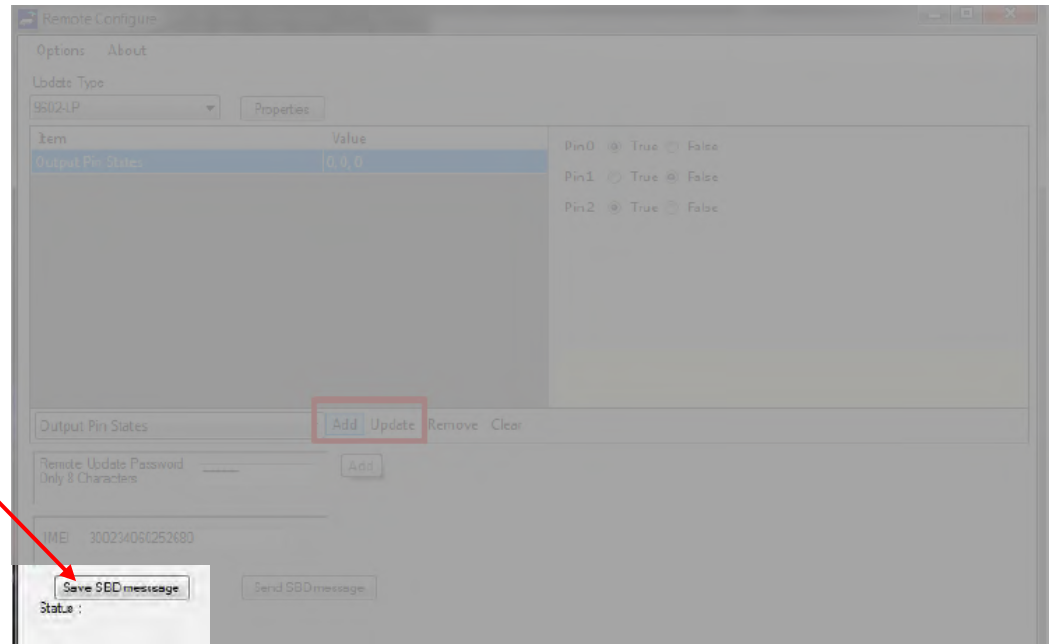
Command Creation (cont.)

- Select the pin states. True is a '1' while False is a '0'.
- Select *Update* to change the *Value* field.



Command Creation (cont.)

- Save the .sbd message so we can send it as an attachment.
- Follow the steps under “Commands” to send this packet to the iridium modem.



Field Operation Overview

1. Power the OCCAMS Control board (connected to Iridium)
2. Verify the Iridium's Connection via GPS coords on website
3. Send the .sbd command so that the command bits from Iridium to OCCAMS are all zeros (000). This is the system idle command.
4. Power on the OCCAMS Cutdown Board (connected to termination)
5. Reset the timers on both OCCAMS immediately prior to launch
6. Send email to terminate balloon flight.
7. Watch for confirmation email
8. Watch GPS data on website for termination confirmation

Resetting the Timer on OCCAMS

- The timer on OCCAMS is designed to be power cycle resistant. This means that pressing the reset button or power cycling the board by unplugging the battery will not reset the timer. Rather the timer is reset by a sequence of events or steps.
 1. Move the shunt jumper from the *SAFE* to the *RES* position.
 2. Slide the slide switch upwards (towards the reset button and top of board).
 1. At this point the SCK LED (heartbeat LED) will begin flashing rapidly
 2. The timer is reset to zero continuously while these two conditions are met
 3. When the switch or shunt jumper return to their safe positions, the timer begins and increments every second until the timer overflows and triggers cutdown.

Resetting the Timer on OCCAMS (cont.)

Step 1

Move shunt jumper

Normal Position



Reset Position



Step 2

Move slide switch



Step 3

Return shunt jumper and slide switch to normal/off position



Off Position



Reset Position