**Power Supply for High Current Box:**

Previously, the WAM-V was equipped with 55lb thrusters which took 26V. The problem with these thrusters were that it was too weak so that the current would push it around. Thus, a new thruster was chosen, the 110lb Mini Kota thrusters.

**Concept:**

In order to meet the power requirement of 50 V and 100A for the propulsion system, a series connection of multiple batteries was required.

Each battery pack has an output of 14.8 V. 3 packs of batteries were to be connected in series to generate a total voltage of 44.4V. Then a voltage regulator will step up the voltage to 50V, thus meeting the power requirement.

**Connectors:**

The series connectors were made using XT connectors and a 3D printed piece to hold 10 XT connectors each.

3 female connectors which will be attached to the battery were to be soldered.

3 male connectors which will attached to the female connectors to be soldered.

The male connectors will be wired to create a series connection, with one ground, one power out, and the rest of the wires bridging between each of the male connectors.

The output of the male connector will then be connected to a circuit breaker (in case of power surge) which will finally be connected to the high current box.

**Wires:**

10 gauge wires were used to solder onto the XT connectors. The 10 wires were chosen because it will fit into the cup of the XT connector, making soldering easier. Although this is not ideal because the 10 gauge will lessen the current flow, it is a short run, so it will not affect the power output significantly. Initially, 8 gauge wires were directly being soldered onto the XT connectors, but this proved to be time consuming and less effective in terms of heat transfer and the solder sinking in.

**Soldering tips:**

Before soldering, be sure that the temp is correct, in this case, it was set at 825 degrees Fahrenheit for maximum heat transfer. Also, be sure that the solder tip can accept solder when tinning. If the solder falls off, do not proceed. This means that either oxidation occurred or there is gunk on the tip, hindering heat transfer. To resolve this, clean it by using the solder tip cleaner. If this does not resolve it, use a file to file off the gunk. If the problem persists, look in the soldering supply box for flux to recoat the tip. If the solder still fails to stick to the tip, ask a team member, consider replacing the tip or using a different soldering iron.

**Prepare the wires:**

In this case, the 20 gauge wires are measured to be 3in. Strip the wire enough so that it will be able to fit into the XT connector and a little extra. Use appropriate stripper and be sure not to cut the wires. If some of the wires are accidentally cut, consider discarding the wire.

Now place the stripped part of the wire into the XT connector cup and get ready for soldering.

**Wire color and XT connector:**

On each XT connector, there are 2 sides. One side is Flat, and the other is chamfered. The flat side is Volt, and the chamfered side is Ground.

In our case, for the female connectors, use black wires for the ground and red for volt

For the male connectors, use black wires for the ground, and alternating red and black wires for the Volt. It doesn’t matter what color it starts in as long as it is alternating.

**Safety:**

Wear safety glasses, long pants and close toes shoes. Tie up long hair and do not wear loose clothing or roll up sleeves. Do not leave the soldering station while the soldering iron is turned on.

Use a fan to direct it away the solder smoke if necessary.

**Soldering:**

For absolute beginners, get trained by a team member

The aim is to let the solder sink into the wire and take advantage of capillary forces to let it sink down into the cup. The key is to get the material hot enough. When applying solder onto the wire, if it does not sink in, but sits on top, wait a little until the material is hot enough. We do not want to create a “jacket” of solder. The result will look like a melted heresy’s kiss. Do not put excess solder, but enough for it to fill the cup and cover the wire. Don’t forget the solder the back of the wire onto the backing of the cup.

**Heat shrink:**

When one connector is done, it should immediately be heat shrunk so that it will not be forgotten. Heat shrinks protect against short circuits. If this step is forgotten and the next step is started, the progress must be backtracked until the heat shrink can be applied to the wires.

Be sure to cover the entire portion of exposed wire.

**Bridging:**

Now that each of the male connectors are soldered with 10guage wires, it is ready to be connected in series. To do this, use 8 gauge wires.

The black 8 gauge will go to the black 10 gauge.

The Blue 8 gauge will go to the red 10guage

When bridging, all of the ground of the first male connectors will act as the ground for the series connection. The power wires will then bridge over to the ground of the second connector. Now the power wires of the second connector will bridge over to the ground wires of the third connector. Now the power wires of the third connector will act as the total output for the three batteries.

much like connecting AA batteries together, the result will be one ground and one Power.

When soldering two wires together, it is standard to twist them together, or sprawl each wire out and join it much like interlacing fingers together. In this case, the wires are sprawled out and joined. This creates more friction forces to ensure better quality.

Now that the wires are interlaced, tin the tip of the solder, get the wires to appropriate temperature, apply solder. Be sure that the solder is sinking in. Bigger wire means that it takes longer for it to heat up, so if the solder is sitting on the top, creating a “jacket,” wait a little, add heat and try again.

Soldering larger gauge wires can be quite tricky so practice first if needed. Remember, this work goes on the boat and it is very important that the soldering is of good quality, especially when dealing with high current. Get a team member to review the work.

**WAM-V Screws on ski on each pontoon:**

We have our front thruster mounts set up in a way that utilizes the existing tapped holes and screw on the ski. This means that we needed to take out the screws in order to attach and detach the front thruster mounts.

The problem was that the screw started rusting, causing it to freeze in place. Since the screw was a Philips head, the screws soon stripped, and we had to take extreme measures to get them off.

The solution to this was to get bolts instead of screws, and to also to spray corrosion proof spray on the holes and on the bolts.

In the future, when using screws or bolts that will encounter salt water or used in an environment that may cause it to rust easily, remember to corrosion proof it and keep it maintained regularly.

**IMU, GPS, Box mounts:**

Previously, Velcro were used to attach IMU and GPS to the husky box. The husky boxes were also mounted onto the WAM-V using Velcro.

This was only a temporary solution and we needed a better way to mount them. The IMU is also very sensitive to movement, and the Velcro was not ideal.

Using SolidWorks, a CAD program, the mounts for the IMU, GPS and Box mounts were created.

First step is to come up with a feasible design. For mounts, a simple design that will secure the object and restrict it from any movement will do.

Second step is taking measurements. Since precise measurements are needed, a caliper is the right tool. Measure the object and jot down the measurements, preferably with a figure for reference.

Now use SolidWorks, or any CAD program to design the mount. There are simple tools to use such as extruded bass, extruded cut, and hole wizard to help you make simple deigns.

Hole wizard is a useful tool that allows the user to create clearance holes depending on the screw size. There is also an option to create a tapped hole, but since we are 3D printing, a tapped hole cannot be printed. There is also an option to print it and create the holes afterwards.

Be sure to make all sketches in the design fully defined. This is basic CAD procedure.

The design allowed the sensors and box to sit on the WAM-V steadily.

**Buoy:**

One of the tasks for the competition is to detect a light pattern off a light-pole on a buoy. To do this, we needed to train the Color Recognition code to recognize color in a similar environment to ensure more precision.

To put the light-pole previously created onto a buoy, there were a few things that needed to be considered. Its weight, its center of mass, and simple concepts on buoyancy.

After some research, we found that the buoyant force is equal to the amount of water displaced. One gallon of water weights 8.34 pounds.

Taking this information, a group of teammates brainstormed until a final decision of using 5 gallon buckets as floats were decided upon.

The 5 gallon buckets were to be placed in a 4’x4’ plywood (we used a 4’x3’ because that’s what we had), in holes of diameter of 11in created each four corner 5 in from the edges. This allowed the buckets to fit in from the top, but not go all the way through. Then we used ratchet straps to place a downward force on the lids of the buckets to counteract the buoyant force when it is placed in the water.

Since the light pole is a 6ft PVC pipe with a CAD light fixture on the top, the center of mass is approximately 6ft above water. Thus, we used an equal length PVC going 6ft below the surface of water with counterweights attached to the end. Some calculations of torque with the light pole, counterweights and buoyant force from the buckets showed that the light pole will be able to tip 30 -40 degrees if it is pushed by the wind or waves before it tipped over with weights twice the weight of the light. This calculation was overly generalized, but it showed that the more weights we added, the sturdier it was.

The light pole were mounted at the center of the plywood using L-brackets and bolts. We used one short 2in PVC to act as the connecting piece, which went through the center of the plywood, connecting to the L-brackets and the light pole and weight pole going on either side and bolted on using drilled clearance holes and appropriate bolts.