Power Systems 5
Electronics Technology and Robotics III
Power Systems 5 Lab 1 – Assembling Joystick Control Box and Tether for ROV

- **Purpose:** The students build the joystick control box and the 25' tether for their class ROV project.

- **Apparatus and Materials:** (See Parts List for Details)
  - 1 – Competition Style Arcade Joystick, RA-Joystick-JS10 from ABlackHorse.com Link: http://www.ablackhorse.com/store/pc/showsearchresults.asp?pageStyle=H&resultCnt=20&keyword=ra-joystick-js10

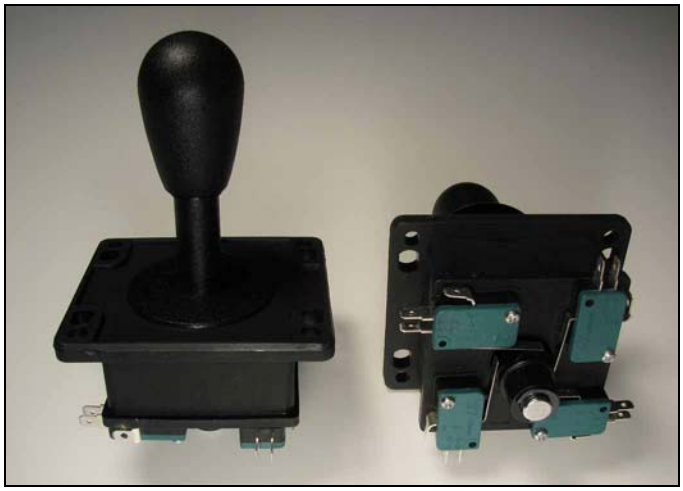


Figure 1: RA-Joystick-JS10 Joystick

  - 1 – 25' 16/3 AWG Extension Cord (Cut 100' 16/3 Extension Cord – Home Depot #277-525 into 4 – 25' Pieces)
  - 1 – 25' 24 AWG/4 Pair Category 5e Network Cable (Jameco #645722)
  - 1 – 25' 16/2 AWG Stranded Wire Cable (for Vertical Thruster) (Not shown in Final Tether Photo)
  - 1 – 8' 16/2 AWG Stranded Wire Cable (for Vertical Thruster)
  - 1 – 5" L x 4" W x 3" H Aluminum Enclosure (Jameco #11886)
  - 1 – DPDT Momentary Center Off Switch (Electronix Express #17TOGMOMDD8012A)
  - 4 - #8-32 x ½" Stainless Steel Screws w/ SS Nuts and Washers
  - 9/32" ID Rubber Grommet (MSC #32828659) Slot Drill Diameter = 3/8"
  - 2 - 1/4" White Plastic Cable Clamps (Home Depot SKU #541729)
  - 1 – Automobile Fuse Holder
  - 1 – 10A Auto Fuse
  - 2 – Crimp Ring Terminals
  - Heat-Shrink Tubing
  - 25' of ½" Braided Expandable Sleeving
  - ½" x 20' Caulk Backer Rod

- **Procedure:**
  - **Assemble Joystick:**
    - Assemble the RA-Joystick-JS10 joystick with the parts in the order as shown in Figure 2.

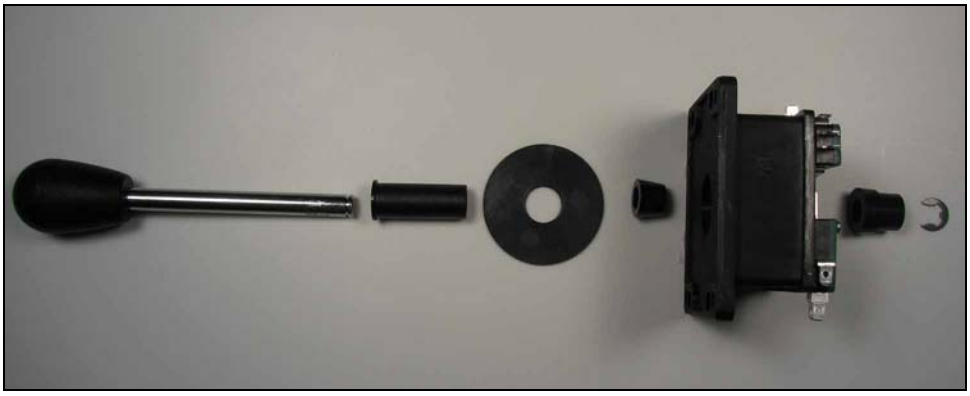


Figure 2: RA-Joystick-JS10 Joystick Assembly Order

- Make sure each part is in the proper orientation.

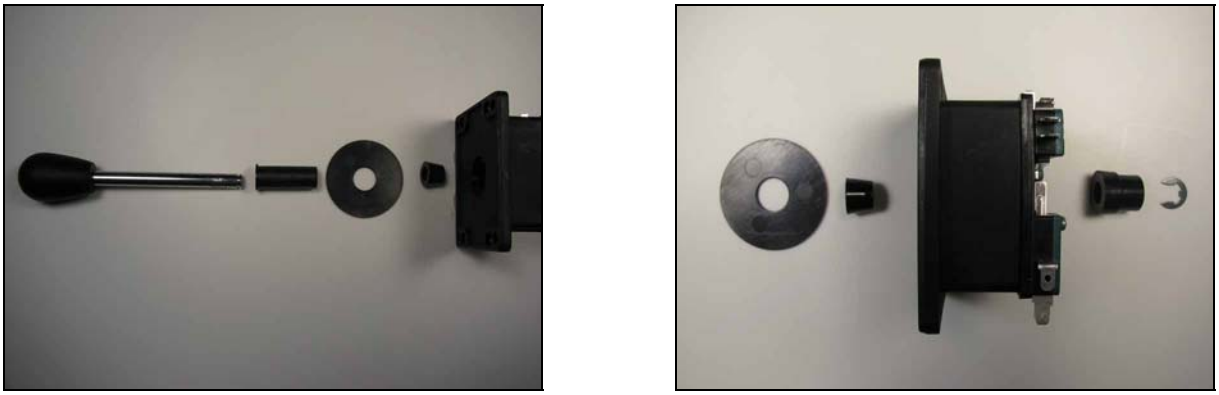


Figure 3: RA-Joystick-JS10 Joystick Assembly Order

- Hold down the plastic insert to expose the slot and push in the external retaining ring.

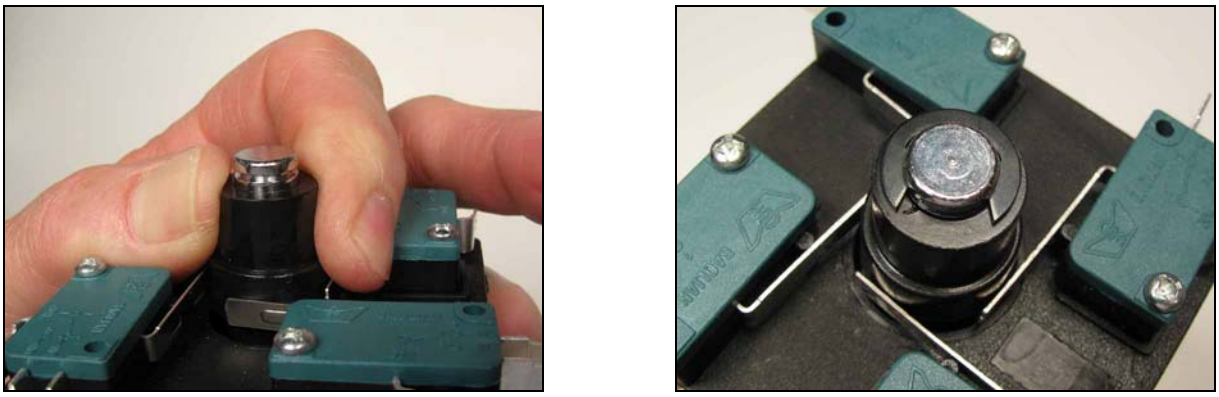


Figure 4: Holding down the Plastic Insert and Retaining Ring Inserted

Mount the Joystick to the Aluminum Enclosure:

- Select the half of the aluminum enclosure that <u>does not</u> have the 3/8" flanges.
- Layout a 2 ¾" x 2 ¾" (7 cm x 7 cm) square hole centered on the 5"x4" side of the aluminum enclosure.
- Use masking tape to tape over the aluminum outside the square hole so it won't be scratched when cutting the hole.
- Drill 3 – ½" holes inside the square hole as in Figure 5. They will be used to insert the jigsaw blade.

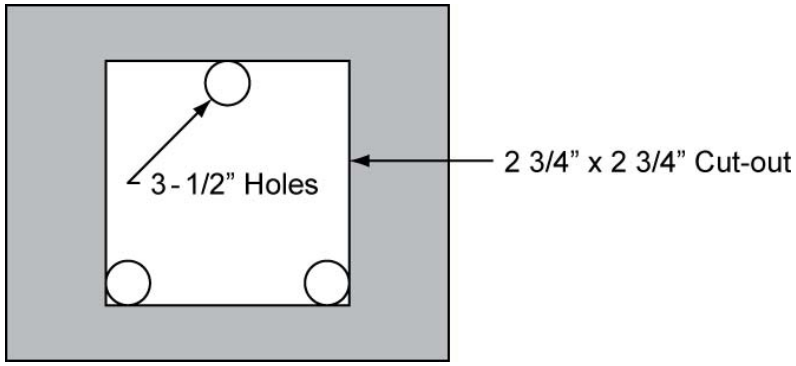


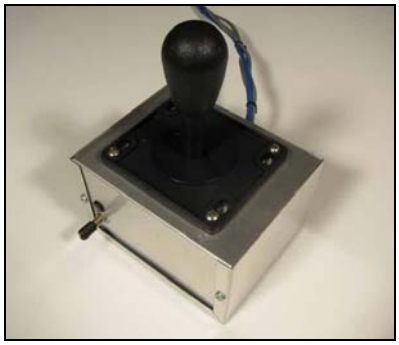
Figure 5: Square Hole and ½" Hole Layout

- Using a jigsaw equipped with a metal cutting blade for thin metals, cut out the 2 ¾" x 2 ¾" hole. Refer to Figure 6.

Figure 6: Cutting the Square Hole with a Jigsaw

- Insert the joystick into the square hole cut and layout the holes for the mounting screws.
- Drill the four mounting screw holes using a #16 drill bit.

- Attach the joystick to the aluminum enclosure with 4 – #8-32 x ½" machine screws and nuts. Fasten two plastic cable clamps onto the #8 screws inside the enclosure on the side of the joystick where the cables will enter.



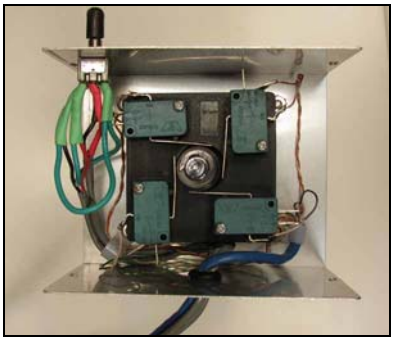


Figure 7: Joystick Attached to the Aluminum Enclosure

- **Drill Vertical Thruster Switch and Grommet Holes:**
  - It is best that all of the holes be drilled in the same piece of the aluminum enclosure that includes the joystick.
  - Determine the location of the vertical thruster switch so that it can be easily controlled while holding the control box. Do not let the switch placement conflict with the joystick. Drill the hole for the switch.
  - Locate the spot where the Cat 5e cable will enter the aluminum enclosure.
  - Drill an 11/32" hole at this spot.
  - Insert the ¼" ID rubber grommet into the hole.
  - Clean off all aluminum filings from the control box.
  - Feed the 25' Cat 5e Cable, the 25' 16/2 AWG Stranded Wire Cable, and the 8' 16/2 AWG Stranded Wire Cable through the grommet hole into the control box.

- **Cat 5e Cable – Control Box Connections:**
  - Route the Cat 5e cable so the individual wires will follow the path as shown in Figure 8.
  - Secure the Cat 5e cable in one of the cable clamps.
  - Now strip 10 mm of insulation off all 8 – Cat 5e cable wires that were inserted.
  - Solder the Cat 5e wires to the joystick switch terminals as illustrated in Figure 8.

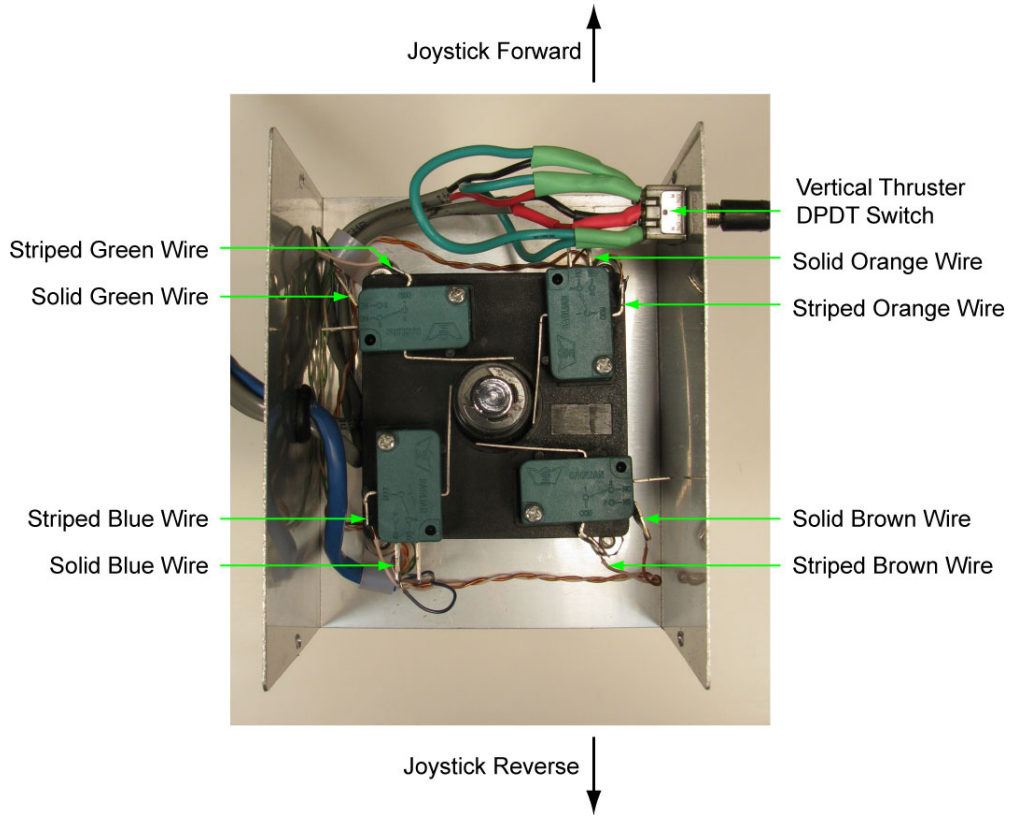


Figure 8: Cat 5e Wire Connections to the Joystick

- **Vertical Thruster Connections:**
  - Route the 25’ 16/2 AWG stranded wire cable and the 8’ 16/2 AWG stranded wire cable to the DPDT switch.
  - In Lesson 19, we learned that there were two different ways to wire a DPDT switch in order to reverse the polarity of a dc motor; both techniques will work. See Figure 9.

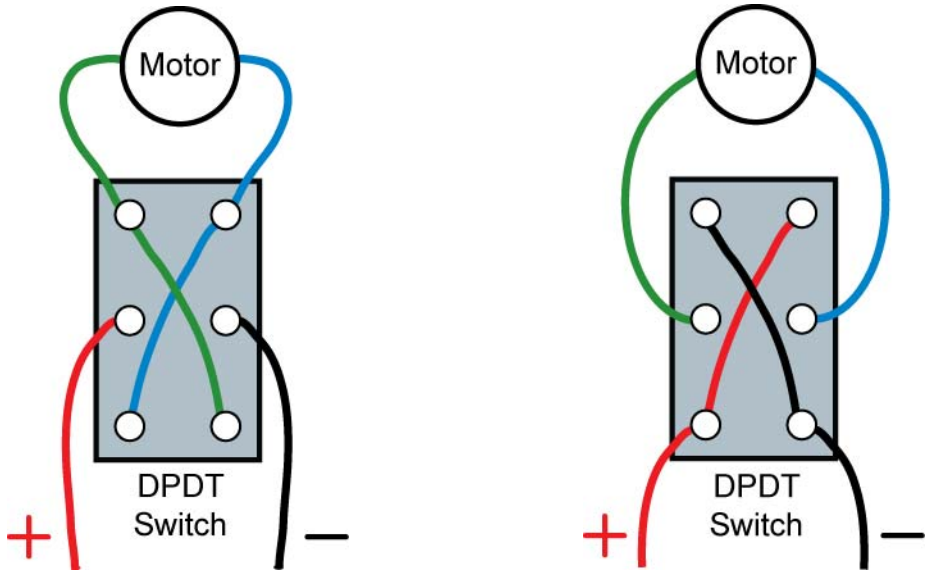


Figure 9: Two Methods to Wire a DPDT Switch to Reverse the Polarity to a DC Motor

In Figure 10, you cannot tell which way was used because the same type of wire was used for the battery power feed and motor feed. Notice that the two wires that are connected to a single lug are joined together before the lug because only one wire can fit through the switch solder lug. One way around the small lug problem is to sufficiently strip the insulation off one wire and pass it through both diagonal lugs before soldering (Figure 11).

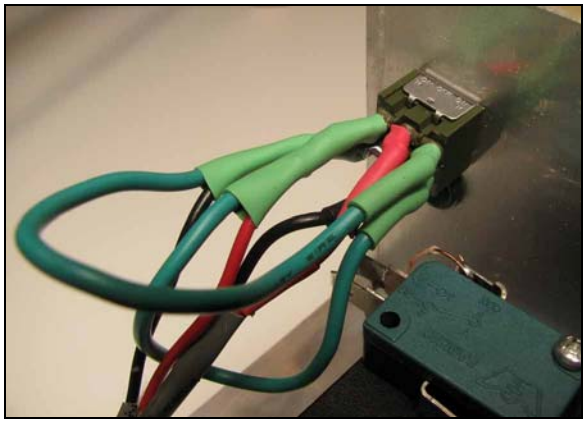


Figure 10: DPDT Switch Wired

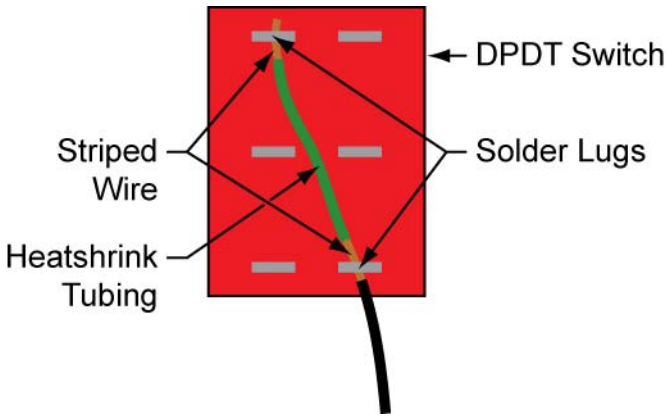


Figure 11: Way around Small Lug Problem

- Solder the power feed and motor wires to the DPDT switch. Don’t forget to feed the heat shrink tubing onto the wires before you solder.

- **Extension Cord and 8’ 16/2 AWG Cable Preparation:**
  - Using a Lil’ Ripper Stripper from Ideal, strip back 10” (25 cm) of the outer insulation jacket from one end of the extension cord and 4” (10 cm) of the jacket from the unused end of the 8’ 16/2 AWG cable. See stripper in Figure 12.

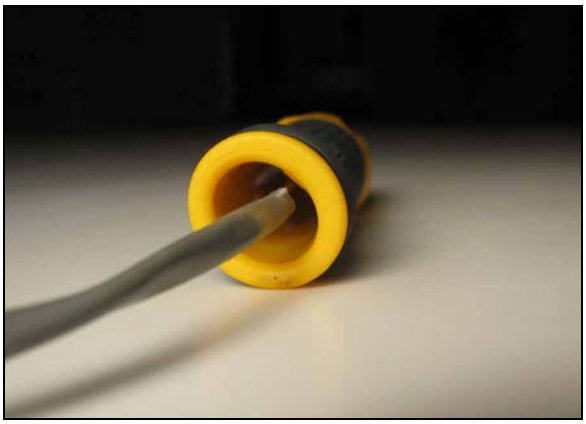


Figure 12: Stripping the Outer Jacket from the 16/3 AWG Cable

- Place a 15 cm piece of heat shrink tubing over the extension cord and the 8’ 16/2 AWG cable.
- Cut off the exposed green wire and discard.
- Cut the white lead of the extension cord and the red wire of the 8’ 16/2 cable to 3 cm in length and stripe off 1.5 cm of insulation. Also stripe 1.5 cm of insulation off the fuse holder wire (Figure 13).

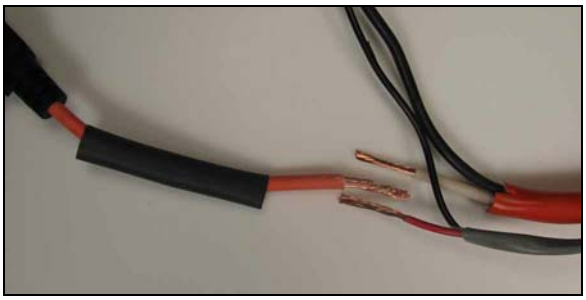
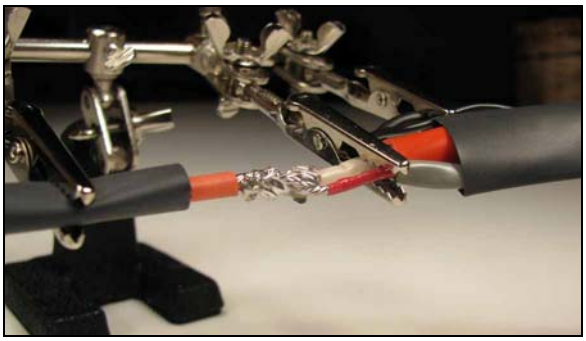


Figure 13: Fuse Holder and Connecting Wires Prepared for Soldering

- Slip on a piece of heat-shrink tubing onto the fuse holder lead before twisting and soldering the connection (Figure 13).
- Twist and solder the three wire connection. Apply heat shrink tubing (Figure 14).



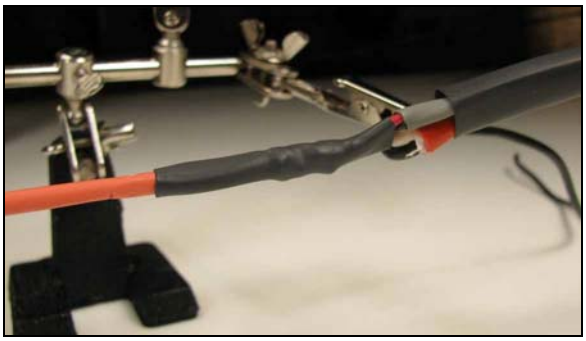


Figure 14: Connection Soldered and Heat Shrink Tubing Applied

- Now cut the 8’ 16/2 AWG cable black wire to a length of 7 cm. Strip off 1.5 cm of insulation.
- Using a razor blade holder, carefully remove 1.5 cm of insulation off the extension cord wire as shown in Figure 15.

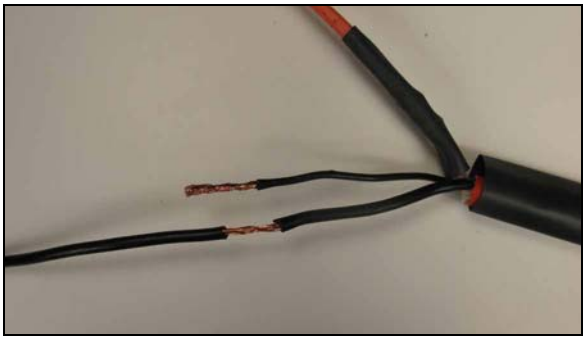


Figure 15: Black Wires Ready for Soldering

- Twist the two black bare wires and solder (Figure 16).
- Insulate this solder joint with the heat-shrink tubing (Figure 16).

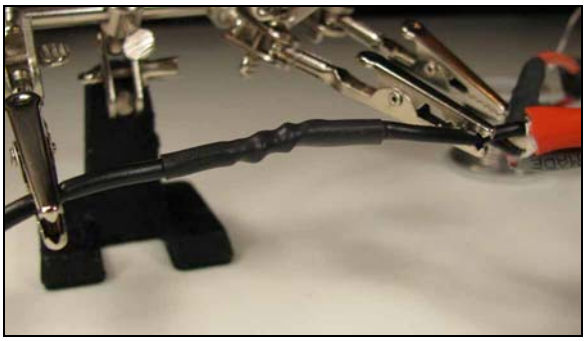


Figure 16: Soldered Black Wires and Heat Shrink Tubing Applied

- Cover both soldered connections with the 15 cm heat shrink tubing (Figure 17).
- Crimp the ring terminals onto the black lead and the fuse holder lead (Figure 17).
- For this lab, do nothing to the other end of the extension cord.

Figure 17: Completed Power Connection

- **Tether Assembly:**
  - Tether Layout:

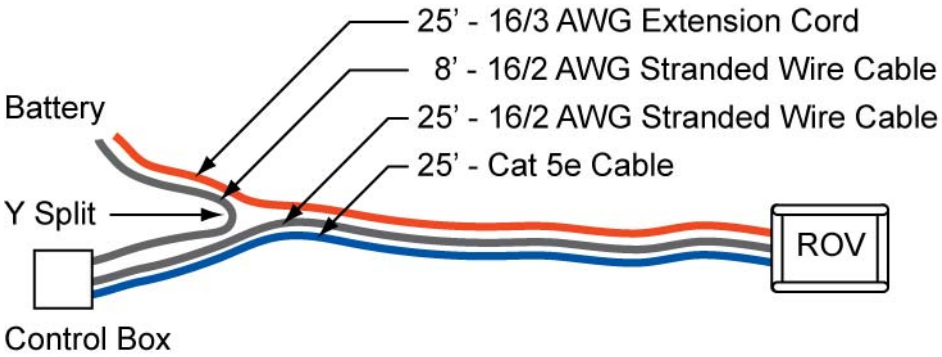


Figure 18: Tether Layout

- Stretch out the 25' – Cat 5e cable, the 25' – extension cord, and the 25' – 16/2 AWG cable side by side (Figure 19).
- Holding the three cables taut, cut the three cables to the same length (Figure 20).

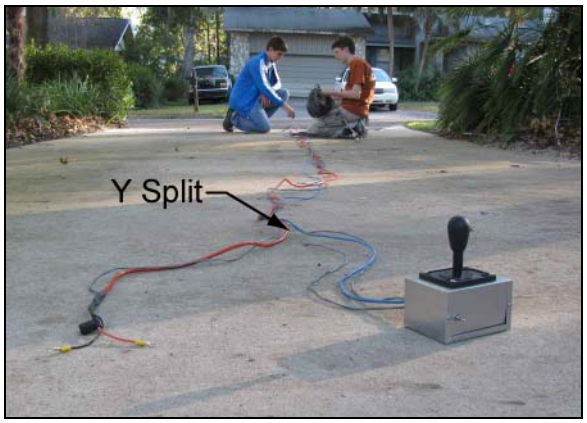


Figure 19: Stretched Tether and Y Split

Figure 20: Cut Three Cables to the Same Length

- Tape the three cable ends together (Figure 21).
- Cut the ½" expandable sleeving to a length of 25' using a hot knife rope cutter or scissors (Figure 22).

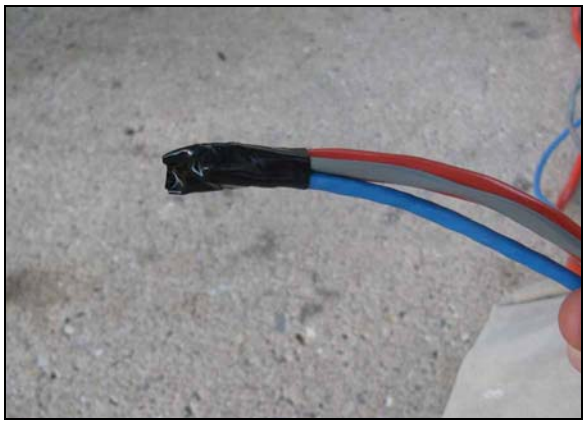


Figure 21: Tape Three Cable Ends

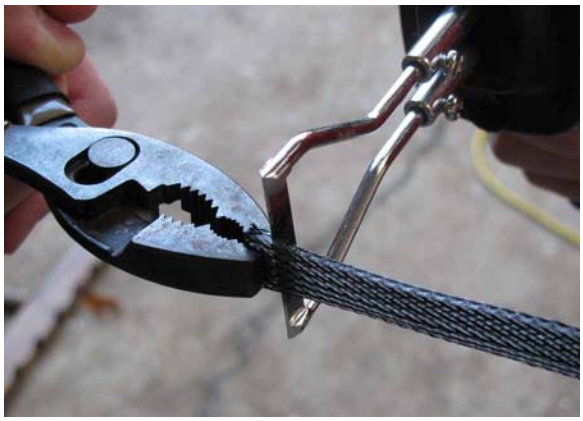


Figure 22: Cut Sleeving with Hot Knife Rope Cutter

- If you are cutting with scissors, fuse the filaments at both ends of the sleeving with a small flame (Figure 23).

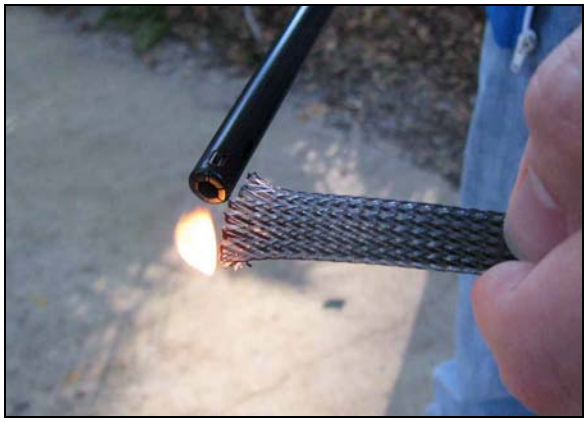


Figure 23: Fuse Filament Ends with Small Flame

- Feed the braided expandable sleeving over the tether (the three cables) (Figure 24) and work all of the sleeving past the Y split to the control box end (Figures 25, 26, and 27).

Figure 24: Feed Sleeving over the Cables

Figure 25: Pushing Sleeving over End

Figure 26: Work the Sleeving Down the Tether

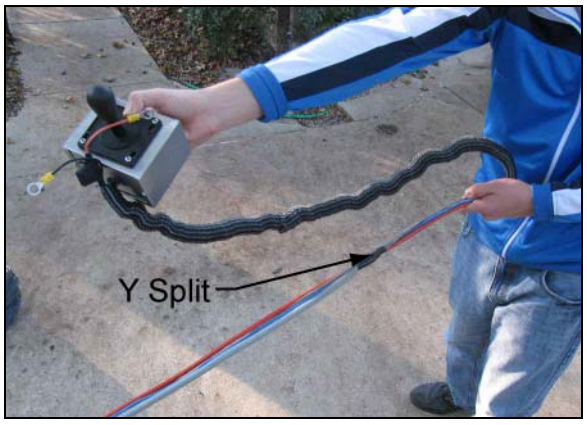


Figure 27: Gather All the Sleeving Past the Y Split

- Tape one end of the ½" backer rod into the tether at the Y split and extent the backer rod to the ROV end of the tether (Figure 28). Tape down the rod for about 5" at the Y split.
- Gently work the braided expandable sleeving back down the tether to approximately 12" from the end of the three wires (Figure 29). Cut off the excess sleeving and backer rod.
- Secure both ends of the sleeving with zip ties.

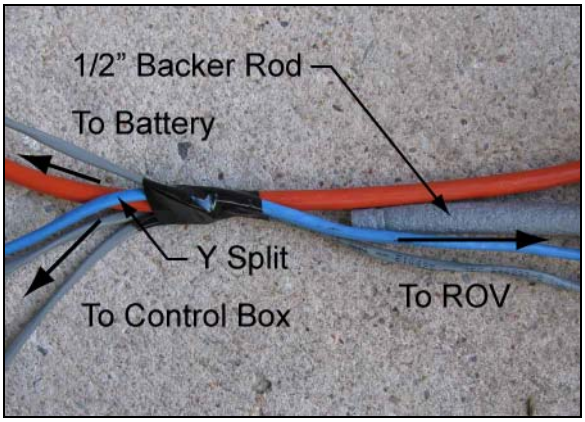


Figure 28: Add Backer Rod to Tether And Tape It in

Figure 29: Work Sleeving Back Down the Tether