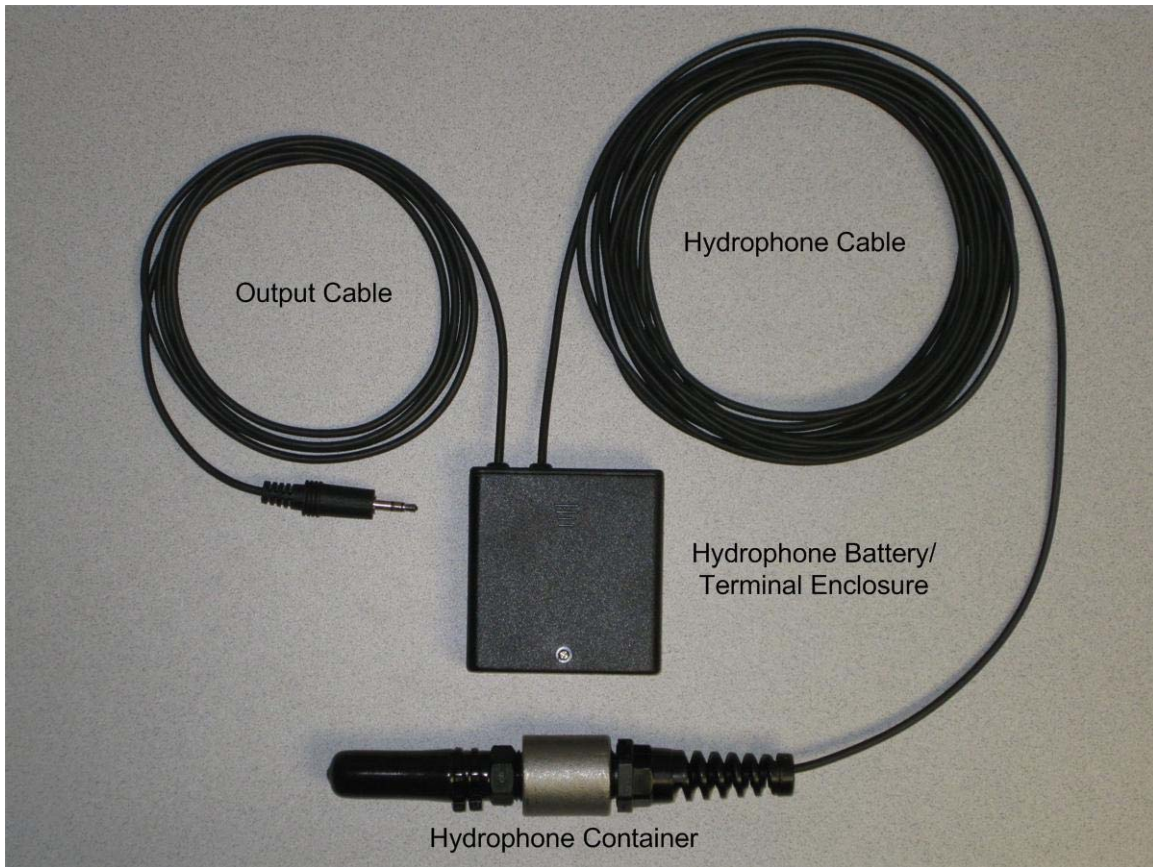
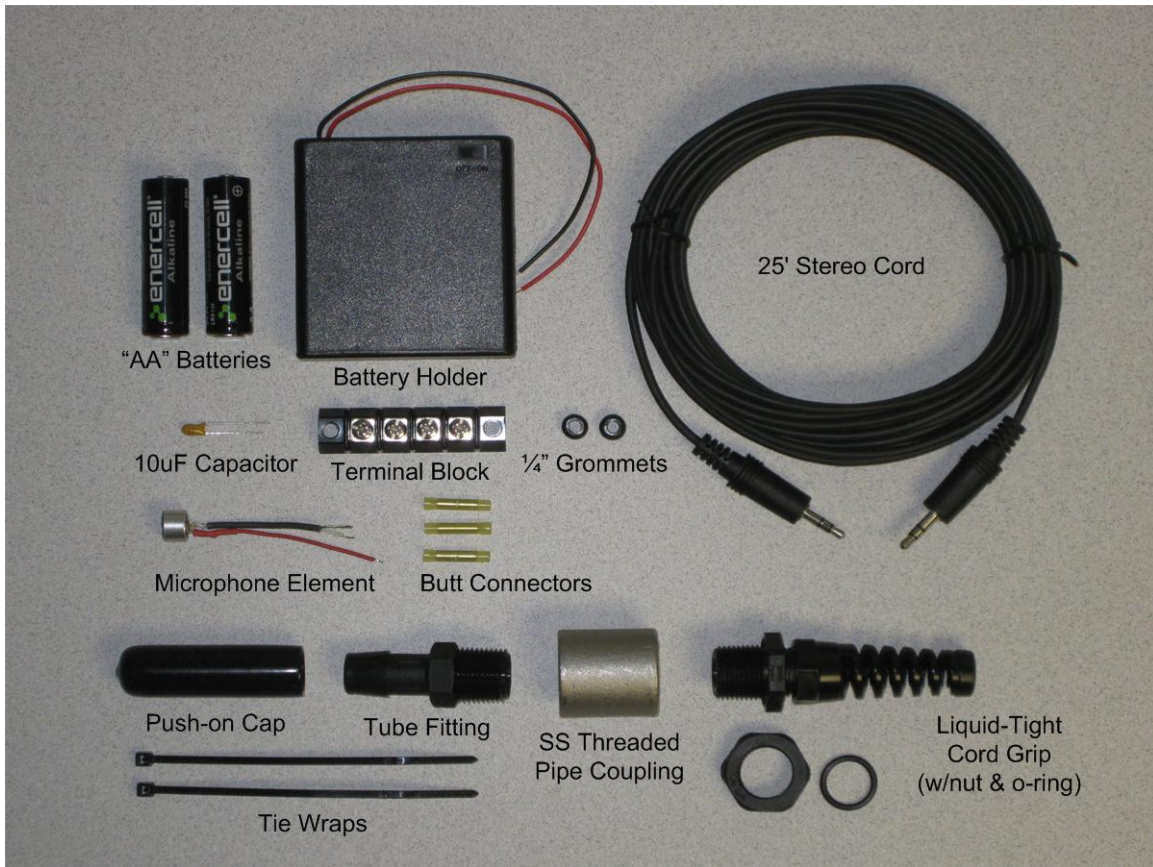


COSEE TEK ~ University of Connecticut Simple Hydrophone Design

Material List and Fabrication Instructions
Version 3.0 (4/24/2012)
by Kevin Joy, John Hamilton & Ivar Babb



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Simple Hydrophone Design Material List



Description	Vendor	Part Number
Condenser Microphone Element	Radio Shack	270-092
4 "AA" On/Off Battery Holder	Radio Shack	2700409
Vinyl Grommets	Radio Shack	6403025
Tantalum 10uF Capacitor	Radio Shack	272-1436
Telephone Butt Connectors (24pk)	Radio Shack	6403073
"AA" 4-Pack Alkaline Batteries	Radio Shack	2300849
Stereo Cord with 3.5mm Connectors (25')	McMaster-Carr	8317T15
Push-on Round Cap, 1/2" OD, 2" Height (25pk)	McMaster-Carr	40005K22
Nylon Single-Barbed Tube Fitting (10pk)	McMaster-Carr	5463K253
Stainless Steel Threaded Pipe Fitting, Coupling	McMaster-Carr	4464K353
Nylon Liquid-Tight Cord Grip (.08" - .24")	McMaster-Carr	69915K62
Space Saver Terminal Block, 4 Circuits	McMaster-Carr	8173T12
Standard Nylon Cable Tie 4" L, Black (100pk)	McMaster-Carr	7130K52

Note: McMaster-Carr is an online reseller of industrial supplies (see www.mcmaster.com). See Appendix 1 for the complete material list and alternative sources.

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Background: The COSEE-TEK Simple Hydrophone Design project is meant to offer a modified design to that of the “Build A Hydrophone” project first introduced by Kevin Hardy of the Scripps Institute of Oceanography UCSD, February 18, 2000. The original “Build A Hydrophone” project provided the basis for this exercise and offers a glossary of terms, valuable references, and other project ideas that should be reviewed.

The design offered in this document is meant to provide a means of building a simple and functional hydrophone that minimizes the need for electrical or mechanical expertise while providing a fabrication-to-deployment path that utilizes no adhesives or sealants. Furthermore, this hydrophone may be deployed as an air-filled unit to depths of up to 10 ft or to greater depths when oil filled.

Web References:

- Discovery of Sound in the Sea, University of Rhode Island, Office of Marine Programs, <http://www.dosits.org/>

References:

- Hardy, K. 2000. *Build A Hydrophone*. Scripps Institute of Oceanography/UCSD

Recommended Tools:

1. Ruler or tape measure
2. Small Phillips head screwdriver
3. Small flathead screwdriver
4. Wire strippers (#26AWG to #14AWG)
5. Crimp tool
6. Electric hand drill
7. 7/32” drill-bit
8. Adjustable or open-ended wrenches
9. Hacksaw or razor knife (see alternate terminal block arrangements)

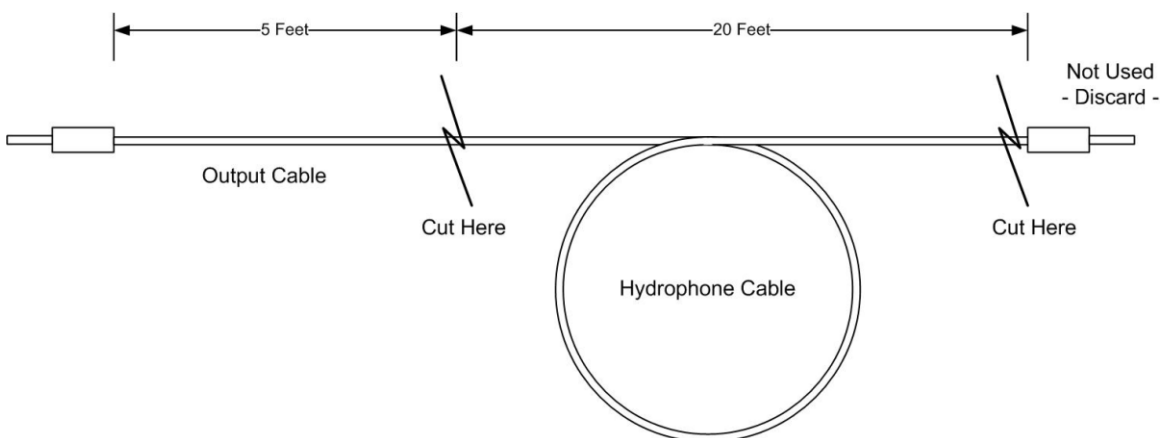
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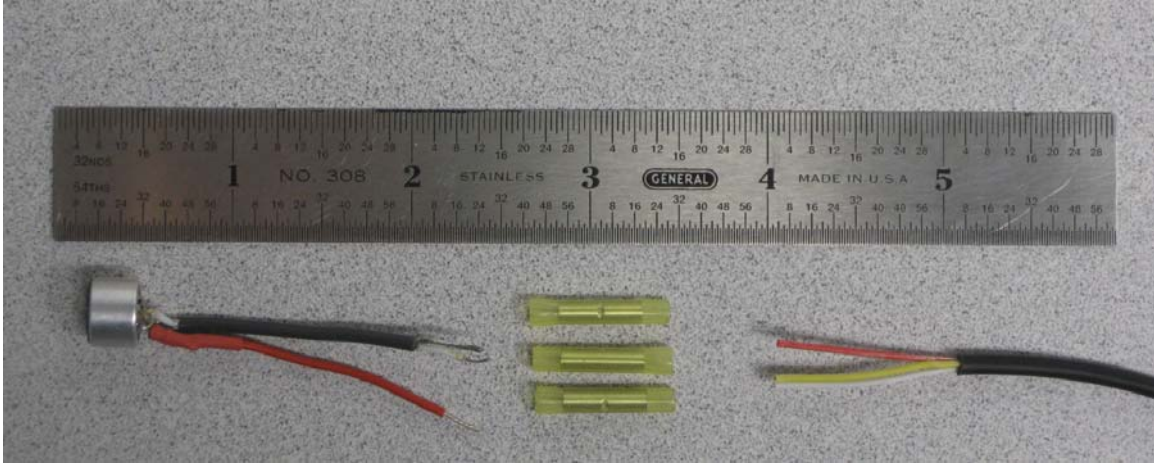
Electrical Preparations of the Hydrophone Components and Cables:

In the following steps, you will be dividing your stereo cord into two lengths forming the hydrophone cable and output cable and will be making the electrical connections for the underwater components of your system. The hydrophone cable connects the microphone element to the power supply and terminations within the topside battery/terminal enclosure. The output cable provides the connection between this enclosure and the device to which the sound will be transmitted (i.e. computer, speaker, etc.).

The first step of the process determines the length of cable available for deploying the hydrophone (hydrophone cable) as well as the length available to connect the hydrophone to the topside computer or audio device (output cable). Be sure to make the cut appropriate for your application. As an example, if using the 25' cable specified within the material list, cutting the cable 5' from one male-plug end would provide you with a 5' output cable and a 20' hydrophone cable (see diagram below).

Additionally, the cable that you receive may come in one of two different configurations; Type 1 has white, red and yellow wires. This is known as a three conductor cable and was the cable used in documenting/illustrating these instructions. Type 2 has white and red wires and an un-insulated shield wire. This is known as a twisted shielded pair (TSP) cable. If using the Type 2 cable, the shield wire should be used in place of the yellow wire described within this document.



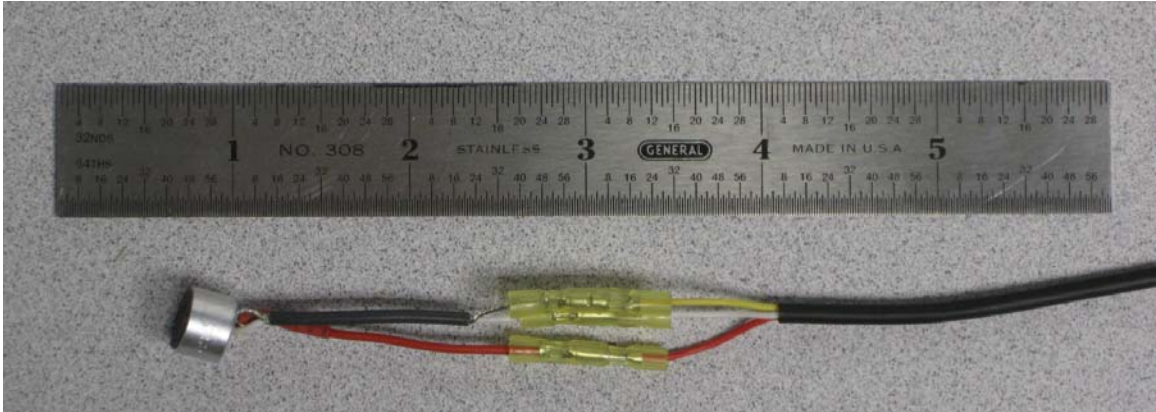


Hydrophone Cable Preparation: Complete steps 1 through 3 below for initial hydrophone cable preparations...

- 1) Measure the required distance from the male-plug end of the audio cable and cut the cable through. This will form the “output cable”, connecting the hydrophone battery/terminal enclosure to the topside computer or audio device. The remaining length of cable will form the “hydrophone cable”, connecting the hydrophone container to the battery/terminal enclosure. If the original cable assembly had two connectors, cut off the second connector from the hydrophone cable.
- 2) Working from one end of the hydrophone cable, strip back and remove approximately 1” of the outer cable jacket, exposing the individual wire leads within. Note, the #14 AWG wire stripper works well for this task. Be careful not to penetrate the insulation of the wires inside.
- 3) Using the #26 AWG wire stripper, strip approximately ¼” of insulation from the end of each wire. Set the hydrophone cable aside until step 8.

Microphone Preparation: Working with the microphone element, complete steps 4 through 6 below...

- 4) Cut the red wire so that all three wires are of equal length.
- 5) Strip and remove the gray insulation surrounding the white wire and un-insulated shield wire to expose approximately ¾” of each.
- 6) Using the #24 AWG wire stripper, strip approximately ¼” of insulation from the end of the white and red wires.



- 7) Working with the microphone, slide one butt connector onto each of the individual wires until the exposed wire strands are completely contained within the centermost metal section of the connector. Use the crimp tool to crimp the metal section of the connector to the wire leads.
- 8) Matching wires from the hydrophone cable to those from the microphone (white to white, red to red, and yellow (or shield) to shield), slide each wire into the open ends of the three butt connectors. Use the crimp tool to crimp the connector to the wire leads.

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Mechanical Preparations of the Hydrophone Container:

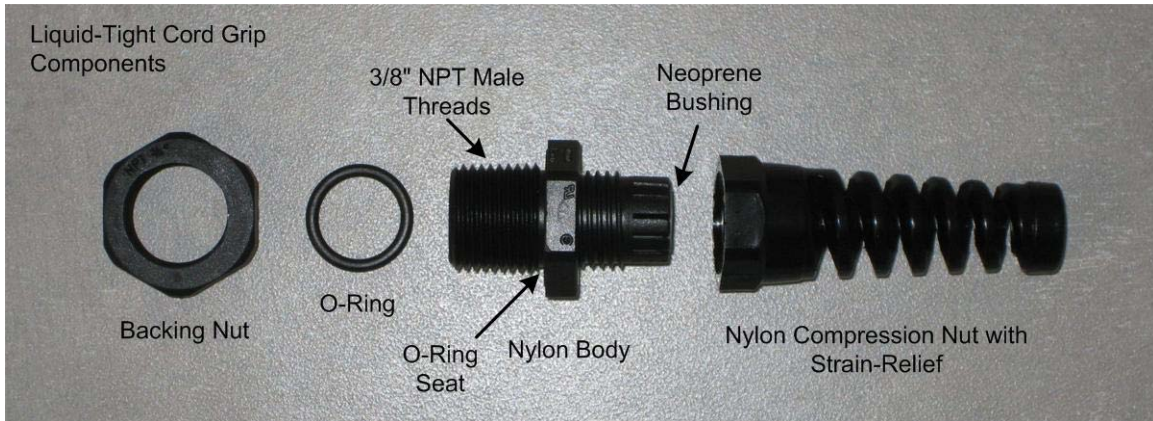


The hydrophone container is the underwater component of the system designed to provide a watertight enclosure in which to house the microphone element. In this design, the hydrophone container utilizes simple nylon and stainless steel parts that seal to one another by means of compression.

All threaded components utilize National Pipe Thread (NPT) tapered threads to form a compression seal between interlocking threads. When installing an NPT fitting, thread the two components together by hand until they are "hand tight". Next, using a suitable wrench, tighten the fittings another 1-1/2 to 3 turns past finger tight to complete the installation. Caution: never loosen an installed NPT fitting. Loosening installed NPT fittings may compromise the seal and contribute to leakage and/or failure.

- 1) Following the description above for installing NPT fittings, thread the tube fitting into the stainless steel (SS) threaded pipe coupling until the two units are properly secured. If available, vise-grip pliers are a useful tool for holding cylindrical objects like the SS pipe coupling.

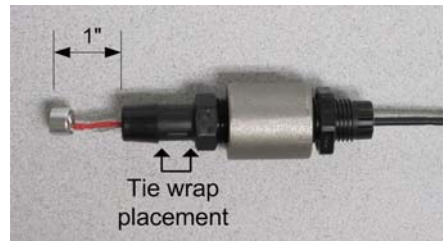




- 2) Working with the liquid-tight cord grip, remove the compression nut with strain-relief from the nylon body and set the compression nut aside for later use.
- 3) If the liquid-tight cord grip came assembled with the backing nut threaded to the nylon body, remove the backing nut and set aside. This nut will not be required for the hydrophone assembly.
- 4) Take the O-ring supplied with the cord grip assembly and feed it over the NPT male threaded end of the nylon body until it fits within the O-ring seat on the underside of the built-in nut (see diagram above)
- 5) Thread the nylon body of the cord grip into the open end of the stainless steel (SS) threaded pipe coupling until the two units are properly secured.



- 6) Working from the tube fitting end of the hydrophone container, feed the hydrophone cable through the container and out the end of the cord grip body. Continue feeding the remaining length of cable through the hydrophone container, until the cloth head of the microphone is approximately 1" from the end of the tube fitting.



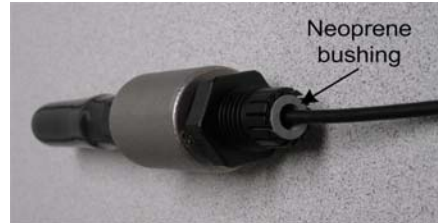
- 7) Slide the push-on nylon cap over the microphone element and tube fitting end of the hydrophone container until it bottoms out against the built-in nut.



- 8) Install each of the tie wraps over the push-on nylon cap and cinch down securely, compressing the cap against the outside of the tube fitting. These tie wraps should be positioned over the cap and within the tie-wrap channel of the tube fitting (see step 6 diagram above).



- 9) Holding the assembly in one hand, gently push the hydrophone cable into the hydrophone container until you feel a slight resistance. This should be the point at which the microphone element is touching the interior end of the nylon cap.



With the cable in place, view the point at which the hydrophone cable penetrates the nylon body of the cord grip. You will see a gray neoprene bushing around the hydrophone cable and within the cord grip body. When compressed, this bushing will form a watertight seal around the outer jacket of the hydrophone cable. This seal will be ineffective if the neoprene bushing is compressed against the individual conductors of the hydrophone cable rather than the outer jacket of this cable. You must therefore ensure that the outer jacket of the hydrophone cable is completely within the neoprene bushing before proceeding on to the next step.

- 10) Slide the nylon compression nut with strain-relief over the length of hydrophone cable until you reach the hydrophone container assembly. With the outer jacket of the hydrophone cable positioned appropriately within the neoprene bushing, thread the compression nut onto the body of the cord grip, tightening it fully.



- 11) Ensure that an appropriate seal is made between the cord grip and the hydrophone cable by pulling on the cable with slight to moderate force as it exits the hydrophone container assembly. You should not feel any movement between the cable and the container if the seal is in place.

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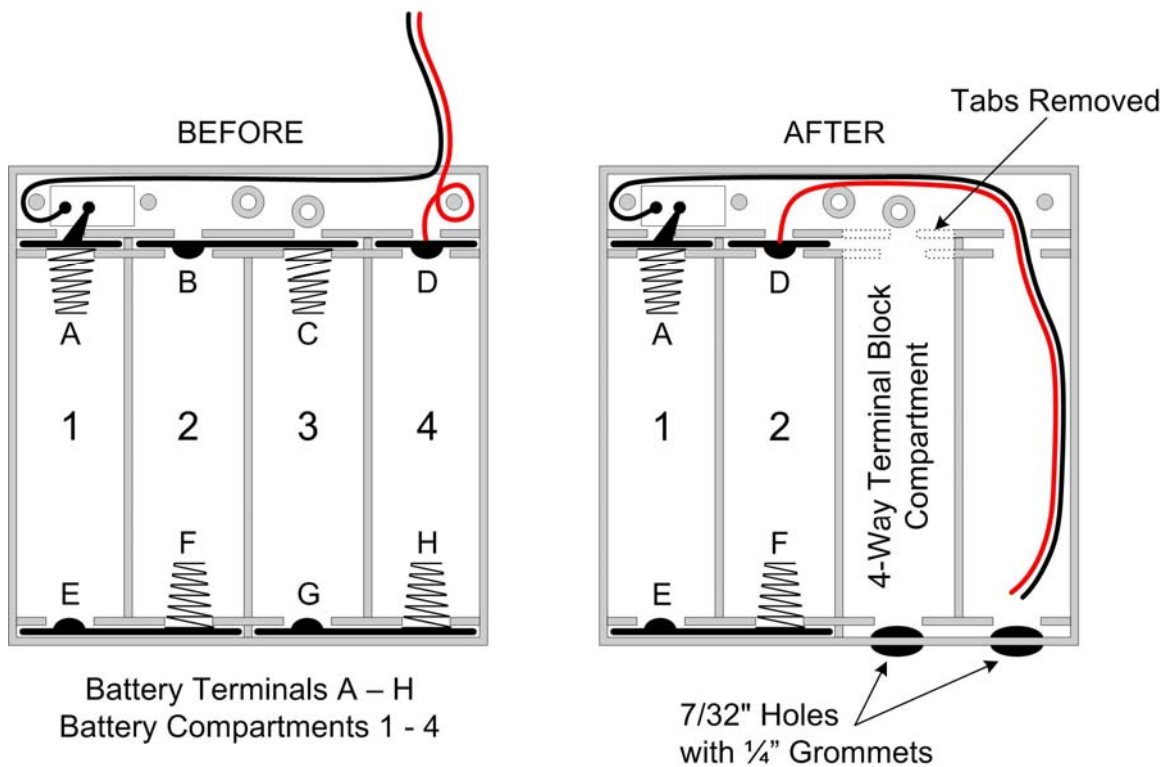
Mechanical Preparations of the Battery/Terminal Enclosure:



The battery/terminal enclosure provides a single, splash-proof environment for the provision of power to the hydrophone as well as for connections between the hydrophone cable and the output cable. The basis for this enclosure is a simple 4 “AA” on/off battery holder that you will modify to accommodate the required 2 “AA” batteries and terminal block, necessary to make the final connections.

- 1) Remove the Phillips head screw securing the outside cover of the “AA” battery holder and remove the cover. Set the cover and screw aside for later use.
- 2) Remove the Phillips head screw securing the plastic wire cover within the battery holder and pry off the cover with a small flathead screwdriver. Note: in addition to the Phillips head screw, there are three plastic melted grommets securing the wire cover to the battery holder base. In prying off the cover, the heads of these grommets will snap off releasing the cover for removal. Set the wire cover and screw aside for later use.





- 3) Using a small flathead screwdriver, pry out and remove battery terminals B-C, D, & G-H. Note the orientation of terminal D as it will be reused in a different terminal location. In removing terminal D, the red wire will need to be fed into the battery holder, through the exterior hole in the enclosure. Similarly, feed the black wire through the same hole and route this wire into battery compartment 4. Discard terminals B-C and G-H.
- 4) Insert terminal D into the slot previously occupied by terminal B and route the red wire into battery compartment 4 following the path of the black wire.
- 5) Using an electric drill or similar tool, center and drill two 7/32" holes through the sidewall of the battery holder centered on battery compartments 3 & 4.
- 6) Insert a 1/4" rubber grommet into each of the 7/32" holes drilled through the sidewall of the battery holder. You may find that a small flathead screwdriver is helpful with this task.

You will note that the 4-circuit terminal block, as delivered, is too long to fit within the "AA" battery compartments. Depending on available tools or individual preferences, two options are provided to address this challenge. Option A employs the use of a hack saw to shorten the length of the terminal block itself, while option B requires the use of a razor knife or similar tool to remove interior

partitions of the battery holder to accommodate the full length of the terminal block.

- 7) Option A: Using a hack saw, remove one end of the 4-circuit terminal block up to the outside edge of the first terminal divider. This removes an unnecessary portion of the terminal block while enabling it to fit comfortably within the battery compartment 3.



- Option B: Using a razor knife, or similar tool, cut away and remove the four plastic tabs at the topmost end of battery compartment 3 (see the dashed lines on the diagram above depicting the tabs to be removed). This will form a compartment of sufficient size to fit the 4-way terminal strip.
- 8) Insert the 4-way terminal block into battery compartment 3.
 - 9) Replace the wire cover removed previously and secure it with the Phillips head screw.
 - 10) Cut each of the red and black battery wires approximately 2-1/2" from the point at which they enter battery compartment 4.
 - 11) Using the #24 AWG wire stripper, strip approximately 1/2" of insulation from the end of each wire.

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Final Assembly and Wiring of the Battery/Terminal Enclosure:



In this final step, the hydrophone and output cables will be prepared and connected together along with the remaining components within the battery/terminal enclosure.

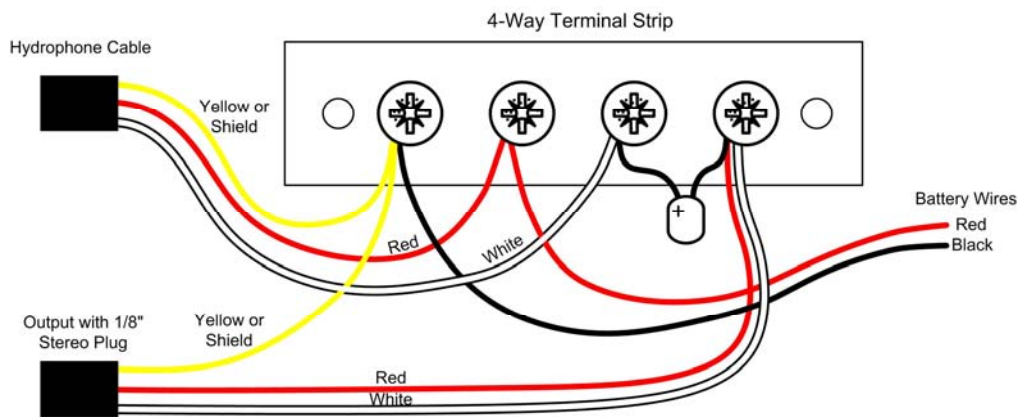
A screw-type terminal block will be utilized to enable all necessary topside connections for this hydrophone assembly. Screw terminals form an electrical bond between two or more conductors by joining and securing wires between the head of a screw and a conductive plate. When connecting multiple stranded wires under one terminal, it is recommended that these wires be twisted together before making the final connection. It is also recommended that all conductors be inserted under the left-hand side of the screw to ensure that they are pulled into the terminal as the screw is tightened.



- 1) Working with both the hydrophone and output cables, strip back and remove approximately 3" of the outer cable jackets, exposing the

individual wire leads within. Note, the #14 AWG wire stripper works well for this task. Be careful not to penetrate the insulation of the wires inside.

- 2) Using the #26 AWG wire stripper, strip approximately 1/2" of insulation from the end of each wire.
- 3) Working with the hydrophone battery/terminal enclosure, insert the un-terminated end of the hydrophone cable into the enclosure, routing it through the inner-most grommet. The outer jacket of the cable should be captured by the grommet and just penetrate the enclosure.
- 4) Insert the un-terminated end of the output cable into the hydrophone battery/terminal enclosure, routing it through the outer-most grommet.
- 5) Following the wiring diagram below, attach each of the wires and capacitor leads to the terminals of the 4-way terminal block. Take note of the mark on the capacitor indicating the + lead on this component.



Note: if the hydrophone and output cables contain un-insulated shield wires, it is recommended to make them as short as possible to connect to the terminal while ensuring that no wire strands make contact with any other terminals.

- 6) With all wires connected accordingly, insert two AA batteries
- 7) Slide the cover onto the hydrophone battery/terminal enclosure and replace the Phillips head screw securing the cover in place.

Congratulations: You have just completed the fabrication and wiring of your hydrophone assembly.