

COSEE-TEK ~ University of Connecticut Underwater Camera for the SeaPerch ROV

Material List and Fabrication Instructions
Version 1.0d (6/12/2016)
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COSEE-TEK ~ University of Connecticut
Underwater Camera Design - Basic Material List



Hydrophone Components		
Description	Vendor	Part Number
Reusable Adhesive Putty, 1-Ounce Package	McMaster-Carr	7576A2
PVC Pipe Fitting, 1 Pipe End Male X 3/8 NPT Female	McMaster-Carr	4880K826
PVC Pipe Fitting, 1-1/2 Pipe Size X 1-1/4" Pipe Extender	McMaster-Carr	4880K735
PVC Pipe Fitting, 1-1/2 Pipe Size, Union, Female to Female	McMaster-Carr	4880K305
Acrylic Circle, UV-Resistant, 3" Diameter, 1/8" Thick	McMaster-Carr	8581K23
Nylon Liquid-Tight Cord Grip, 3/8" NPT, .08"-.24" Dia.	McMaster-Carr	69915K62
Alligator Clip, Screw-Down Connection, with Black Sleeve	McMaster-Carr	7236K36
Alligator Clip, Screw-Down Connection, with Red Sleeve	McMaster-Carr	7236K33
DAL 700TVL FPV HD 1/4" CMOS Camera Module	Banggood	SKU183213
50ft 3.5mm Mini-Stereo Male to Female Extension Cable	MyCableMart	FS-3MM-50MF
6ft 3.5mm Mini-Stereo Male to Two RCA Male Audio Cable	MyCableMart	FS-3MM-MRCA-06

Note: McMaster-Carr is an online reseller of industrial supplies (see www.mcmaster.com).
Banggood is an online reseller of electronics & other supplies (see <http://www.banggood.com>).
MyCableMart.com is an online reseller of audio and video cables (see www.mycablemart.com).
See Appendix 2 for the complete material list.

COSEE-TEK ~ University of Connecticut
Underwater Camera Design – Overview & Component Description

The COSEE-TEK SeaPerch Camera Design, Version 1.0 project has been developed to offer a simple, functional, and affordable underwater camera to accompany and enhance the capabilities of the SeaPerch ROV. This document and activity provides a complete material list (Appendix 3), fabrication instructions, and detailed schematics (Appendix 2) to enable the construction of a turnkey underwater camera system for completion within a single laboratory or classroom session.

Underwater Camera Components:

The underwater camera design presented through this activity demonstrates the use of simple and affordable components for the construction of a useful and functional scientific tool to enhance and expand the basic capabilities of the SeaPerch ROV. The complete underwater camera system has been designed to offer a turnkey solution through the inclusion of three major system components; 1) camera housing; 2) camera cable; and 3) power/video adapter.



The camera housing is the underwater component of the system designed to provide a watertight enclosure in which to house the board camera module as well as all associated electrical connections. This container is fabricated from simple PVC pipe fittings, an acrylic disc and nylon liquid-tight cord grip. The PVC fittings provide a suitable enclosure for the board camera module and electrical components, while the cord grip with strain-relief secures and seals the cable as it enters the camera housing and provides strain relief for the cable at this point of entry. A clear acrylic disc functions as a flat-port for the camera, sealing against the o-ring of the PVC union. Adhesive putty is used to hold the camera module in position against the acrylic disc.



The camera cable is the component of the system designed to carry power down to the camera module and the video signal back to the surface. The black PVC jacket of the camera cable provides a watertight layer surrounding the individual conductors of this cable, while the 3.5mm female stereo plug provides an ideal means of connecting the camera to the surface-mounted components.



The power/video adapter cable is the component of the system designed to distribute the conductors of the camera cable between the topside power source and a suitable video monitor.

COSEE-TEK ~ University of Connecticut
Underwater Camera Design – Fabrication Steps

Recommended Tools and Supplies:

1. Scissors
2. Ruler or tape measure
3. Ohmmeter or multimeter
4. Wire strippers (#26AWG to #14AWG)
5. Soldering iron and solder
6. Diagonal cutters
7. Small flat head screwdriver
8. Adjustable or open-ended wrenches
9. Belt sander or disc sander
10. Small rubber drum with sanding sleeve for an electric drill, Dremel or similar rotary tool
11. Electrical tape (left over from the SeaPerch kit), or heat shrink tubing
12. PVC cement
13. Fine tip marker (from SeaPerch kit)
14. Rubber gloves
15. Safety glasses (from SeaPerch kit)

Preparations of Primary Components:

See Appendix 2 for a complete assembly schematic

The following steps outline the preparation of the three underwater camera components described in the previous section of this document (Camera Housing; Camera Cable; Power/Video Adapter Cable).

Preparation of the Camera Housing and Camera Module:



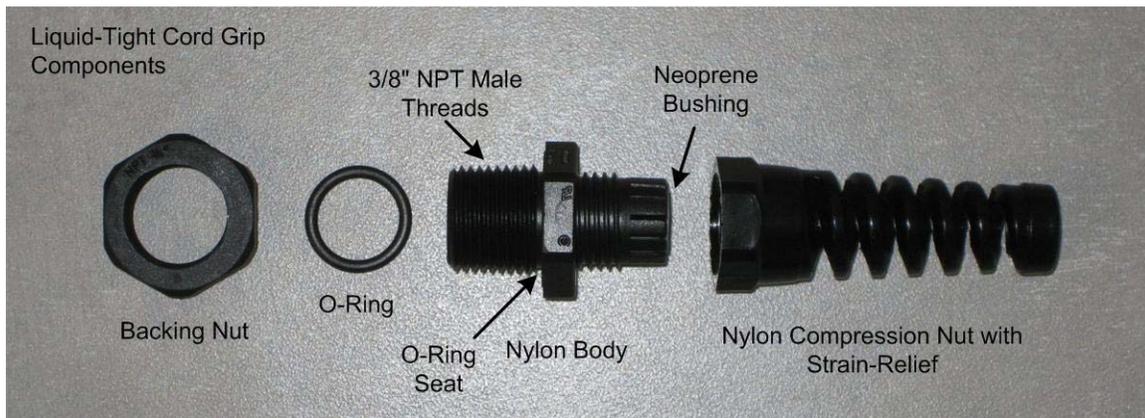
The camera housing incorporates simple nylon and PVC components that press fit together, or utilize threaded compression fittings to connect to one another. Note, all fittings that press fit require PVC cement to seal against water incursion.

- 1) Working with the PVC pipe union, unthread and remove the central threaded coupler (i.e. collar nut) from the half of the union having the o-ring face.
- 2) Continue to separate the other two components of the PVC union by removing the other half of the union from within the threaded coupler.
- 3) Set the half of the PVC union (without o-ring face) onto the acrylic disc with the larger diameter of the union centered and face down.
- 4) Using a fine tip marker, draw the large diameter outline of the PVC union onto the face of the acrylic disc. Note, this half of the PVC union will not be used for any other portion of this project and may be set aside or discarded.
- 5) Using a belt sander, disc sander, or sanding drum, remove material from the outside edge of the acrylic disc, working around the perimeter and inward until you reach the circular outline marked in the previous step. The end result should be a circular disc having an outside diameter of approximately 2-1/2" inches. Test fit the finished disc into the large diameter opening of the central threaded coupler of the PVC union. The disc should fit snugly within the coupler and up against the inside face of the small diameter end of this fitting. If the disc is too large to fit within the coupler of the PVC union, continue to remove small amounts of material from around the perimeter of the disc until it fits correctly.
- 6) Using an electric drill or rotary tool (e.g. Dremel), with a small rubber drum with sanding sleeve (approximately 1/2" diameter), expand the inside diameter of the small end of the PVC pipe extender uniformly until the PVC pipe bushing fits snugly inside. Note, the PVC pipe bushing should be able to be inserted fully into the PVC pipe extender to within 1/4" of the octagonal portion of the PVC pipe bushing. Remove the PVC bushing from the PVC pipe extender before proceeding with the following steps.
- 7) Put on the rubber gloves to protect your hands prior to working with the PVC cement.
- 8) Using the applicator of the PVC cement, spread the liquid cement liberally around the perimeter (rounded portion only) of the PVC pipe bushing and within the small end of the PVC pipe extender.



Insert the bushing as far as possible into the small end of the PVC pipe extender. Use a rubber mallet, if available, to tap the bushing fully into the pipe extender.

- 9) In a similar fashion to the previous step, spread the liquid cement around the large diameter perimeter of the PVC pipe extender as well as within the female end of the half of the PVC union having the o-ring face. Insert this fitting as far as possible into the female end of the PVC union having the o-ring face.



The nylon liquid-tight cord grip provides a flexible means of terminating and securing the camera cable into the body of the camera housing and sealing the housing from water incursion. Note, NPT stands for National Pipe Thread which is a U.S. standard for tapered threads used on threaded pipes and fittings.

- 10) Working with the liquid-tight cord grip, remove the nylon compression nut with strain-relief from the nylon body and set the compression nut aside for future use.
- 11) If the liquid-tight cord grip came assembled with the backing nut threaded to the nylon body, remove the backing nut and set it aside. The backing nut is not required for this activity and may be discarded or repurposed.
- 12) Slide the o-ring over the 3/8" NPT male threads of the nylon body until it is positioned within the o-ring seat (see figure above).
- 13) Thread the 3/8" NPT male threads of the nylon liquid-tight cord grip into the PVC pipe bushing until the o-ring is slightly compressed against the face of the pipe bushing. If Teflon tape is available, wrap the threads of the cord grip in a clockwise direction (as viewed from the end



with 3/8" NPT threads) before threading this piece into the PVC pipe bushing.

- 14) With your camera housing complete, center and insert your camera module, lens first into your camera housing until the surface of the camera board rests on the surface of the PVC union having the o-ring face. When centered accordingly, the four corners of the camera board should rest just inside the o-ring of the PVC union.



- 15) Using your fine-tip marker, mark across the back of your camera board indicating the amount of material that will need to be removed for the camera module to fit within the camera housing. Ensure that no components on your camera board will be impacted by the removal of material before proceeding.

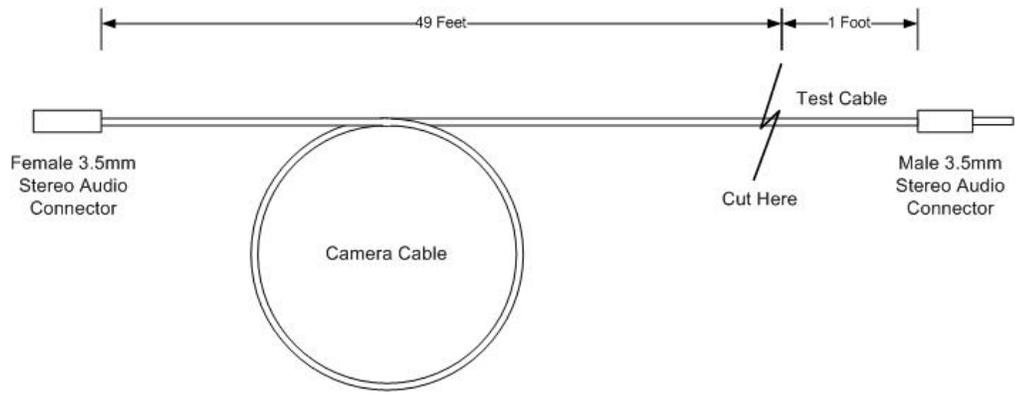
- 16) Put on your safety glasses and using your diagonal cutters, carefully snip off small amounts of board material from each of the four corners until you reach the cut lines made in the previous step. Test the fit of the camera module within the camera housing and continue removing material until the board fits on center within the camera housing.



Preparation of the Camera Cable:

In the following steps you will prepare the camera cable used to carry camera power and video signal between topside equipment and the camera housing mounted on the ROV. This cable should be of sufficient length to marry to the SeaPerch ROV umbilical (approximately 50'), while having one end terminated with a 3.5mm female connector and the other end cut to expose the individual wire leads within. These leads will eventually be connected to the camera module connector cable used within the camera housing. An additional test cable will also be made from the original audio cable to assist in determining the relationship between pins of the 3.5mm connector and wires within the camera cable itself.

- 17) To begin, use your diagonal cutters to cut off the 3.5mm male connector approximately 1' (foot) from the male end of the cable. This will provide you with a camera cable of the maximum length having one 3.5mm female connector at one end and flying leads at the other, and a test cable having one 3.5mm male connector with flying leads.



Camera and test cables from 50' stereo audio cable with 3.5mm female to 3.5mm male connectors.

- 18) Working from the cut ends of both camera and test cables, strip back and remove approximately 1" of the outer cable jacket, exposing the individual wire leads within. Note, the #12 or #14 AWG wire stripper works well for this task. Be careful not to penetrate the insulation of the wires inside.
- 19) Using the #26 AWG wire stripper, strip approximately 1/4" of insulation from the ends of the individual wires. Be careful not to cut any of the copper conductors within the insulation.
- 20) Using the ohmmeter (or multimeter) and referring the diagram below, identify and document the wire colors (or wire type) associated with the tip, ring and sleeve of the 3.5mm male stereo connector attached to your test cable. Complete the empty cells of Table 1. below (shaded in blue) to assist you in documenting the relationship between connector pins and wire colors or wire type (e.g. shield wire) for your specific cable.

3.5mm Male Stereo Plug (3 conductor)



Table 1.

3.5mm Male Connector	Camera Cable Wire Color/Type
Tip	
Ring	
Sleeve	

To accomplish this step, you must first set your ohmmeter (or multimeter) to measure resistance in ohms, or to the continuity beeper (audible tone) setting. Holding one probe of the meter in contact with one of the pins on the 3.5mm male connector, use the second meter probe to make contact with each of the exposed wire leads until you identify the conductor (e.g. wire) that is connected to the pin you are probing. With the meter set to ohms, you should see a low resistance (e.g. less than 10 Ohms) when you make a connection across a common conductor, or you will hear an

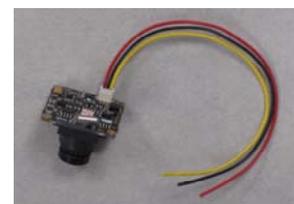
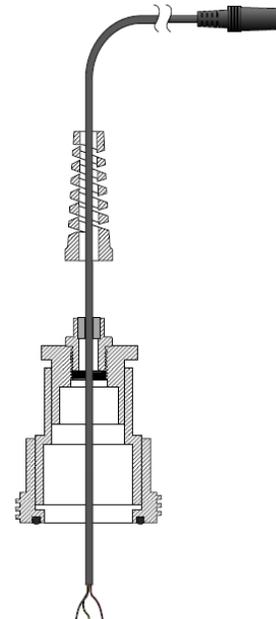
audible tone if your meter is set as such. Once you identify the particular wire that shows continuity to the pin you are probing, document the wire color or wire type (e.g. shield wire) in Table 1. and repeat the process for each of the remaining pins of the connector until you have completed the relationship table. Note, even after you have identified a particular wire associated with the pin you are probing, it is a good idea to probe all remaining wires to ensure you see no continuity to other wires of your cable.



Ω Resistance (Ohms)
))) Continuity beeper

Electrical Connections within the Camera Housing:

- 21) Feed the cut end of the camera cable through the nylon compression nut with strain-relief, and through the cord grip end of the camera housing. When feeding the cable through the nylon compression nut with strain relief, ensure the female threaded portion of the compression nut is pointed toward the camera housing but do not thread the compression nut onto the nylon body of the cord grip as of yet.
- 22) Plug the camera module connector cable into the appropriate connector on the back side of the camera module. Note, this cable likely came pre-terminated with a connector on each end. Only one of these connectors is suitable for making a connection to the camera module. The other connector will be removed in the following step.
- 23) With the camera module connector cable plugged into the camera module, use your diagonal cutters to clip off the unused connector from the opposite cable end. You should now be left with a short cable of approximately 4" in length, having a



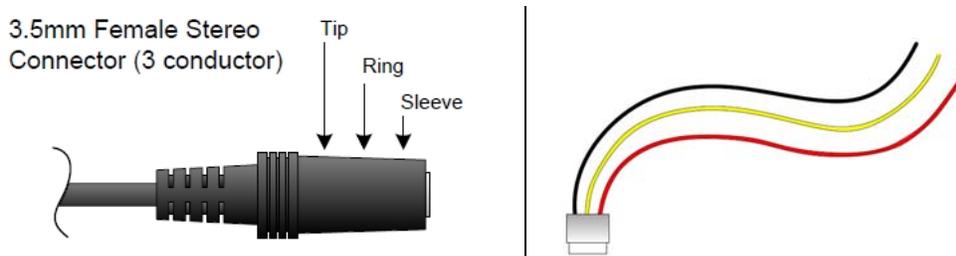
connector at one end and flying leads at the other. Unplug the connector from the back of the camera module and set the module aside for future use.

- 24) Working with the connector cable, use the #26 AWG wire stripper to strip approximately 1/4" of insulation from the ends of the individual wires. Be careful not to cut any of the copper conductors within the insulation.
- 25) Working with both the connector cable and camera cable, use your soldering iron and solder to tin the ends of each of the exposed wire leads. Tinning is the process of heating and melting solder into the exposed ends of stranded wire for the purpose of making the wire more rigid and simplifying solder connections between two or more electrical components.

To tin a wire, apply the tip of your soldering iron to the wire for a few seconds until the wire strands are sufficiently heated. With the tip of the iron still in contact with the wire, touch the solder to the wire. The solder should flow freely onto the wire and coat it.

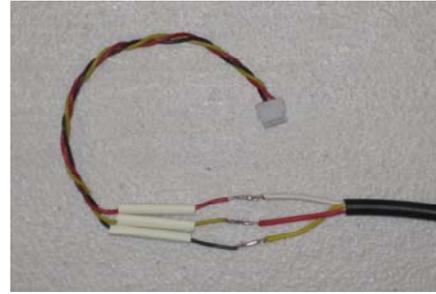
- 26) If heat shrink tubing is available, cut three pieces of small diameter tubing (1/16" to 1/8" dia.) approximately 1/2" in length and slide one piece of tubing over each of the three wires of the connector cable. Be sure to slide the tubing down the wire a sufficient distance to ensure it doesn't shrink while soldering the wires in the following step.
- 27) Transfer the cells you completed in Table 1. to the corresponding cells in the following table (Table 2.) to document the relationship between wires that will be connected together in the following step. Note, the wire color/type associated with the pins of the 3.5mm female connector will be the same as that of the male connector tested previously.

Table 2.



3.5mm Female Connector	Camera Cable Wire Color/Type	Camera Module Connector Cable
Tip (Power)		Red
Ring (Video)		Yellow
Sleeve (Common)		Black

28) Referencing Table 2, match each of the three wires from your camera cable to the corresponding wires of your camera module connector cable. Working with one wire pair at a time, align the wires parallel to and against one another, with the tip of one wire touching the insulation of the other. Using your soldering iron, heat and join the two wires of each corresponding pair. Repeat this process for all three wire pairs.

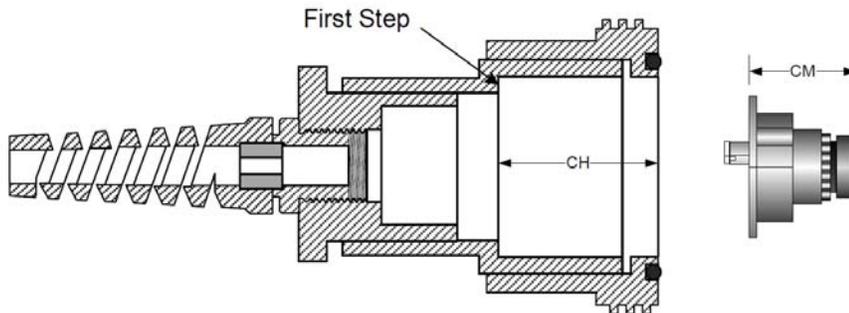


29) If heat shrink tubing was used, slide the tubing over the exposed wire connections, and using a suitable heat source, shrink the tubing in place covering all exposed wires. Otherwise, cut three pieces of electrical tape approximately 3/8" x 3/4" and roll each piece tightly around each of the exposed wire connections.

30) With all connections made, gently pull the camera cable back through the nylon cord grip until the end of the black jacket of this cable is even with the bottom of the camera housing.

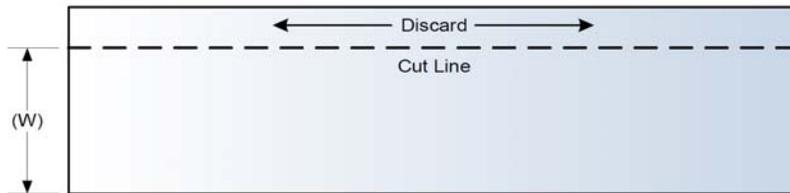
31) Slide the strain relief up the cable and holding the camera housing in one hand, tighten the compression nut with strain relief fully against the nylon body of the liquid-tight cord grip. When fully tightened, little or no space should be visible between the two components of the cord grip and the camera cable should be held securely in place.

32) Using your ruler or other measuring device, measure the distance indicated as "CH" on the diagram below, from the face of the camera housing to the first step of the PVC fitting within this housing. Next, remove the lens cover and measure the depth of the camera module, from the face of the lens to the back side of the printed circuit board (CM). Replace the lens cover to protect the camera lens. Subtract CM from CH to determine the Width (W) of the putty strips to be cut in the following step.

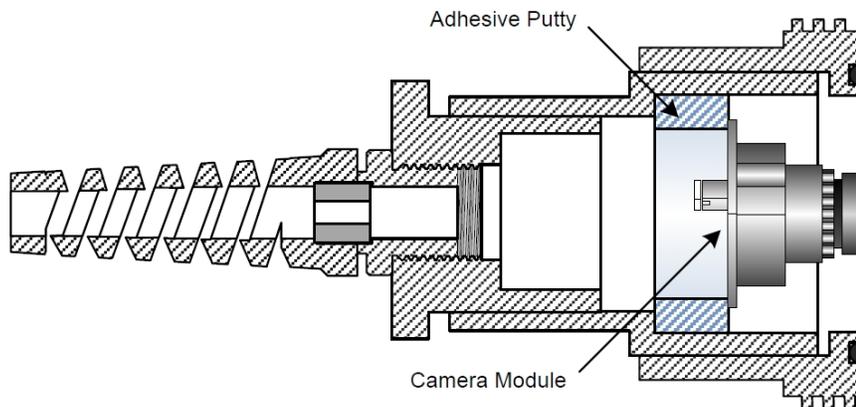


$$CH - CM = \text{Width (W)}$$

- 33) Open the pack of adhesive putty and remove two pieces to work with. Using your ruler, mark each piece of putty lengthwise to the Width (W) determined in the previous step (see diagram below). Using your scissors, cut each piece of putty along the marked line and retain the pieces having final dimensions of approximately 2" by W". The remaining pieces of putty may be discarded or used for another purpose.



- 34) Hold the two pieces of putty together end to end, forming a single piece approximately 4" in length by W" in width, and place it around the inside perimeter of the camera housing, down against the first step of the PVC fitting. See the diagram below for placement guidance. You should end up with a small gap between the two opposite ends of the putty as the total length of putty is less than the interior circumference of the PVC pipe. This putty will form a shelf on which to place and secure the camera module while the gap in the putty will allow the connector cable an avenue to pass into the lower compartment of the camera housing.



- 35) Plug the connector cable into the back of the camera module, and with the lens facing outward, insert the module down inside the housing and against the surface of the adhesive putty. Ensure the connector on the rear side of the camera module is positioned within the gap in the putty

and all wires are tucked into the lower compartment of the camera housing as you insert the module into place. When inserted correctly, the lens of the camera should be almost flush with the surface of the PVC union having the o-ring face.

36) Peel the blue protective layer from both sides of the acrylic disc and insert the disc into the threaded coupler of the PVC union.

37) Gently clean both sides of the acrylic disc (if necessary) and the lens of the camera module and thread the union coupler over the end of the camera housing until the entire face of the o-ring is partially compressed by the inside face of the acrylic disc.

Preparation of the Power/Video Adapter Cable:

38) Working with your 6ft adapter cable, shown here, use your ohmmeter (or multimeter) to identify the relationship between the tip, ring and sleeve of the 3.5mm male stereo connector, and the tip, sleeve and color of each RCA connector. Complete the empty cells in Table 3. below (shaded in blue) to assist you in documenting the relationship between these three connectors. You will notice that the sleeve of the 3.5mm connector will connect to the sleeves of both the black and red RCA connectors. Note, no cables should be cut to complete this step of the instructions.



Table 3.

3.5mm Male Stereo Plug (3 conductor)



Male RCA Plug (2 conductor)



3.5mm Male Connector	RCA Connector Color	RCA Tip/Sleeve
Tip (Power)		Tip
Ring (Video)		Tip
Sleeve (Common)	Black & Red	Sleeve

39) Working with your 6ft adapter cable and referencing Table 3. above, cut off the RCA connector associated with the tip of the 3.5mm male connector. This will be the connector listed in the first row of Table 3.

40) Working from the cut end of this wire, strip back and remove approximately 4" of the outer cable jacket, exposing the individual wire leads within. Note, the #12 or #14 AWG wire stripper works well for this task. It is recommended to remove small sections of the outer cable jacket at a time, being careful not to penetrate the insulation of the wires inside.



41) Using the #26 AWG wire stripper, strip approximately 3/4" of insulation from the ends of the individual wires. Be careful not to cut any of the copper conductors within the insulation.

42) Using the ohmmeter (or multimeter) and referring to the diagram below, identify and document the wire colors associated with the tip and sleeve of the 3.5mm male connector attached to this cable. Note, the ring of the 3.5mm male connector, connects to the tip of the other RCA connector. Use the partially completed table below to document the relationship between connector pins and wire colors within the adapter cable.

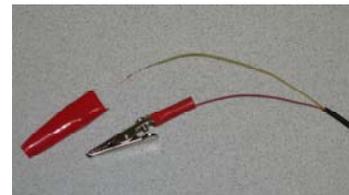
Table 4.

3.5mm Male Stereo Plug (3 conductor)



3.5mm Male Connector	Adapter Cable Wire Color/Type	Alligator Clip Color
Tip (Power)		Red
Sleeve (Common)		Black

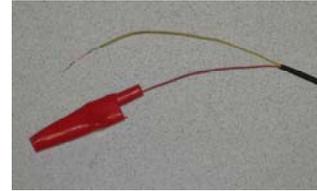
43) Working with one of your alligator clips, remove the colored sleeve protecting the clip. Referencing Table 4, match the wire color of the adapter cable to the color of the alligator clip protection sleeve you are working. Twist the exposed leads of the wire together and secure them to the alligator clip using the screw provided. Note, when connecting stranded wire to a screw terminal, it is often useful to twist the wire strands together and twist them around the screw in a clockwise direction (viewed from above) before tightening the screw to secure the



wire. Tinning the exposed wire strands to make them more ridged will also simplify the connection process.

44) Slide the protection sleeve over the alligator clip, fully covering the wires and terminal within.

45) Repeat steps 43 and 44 for the other alligator clip and corresponding wire of the adapter cable.



Testing and Use of your Underwater Camera:

Whenever you use your SeaPerch underwater camera, you must first plug the 3.5mm male connector of your adapter cable into the 3.5mm female connector of your camera cable. Failure to make this connection before connecting the camera power may result in a 12V electric shock and/or discharge the battery.

With the two cables connected, plug the RCA connector of your adapter cable into the input jack of a suitable video monitor and connect the alligator clips to the appropriate terminals of a 12Vdc battery (red to positive and black to negative). Note, the SeaPerch ROV battery works well for this application although you may experience some video noise as a result of running the camera and thrusters from the same power source. Using a secondary 12Vdc power source to power the camera will alleviate this problem.

With the camera powered on, rotate your camera housing until the image is oriented correctly on the video screen and mark the outside top of the camera housing to indicate the "UP" position for the camera.

Note, before underwater use, you will want to secure your camera to a suitable location on your SeaPerch ROV and should marry the camera cable and SeaPerch umbilical together with a double wrap of electrical tape every 1'-2' from the SeaPerch ROV to the topside connections.

See Appendix 2 for a complete assembly schematic

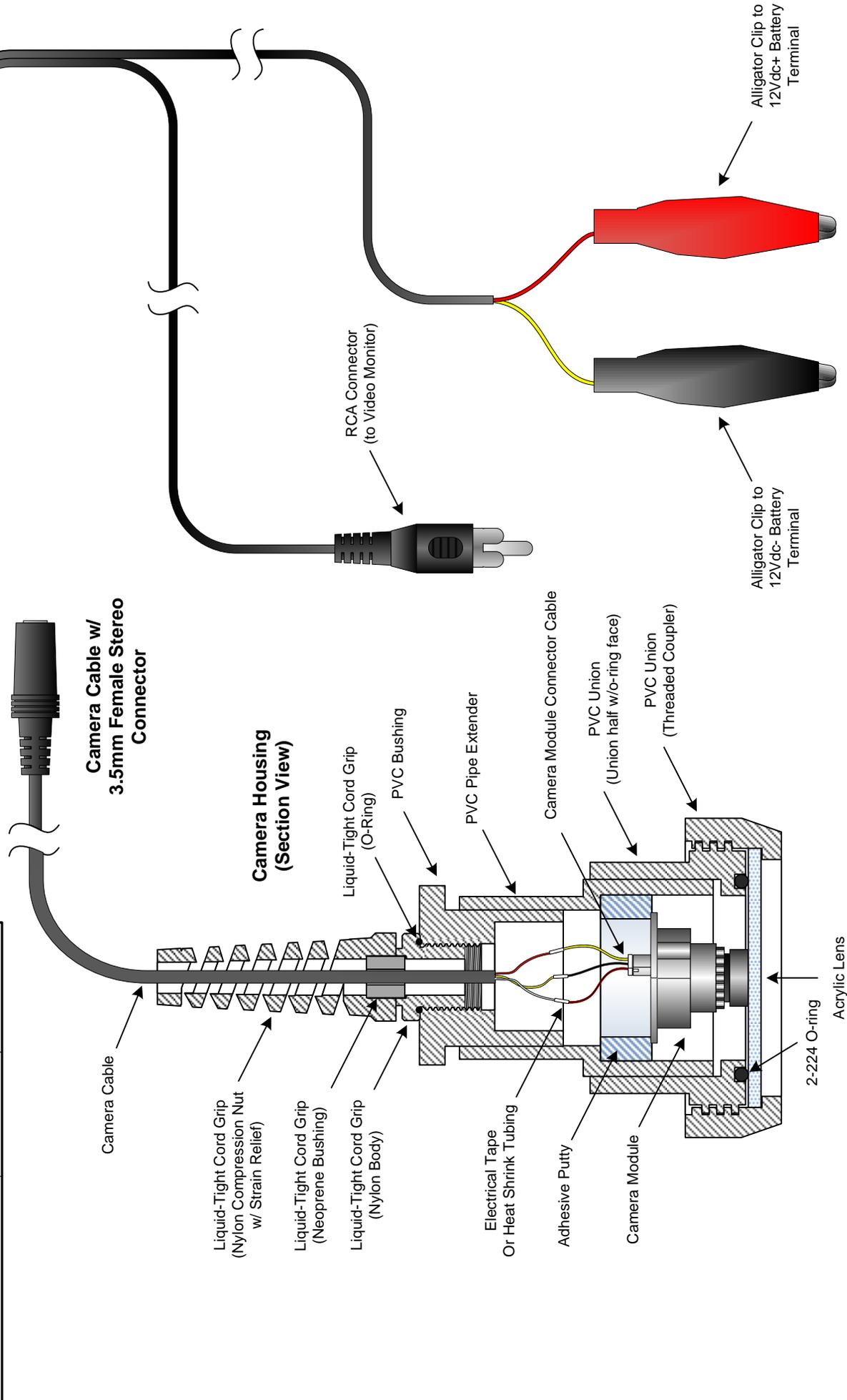
Simplified Instructions for Camera Fabrication:

1. Begin by separating the components of the PVC pipe union.
2. Remove material from the circumference of the acrylic disc to approximately 2-1/2" in diameter and just fits within the collar nut of the PVC pipe union.
3. Remove material from the inside diameter of the PVC pipe extender to accommodate the installation of the PVC pipe bushing.
4. Wearing rubber gloves, and using PVC cement, install the PVC pipe bushing into the PVC pipe extender.
5. Similarly, install the PVC pipe extender into the component of the PVC pipe union having the o-ring face.
6. Complete assembling the camera housing by attaching the body of the liquid-tight cord grip to the outside of the PVC pipe bushing, compressing the o-ring.
7. Mark and cut off the corners of the camera board so it just fits within the camera housing. Be sure to avoid cutting any electrical components on the board itself.
8. Cut the 3.5mm male stereo connector off approximately 1' from the end of the 50' stereo cord.
9. Strip and remove 1" of outer jacket from the end of both cables resulting from step 8 above.
10. Strip and remove 1/4" of insulation from the ends of all wires.
11. Complete the connector/cable relationship table (Table 1) by testing for continuity across the associated wire leads and connector pins.
12. Insert the cut end of the camera cable through the nylon compression nut w/strain relief and cord-grip end of the camera housing.
13. Remove the unused connector from the end of the camera module connector cable. This is the connector unsuitable for connecting to the camera module.
14. Strip and remove 1/4" of insulation from the ends of the three wires.
15. Tin the exposed wire ends of both the camera and connector cables.
16. Add heat shrink tubing to the wires of the connector cable if available.
17. Transfer the cells from Table 1 to Table 2 and solder together the corresponding wires of both the camera and connector cables.
18. Cover and insulate the exposed wire connections with the heat shrink tubing or an electrical tape wrap.
19. Pull the camera cable back through the liquid-tight cord grip until the jacket end is flush with the bottom of the PVC bushing.
20. Fully tighten the compression nut to the body of the liquid-tight cord grip.
21. Measure to determine the difference between the depth of the camera module and the depth of the camera housing to the first inner step (W).

22. Cut two pieces of adhesive putty lengthwise, to a dimension of approximately 2" by W" from the previous step and attach the two pieces together end to end.
23. Position the putty inside and around the perimeter of the camera housing, against the first step of the PVC pipe extender.
24. Connect the camera and insert it into the housing, against the surface of the adhesive putty, ensuring the connector is within the gap in the putty.
25. Peel the blue protective layer from the acrylic disc and insert the disc into the collar nut.
26. Clean all lens surfaces and thread the collar nut with acrylic face onto the camera housing, sealing the acrylic against the o-ring.
27. Complete the connector/cable relationship table (Table 3) by testing for continuity across the connector pins of the adapter cable.
28. Working with the adapter cable, cut off the RCA connector associated with the tip of the 3.5mm male connector.
29. Strip and remove 4" of outer jacket from the cut end of the adapter cable.
30. Strip and remove 3/4" of insulation from the ends of all wires.
31. Complete the final connector/cable relationship table (Table 4) by testing for continuity across the associated wire leads and connector pins.
32. Remove the outer sleeves protecting the two alligator clips.
33. Insert the corresponding wires from the adapter cable through the open end of the alligator clips and connect the adapter cable wires to each alligator clip.
34. Slide the protection sleeves back in place over the alligator clips.
35. Plug the 3.5mm male connector of the adapter cable into the 3.5mm female connector of the camera cable and connect the RCA connector into the input jack of a suitable video monitor.
36. Connect the alligator clips to the appropriate battery terminals to power and test the system.
37. With the camera operational, mark the outside of the PVC pipe extender indicating the top of the camera.
38. Install your camera upright on your SeaPerch ROV and marry the ROV and camera cables together with electrical tape every 1'-2' from the ROV to the topside connections.

Northeast Underwater Research Technology & Education Center at the University of Connecticut
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Appendix 2		
COSEE TEK SeaPerch Camera Design Schematic (v.1d)		
Size Letter	Drawing No. SPCameraV1001	Rev. B
Date: July 6, 2016	Scale: 3/4 = 1	Sheet: 1 of 1



Power/Video Adapter Cable w/ 3.5mm Male Stereo Connector

Connector Sleeve ~ 12Vdc- / Video Shield
 Connector Ring ~ Video Signal
 Connector Tip ~ 12Vdc+

Camera Cable w/ 3.5mm Female Stereo Connector

Camera Housing (Section View)

RCA Connector (to Video Monitor)

Alligator Clip to 12Vdc+ Battery Terminal
 Alligator Clip to 12Vdc- Battery Terminal

Appendix 3.

Material & Price List for COSEE TEK Underwater Camera Version 1.0d ~ 6/16/2016

<u>Item</u>	<u># Req</u>	<u>Distributor</u>	<u>Distributor Part#</u>	<u>Total Price</u>
Reusable Adhesive Putty, 1-Ounce Package	1	McMaster-Carr	7576A2	\$2.95
PVC Pipe Fitting, 1 Pipe End Male X 3/8 NPT Female	1	McMaster-Carr	4880K826	\$0.94
PVC Pipe Fitting, 1-1/2 Pipe Size X 1-1/4" Pipe Extender	1	McMaster-Carr	4880K735	\$5.80
PVC Pipe Fitting, 1-1/2 Pipe Size, Union, Female X Female	1	McMaster-Carr	4880K305	\$9.23
Acrylic Circle, UV-Resistant, 3" Diameter, 1/8" Thick	1	McMaster-Carr	8581K23	\$3.71
Nylon Liquid-Tight Cord Grip, 3/8" NPT, .08"-.24" Cord Diameter	1	McMaster-Carr	69915K62	\$3.24
Alligator Clip, Screw-Down Connection with Black Sleeve	1	McMaster-Carr	7236K36	\$1.12
Alligator Clip, Screw-Down Connection with Red Sleeve	1	McMaster-Carr	7236K33	\$1.12
DAL 700TVL FPV HD 1/4" CMOS Camera Module Wide Angle	1	Banggood.com	SKU183213	\$9.44
50ft 3.5mm Mini-Stereo Male to Female Speaker/iPod/MP3 Extension Cable	1	MyCableMart.com	FS-3MM-50MF	\$3.30
6ft 3.5mm Mini-Stereo Male to Two RCA Male Audio Cable	1	MyCableMart.com	FS-3MM-MRCA-06	\$1.55
			Single Unit Price	\$42.40

Distributor Contact Information:

McMaster-Carr (www.mcmaster.com or 609-689-3415)

Banggood (<http://www.banggood.com>)

MyCableMart.com (<http://www.mycablemart.com>)