Signal Processing Research Group - Bioacoustics & Sonar,
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Underwater Acoustics Group
Bioacoustics & Sonar

DATA SHEET : ADG/PL/PREAMP1/JAN/95 (Last updated 6/2/95 - circuit diagram corrected)
FILE: PREAMP2.DOC (MS-Word format)

GENERAL PURPOSE BAND LIMITING PREAMPLIFIER.

This circuit is provided to suit the 'bender' hydrophone described in Technical Note 1 (Bender.doc). The amplifier circuit is easy to assemble and is quite stable up to +60dB using the recommended pcb layout with a ground plane (for gains above +40dB this should placed inside a screened box). Construction on 'vero' prototyping board' is also possible. It is a relatively low noise general purpose circuit, but it is always good practice to restrict the bandwidth to suit the application. The circuit should be self explanatory. All the components are easy to obtain though hobby electronic suppliers.

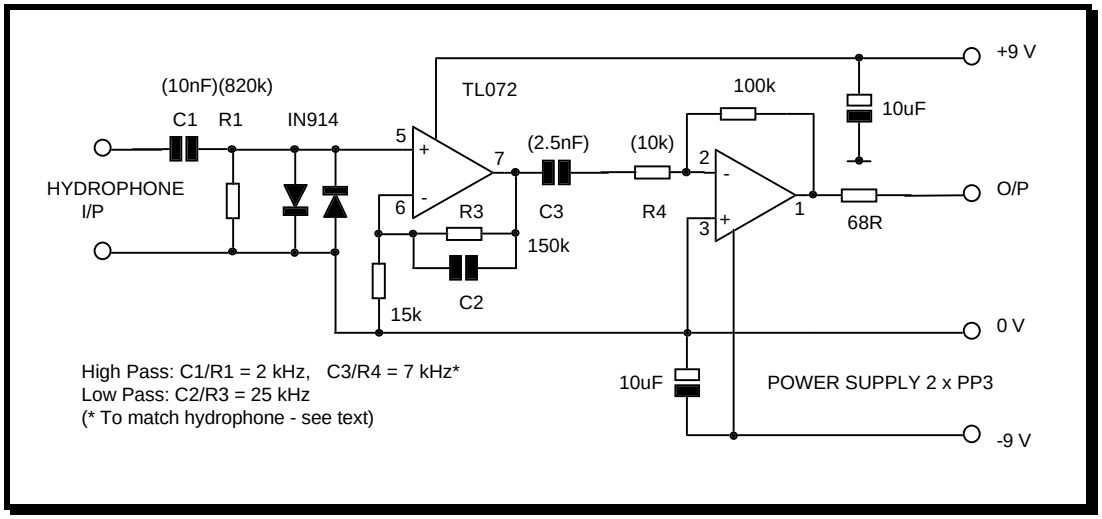
The output impedance is low enough to drive medium impedance headphones.

Technical description - A two stage ac coupled Bi-Fet operational amplifier circuit with 4 filter poles.
Input impedance 1 M recommended (R1 defines this and higher values can can be selected).
Maximum useable frequency is usually around 150-180 kHz depending on the amplifier device and the circuit board stray capacitance. Reduce this to suit this application, (select C2/R3).
Recommended band pass characteristic for dolphin whistle recordings.
Filter poles:
1. -3 dB at 2 kHz
2. -3 dB at 4 kHz
3. -3 dB at 20 kHz (set to 24 kHz for R-Dat recorders)
4. -3 dB at 20 kHz (set to 24 kHz for R-Dat recorders)

(Calculate filter break point component values from: **Freq = 1/(2 * π * C * R)**
Where C is in Farads and R is in Ohms).

Recommended Gain Settings:
+40 dB to +50 dB - For headphone monitoring, using a hydrophone.
+10 to +20 dB - for direct recording onto taperecorder (mic) input.
+40 dB for direct recording using the line input.

Circuit Diagram



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Parts List:

1 off TL072 Dual Bi-fet Preamplifier (TI)
2 off IN914 or IN4148 protection diodes.
1/4 watt resistors: values 1M, 15k, 150k, 10k,100k 68R
Capacitors 2 off 10 µF
0.33 nF, 0.1 µF, 120 pF
6 terminal pins.
Vero board or pcb.
2 off PP3 batteries and terminal clips
1 double pole double throw (DPDT) power switch
2 suitable connectors, i.e. 3.5mm jacks, for connecting the hydrophone and either headphones (or tape recorder*).
A suitable small box, preferably metal, to protect the circuit and screen it from RF interference.

* The gain will need to be adjusted to suit the recorder input sensitivity.

Finally - We are not planning to offer any technical support, but if you build both the hydrophone and preamplifier we will be quite interested to hear about any cetacean applications posted on the European Cetacean Society 'ECS-ALL' email net.

2/2/95

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DATA SHEET : ADG/PL/BENDER/JAN/95 (Last updated 6/2/95)
FILE: BENDER2.DOC (MS-Word format)

A CHEAP SENSITIVE HYDROPHONE FOR MONITORING CETACEAN VOCALISATIONS.

PARTS LIST

1. Piezo ceramic disk - mounted on a brass shim. (As used in musical greetings cards, smoke alarms etc.). - available from hobby electronics suppliers.
2. Polycarbonate (or acrylic) sheet approximately 3-5 mm thick. Cut two circular blanks 60 mm diameter (*option leave square*).
3. One 'o' ring seal (40 mm diameter 3 mm minimum thickness). 4 or 5 mm thickness rings are much easier to use.
4. Six 20 mm long x 4 mm nylon screws (Cheese head) - *Brass screws can be used.*
5. Six 4 mm nuts to match screws.
6. 4.2 mm diameter drill bit (*option - use 3.2 mm tapping diameter drill and 4 mm taper tap*).
7. Quick setting epoxy adhesive (Araldite).
8. Thin coaxial cable (3 mm diameter 50 ohm Suhner recommended) - must be small in diameter as the clearance inside the case is minimal.
9. Suitable connector to plug for preamplifier, e.g. 3.5 mm jack plug.

CONSTRUCTION

Although most of the easily available piezo ceramic disks will work well, those extracted from greeting cards with diameters around 28 mm are best (The dimensions given presume this size). If using a ceramic salvaged from this source carefully prise off and discard the plastic 'cavity resonator' that is clipped to one side. Carefully clean the brass side by sliding the disk on a piece of very fine silicon carbide abrasive paper laid on a flat surface. Once clean and bright, place this on one side without making finger contact with this freshly cut surface. Take care not to bend this disk while cleaning as the ceramic can crack and be destroyed.

Take the two plastic 60 mm diameter disks and place the ceramic (brass shim side) in contact with the centre of one. Lay the 'o' ring around this and determine the pitch circle diameter that the assembly screw holes will fit. (48 mm diameter PCD for a 40 mm 'o' ring). Using engineers dividers (or a drawing instrument dividers).
Scribe concentric circles at:

- 28 mm (brass disk size).
- 48 mm (Pitch Circle Diameter for the screw holes).
- Clamp the two disks together and drill 6 equally spaced clearance holes on the 48 mm PCD through both disks. (*if you decide to thread the holes on one side, then make these the through holes 3.2 mm diameter first to ensure alignment and enlarge them to 4.2 mm diameter clearance in only one disk afterwards.*)
- While still clamped together make an unambiguous mark across both disk edges to ensure correct alignment on assembly.

Important - Ensure that no scratches occur in the area between the two scribed circles.

- Use adhesive tape to protect the area outside the 28 mm circle
- Prepare the centre zone for the adhesive, use clean wire wool or abrasive paper, to scour the surface.
- Mix small volume of two part epoxy adhesive (1 cm long resin/hardener) and apply carefully to both the cleaned brass face of the disk and to the scoured centre of the polycarbonate disk.
- Centre the brass disk into position and gently press to exude the excess adhesive and any visible air bubbles (these can be seen through the polycarbonate). Excess adhesive must be smeared over the zone where 'o' ring will seal. (Keep protective tape in place).
- place a foam pressure pad over the assembly and weight this down until after the adhesive has set (leave in a warm area).
- Prepare cable entry hole by drilling the cable diameter though the second plastic disk. (*Best if this entry hole is offset from the centre but the position is optional as long as it is inside and clear of the 40 mm 'o' ring seal.*) Chamfer the hole on the inside to more than

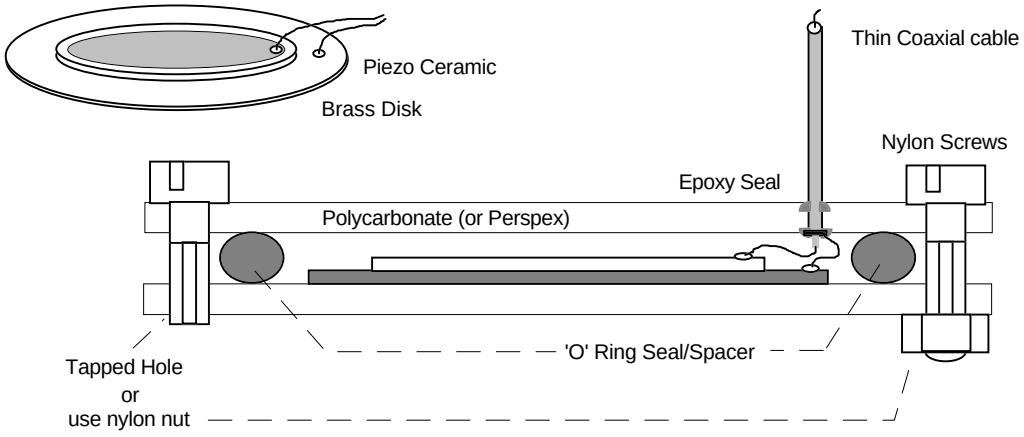
50% of the thickness, deburr the outside edge of the hole. Clean the hole and both sides with suitable degreasing solvent (alcohol).

- Prepare the coaxial cable by stripping back at least 20 mm of the sleeving. Push the braid back to form flange and pull this down into the chamfered hole and press to shape. (Aim to make the braid flange sit flush inside chamfered hole). Solder the braid flange to make this rigid and attach a very fine flexible wire to the braid. Trim back the centre core and leaving less than 1 mm of insulation, solder a second very fine flexible wire to the centre connection and trim back the joint to the minimum possible height. Assemble (dry) as before and check that the protrusion is small enough not to contact the piezo ceramic disk when assembled with the 'o' ring spacer.
- Clean the cable in the joint area with solvent.
- Make a second small mix of quick setting epoxy adhesive and apply carefully to the cable and braid 'flange'. Pull the wire down into position inside the chamfered hole. Apply more adhesive to seal the outside surface and add just sufficient to seal the wires on the inside. Weight the cable and clamp the disk so that the tension pulls the cable firmly into its recess. Leave to set.
- Support both plastic disks alongside each other (clamp their outer edges in a soft jaw vise) and cut the two flexible wires to length (so that they just reach the ceramic). Bare the wire ends and 'tin' these with solder. With a fine tip soldering iron unsolder any original wires still attached to the ceramic and quickly 'sweat' the new wires in their place (*For new ceramic disks see note below about soldering to ceramics*). Take care not to overheat the ceramic as the silver in the surface will dissolve leaving a blackened unusable zone).
- Use a small smear of silicon grease or 'o' ring lubricant and wipe this onto the 'o' ring.
- Assemble using the 6 screws to clamp the 'sandwich together.

Note - make sure the contact zone for the 'o' ring has been carefully cleaned.

Do Not over-tighten the clamp screws. These should be finger tight (no screwdriver). The width of the lubricant wetted contact line where the 'o' ring presses against the polycarbonate can be observed while tightening and this should not exceed 1 mm in width. (If one disk was tapped then the nuts can be used lock this adjustment. Alternatively if metal screws were used then loctite can be applied to the threads to stop them working loose.

- Finally attach a suitable plug to the other end of the coaxial cable and test for short circuits with a meter. (If you have access to a signal generator, set this to about 5 kHz with a maximum level of 1v rms and listen to the device acting as a projector in air. You can sweep the generator through the audible range and listen for any obvious peaks or dips in the response.)
- To hear underwater signals on headphones you need at least 40 dB of gain (x 100) and a simple preamplifier can provide this. In air this will also function as a poor quality microphone but underwater the quality and sensitivity will surprise you.



Note - for new ceramic disks - When soldering connecting wires to the silvered ceramic surface clean the joint surface very carefully (scrape lightly with a scalpel). Use a

temperature controlled, small pointed tip soldering iron and fuse a small blob of resin cored solder onto the ceramic near to the edge.
If you overheat the piezo ceramic you will dissolve the silver (or lift it off) and you will also de-polarise the ceramic. {*If you try to be too quick the solder joint will be 'dry' and unreliable*!}

Try ensure that the small solder spot has just alloyed (wetted) to the silvered surface.

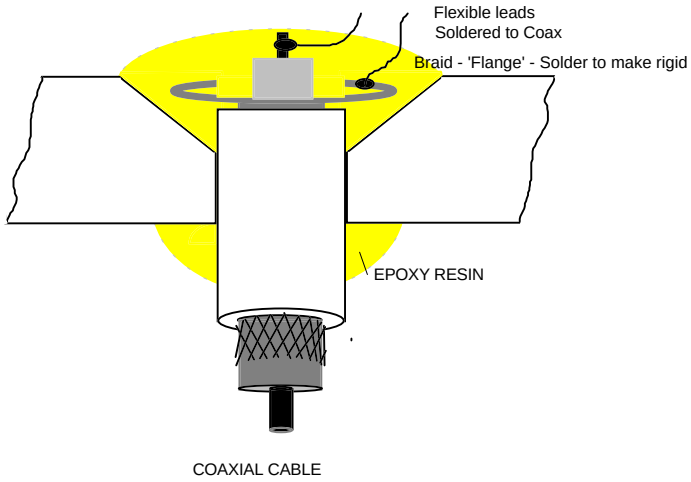
Prepare a similar solder spot on the brass plate as reasonably close to the one on the ceramic.

The prepared leads with 'tinned' ends can be attached to the ceramic and brass disk by quickly re-melting the solder spots while pressing the wire into place with the soldering iron. Use a scalpel, or a knife edge, to hold the wire in place as you take the iron away.

If you haven't done this type of joint before, then first practice on some clean pieces of copper clad board or with scrap metal until you can make strong joints to the wires quickly and cleanly.

The cable entering the case is a potential weak point so use thin coaxial cable 3 or 4 mm in diameter. Drill a hole which is a close fit on the cable outside diameter and countersink the inside of the plastic plate to give the epoxy adhesive a good seating.

Prepare the coaxial connecting lead by making a small rigid 'flange' out of the braid by soldering it carefully. This should have a thin flexible wire attached to the braid <u>before using the epoxy to bond the wire into position</u>, (the soldered braid 'flange' then acts as a strain relief).



I hope this provides an adequate guide. We will not provide any additional technical support. But we will be interested to hear about any successful application via messages posted on ECS-ALL. Several hydrophones of this type have been built in the past and no sophisticated tools or skills are required. One survived three years continuous use immersed in salt water. The quality of the result will vary depending on the ceramic, the volume of the air space and the thickness of the polycarbonate sheet used. The frequency response is fine for listening purposes but is not flat enough for analysis work (Buy a professional ball hydrophone if you plan more serious studies). However its very low cost means that it can be used where an expensive hydrophone might be at risk of loss or damage. If you use a video camera then investigate whether you can plug this into the external microphone socket. Even without preamplification you may find this has sufficient sensitivity to hear cetaceans vocalisations together with the images. (Better results will be obtained using the camera 'line input' after a preamplifier/filter which can be made to reject sea state and boat noise).

For technical performance data obtained from one of these devices see:

Goodson.A.D & Lepper.P (1995) A simple hydrophone monitor for cetacean acoustics. In: P.J.Evans (ed) European Research on Cetaceans - 9. pub. European Cetacean Society, Cambridge.

furious contact microphone assembly

There are too many posts on alt.noise concerning how to build contact microphones, and to my knowledge, nobody ever posted a page like this in response. Plenty of bad advice out there... Hopefully this page is a little more useful than some of the responses I have seen over the years. If you actually follow these directions, please e-mail me and let me know where they're flawed/lacking.

This is *one* way to put together a contact microphone. It is not the best way, but the end result is pretty satisfying. And it doesn't cost much (once you have a soldering iron).

Here are a couple of interesting ideas on improving this design that were sent to me.

Radio Schlock parts list:

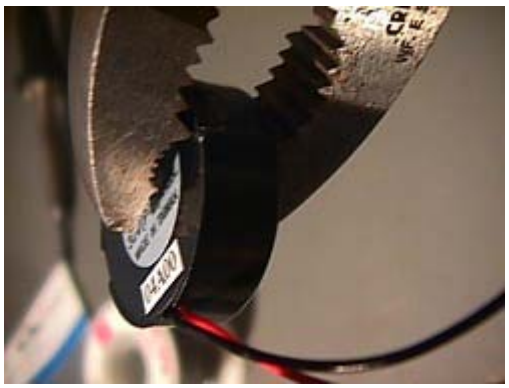
- **Piezo Transducer 273-073A**
- **Two conductor inline 1/4" Phone Jack 274-340A**
- **24AWG "audio cable" 2 conductors plus shield part no. 278-514**
- **Heat shrink tubing**

The functional element - a piezo electric transducer is commonly used as a speaker. Different models come in different plastic packaging, each more annoying to excise than the other. Do not buy the 12VDC versions - they cost more, and you'll end up throwing away the drive electronics anyway.

Start by breaking off the two plastic tabs on the sides of the casing with a pair of pliers.

Next, take pliers and 'crunch' the back panel around the circumference. Do not 'crunch' the input leads. Do not 'crunch'

hard enough to mash the PZT.

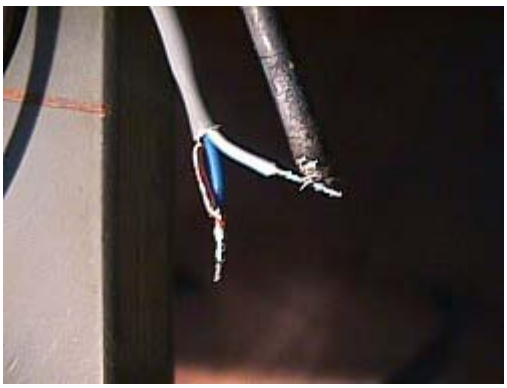


Use a thin edge (screw driver, xacto blade etc.) to gently pry the back plate off of the packaging. Careful not to bend the visible brass PZT disc

The back is off. Now, take the pliers and grip the 1/8" top edge of the plastic cylinder. Bend radially outwards. Repeat all the way around the housing cylinder. This should free up the PZT. Gently pry it out of the casing.

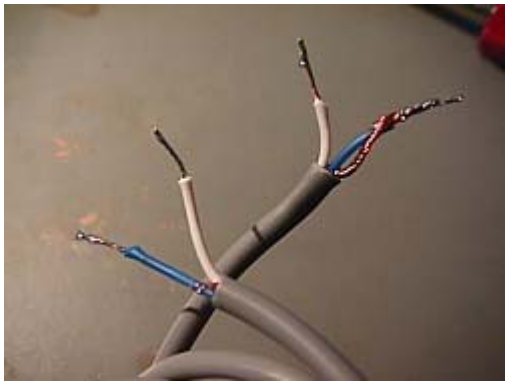
There it is, your very own $1.50 contact microphone. It needs to be connected to something...

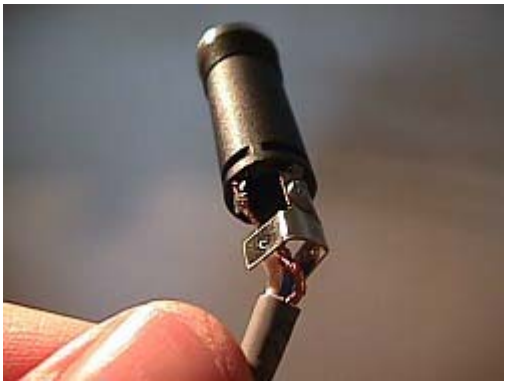
Cut off about a 3 foot length of wire and strip the ends. The ground wire needs to be twisted together (far left of the three).



Twist one of the wires together with the ground wire, and tin the ends of the wire with solder. Do this on one end only. On the other end of the cable, cut off the ground wire so that only the two insulated wires are exposed.

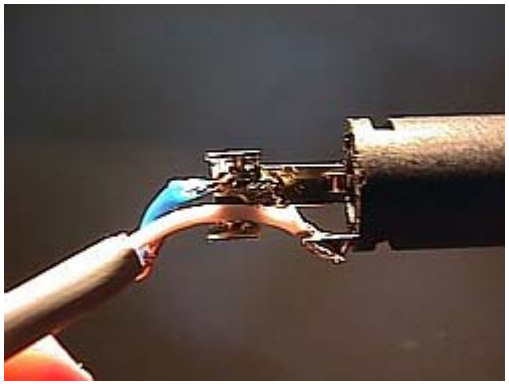
Your cable ends should look something like this:

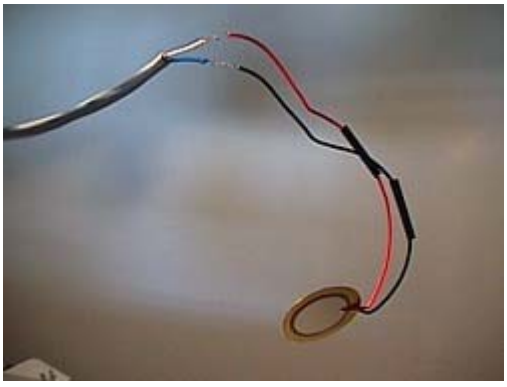




Unscrew the housing from a 1/4" jack. Solder the ground wire to the large contact, and the 'signal' wire (white) to the contact point (see below). Careful not to melt the cheapo connector. Also, be careful to make sure your solder wycks on the surface of the contacts, meaning that you have a good solder joint.

Clip off any excess wire that protrudes from the contact points (the white wire goes through the a hole, cut off the excess once it is soldered into place).





Tin both wires on the other end of the cable. Put two short pieces of heat-shrink tubing on the PZT leads. Solder wires together. I prefer to do this by lining up two tinned leads side by side. Some people prefer to twist the wires together before tinning and soldering.

Pull the heat shrink tubing back over the solder joints. Use a hair dryer to shrink the tubing over the joints. You're done. Go stick your contact mic on something, and call it art.

Mounting the microphone is easy - I use double sided tape to affix the element to whatever I wish to probe. It is a VERY good idea to tape the grey cable down to the object for strain relief. If you don't do this then one good tug and you'll be e-mailing me asking about soldering to the element itself. This is a pain in the ass, but can be done - usually with some minor damage to the element.

BACK TO ERINYS HOMEPAGE