How I Saved My Acoustat Model 3s,
Messed Them Up By Saving Them,
And Then Saved Them From Being Messed Up.
aka
Acoustats: Repair of High Voltage Bias (HV) Connection at the Panel

This is a detailed write-up of how I salvaged two of my speaker panels and brought two more panels up to standard. Before this, a panel that loses its HV connection was considered “done”.

This started with one panel that had low sound output and had no high voltage connection. I determined that with an ohmmeter (details in the section on Measuring.) My panel was no good and I couldn't make it worse, so I decided to try a delicate operation that would fix it – if I didn't screw it up permanently.

Ultimately there were poor or open High Voltage Bias (HV) wire connections to four of the six panels of my Acoustat 3 speakers. This work had two benefits: two of the panels which had or developed low volume now played properly. The other two panels improved in dynamics and clarity. All six panels now exhibit the same volume, dynamics, and clarity.

Note: I have only "played with" (repaired) one pair of Acoustats, my Model 3's. I am reporting what I observed and what I have developed. Some construction details may change from model to model or possibly year to year of their production. Observe the details of what you have. The techniques can be adapted to any differences you observe.

This write-up includes how to determine if any of your panels need this action.

For the explanation of the title, that is at the end.

Skill Level: Advanced
Patience Required: A *lot*.

I have included “way too much” detail – for the person that is good with their hands but has not worked with these tools and materials.

This repair or even just checking the resistance requires that the grill cloth be off.

Checking Each Panel
This is done in two ways:
* Listening
* Measuring

<u>Listening:</u> Put on some music with mids and highs in it, and plenty of dynamic notes. A chorus singing would not be a good choice as the music is more steady, something with guitar and drums, maybe piano, is better. High volume is not needed: you are listening for differences. Put your ear near each panel. See if any are better or worse than the ones next to them. You may have to cover the panels you are not listening to with folded towels or similar. Just cover the top foot or so if you have trouble judging. Just listen near the top, move the towels as needed, and compare panels. I had one or two panels that were a bit quieter in one speaker – I had to turn the balance knob a few degrees towards that speaker to get a mono sound to be right in the center.

On the other speaker it sounded OK overall – I had so far done only the conductive paste (grease) fix as given in “RE-ESTABLISHING CONDUCTIVITY to the DIAPHRAGM” below, start at “If you can do this in a workshop area…” (I was able to push the paste into the gap, but this was not as good sonically as the full repair given here.)

But when I put my ear up close the repaired panel sounded *better* than the other two! Not night and day different, but definitely better. I ended up doing all three with the technique in this article. And then one panel on the other speaker.

The music sounded much better (details later).
And I enjoy it more – which is the point!

Measuring: Checking Panel Resistance
This is not yet as reliable as listening, as explained in the last two paragraphs of this section.
If someone comes up with a voltage divider tester as I will outline in a subsequent post, that should be a reliable test.

Prep:
The grill cloth needs to be off.
You need an ohmmeter that should measure up to tens of millions of ohms or more.

Discharge the speaker: Unplug it and wait a while, or
Unplug it, take the cover off the interface.
Discharge the speaker, if not done:
At the interface I take a piece of insulated wire and short each stator wire connector to each other then to the HV connector, and/or short the HV connector to an AC outlet ground.

(I am open to suggestions here.)

Measuring

I suggest checking the HV-wire-to-panel resistances when you have the grill cloth off for any other reason. But first compare the sound of each panel.

Free up the high voltage wire connector. On the Model 3 it goes to the center tap on the circuit board and it just pulls out. Set your meter to ohms. Clip one lead of your meter to the HV connector,. Make sure it touches no other metal. The other lead should be a normal pointed probe. You're going to measure resistance to the panel where the diaphragm coating is, the front side in mine. Very gently insert the probe between the wires of a grid square that is near the square where the wire connects. I usually pick one about three to four inches away. This is where Gentle Touch is needed. You don't want to penetrate the mylar plastic diaphragm. You can lay the probe on your fingers held flat so that it will slide back on your fingers with a slight pressure. Do not use your thumb! We are going to apply perhaps 1 ounce of pressure. When you get a connection, hold the probe there until the reading stabilizes. I usually check 2-3 spots to check for consistent (close values) readings.

If it reads open you can check your probe pressure. To check your pressure, You can use two probes with light pressure at different points on the panel, and should get a resistance reading in kiloohms or 10's of kiloohms. I found that the round tip of an alligator clip did not give a reading. With two pointed probes I got a reading of just under 15 kiloohms from top to bottom (end to end) of the panel.

Different diaphragm coatings would give different resistances. Measure from end to end on the panel (a few squares in from each end) and this will give you a ballpark measurement. Your HV wire to panel measurement should be close to this – within a factor of about 3. That is from 1/3 to 3 times the measurement. If it is 10 or 100 times it needs more work.

However I had a couple panel connections that measured greater than my meter, so somewhere above 33 megaohms, and yet they played. The meter probably only puts out 0.5 volts.

Here is what I believe was happening: 0.5 volts or even if it were a few volts, that is not enough to punch through the oxidation. But when hit with thousands of volts from the interface it goes through. It sounds better with a good conductive path however.

<u>Tools needed:</u>
1. A Dremel tool, or similar rotary tool. (See notes at end.)

2. A small bit: The one I used came from a set of tungsten carbide tipped bits I got through Amazon.com. You want a Tungsten Carbide Rotary Burr Set 1/8" head, or 3mm head. The head is no wider than the 1/8" shaft. (Most have ¼" heads which are too big.) And it needs to have teeth on the end. Steel is OK, but most are Tungsten Carbide.

I tried a couple and the one that worked best had a head that was a 1/8 inch by 1/8 inch cylinder with "teeth" on the flat end as well (*very* important, as the end teeth do most of the work). The bit shaft is 1/8" (3 mm) as well. The shaft tapers down before the cutting head.

Do not use a ¼" wide bit. It will be much harder to control *in this application* and you do NOT want to grind away the HV wires that you are exposing. It is also more likely to grind away grid squares' sides.

A rounded 1/8” tip may also work, though may be slower.

3. You need a Delicate Touch / Good Control of the Dremel tool.
(An Electric drill with the same bit would carve the plastic but would be much harder to control due to much larger size, so I would never use it for this.)

4. A good quality VOM (volt ohm meter), preferably digital.

Overheating Bit Problem

I am putting this section next to help you avoid frustration later.

Dremels rotary tools turn very fast like 30,000 RPM and the friction causes the bit to heat up and it starts melting the plastic. This causes the plastic to coat the tip. I had to cut the plastic along the tip parallel to the shaft with a utility knife and then pry it off, several times.

Solutions:
1. Only carve a little bit of depth at a time. This works pretty well.

2.A. Get a variable speed Dremel or rotary tool and run it at low speed, like 5,000 or 8,000 RPM.
2.B. Use a flexible extension also. This may give you better control.

3. This also helps: get a straight-sided mug or small plastic tub and put less than an inch of water in the bottom. Don't cut/ grind plastic for more than 20-30 seconds and then stick the bit and the bit collar into the water for about 10-15 seconds to cool it. With the Dremel off of course.
You do this at your own risk. If you are a klutz don't do it! If you want to be real safe unplug it first. Make sure that cords are placed so that if you knock over the container the water will not go into the tool or any plugs /outlets, or your body.

I have settled on 1 above, with 3 as a backup. 2.A and 2.B may be better but I did not try them.

Cutting plastic through to the Wire

Note: I came across info that in some Acoustat models the HV wire is across three squares. Hopefully study and thought will guide you to which square or squares to cut into first.

On my panels the high voltage line has a piece of red or pink plastic insulation on it. It goes into the back of each panel in the fourth square up, along one panel edge.

So we want to cut the plastic out on the FRONT side of that square (front of speaker). The diaphragm coating is on the front side so the wire contacts the diaphragm coating there. I suggest make a small mark with a felt tip pen to keep you in the correct square. Test the front of the panel to make sure it has the coating, you want to work on the side that has the coating. Testing is detailed above in How to test the panel connection. You can test between random squares for conductivity, just not at the edges which don’t have a coating. You are just trying to confirm which side has the coating. On mine it looks duller than the diaphragm plastic.

By looking through a panel screw hole I could see that the plastic behind the panel, along the edge, is about 1/8 inch thick. There is another 1/8 in. piece on the backside. The diaphragm is between them.

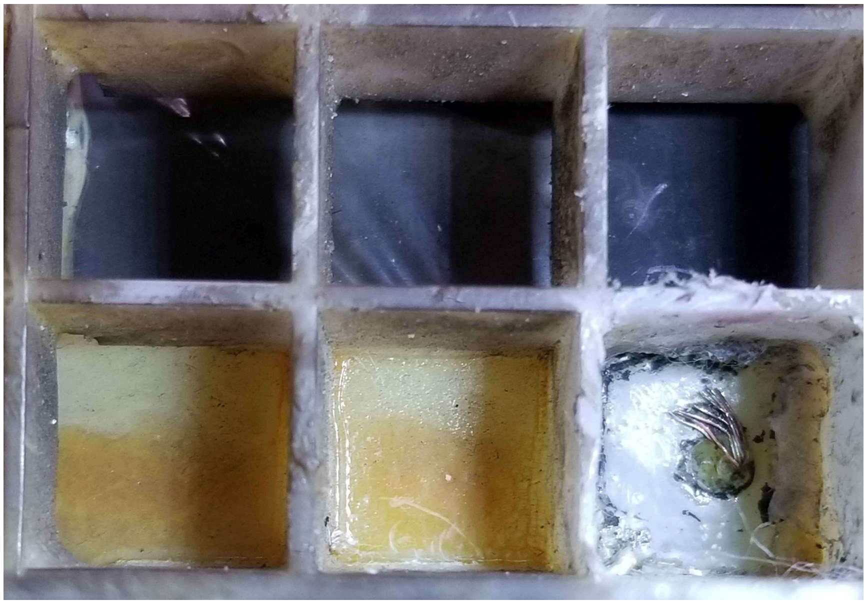
Lay down the speaker for better control of your tools.

So you can set the bit depth (sticking out of the Dremel) to the depth of the grid Plus about 1/32 in. Go along each edge of the square hole. I used the tool collar / collet against the grid as a depth stop. Then I went a hair deeper and did it again and a hair deeper and did it again, I was learning to control the tool as I did this. You have to be patient, cut a tiny bit deeper each time. Eventually I started to see tin foil. Checking with an accurate ruler, when I was done the end of the bit extended out from the tool colett by a just over 5/8 in. (at 1.6 cm). Never let the collet go in past the top edge of the grid hole.
Angle the tool slightly in towards the center of the hole. This is to minimize the bit shaft from rubbing on the side of the grid hole, as the shaft will roughen or sand off the grid plastic. The inward angle changes 90° for each side, of course.

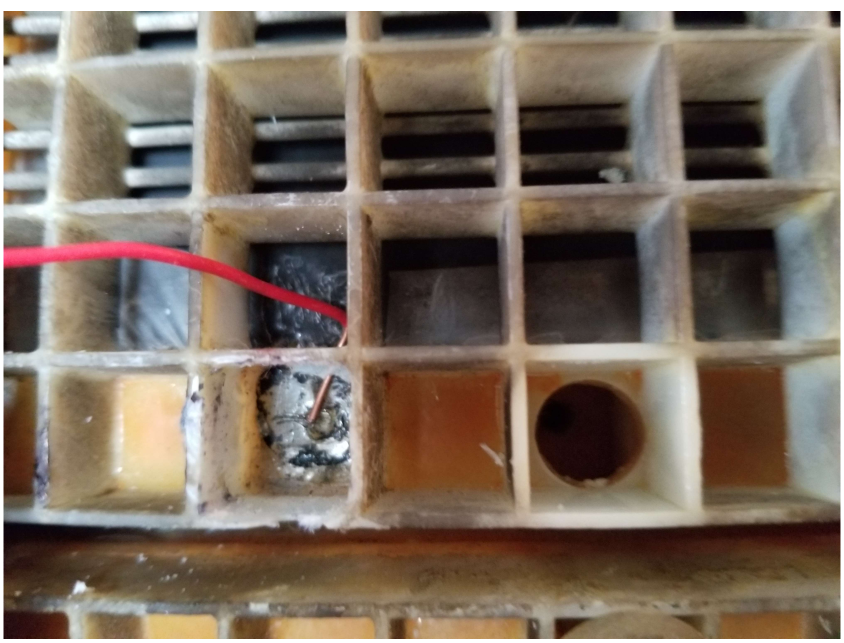
When the square plastic in the bottom of the hole was very thin all the way around, and some of it was gone (I was seeing some tin foil) I took a flat blade screwdriver and pushed the center part sideways to break it loose. Caution: do not pry against the edge of the grid hole as the grid is very, very brittle.

There was tin foil, then black goo on top of the wire. Then the wire strands, then the diaphragm. (Then more plastic or epoxy.)
The wire was coming through in the middle of the grid hole and in the first one I did, there were only a few strands extending out from the hole, laid flat. Other panels had more strands evident. My digital VOM set to ohms confirmed that this was the other end of the HV wire (0 ohms).

After cutting. Two spots have cut all the way through (in corners). You can push the remaining center tab sideways to break it loose. (The lower section in the picture is the next panel.)



After cleanup then scraping the wires until shiny.



Showing the gap behind the grid.

After application of conductive grease (paste).
The grid square above the wired square, and the one to its right, were low on diaphragm coating so I added a thin layer of the conductive grease.

After cleanup. The exposed strands in the bottom square will get a little more grease to insure a seal against oxidation.

The Paste. It is about as “fun” to work with as wheel bearing grease. It contains carbon.
I think they do not call it grease because it is not designed as a long-term lubricant.

When doing this repair, you may cause some minor damage to the grid square(s) where you are working. This will not affect the sound, and is a small price for saving or improving a panel.

RE-ESTABLISHING CONDUCTIVITY to the DIAPHRAGM

First clean what was in the hole with a Q-tip type swab and alcohol a couple times and dry it with a swab, or wait until it dries. I also scraped the wire strands with a thin flat bladed screwdriver. Scrape along the direction of the strands, as we don't want to move them.
Start where they come through and scrape to the end a few times. You're just trying to make the exposed copper strands be shiny, so don’t use a lot of pressure. Copper is fairly soft.
Test with your ohmmeter. When they conduct with almost no meter probe pressure, you are done.

If you can do this in a workshop area, your house will be safer from the conductive grease. If not lay out a tarp or plastic sheet of about 6 mils thickness or more (= 6/1000ths of an inch).
Wear disposable gloves, and clothes you don’t care about.

Using my VOM I found that the panel in the grid hole *next to* the wired drilled hole (going inwards towards the center line of the panel) was not conducting reliably so I picked up a little bit of conductive grease on the end of a cotton swab and thinly coated that square of panel.
Then I put more grease in the drilled square getting a substantial layer on the diaphragm over the wire and then over through the edge of the hole. I angled the swab from both sides of the side of the grid square, under the edge of the grid to make sure I had a complete path. You are forming a conductive path, and you are protecting the wire strands from the atmosphere (oxygen and water).

WARNING: do not get any grease touching the stator grid wires especially on the side facing the diaphragm as it will probably cause arcing or a short circuit. If you do, the “Cleaning” section will help.

Cleanup: you don't want excess grease on the grid as it will make a conductive path. (I accidentally touched the grease with the speaker plugged in – I had not yet cleaned up the excess yet – and felt: nothing! Note: my body was not touching any electrical ground.) You will need *lots* of Q- tips type swabs. You can cut them in half. First wipe off all excess grease possible with dry swabs. Then use rubbing alcohol to dampen a swab. If dripping touch it to a rag or paper towel. Then wipe off some conductive Grease. Repeat until all possible has been removed from the grid, but not from the HV bias wire/diaphragm area. You may need a bit of paper towel or clean rag and a sharp tip to get the corners.

To get under the wires in the first square with wires, you can bend the last half inch of a swab.

I was able to get the grease out of synthetic carpet with alcohol and blotting repeatedly. Folex may work too. It is very unlikely you can get it out of fabrics, especially natural fibers.
After I got things working well, there was a faint hissing or at times a T-T-T-T sound, once it even whined, at or near a couple of the HV connections. Solution: clean more thoroughly! Also, handle any carbonized (burnt) paths.

Results: Measurements:
I checked my work with my VOM and ultimately ended up with a reading of around 5 kiloohms (5,000 ohms) on most of the panels between the wire that plugs into the high voltage board and any point on the panel near the wire. One was higher. That is a significant improvement upon a resistance that was off the scale of my VOM which goes to over 30 megaohms (30,000,000 ohms)! See "Checking Panel Resistance" below.

Russ Knotts, ESL expert at www.justrealmusic.com, told me that any reading, even 10's of megaohms, is okay. He is usually right, but my listening results showed this to be too forgiving. Before this repair panels were reading open circuit (infinity). The limit of my digital VOM is over 30 megaohms. The other two panels on this speaker were playing OK (but not their best) but also read open circuit. My working theory is that the high voltage may punch through the resistance (which includes wire oxidation) which my ohm meter cannot. It may only put out under 1 volt.

Other speaker: two panels read about 30 kiloohms. One had been treated with conductive grease. The middle one read about 33 megaohms. I added conductive grease and it dropped to 0.9 megaohms. I did the full repair and it dropped to 30 kiloohms.

Results: Listening:
After I fixed the first bad panel I put my ear up close to each panel with music on to see if it was playing. The one I had repaired played fine – but now it sounded clearer, more dynamic than the other two panels! Most notable in the mid-range – voices and instruments. I checked the panels each several times, front and back, to be sure. So then I went through this repair procedure on the other two panels of that speaker as well. They had been reading on the VOM as open (over 30 megaohms) even though they played! Now all three are around 5 kiloohms.

My ears say: under 1 megaohm is likely acceptable, but under 50 kiloohms is best. Under 100 kiloohms ohms may be just as fine – since I have not encountered readings greater than about 30 kiloohms and under 900 kiloohms (0.9 megaohms), I am not certain.

At this point the clarity, dynamics, soundstage and depth were all improved! I am learning why so many people are passionate about Acoustats!

Why does it matter?
To play, some high voltage electricity needs to get through to the diaphragm. But I read from Stereophile Aug 1, 1987 issue (online now – see quote below) that the static charge can be diminished by strong bass passages. So obviously it needs to be replenished quickly. We don't need a lot of current ability but adding tens or possibly hundreds of megaohms at the panel connection, after the HV Supply which already includes a 500 megaohm resistor, will reduce the current capability that is there. The static charge is about high-voltage it is not about current flow – but only to a point. My results indicate that you can have too little current flow to the panel.

I believe the improvement in clarity, dynamics, and soundstage is due to improving the "recovery time" of the static charge. I am referring to the panels that were already working.

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TYU in this "Acoustat Answer Man is here" thread on DIYAudio.com has repeated many times that upping the high voltage makes the speakers sound better.

There are three possible explanations:
1. Did he have a poor panel connection (higher resistance) which he was then overcoming, and which this technique remedies? One of the results of TYU's high voltage increase would be an increase in HV current flow, (which my fix will also accomplish) IF the panel connection had way too high a resistance. However I consider it unlikely that he had this problem with all of his many panels, unless he washed them all.

2. Did his increased voltage alter the designed sound of the panel?

3. Does the increased high voltage simply reduce the re-charge time for the diaphragm? This would be a good thing. Note: reducing the 500 megaohm resistor would accomplish the same thing. More thoughts and questions on this in a later post. Part of my thoughts are about safety – safety for people and safety for the speakers.

I am not willing to do his change as I am possibly moving to a humid climate, which Acoustats can handle as they were designed / built. A stock panel is designed to handle a humid climate without arcing etc.

<u>Some Information about Rotary Tools /Dremels:</u>
My opinion on cordless Dremels: unless you have an extreme need for a cordless Dremel, know that cordless tool batteries only last for years. I've had my *corded* Dremel for at least 30 years.

Look for:
1/8" collet / collar. That is the standard and most bits use a 1/8" shaft.

Variable speed. Minimum speed of not over 8,000 RPM.

Some kits contain a flex shaft which may be more controllable – I have not tried one for this type of work. Let me know. Possibles from Amazon.com:
Dremel 3000 kit $60, Minimum speed 5,000 RPM
Or Dremel 4000 model / kit.
Amazon may still sell a package that includes a flex shaft for $100.

All other brands:
I would study the reviews, especially regarding the flex shaft if you want to try one. I've never regretted buying a good tool, but I have sometimes regretted buying a too cheap tool.
For this project you NEED a minimum of one rotary tool plus one bit as above.

Other Thoughts:

1. Uncertain: did the connections in my panels deteriorate and the wire oxidize with age, or because I had previously cleaned the panels with a cleaner and water which may have oxidized the high voltage wire strands? Or both? (I blame it more on the cleaning.)

2. The conductive grease has a high melting point and will seal the wires against further oxidation so this repair should last indefinitely.

3. Question: Won't the grease /paste hold dust?
Yes. So what. If you have a grill cloth on it should be an insignificant problem. If no Grill cloth then check it a couple times a year and be prepared to use canned air or a blower or if it is thick, use very thin (1/16”) needlenose pliers or tweezers, to remove dust or cat hair etc. A very thin layer of dust should not matter.

4. I am open to any suggestions based on your actual experience.

5. If you figure out a way to get the carbon grease onto the diaphragm through /behind the wires, (other than at the edges) but getting none *on* the wires, let us know! Sometimes it is needed.

6. I don’t claim this is the best or cleanest way to do this repair. I just claim that it works well. If you come up with an improvement and you try it and it succeeds let us know!
(But remember, different is not necessarily better.)

* Quote From Stereophile:
"On many recordings—some Telarcs in particular—at average listening levels of only around 85dB, sudden LF onslaughts (as from bass drum) caused the entire sound to choke down for a moment as though the step-up transformer was saturating. At one point during the Sheffield Shostakovitch 1, three rapid bass-drum strokes took the output level down by increments of about 2dB each, reaching about -6dB before the drum let up and the signal output could recover.

"Acoustat's chief engineer, Jim Strickland, told me this had nothing to do with the step-up transformer, but was due to momentary loss of the high-voltage charge when the diaphragm comes very close to the stator wires. He also pointed out that that is the main reason for incorporating the dynamic woofer."
-- https://www.stereophile.com/content/acoustat-spectra-3-loudspeaker-page-2
Acoustat Spectra 3 loudspeaker
J. Gordon Holt | Nov 9, 2017 | First Published: Aug 1, 1987

How did my panels get this way (less conductive or non-conductive) in the first place?
and
What do you mean, you "Messed Them Up By Saving Them"?

1. A conductive substance got into the panels, on the wires, etc. Plus cat hairs had floated through the air and some got behind the stator wires, and gravity bunched them at the bottom. This provided a matrix that held the conductive substance in place. Then one panel started arcing – at the bottom.

2. So I HAD to wash them to stop the arcing. I used spray cleaners, and water, and for one speaker, I disassembled and put each panel in the bathtub. (This required unsoldering the connectors.)
(I first plucked out all the cat hair, and also used a blower.)

3. The HV wire connections were not fully waterproof, though everything else is in the panels, and so after these actions, I believe the connections (the wire strands) oxidized on their surfaces. Oxidized metals usually conduct poorly. (Silver is an exception.)

At each step I had nothing to lose, I tried what seemed likely, and now have great sounding speakers.

Brandon