Troubleshooting the OPA-Alice based microphones

We are going to apply the Navy Six Step Troubleshooting method to the OPA-Alice build. This methodology is part of academic and professional courses and certifications around the world. The biggest challenge with doing this is what I like to call, “Jumping Ahead”. You think you already know what the problem is so that is where you focus. The Six Step method avoids this, and approaches troubleshooting logically.

The Six Steps:

1. **Symptom Recognition.**
2. **Symptom Elaboration.**
3. **List Probable Faulty Functions.**
4. **Localize the Faulty Function.**
5. **Localize the Faulty Component.**
6. **Failure Analysis.**

Step One Symptom Recognition: “What is wrong?” In our case there are usually three things that occur with DIY microphones.

1. No output – just does not work
2. Noise or hiss
3. AC Hum or buzzing

Step Two Symptom Elaboration: “Gather more details”
Here we start to investigate. Wiggle cables, check that phantom power is turned on, adjust gain up and down, tap the mic body etc. Typically, this step has you gather more information without taking things apart.

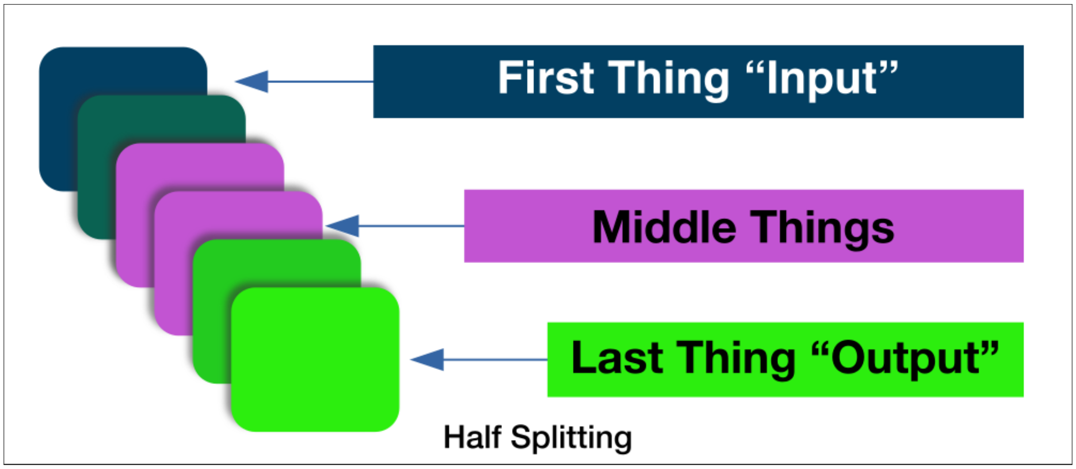
1. No output:
   1. Is there any signal at all?
   2. Is it just noise?
   3. Is it complete silence?
2. Noise in the microphone:
   1. Is it loud in comparison to the signal?
   2. Is the preamp cranked all the way up?
   3. Is it white noise?
   4. Is it intermittent?
   5. Is there something close by that could cause it?
3. AC hum or buzzing:
   1. Is it when you touch the mic?
   2. Does it go away when you touch other metal?
   3. Is it constant?

Step Three List the Probable Faulty Functions: “What could cause this?” However remote or unlikely. Think through the things that could cause the problem. Think about the elaboration that you just did in the previous step. The goal here is to list the probable faulty functions, hopefully somewhat prioritized.

1. The OPA Circuit Board (Did you make it yourself and first use?)
2. The Hex Inverter Board (Are you using a full condenser capsule?)
3. The XLR Connector wiring (I know you already looked at this...)
4. Interconnecting wiring (Connectors and interconnecting wiring are the bane of electronics)
5. The metal case and housing (Different vendors have different quality)
6. The mic cable (Less likely)
7. The microphone capsule (Only one of my builds had this)

8. The mic preamp or recorder (Least likely but… Is Phantom Power on? Are you plugged into the right input?)

Step Four Localize the Faulty Function: Now we actually start measuring and doing things. The best way to move forward here is something called "Half Splitting".



"Half Splitting" is where you don't have an output but do have an input. Troubleshoot by going to the middle of the functional blocks and test. Based on your outcome, you split in the middle. Either towards the "Input" or back to the "Output". Repeat this until you find the part that isn't working.

This is the first time you should break out your multimeter and disassemble things.

Scenario one: **No Output.** Our probable faulty functions for this are: the OPA Board, the Capsule, Wiring, or Fault in the wiring, such as something touching the metal mic body. Let's start with the circuit board. Take the body of the mic apart so you can connect it to a source of phantom power. Measure the voltages on the board. See *figure 1* for typical values.

Note: If you are using a Hex Inverter board, you should have about 79VDC on the POL_T point. The "T" is for test point. The capsule connection comes after the RC filter and will show about 67- 69VDC.

If the voltages look good, then listen to the output with headphones on and touch the area near the SGNL pin. If you hear buzz and hum then the board works, and the capsule is suspect. If it is a true condenser, the bias voltage is suspect. Unsolder the SGNL lead and touch the area near SGNL again to make sure.

If the voltages are not correct, then there are several potential faults.

1. If the 22VDC on the XLR_2 and XLR_3 is low or close to ground, check for a short in the wiring, XLR connector, or the PCB board traces near the edge to the metal shell.
2. Remove the board mounting screws so that the PCB can float in the air but still be connected. Check the voltages again. If they are normal, then the PCB is touching something when it is attached to the metal shell. See *figure 2* for suspect areas. One build, with a U87 style body, the mounting frame was folded over stamped sheet metal. The area around the mounting holes was large enough to intrude into the PCB trace area.
3. If both XLR_2 **AND** XLR_3 are low and VCC_1 is less than 1.7VDC, then the Zener Diode is installed backwards (Yes, I and others have done this, or it isn't a Zener, it is a regular diode – don't ask...)
4. If one of XLR_2 **OR** XLR_3 is low or zero, and the other one is around 15VDC, then one side of the XLR is shorted to ground. That will also cause about 4VDC on VCC_1 as there isn't enough current to make the board work. You may get a lot of noise as well.

5. If XLR_2 **OR** XLR_3 is 20VDC and the other is zero, then there is an open in the connection to the one that is zero. Either in the XLR cable or other wiring.

Scenario two: **Noise.** Our probable faulty functions for this one are wiring or a short of some kind to the shell. If XLR_2 or XLR_3 is shorted to ground, you can have noise.

This is caused by not enough supply current and running the operational amplifier below rated voltage. You can hear what this sounds like if you have the mic connected, and then turn phantom power off. As voltage drops, at some point noise kicks in, then falls off as voltage completely goes away.

I have seen where the tightening and loosening the shell causes noise to come and go. This is due to shell connection issues internally.

There is one more source of potential noise: dirt or excess flux residue on the input 1Gig resistor area. This should have been cleaned when you soldered the PCB. If you have purchased an assembled board, this should not be an issue. This issue is rare, but has happened to me. The mic worked fine and then in a humid environment, it started acting weird and became noisy. It was one of my first builds, and I was in a rush.

Intermittent noise. This is usually caused by not using the 22nF input caps. Questions have come up on these and why the value was chosen. These filter out any incoming induced RF or EMI noise. This is generated by cell phones and WiFi. At those frequencies, the RF has a small wavelength. It can easily sneak into the mic. Because we are using a very high impedance circuit, the amount of RF energy brought in does not have to be large. It turns into a voltage signal that is picked up by the OPA circuit, thus heard as noise or clicks. The other question that comes up with these capacitors is this: "The input impedance of my Mic Preamp is 2Kohms". Which would mean that the cutoff frequency would be 3Khz… That misses the point. We are concerned with the output impedance of the microphone electronics, not the following input stage. In our case, the mic has an output impedance of about 50 Ohms (The 47-49 Ohm resistors in series with the OPA output of a few ohms). That gives us a cutoff frequency of 144Khz or so. Remember, the RF/EMI is sneaking into the microphone. That is what the 22nF capacitors prevent.

Scenario three: **AC Hum or Buzzing.** There are two things that can cause this. First, is poor shielding around the capsule. For 99% of the donor bodies used, this should not be a problem. Second, is poor electrical connections within the microphone body metal components. This is usually due to paint on the metal ends of the body cylinders or the base part that screws the assembly together. This can easily be remedied with some light sanding of the edges. Occasionally, the XLR connector has an intermittent connection to the shell. This can happen if the screw is not tight that mounts the XLR to the mic body. Or, if you don't connect PIN-1 of the XLR to the metal tab that connects to the mounting screw.

1. If the hum comes and goes with handling of the microphone, there is a poor electrical connection between the mic body parts.
2. If the hum is constant, the head basket is not connected to ground or the mic cable itself has a fault.

Figure 2 details some of the things to look for while troubleshooting an OPA-Alice based microphone. Specifically, the places where metal flakes and little shards may exist. This can be an issue with the BM700/800 bodies depending on the manufacturer.

Step Five Localize the Faulty Component. Depending on what you discovered above, you have a couple options. If there is metal shard or left over burr touching something it shouldn't, just remove it. If there is paint covering the end of the metal cylinder of the mic body, sand it smooth so that there is bare metal exposed.

Step Six Failure Analysis. This one really extends to something that was working and then stopped. But this step is a critical for any future builds you do and overall learning. Back in my Navy days, this one got the most scrutiny. This is the classic: "Treat the Symptoms" but not the underlying cause. Let's fix the root cause.

Troubleshooting the OPA Alice Boards

Normal Voltage Readings:

All Readings were taken with a Fluke 87III and supplied by a ZoomF6 for phantom Power.

Not connected:
Zoom Pin 2 and 3 to Pin 1 = 47.3V

Connected to the Zoom, all measurments referenced to Pin 1

PCB XLR_2 = 20.83V
PCB XLR_3 = 20.83V
VCC_1 = 12.18V
VCC_2 = 11.45V
Left Side of 1Gig resistor = 5.72

The reason to measure the voltage at the 1Gig resistor is to ensure the virtual ground is working. Due to the high resistance of 1Gig, measuring at SGNL will give a low reading as the 1Gig will form a voltage divider with the input impedance of the Voltmeter.

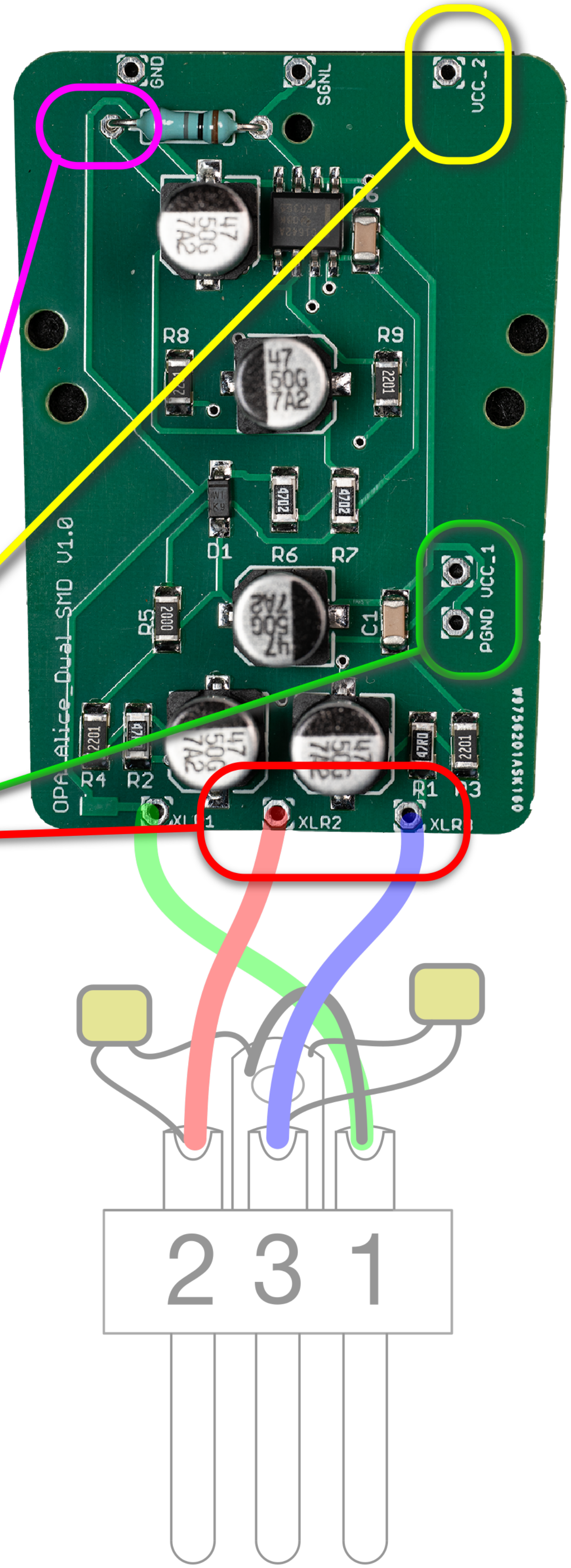


Figure 1

Typical metal work problem areas for mic donor bodies

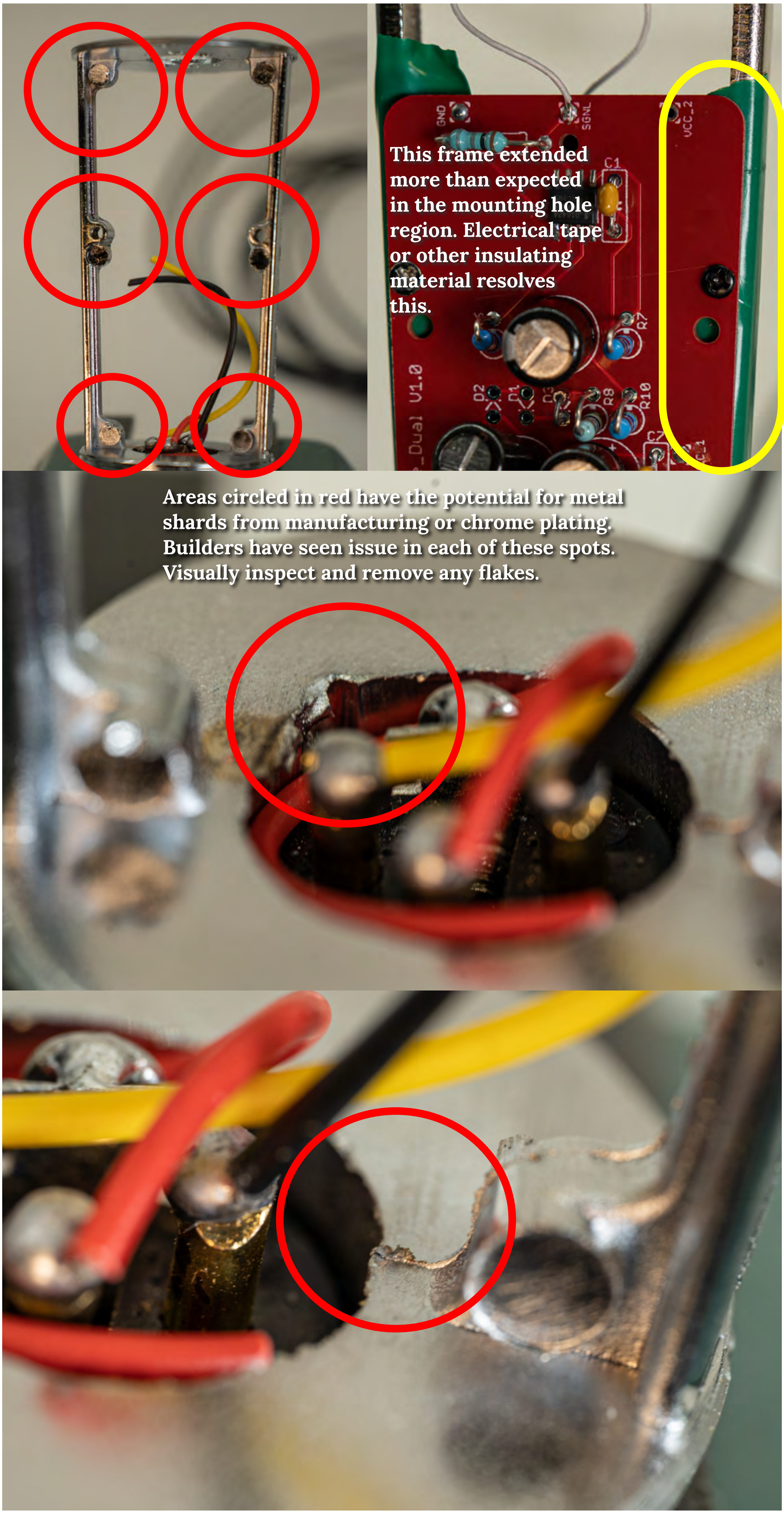


Figure 2