

Steps you can take to trouble shoot your problems

Have in front of you a circuit diagram when you troubleshoot so you are able to see what works and what doesn't. You can solve most problems by yourself using the following procedures:

1. DMM is ready?

Your digital multimeter should be connected to the minigrabbers and these should be holding wires about a foot long that can easily be plugged anywhere on your protoboard. This configuration will allow both you and your instructor to quickly test for problems. You should not use wires so short that you have to hold the multimeter directly over your circuit. This obstructs the view and doesn't give you a free hand to turn a knob while looking at the DMM.

2. Layout is easy to follow

The circuit layout should not involve a lot of crisscrossing wires and there should not be multiple grounds. In other words, once you decide that a row of pins is ground, don't run a wire from there to another row of pins and call them ground also. A nice layout puts plus voltages at the "top" and minus voltages (or ground) at the "bottom" (like figure 2.3 in Lab 2). An exception to this will be when a compact layout is needed to avoid pickup that can cause oscillations, as in Lab 7.

3. Check the ground connections.

Lab power supplies are usually constructed with neither the + nor - side of the outputs grounded. You will ground the + side to create a negative voltage relative to ground or you will ground the - side to create a positive voltage with respect to ground. See Figure 2.3 on page 2.4. There should be a ground wire running from the power supply ground to a black connector at your prototyping board, and then a wire from that connector to a hole in a row on the board. Check visually the following:

- A. A wire from one side (+ or -) of the power supply to the ground on the power supply.
- B. A wire from the power supply ground to the aluminum panel holding the protoboard.
- C. A wire from the aluminum panel to a row of holes on the protoboard.
- D. Your circuit is connected to a hole in the correct row.

4. Check that the power supply voltages arrive to the protoboard

Now use the DMM.

A. Be sure that the power supply is on and indicates the desired output voltage. Put the DMM leads on the power supply outputs to be sure the voltage is there and be sure that the wires carrying the power supply voltage to the protoboard are plugged into the right places. *If the voltage of the power supply is initially OK and then goes to zero when the protoboard is connected, then you may have a short circuit on your protoboard. [There is a current limiter built in to your power supply.]*

B. Put the DMM leads in holes on the protoboard where you think the power supply voltage is arriving and be sure the voltage is there. Do this for both the + and - voltages if both are supposed to be there.

5. Diode and transistor testing

If you are using a diode or transistor, be sure you know what is “p” and what is “n.” The DMM has a tester for pn junctions. This feature is indicated by a picture of a diode on the dial of the meter. When the meter is in the diode testing mode, it will indicate a voltage drop of about 0.6 volts when the red lead is connected to the anode (“p”) and the black lead is connected to the cathode (“n”). A transistor can be tested as though it were two pn junctions. If the transistor or diode is burned out, then the 0.6 V (approximately) will not be there.

6. Junction transistor amplifier testing

A. First, test that the transistor has the proper DC bias at the base. Put the DMM leads on the base of the transistor and on ground and test that the expected bias is there. If not, remove the transistor and test the resistor voltage divider by itself.

B. Second, put the DMM leads on the collector and ground. The collector should be more positive (if npn) than the emitter and not at the full power supply voltage. If not, and the transistor is ok (see 5 above), then the resistor values are wrong and should be checked using the DMM.

7. Op amp testing

A. First test that the power is there. With one lead of the DMM grounded, use the other lead and touch the power supply pins on the op amp itself and see if the supply voltages are there.

B. Second, test that the + and – inputs of the op amp are near to one another (as they should be) in voltage, either by measuring each voltage to ground or by using the meter to measure the voltage difference between the + and – inputs.

C. Third, measure the output voltage of the op amp with no signal input. It will be near ground if the op amp is properly biased. If it is within 1 volt of either supply voltage, it is said to be “railed” because the power supply lines (being heavy duty) were called rails in the past. A “railed” amplifier will not work properly.

8. Troubleshooting AC signals

A. If an AC signal is put into your circuit and does not appear at the output, follow the signal through the circuit and find where it stops. Begin by placing the oscilloscope probe on the protoboard at the input and verify the signal from the signal generator has arrived.

B. Keep in mind that AC signals often reside on top of DC bias (offset) voltages. If the scope is AC coupled, it does not “see” DC offsets and you can miss the fact that your amplifier is “railed” (see 7C above).

C. A fuzzy looking oscilloscope trace is a sign of high frequency oscillation. An amplifier can oscillate when you don’t want it to because of stray capacitive coupling that creates positive feedback. The first “cure” to try is the bypass capacitors shown in Fig. 4.4. It is never a good idea to leave these out. These should be placed in the circuit near the component (transistor or op amp) that has the gain. A second cure is to reduce the gain bandwidth product by placing a small capacitor (10 pF, for example) between the output and input (parallel to R_F if an op amp, and from collector to base if a junction transistor).