Electronics Reference Guide

Building and measuring circuits can be a lot of fun, and with a bit of practice and attention to detail, you'll find that it is not terribly difficult. However, if you are not careful, mistakes will happen and your equipment and/or circuit components can be damaged. Follow the provided checklists **EXACTLY** to avoid any critical errors, and when you have a problem, refer to the troubleshooting section for possible solutions.

Warning!

The most common critical error among students is incorrectly using their multimeter, causing the fuse to blow out. If this happens, you will lose some or all of its functionality. Some meters continue to measure voltage and resistance while others fail completely.

While you can replace the fuse, it will cost you time during the lab. In order to avoid this, be very deliberate when making measurements. Follow these checklists carefully and build the circuits according to the diagrams. Plan ahead what and where you need to measure. Then double check before proceeding. This will go a long way in preventing mistakes.

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Safety Checklists:

When Building ANY Circuit

1. Follow the circuit diagram and breadboard diagram closely.
2. Try to build the circuit **neatly** to make it easier for checking and troubleshooting. Also, it just looks much nicer in pictures and matches the circuit diagrams better.
3. **Before** connecting power (battery), double check the circuit.
4. **Before** connecting power (battery), have the TA check your circuit.

When Measuring DC Current (A ⎓)

1. Build the circuit as shown in the diagrams, but **wait** to connect power (battery).
2. Place the probes in the correct multimeter ports (Black in COM, Red in mA/A).
3. Set the mode dial to measure DC current (**A** ⎓).
4. Adjust the dial to the highest DC current range (work your way down from there).
5. **Before** connecting power (battery), have the TA double check your circuit.
6. **Before** connecting power (battery), show the TA **where** you plan to place the multimeter probes and tell them **what** you plan to measure there.
    a. Note: **ALWAYS** measure current in **series**. If you measure in parallel, the fuse will most likely blow.
7. Place the probes on the circuit and check for a value.
    a. If no value, **REMOVE the probes IMMEDIATELY!** Double check and/or have the TA check your circuit and multimeter. Then try again.
8. When you finish, **turn off** the multimeter to save the battery.The simpler inexpensive multimeters often do not shut off automatically.

When Measuring DC Voltage (V ⎓)

1. Build the circuit as shown in the diagrams, but **wait** to connect power (battery).
2. Place the probes in the correct multimeter ports (Black in COM, Red in V).
3. Set the mode dial to measure DC voltage (**V** ⎓).
4. Adjust the dial to the highest DC voltage range (work your way down from there).
5. **Before** connecting power (battery), have the TA double check your circuit.
6. **Before** connecting power (battery), show the TA where you plan to place the multimeter probes and tell them what you plan to measure there.
7. Place the probes on the circuit and check for a value.
    a. If no value, **REMOVE the probes IMMEDIATELY!** Double check and/or have the TA check your circuit and multimeter. Then try again.

8. When you finish, **turn off** the multimeter to save the battery.The simpler inexpensive multimeters often do not shut off automatically.

When Measuring Resistance (Ω)

1. Place the probes in the correct multimeter ports (Black in COM, Red in Ω).
2. Set the mode dial to measure resistance (**Ω**).
3. Adjust the mode dial to the expected resistance range and adjust it up/down as needed.
4. If you are measuring the resistance of a single resistor, **disconnect** it from the circuit and measure it by itself.
5. If you are measuring several resistors in series or parallel, disconnect them from the rest of the circuit, and measure them as a group, isolated from other components.
6. When you finish, **turn off** the multimeter to save the battery.The simpler inexpensive multimeters often do not shut off automatically.

Troubleshooting:

Problem	Solution
The multimeter display shows “1”, “OL”, or something else indicating a value above the current range.	Possible Solutions: ● The mode dial range may be set too low. To be safe, set it to the max range and adjust down until you get a value. ● If measuring resistance and it still doesn’t show anything, there may be a break in the circuit. Check that everything is connected and/or measure a different resistor to verify that the meter is working.
The multimeter display shows zero.	Possible Solutions: ● If measuring voltage or current, the power source may be disconnected or there may be a break in the circuit. ● The mode dial range may be set too high. Try dropping down to the next lowest range and try again. ● The multimeter fuse could be blown.
The multimeter value fluctuates randomly.	Possible Solutions: ● If the value fluctuates close to zero, there may be a break in the circuit or no power is connected. Double check the circuit and try again. ● If the last 1-2 digits fluctuate around a non-zero value, there may just be some uncertainty in the measurement or the actual value may be fluctuating. Don’t worry about it unless you have reason to believe the average value is in error. ● If the above solutions do not apply, the circuit may have been built incorrectly, a component may have failed, or the multimeter may have been damaged (high current, blown fuse, etc.).
The multimeter won’t turn on.	Possible Solutions: ● The multimeter battery could be dead. ● The multimeter fuse could be blown. ● The multimeter could have been damaged/ruined by excessive current. It may be unfixable. ● If it never turned on and the above solutions didn’t work, it could be a defective unit.

The multimeter battery is dead.	Unscrew/open the battery cover and replace the battery.
I think the multimeter fuse is blown/burned out.	Before replacing the fuse, you should check to see if this is the problem. Most multimeters can still measure voltage with a blown fuse and some can still measure resistance. However, none should be able to measure current, so this is a good test to see if the fuse might be blown. Check for a blown fuse: ● Set up a simple circuit to measure current (battery, resistor, and multimeter in series). ● Check to see if you can measure current in the mA range (see instructions for measuring DC current). ● If you cannot measure current, the fuse is likely blown. ● Follow the instructions to replace the fuse and check to see if it is working again. If not, there may be another problem.
No current is flowing in the circuit or there is no voltage where expected.	There is probably a break somewhere in the circuit. ● Verify that any wires/leads that should be connected are placed in the same row of 5 holes (row may be horizontal or vertical depending on orientation of the breadboard) or in the same bus line/power rail (blue line or red line). ● If you are using components with a specific polarity (LEDs, capacitors, etc.), verify that you connected them in the right direction. ● Verify that any alligator clip wires are connected properly. ● Verify that any multimeter probes are touching metal to metal where the connection needs to be made. Touching the metal probe tip to the plastic breadboard does nothing. It must touch a metal wire or component lead. ● Verify that the battery/power source is working (check its voltage independently from the circuit). ● Disconnect the power, switch the multimeter to measure resistance (or continuity) and check the paths between components to see if there are any breaks in the circuit. Complete connection means resistance should be zero or very close. ● If you believe the breadboard may have a faulty connection between some of the holes, try

	shifting the components over to different holes.
The LED won't light up.	Possible Solutions: ● Make sure you have a sufficient resistor in series with the LED (400 Ω - 1 kΩ for 9V). ● LEDs have a specific polarity (+/- vs. -/+). Verify that it is oriented correctly. ● Verify that the LED is supplied with sufficient voltage (check voltage across LED). ● If the LED previously lit up brightly and then went out, it is probably burned out due to high current. Keep the current low and try again with a different LED.
The capacitor voltage (RC circuit) isn't changing.	Possible Solutions: ● Make sure you have a resistor in series with the capacitor. ● Capacitors have a specific polarity (+/- vs. -/+). Verify that it is oriented correctly. ● Most likely, the capacitor is already fully charged or fully discharged. Once either of those states is reached, the voltage stays constant. Follow the instructions to charge/discharge the capacitor and try again.

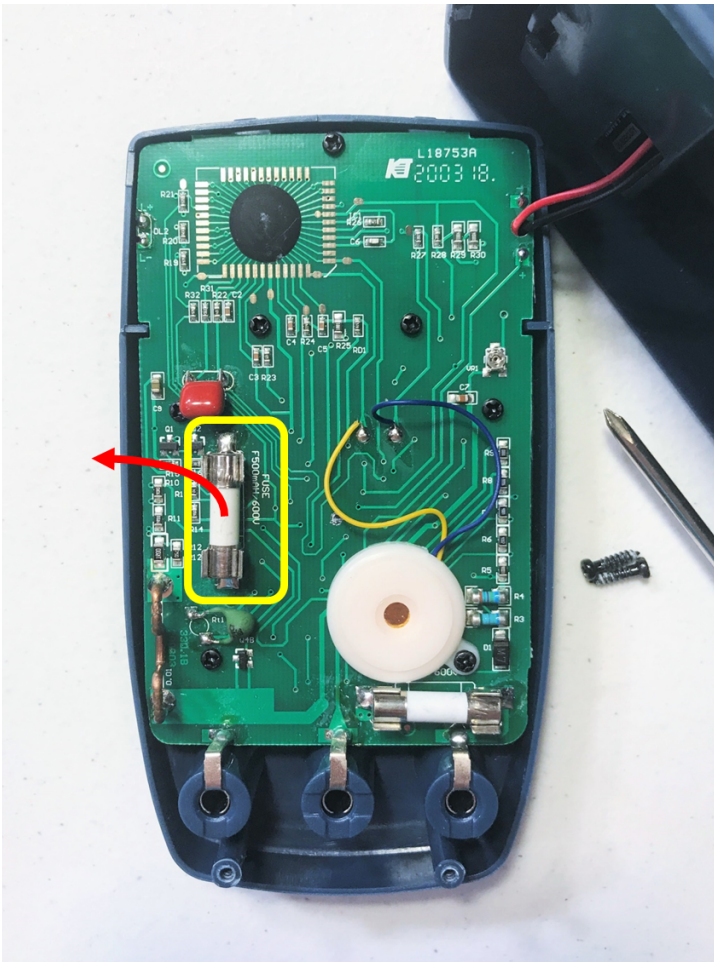
Replace Multimeter Fuse:

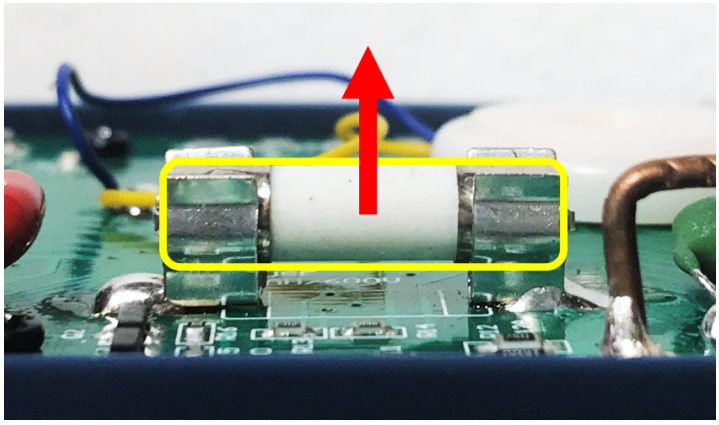
Before changing the fuse, check the troubleshooting section to verify that the fuse is burned out. Then proceed with the following steps.

Note that these steps are specifically for the AstroAI AM33D multimeter. If you have a different model, the process may be slightly different but it should be fairly similar. Ask your TA or instructor for help if you have trouble.

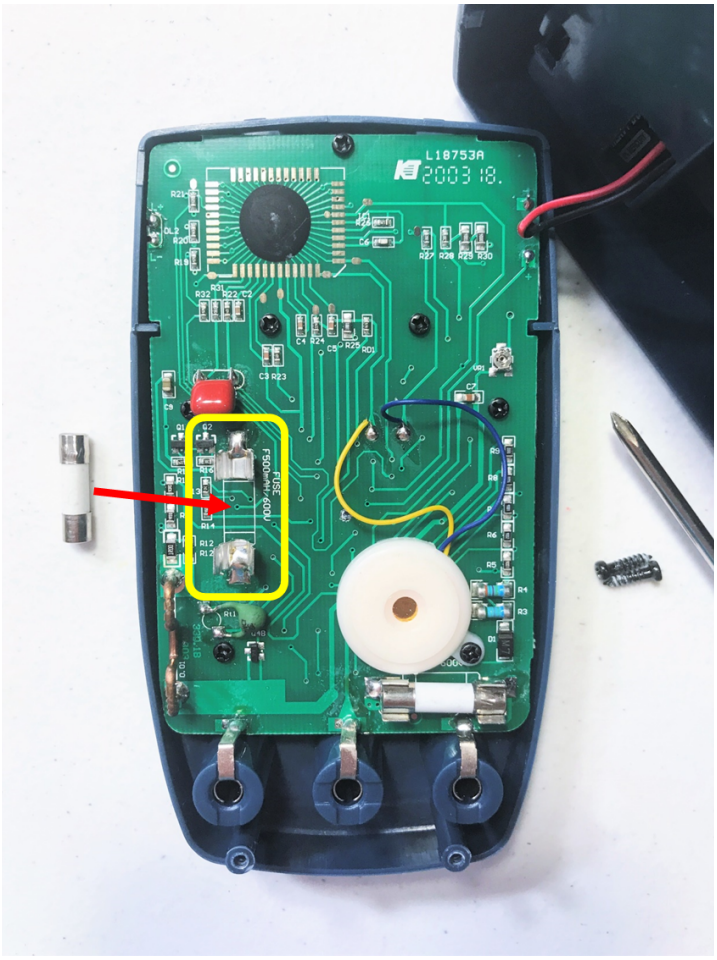
1. First, turn off the multimeter.
2. Flip the multimeter over and remove the rubber casing (red in this example).
3. Use a screwdriver to remove the screws holding the back of the multimeter in place (screws identified in yellow).

4. Remove the back cover of the multimeter and look for the fuses. You should see two fuses on the circuit board - one for high current (10 A) and one for low current (maybe 500 mA). You will need to replace the low current fuse.
5. The AM33D multimeter is rated for 500 mA of current, corresponding to a 600 mA fuse (identified in yellow).
6. Pull the fuse straight up and out from the spring clips.





7. Insert the new fuse into the spring clips (direction doesn't matter).



8. Replace the back cover, screws, and rubber case.
9. Verify the multimeter turns on, then **CAREFULLY** test it by measuring something you couldn't before replacing the fuse.
    a. If it works, congratulations! Your multimeter is fixed.
    b. If it still doesn't work, you may have replaced the wrong fuse (different multimeter models may have different fuse placement and/or fuse labels) or something else may be the problem. Refer to the troubleshooting section or ask a TA/instructor for help.
