

Capacitor Charging Guide



This guide is intended to provide a tutorial for charging the capacitor stack in the ND Formula Hybrid testbench. It includes safety notes and step-by-step instructions for charging.

Safety Notes:

- There is very low resistance with the capacitors so if you connect them uncharged to a 120 volt voltage source, there will be a massive spike in current that will melt the wires and trip any fuses. Therefore you need to limit the voltage difference between the capacitors and the voltage supply. To achieve this you will need to use a transformer and slowly increase the voltage output of the transformer as you charge the capacitors. The power supply provided by Professor Bauer allows for this via the black knob. We recommend future teams purchase a power supply such as the Mophorn 110V AC 60Hz variable transformer linked below. <https://tinyurl.com/2229v57m>
- Using the alligator clip wire, do not exceed 10 amps of charging current. (5-7 amps is a safe range)
- It is suggested that you do not charge the capacitors to their maximum voltage. The maximum voltage can be found by multiplying the number of capacitors * 2.7V. It is fine to approach 95% of the max voltage.
- Charging time is dependent on the rate of charge, the initial charge on the capacitors and the desired final voltage.
- Be careful that the jumper cable leads do not touch. This will short the capacitor bank and cause a surge in current,

Step by Step Guide:

1. Measure the voltage of the entire capacitor stack using a Digital multimeter connected to the positive and negative terminals of the capacitors.
2. To the transformer, connect two alligator clip wires to the unrectified output.
3. These wires (both black in the photo) are then fed into the bridge diode rectifier on the AC input terminals (polarity does not matter) to convert to DC.
4. On the DC output of the rectifier, insert red and black lead wires (red to the positive, black to the negative)
5. Connect the other ends of the red and black wires to the jumper cable clamps, matching red to red and black to black.
6. For safety purposes, place a current probe around the red jumper cable lead to measure the charge current. (Optimal charge current is 5-7amps)



Figure 1. Illustrates the connections described in steps 2-6.

7. Then on the vehicle test bench, connect the jumper cables to the large high voltage cables with black shielding, matching red with the positive terminal and black with the negative. The jumper cables should be placed "outside" of the system relays and fuses for added safety. Proper connections are shown below in figure 2.



Figure 2. Proper jumper cable connection to capacitors.

8. Now unlock and open the red switch and plug in the transformer to a wall outlet.
9. Slowly turn the black knob clockwise to increase the voltage output of the transformer until the current probe indicates current is flowing. Continue increasing the voltage on the transformer to maintain a relatively constant flow of current (5-7amps).
10. It is necessary to connect a DMM to measure the total voltage of the capacitor stack. With current flowing, you will see this voltage slowly increase.
11. Continue charging the capacitors until your desired voltage is reached. (We recommend charging to no more than 95% of the max voltage for safety reasons)
12. To end the charging process, flip the red switch to stop the flow of current. Then turn the black knob on the transformer counterclockwise to the stop and unplug the transformer. Finally, disconnect the jumper cables from the capacitors.
13. The capacitors are now charged.