CEEN 1030

Purpose

You will continue adding components to your TekBot™ ending with a Bot that will run. You will take electrical measurements on the TekBot to determine the resistance of each motor.

Lab overview

During the course of this lab you will perform the following tasks:

- Assemble more components for your TekBot.
- Use the DMM to measure voltage and current.
- Learn basic ideas about how a DC motor operates.

Prelab

Be sure your TekBot is fully charged before coming to lab. To do this be sure that your TekBot has been plugged into the wall for at least 8 hours prior to lab. If your TA has not looked at your system yet make sure she does BEFORE you plug it and try to charge it.

Procedure

1. You will need to make a power cable for your robot to get power from your batteries to your protoboard. TekBots has adopted a 'keyed' connector system for power. This means that in order to work correctly you can only insert your power cables one way. This will help protect you as well as your TekBot. An example of this can be seen in Figure 1. To do this the cable is constructed from two four-position male headers on each end of a two wire cable. Only two of the pins on each connector are used. Make sure that the wires are connected to corresponding pins on both connectors. Figure 2 shows the cable. A female connector strip is used to hold the male connectors while soldering. When soldering wires to the connectors, I recommend tinning the wire and the pin first. Additional solder is usually not needed when you solder the wire to the pin. Insert one end of the cable into the female sockets on the charger board. The two unused male pins on the connector will be over the unused holes on the charger board. See Figure 3.

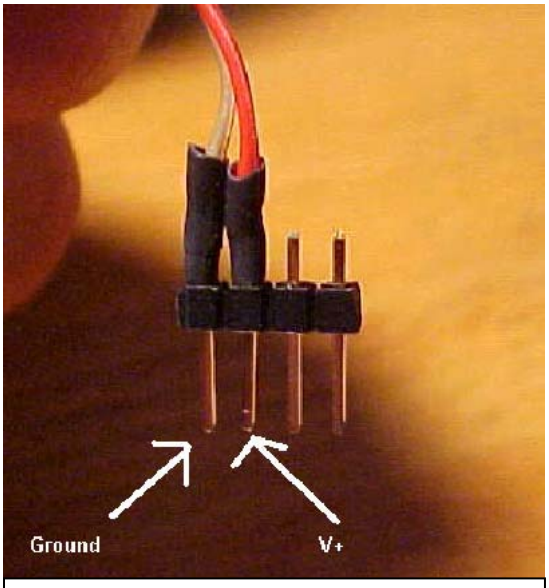

Figure 1 Power Cable Connector

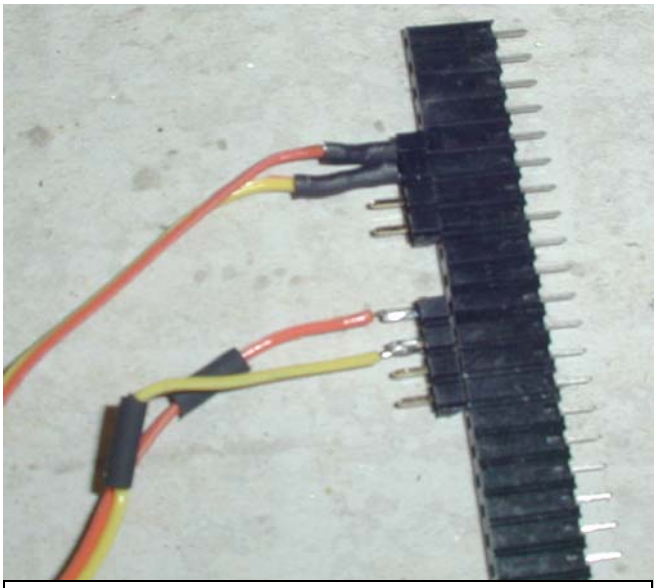

Figure 2 Using Female Connector to Hold Male Connectors While Soldering

Figure 3

2. If you have not already mounted connectors onto the motor leads, solder 2-pin male connectors onto the leads for both motors.

3. To assemble circuits quickly for prototyping a device called a ‘breadboard’ (or ‘protoboard’) is often used. Components can be easily inserted into a set of holes and connected together with wire. Locate the breadboard in your kit and remove it from the box. Now you need to make sure that the internal contacts are firmly seated. You do this by pushing on the backside of the board with your thumbs; Figure 6 shows how this is done.

Figure 4 Breadboard

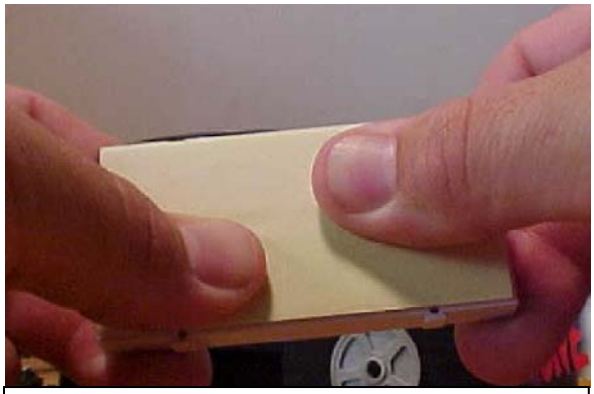

Figure 5 Seating a Breadboard's Contacts

IT IS NOT RECOMMENDED THAT YOU USE THE DOUBLE SIDED STICKY TAPE ON THE PROTOBOARD. THIS WILL MAKE THE PROTOBOARD HARD TO RELOCATE IF YOU EVER NEED TO.

4. Now you can affix the breadboard to your robot. Use the 4-40 5/8" metal machine bolts, and force them through the holes in the breadboard. This then attaches to the Plexiglas layer in your kits. The Plexiglas layer then in turn attaches to the base of your robot using 8-32 Nylon bolts and the nylon standoffs. Bring the wires from the motors and the power cable through the hole in the Plexiglas. Figure 6 shows the placement of the breadboard on the Plexiglas.

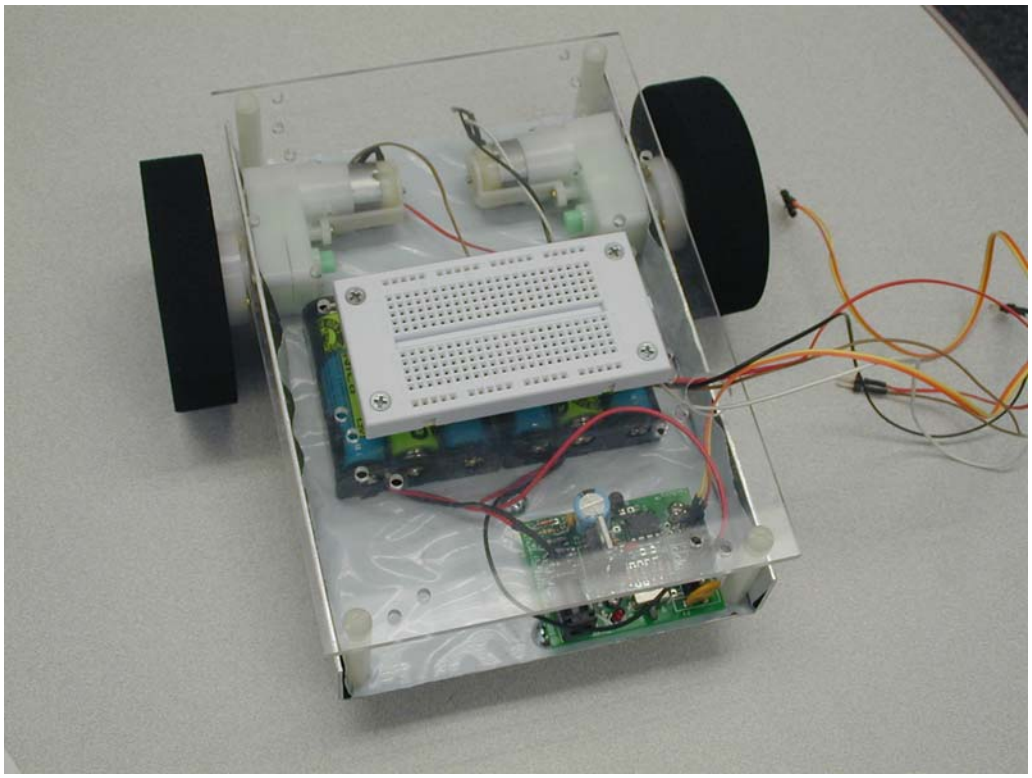

Figure 6. Placement of Breadboard

5. Turn the switch on the charger board to "OFF". Insert the power plug into the breadboard. Make sure each pin is in a separate node. If you have the plug rotated 90 degrees, you will short the batteries to ground. (This is bad!) Connect one of the motor cables to the breadboard in the same nodes as the power and ground of the power plug. See Figure 7. Move the charger switch to "ON". One of the wheels should turn. Repeat for the other wheel. Connect both motor cables and run the Tekbot on the floor. Observe how straight it goes.

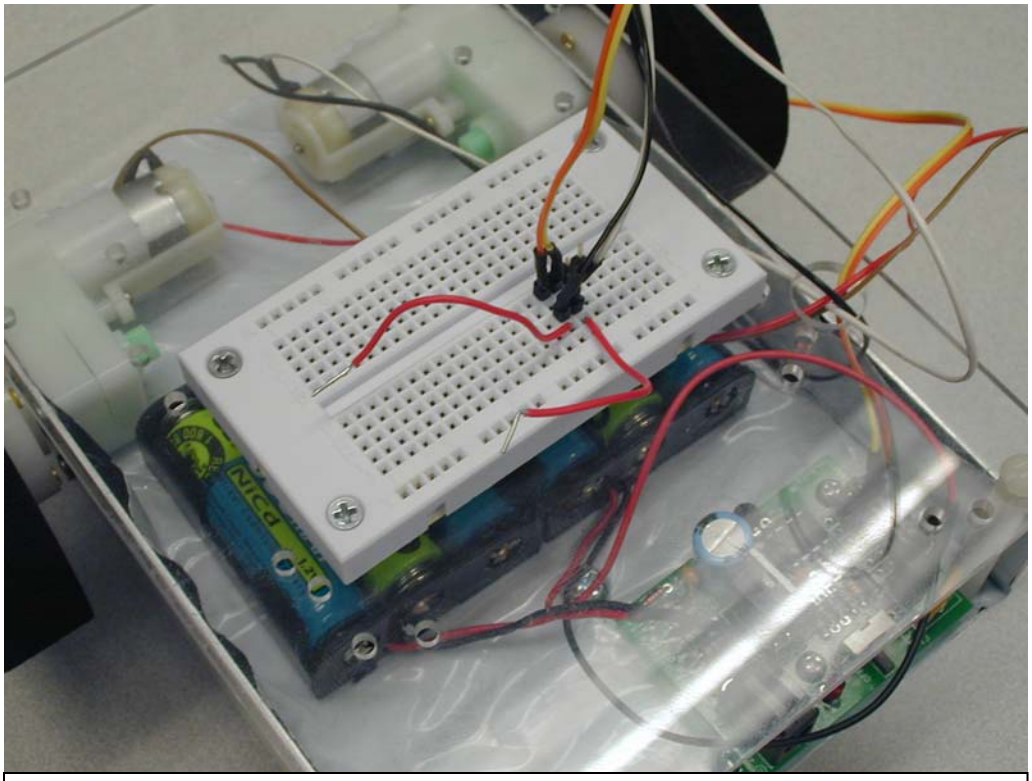

Figure 7 Cable Positions for Testing Motors

6. Remove motor cables from the breadboard and measure and record in Table 1 each motor's resistance with the DMM.
7. Place one short jumper wire in the breadboard node that is connected to ground. Place another in the node for the battery. Connect the voltmeter to these wires to measure the battery voltage when one wheel is turning. See Figures 7 and 8.

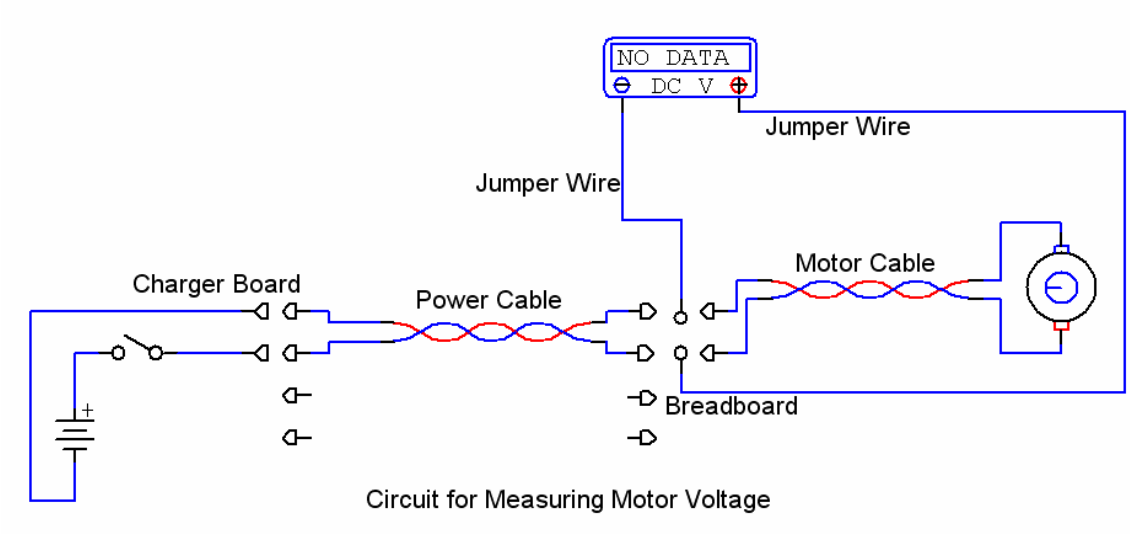

Figure 8

8. Move the motor connector one node position so that only the ground pin from the power cable is connected to the motor. Connect the DMM to measure current. See Figures 9 and 10. Record in Table 1. Why is the measured resistance much less than the value obtained by using Ohm's Law? Use your hand to apply some drag to the wheel and observe the change in current. Don't use enough force to stall the motor; you may strip the plastic gears.

9. Do the same measurements for the other motor.

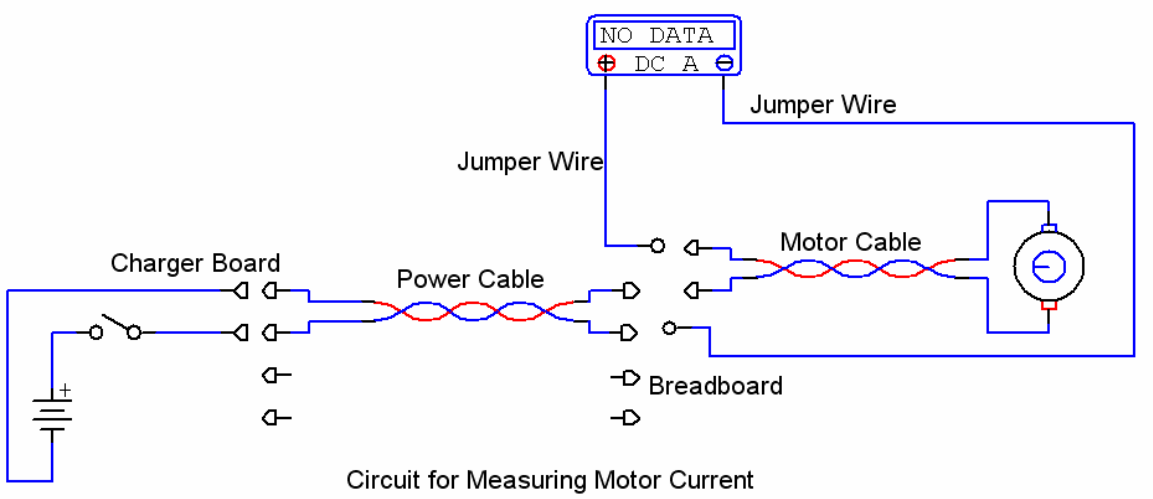

Figure 9

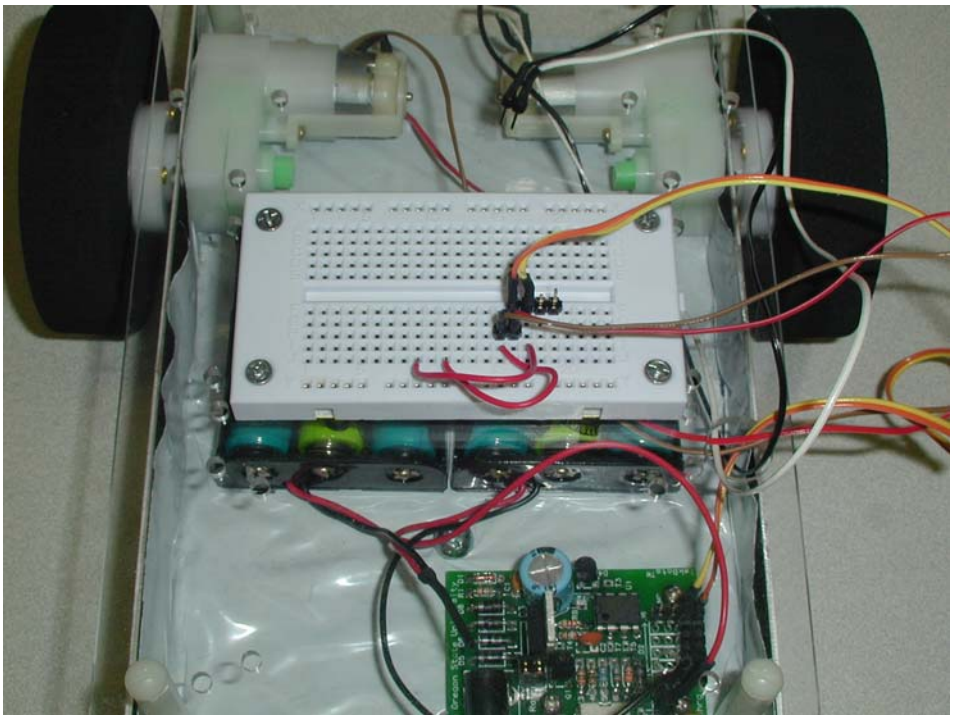

Figure 10. Configuration for Measuring Current

Table 1

Motor	Resistance	Voltage	Current	Volt/Amp
Left				
Right				

10. Elevate the wheels of the Tekbot so they can turn freely. Disconnect one of the motors. Place 44 ohms resistance (two 22 ohm resistors in series) in series with the motor. Turn the Tekbot on and measure the voltage across the resistor, voltage across the motor, and the current. Compute the power dissipated by the resistor and the motor. Record in table 2. Repeat with 22 ohms.

Table 2 One Motor

Resistance	V battery	V Motor	V Resistor	Current	Power Motor	Power Resistors
44 ohm						
22 ohm						

11. Connect both motors. Put 44 ohms in series with the motors and take the measurements in Table 3. Time how long it takes the TekBot to go 10 feet. Each of the floor tiles is 12 inches. You may have to nudge your Bot to keep it going straight. Repeat with 22 ohms and again with no resistance. Note: Measurements for the "no resistance" are available from Table 2; you only need to measure the time.

Table 3

Resistance	V battery	V Motor	V Resistor	Current	Power Motor	Power Resistors	Time/ 10 ft
44 ohm							
22 ohm							
0 ohms							

12. Connect one motor directly across the battery and the other motor in series with a 44 ohms resistance. Run the Bot on the floor and measure and record the diameter circle traced by the Bot in Table 4. Repeat with 22 ohm and 11 ohm (two 22 Ω in parallel) resistances.

Table 4

Resistance	Diameter Circle
44 ohms	
22 ohms	
11 ohms	

13. With no resistors, place the Bot in the middle of the hallway and observe how far it goes before it hits the wall. _____

Sensor Assembly

As the last part of this lab you will assemble your sensor boards from your TekBot kits. They will be needed next time.

The sensor board parts list, schematic, and silk screen are posted on the lab web site. Use female jacks for J1 and J2.

Copy the data from the tables onto the last page and submit to the lab instructor.

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Name_____ **Section_____**

Motor Data

Motor	Resistance	Voltage	Current	Volt/Amp
Left				
Right				

Single Motor Data

Resistance	V battery	V Motor	V Resistor	Current	Power Motor	Power Resistors
44 ohm						
22 ohm						

Both Motors Data

Resistance	V battery	V Motor	V Resistor	Current	Power Motor	Power Resistors	Time/ 10 ft
44 ohm							
22 ohm							
0 ohms							

Unbalanced Motors

Resistance	Diameter Circle
44 ohms	
22 ohms	
11 ohms	