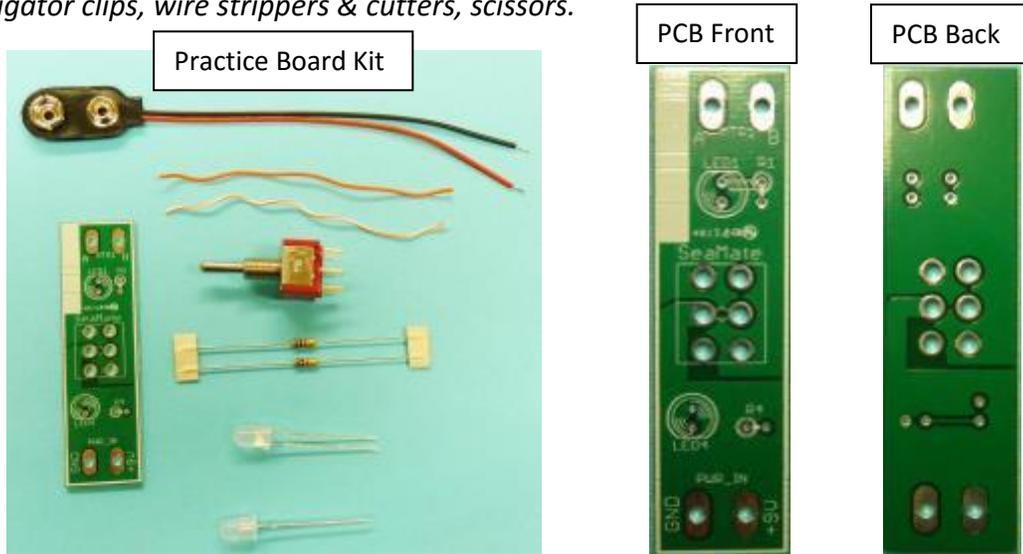


## LAB 3 SeaMATE PufferFish Practice Board

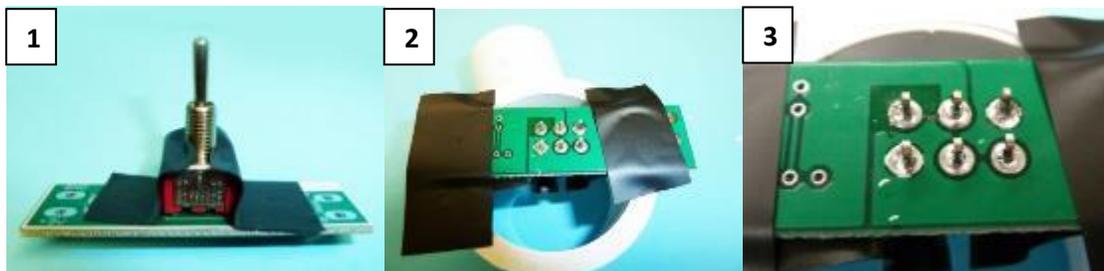
**Components:** Practice Board Kit, (2 resistors, 2 LEDs, 1 DPDT switch, 1 PCB, 1 9-volt battery connector, 2 motor wires – color varies)

**Tools & equipment needed:** Safety Glasses, 9-volt battery, motor, soldering iron (fine tip) & solder (~ 0.8 mm Rosin Core Lead-Free), electrical tape, motor mount (PCB holder), alligator clips, wire strippers & cutters, scissors.



A **printed circuit board** (or PCB) mechanically supports and electrically connects electronic components using conductive tracks (rather than wires) etched from copper sheets laminated onto a non-conductive surface. Take a good look at the printed circuit board. The front of the board or PCB has printed words; the back of the board does not. The components are inserted on the front of the board and soldered on the back. **However** the wires for power to/from the battery and to/from the motor are fed through the back of the board and soldered on the front of the board. Let's install the components.

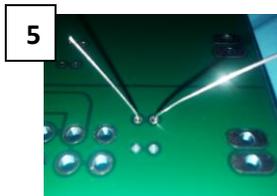
1. **Switch (1): Orientation DOES NOT matter.** Insert the DPDT switch pins into the six holes on the front of the board and tape the switch in securely with electrical tape as shown so it does not wiggle [Photo 1]. Turn the board upside down and tape it to the motor mount; the motor mount will serve as the board holder [Photo 2]. Solder the six pins on the back of the board so that every hole is filled with solder [Photo 3]. Remove all the electrical tape but save the tape, you will reuse it when you secure the board to solder other components.



2. **Resistors (2): Orientation DOES NOT matter.** Bend resistor wire and insert the two resistors into the R1 and the R2 holes [Photo 4]. Splay the wires as they come through the back of the board to hold the resistor in place [Photo 5]. Solder the leads (wires) on the back of the board; the solder joints should look like mini, shiny, silver Hersey Kisses [Photo 7]. Solder both resistors into place. Learning to read the resistor code is helpful.

*Why do we need to use resistors for the LEDs?*

*How many ohm's of resistance do these resistors provide? \_\_\_\_\_*



1. **LEDs (2): Orientation DOES matter.** Look carefully at the LED; it is circular, but if you look closely, one side is flat. Look at the LED symbol on the PCB; one side is flat. Insert the LED so the flat sides match [Photo 7] and solder the leads. These are special bi-polar LEDs. The color will change with polarity change. Clip off the leads above the solder joint [Photo 8].



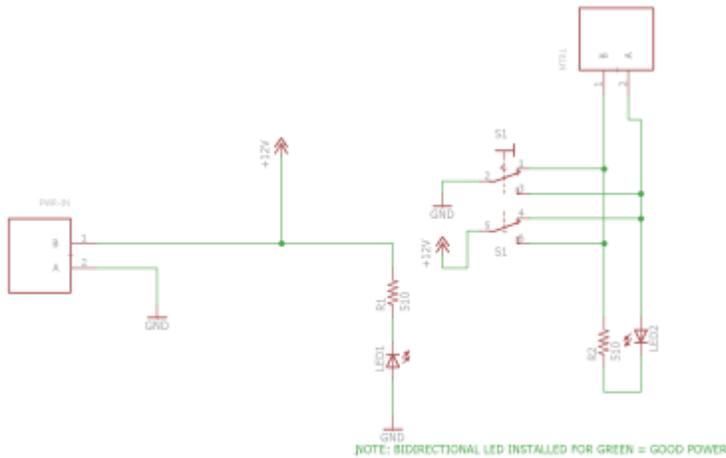
2. **Power Cable:** Look for the PWR\_IN on the PCB. **REMEMBER, Wires are inserted in the back and soldered on the front of the board.** The red (positive) wire is soldered to the +9V hole and the black (negative) wire is soldered to the GND (or Ground) [Photo 9]. Strip 4 mm off of the end of each wire on the 9-volt battery holder [Photo 10]. Take one wire and bend the wire 3 mm from the end at a right angle and feed the wire through the proper hole and solder [Photo 10]. Do the same for the other wire. It is important that your wires and solder DO NOT exceed the footprint of the silver metal pads, otherwise you will short out the system if they touch. The board should look like this [Photo 11].



3. **Motor Cable:** In the practice kit there are two motor wires, these were removed from the gray motor cable that comes with the PufferFish Kit. The gray cable encloses 6 wires in colored sheathes inside it. The two wires in the kit will be 18 gauge wires of different colors (your colors may be different than shown below.) Strip 4 mm off both ends of the wires [Photo 12]. Solder the motor wires to the MTR pads A and B in the same manner as you did for the power wires. For this exercise either wire can be attached to pad A or B.



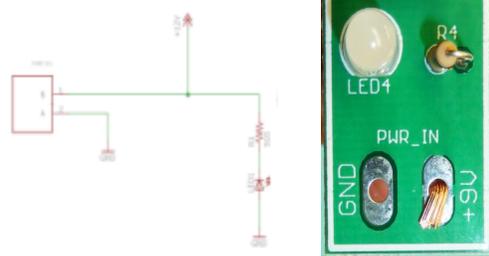
4. **How it works**



Above is the schematic for the puffer fish practice board. At first glance it is a little daunting. So let's deconstruct the circuit into the power circuit and the switching circuit.

### The Power Circuit:

The power circuit consists of the connections to the 9V battery, the resistor, and a LED. The electricity flows out of pin 1 through the resistor and the LED and then back to battery. The wire flowing back to the battery is not shown and the symbol GND (ground) is used to denote these two points connect together. This is a common short hand process used in schematics to reduce the number of lines. The power circuit is the same circuit you built in lab 1 where you learned how resistors are needed to protect the LEDs from burning out.



When you plug in the 9v battery the red power light should glow. If the red light does not go on then use the multimeter to test the power circuit by tracing the voltages.



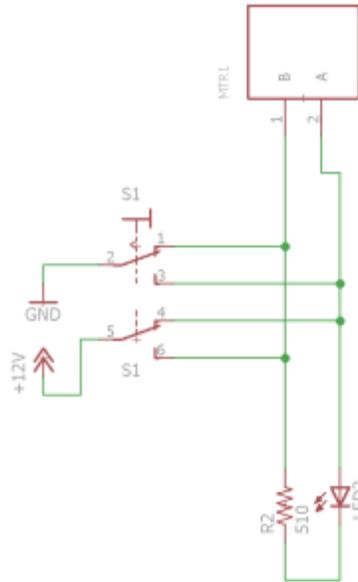
1. With the meter set on DC volts place the red lead on the 9V pad and the black lead on the GND pad of the printed circuit board. The meter should read the battery voltage, close to 9 volts. If it reads well under 9 volts, then the battery might be dead.



2. With the meter still on DC volts, leave the black meter lead on the GND connection and then place the red meter on each side of the R1 resistor. On one side you should get the battery voltage and on the other side you should get less than the battery voltage, approximately 3V, since the resistor used up or dropped some of the available battery voltage. If you do not get these readings, then most likely there is a poor soldering connection on the resistor. Resolder both sides of the resistor.
3. If the Red LED still does not light up, then check the solder connections on the LED. If the connections are good, the LED may have burned out and will need to be replaced.

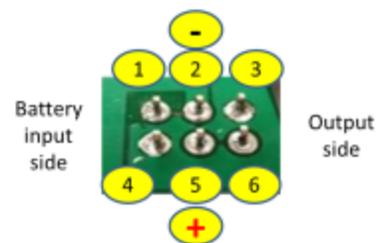
**The Control Circuit:**

The control circuit consists of the double pole double throw (DPDT) switch, a resistor, an a LED. This looks pretty confusing due to all DPDT connections. The green lines are internal to the PCB so you don't have to worry about those. The DPDT switch just flips the ground and positive voltage on the output pads A and B depending on which way the switch is pushed (switches the direction of DC electricity across the motor). This is exactly the same as the knife switch in Lab 1, and the exercise where you traced electricity flowing through the switch circuit in Lab 1.



**Push switch direction 1:**

Switch GND on Pin 2	Connects to Pin 1 on switch	Results in negative on B output pad
Switch V+ on Pin 5	Connects to Pin 4 on switch	Results in positive on A output pad – GREEN output light
<b>Push switch direction 2:</b>		
Switch GND on Pin 2	Connects to Pin 3 on Switch	Result in negative on A output pad



Switch +V on Pin 5	Connects to Pin 6 on switch	Results in positive on output pad B RED output light
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**Testing with the Multi-meter by Tracing the Voltage**

1. Insert a 9 volt battery into the battery holder.
2. With the meter set on DC volts place the red meter lead on pin 5 of the switch and the negative meter lead on pin 2 of the switch. The meter should show the battery voltage, close to 9 volts.
3. The LED in the control circuit is bi-directional. It turns both green and red depending on the direction of electrical flow. As you move the switch towards the red power LED the forward LED should go Green.
4. As you move the switch away towards the red power LED the forward LED should go Red

If the bidirectional LED does not light up then most likely there is a bad solder connection in the LED resistor series.

5. **Add a motor:** Using alligator clips, attach one motor wire to the metal loop on the motor (your motors may differ). Attach the other motor wire to other loop on the motor [Photo 13]. Can you turn the motor on and reverse it using the DPDT switch on the PCB [Photo 14]?

