

# ASSEMBLING the ECEbot

## *Printed Circuit Board: Part Two*

**The Part Two assembly steps must be completed prior to lab session #4:**

**Due Date:** \_\_\_\_\_

Prepared by B.A. Towle and R.C. Maher  
September 2004

Copyright © Department of Electrical and Computer Engineering, Montana State University, 2004  
All Rights Reserved

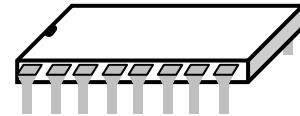
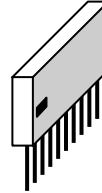
## 2. Resistors, Transistors, Switches, and Headers

### 2.1. Soldering Step 3: Resistor Packs and Transistors

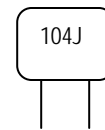
#### 2.1.1. Components list

The components you will use for this step are listed below. The **bold** code refers to the component's name on the PCB silk screen. Find each of the components from your parts kit:

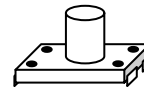
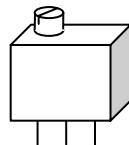
- One 10k $\Omega$  in-line resistor pack, **RN2**
- One 4.7k $\Omega$  dual in-line resistor pack, **R19**
- Four 1 k $\Omega$  resistors, ¼ watt (Brown-Black-Red-Gold), **R3, R4, R5, R6**
- Two 10 k $\Omega$  resistors, ¼ watt (Brown-Black-Orange-Gold), **R23, R24**
- Four 2N3906 PNP bipolar transistors, **T1, T2, T3, T4**



- One 0.1 $\mu$ F (104) capacitor (non-polarized plastic film), **C2**

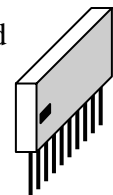


- One 50 k $\Omega$  potentiometer, **R17**
- Three small pushbutton switches, momentary contact, **RESET, BUTTON1, BUTTON2**
- Four 2-pin headers, **JP2, J3, J4, and J9**

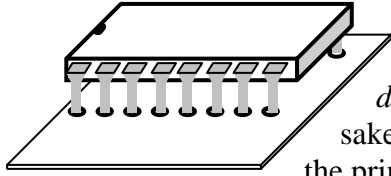


#### 2.1.2. Placing the resistor packs and discrete resistors

Locate position **RN2**, the ten-pin in-line resistor pack in the upper center of the board (see the location circled in Figure 2-1). It is important to solder the resistor pack so the pin with the black square above it is in the first (leftmost) hole of the group.



→ Hold the pack in place on the front side while you solder each pin on the back side.



**R19** is another resistor pack, but it has eight separate  $4.7\text{ k}\Omega$  resistors inside a dual in-line package (DIP). For this particular device it does not matter which direction you put it in, but for the sake of consistency it is suggested that you insert the package so that the printed label has the same orientation as the PCB silk screen lettering.

→ Place the pins through the front side holes and solder each pin on the back side.

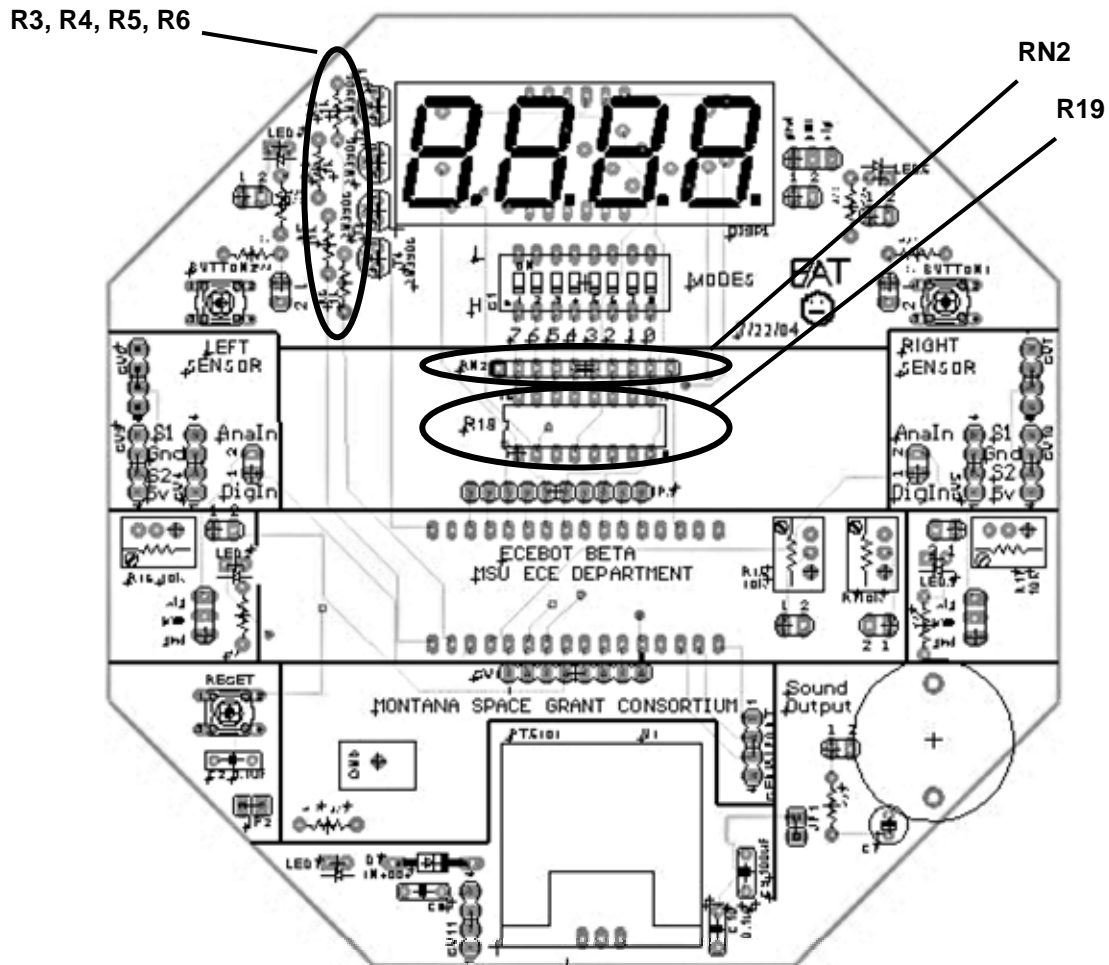


Figure 2-1: PCB layout: Front

**R3, R4, R5, and R6** are all  $1\text{ k}\Omega$  resistors. Using the resistor color code chart, verify that the color scheme should be Brown – Black – Red – Gold.

→ These are installed in the marked holes in the upper left corner of the board (just to the left of the 4-digit LED display silk screen) using the by now familiar resistor soldering technique. Try to make sure the resistors are inserted so that the color bands are all in the same orientation. This doesn't change the way they work, it just makes them easier to recognize and verify when they are in the circuit.

### 2.1.3. Transistors

The next components to install are the four transistors. Find the small half cylinder-shaped objects with three leads. These are the 2N3906 PNP bipolar transistors. Locate the **T1-T4** holes in the upper left corner of the PCB. Orient the transistors so the shape is aligned with the silk screen emblem (curved side to the left, flat side to the right).



*Hint: Gently bend the middle pin out so it will fit in the holes as the transistor is inserted. Do not press it down so hard that the middle pin is in danger of snapping.*

*Hint: When mounting the transistors the force of the pins is usually enough to hold the component in place while soldering the leads to the very small pads on the back side.*

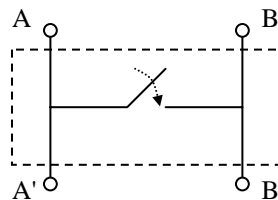
→ Solder the four transistors in place, then snip off the excess wire. Take your time: make sure the solder only contacts the leg of the transistor and the pad, not the adjacent board surfaces and components.

### 2.1.4. Pushbutton circuits

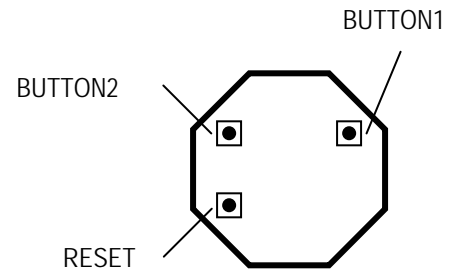
The PCB has three small momentary pushbutton switches: the *RESET* switch, *BUTTON1*, and *BUTTON2*.

**Challenge:** *With the help of your lab partner use the DMM (digital multi-meter) to test the connectivity of the pins on the momentary buttons provided in the kit. When the button is not depressed, which of the four pins are connected to each other? Now push and hold the button while you repeat the measurement: which pins are connected now?*

The answer to the challenge can be determined by looking at the internal circuit schematic diagram for the switch (see below). Note that both pins on the left side are connected to each other all the time, both pins on the right side are connected to each other all the time, and all the pins are connected together when the button is pressed. It is very important that the buttons be soldered onto the board with the correct orientation.



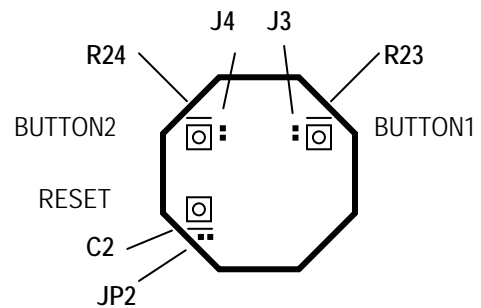
Locate the three button locations on the PCB. Place the switches onto the board: the pin spacing is slightly wider in the horizontal direction than in the vertical direction, so make sure you have the switch in the proper orientation as you insert the pins.



→ Solder the pins of each switch on the back side of the PCB.

Next, install the 10 kΩ resistors R23 and R24, located just above pushbuttons **BUTTON1** and **BUTTON2**.

→ Slide the leads through the front of the board and solder them on the back. Carefully snip the excess wire.



→ Install the 0.1 μF plastic film capacitor C2 located just below the **RESET** switch.

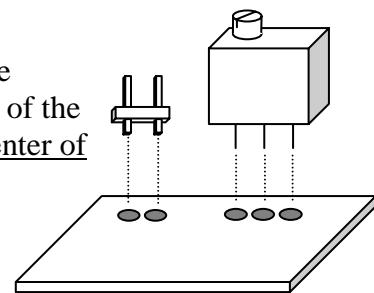
→ Finally, install the three 2-pin headers: J3 next to BUTTON1, J4 next to BUTTON2, and **JP2** below the **RESET** switch.

### 2.1.5. Potentiometer



The PCB has space for four potentiometers, but we will only be installing a single "pot" in position **R17** at the extreme right center of the board. Orient the pot so that the adjustment screw is toward the center of the board (as indicated on the silk screen).

→ Place the pot's three leads through the holes and solder the potentiometer in place.



→ Next, install a 2-pin header J9 in the holes just to the left of the potentiometer.

## 2.2. Soldering Step 4: Main Headers

The other components to be installed this week are headers, and there are quite a few of them!

| Header size | Qty |
|-------------|-----|
| 2-pin       | 3   |
| 3-pin       | 3   |
| 4-pin       | 7   |
| 8-pin       | 1   |
| 10-pin      | 1   |

→ The locations to install are circled in the PCB layout shown in Figure 2-2. Insert all the specified headers and solder them in place. Try to make sure the pins end up perpendicular to the board.

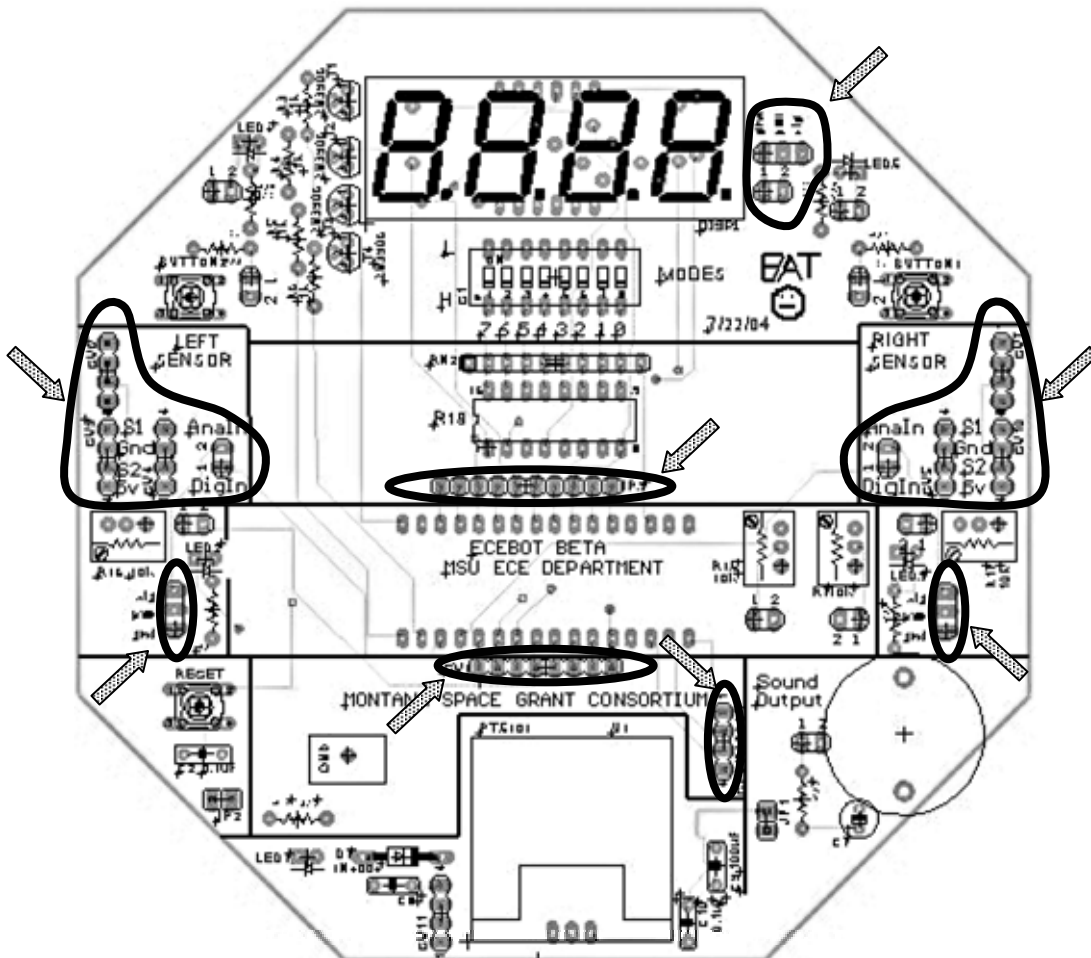


Figure 2-2: Locations to install the indicated headers.

*This concludes soldering Part Two.  
This coming week you will complete the PCB assembly with the Part Three steps.*