MECH-14 Surface Mount Technology ("SMT") Assembly Lab
Jim Weir, Mech-14

"The Simon Game"

Review this video: https://www.youtube.com/watch?v=3NN7UGWYmBY

Assembly

1. Tools and supplies needed:
    a. Temperature Controlled Soldering Pen/Iron with the smallest tip possible
    b. Standard Soldering Tool Kit (Bread Pan)
    c. Tweezers
    d. Magnifying Headband or Visor
    e. Flux Pen
    f. Thin (20 mil) Rosin Core Solder
    g. Digital multimeter

2. Plug soldering iron in. Set temperature control to 6 on the control knob or 600°F on the digital readout. Allow iron to warm up for approximately 5 minutes.

3. Here are the steps for soldering a surface mount component onto the PC board:

    a. Take your time and do it right. It is FAR easier to put components onto the board correctly as it is to have to remove them to do it the correct way.
    b. On one of the top surface pads of the pc board where the component is going to go, melt a LITTLE TINY bit of solder onto the pad, as thin as possible.
    c. Using a flux pen, put a small amount of flux onto this thin layer of solder on the pad in (b).
    d. Using tweezers, place the component into position and use the tweezers to apply a SMALL AMOUNT of down-pressure on the component.
    e. Touch the tip of the iron onto the pad and small bit of solder, then bring the tip of the iron so that the solder flows onto the component creating a concave "ramp" of solder from the pad to the component.
    f. Place a SMALL AMOUNT of pressure sideways onto the component to make sure that the component is soldered onto the pad.
    g. Use the flux pen and put a small amount of flux onto all the remaining pads and solder ends of the component.
    h. Using as little solder as possible, solder all the remaining pads/ends of the component.
    i. Go back and reflow (adding a tiny bit more solder) to the first pad that you soldered.
    j. Examine the solder joints on the pads/ends of the component. Each solder joint should not be lumpy, or have balls of solder sticking to it.
    k. Usually we install the smallest or lowest parts first, then the larger or taller components.

4. Install the resistors ONE VALUE BY ONE VALUE. We usually like to install the resistors in ascending value, that is, from the lowest value to the highest value. The lowest value appears to be 1.0kΩ, so get a 1k resistor from the parts bins on the front desk. Do NOT take anything else. Using section (3.) above, install that resistor at R9 (it is not polarized). Install the resistor with the value printed on the case (tiny numbers) pointing up so that you can read the numbers. Have the instructor inspect your first resistor. If the installation is correct, then similarly, install the following resistors:
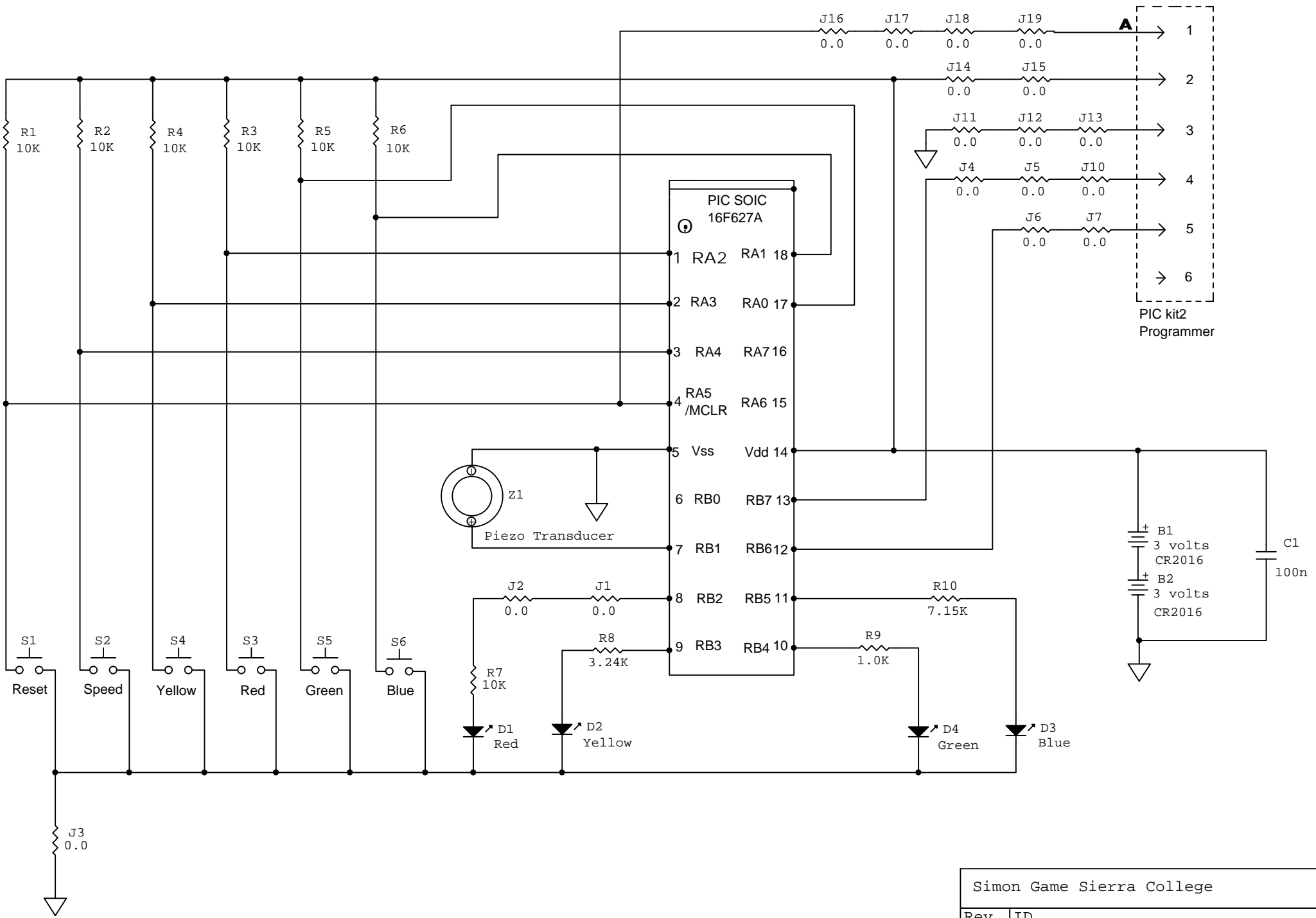
    a. 3.24k at R8
    b. 7.15k at R10
    c. 10k at R1, R2, R3, R4, R5, R6, and R7 (get all 7 10k resistors at the same time, but don't sneeze at your work station).

5. Install capacitor C1 in a similar manner as the resistors.

6. Where we want a trace to "jump across" another trace, we use "jumpers", sometimes called "zero-value resistors". Install 19 jumpers at J1 through J19. (Get them all at once from the parts bin.)

7. Install the LEDs ONE BY ONE from the parts bins.

    a. Get a RED led.
    b. Note that there is a green arrow on the BOTTOM of the LED. This arrow will NOT be visible when you install the LED.
    c. Note that there are green corners on ONE end of the TOP of the LED. The green corners are the CATHODE of the LED. Using the multimeter on the "diode check" scale, put the black lead of the multimeter on the LED *CATHODE* and the red lead on the LED *ANODE*. The LED should light with a RED color. If it does not, do NOT solder it onto the board until the instructor checks your work.
    d. Once the diode checks OK, solder it to position LED1. Hold the board so that you can read the white printing on the top of the board. The CATHODE (green corners) of the LED should be to the LEFT side of the board and the green arrow should be invisible underneath on the surface of the pc board.
    e. In a similar manner, Install yellow (LED2), green (LED3), and blue (LED4) diodes.

8. Install the PIC Microcontroller integrated circuit ("IC" at U1. Note that pin 1 of the IC has a small dimple in the plastic next to pin 1. Be sure that you POSITIVELY identify pin 1 before soldering. There is an identifying dot on the pc board for pin 1 and that pin 1 is closest to the "U1" white lettering on the board. Now using the same technique as the above components, lay a thin coat of solder over the pad on the board at pin 1.. Position the IC so that pin 1 is in the right location, apply flux, and "tack solder" pin 1 to the board. See that all the remaining pads are over their respective pads, and then solder pin 9 (across and at the other end of the IC). Using flux (very important on this part), solder all the remaining pins of U1 to the pc board. You may wish to note that roughly 80-90% of the "it doesn't work" problems are solder joints on U1.

9. Install six switches at SW1 through SW6 (they are identical and not polarized).

10. Install the speaker at "Piezo Spkr" (it is not polarized).

11. Install the batteries with the positive (+) side up (the side with the writing on it). The clip from the (+) side connects to the pad at the edge of the board. To solder them to the board, apply a little bit of solder to both pads of both battery locations on the pc board. Apply a little solder to the tips of both clips of both batteries and apply a little flux to all four pads on the board. Install one of the batteries (observe polarity) and press down on one of the leads to solder it to the pad (the solder should flow up and around the battery lead. Then solder the other lead to the board. Repeat for the second battery.

12. Inspect your board for solder shorts between adjacent pads, especially around U1 (the IC).

13. Bring your completed board to the instructor for inspection and programming.

14. If you want to remove excess flux from the board, it is soluble in alcohol. Denatured alcohol and a brush (a toothbrush works very well) or a cotton swab (Q-Tip). HOWEVER, note that there is some controversy about removing flux. Some folks say it is hydroscopic (attracts water) but there is no evidence to that claim. I happen to have some antique WWII electronics from the 1940s with flux on them and no evidence of any water damage. Some say that the painted numbers on the parts are soluble in alcohol and you wipe the numbers off of the parts. Again, I've washed my share of boards to make them look pretty and haven't lost any printed legends yet. It appears to be your choice.

How To Play

1. Press the "Reset" button to start the game. All 4 LEDs will initially flash and allow you to check them for proper operation. After that, the game plays like the traditional "Simon" electronic game.

2. Pressing one of the other switches while pressing "Reset" will change the game in the manner listed in white printing below the switch (i.e. holding down SW5 while pressing Reset will allow you to play the game in "Silent" mode.
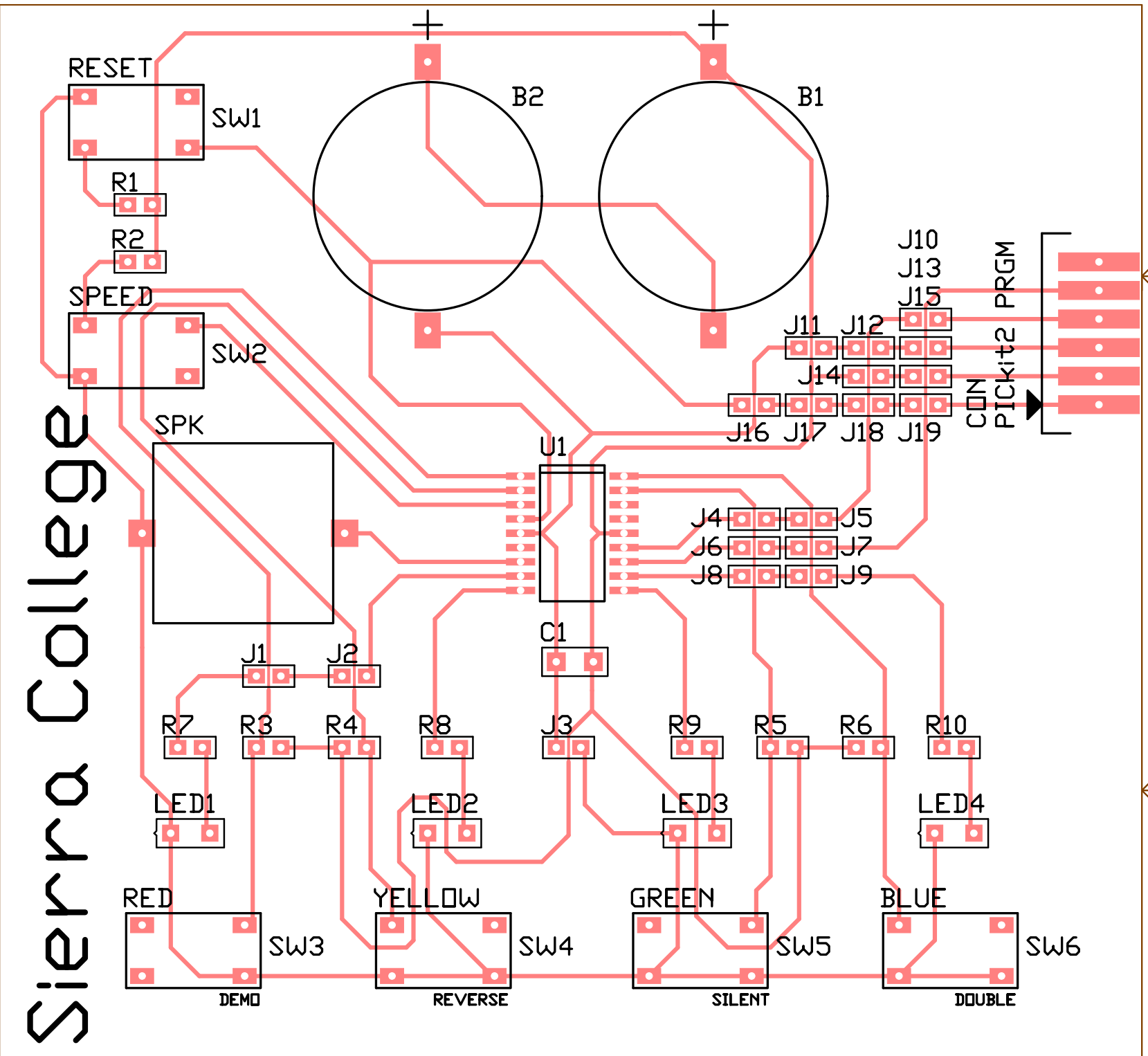
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Simon Game Sierra College

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