# ECE 445

Spring 2016

## Electronic Sand Clock

### R&V Table

<table>
<thead>
<tr>
<th>Project Contributors</th>
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</tbody>
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7.0 Requirements and Verification

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Verification</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Accelerometer</td>
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<td>10</td>
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<td>(1) Detect orientation on the X-axis</td>
<td>Connect Pin-3.3V and Pin-GND of the accelerometer to the +6V output port and the GND port of the DC Power Supply and set the Power Supply to output a 3.3V voltage.</td>
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<td>Place the accelerometer in such position that its labeled X-axis is pointing to the same direction of the Earth’s gravity. Measure the voltage between Pin-X and Pin-GND of the accelerometer using a multimeter, the voltage should read below 1.50V.</td>
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<td>Place the accelerometer in such position that its labeled X-axis is pointing to the opposite direction of the Earth’s gravity. Measure the voltage between Pin-X and Pin-GND of the accelerometer using a multimeter, the voltage should read above 1.80V.</td>
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<tr>
<td>(2) Detect Acceleration on the Y&amp;Z-axis</td>
<td>Power the accelerometer in the same way as stated in (1). Measure the voltage between its Pin-Y (or Pin-Z) and Pin-GND using the oscilloscope. Keep shaking the accelerometer in its labeled Y-axis (or Z-axis) direction and use the oscilloscope to measure the maximum and minimum value of the signal, the maximum should read above 1.80V and the minimum should read below 1.50V.</td>
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<td>(2) Detect shaking on the Y&amp;Z-axis</td>
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When the accelerometer is placed in such position that its labeled X-axis is pointing to the same direction of the Earth’s gravity, its X-channel output generates a voltage below 1.50V.

When the accelerometer is placed in the position that its labeled X-axis is pointing to the opposite direction of the Earth’s gravity, its X-channel output generates a voltage above 1.80V.

When shaking the accelerometer on its labeled Y-axis or Z-axis in a normal manner, the Y-channel or Z-channel output is going to have a maximum value larger than 1.80V and a minimum value smaller than 1.50V.
2. LED Matrix
Addressing & Color

Being able to light up any LED individually. Being able to light up any channel of the three possible color channels of a single LED.

Addressing & Color

Set the DC Power Supply to output a +5V voltage through its +6V output port and GND port.

Connect the +6V output port of the DC Power Supply to the PCB header of the \( i \)th row and the header of the Red channel of the \( j \)th column and connect the GND output port of the DC Power Supply to the PCB header of the other rows and the GND header of the LED matrix. Then, the LED, and only that LED, at the cross of the \( i \)th row and the \( j \)th column should be light up in red color. Repeat the process with all three color channels of the all the LEDs in the LED matrix.

3. Sound Speaker

Being able to generate sounds of different tunes.

Connect the output port of the Waveform Generator to the anode pin of the speaker and connect a 180Ω resistor between the cathode of the speaker and the GND port of the Waveform Generator, set the waveform generator to generate a square wave with a peak-to-peak voltage of 5V, a 2.5V DC offset and frequency of 261Hz. The speaker should generate sound that could be heard by the tester that corresponds to the C musical note.

Repeat for square wave frequency equals 294Hz, 329Hz, 349Hz, 392Hz, 440Hz and 493Hz that corresponds to D, E, F, G, A, B musical notes.
4. **Buttons**

Provide basic button functionality: short when pressed and open when released.

Connect the top left pin of the button to the +6V output port of DC Power Supply and the bottom right pin of the button to the anode of a LED. Connect a 150Ω resistor between the cathode of the LED and the GND port of the DC Power Supply and set the Power Supply to output a +5V voltage. Then the LED should light up only when the button is being pressed; whenever the button is released, the LED should be turned off.

5. **Microcontroller**

Microcontroller working correctly with the peripheral circuit and being able to execute the loaded program.

Connect the microcontroller in the following manner: Pin1 – GND; Pin7 – VCC; Pin8 – GND; Pin9 & Pin10 – 16MHz Crystal in between; Pin20 – VCC; Pin21 – VCC; Pin22 – GND, where VCC and GND are connected the +6V output port and the GND port of the DC Power Supply which is set to output a +5V voltage. Connect Pin19 of the microcontroller to the anode of a LED and connect a 150Ω resistor between the cathode of the LED and GND. The microcontroller is pre-loaded with the blink program and the LED should be turned on for one second and then off for one second, repeatedly.
6. Power

(1) 9V Battery
Supply a 9.0 ± 1.0 V voltage.

(2) 5V and 3.3V Voltage Regulator
Supply a 5.0 ± 0.3 V and a 3.3 ± 0.3 V voltage respectively.

(1) 9V Battery
Measure the voltage between the anode and the cathode of the 9V battery using a multimeter, the voltage should read 9.0 ± 1.0 V.

(2) 5V and 3.3V Voltage Regulator
Connect Pin-Vin and Pin-GND of the 5V Voltage Regulator to the +25V output port and the GND port of the DC Power Supply, connect a 0.33uF capacitor between Pin-Vin and Pin-GND of the Voltage Regulator, connect a 0.1uF capacitor between Pin-Vout and Pin-GND. Set the Power Supply to provide a +9V voltage and measure the voltage between Pin-Vout and Pin-GND of the 5V Voltage Regulator using a multimeter, the voltage should read 5.0 ± 0.3 V.

Connect Pin-Vin and Pin-GND of the 3.3V Voltage Regulator to the +6V output port and the GND port of the DC Power Supply, connect a 0.1uF capacitor between Pin-Vin and Pin-GND of the Voltage Regulator, connect a 10uF capacitor between Pin-Vout and Pin-GND. Set the Power Supply to provide a +5V voltage and measure the voltage between Pin-Vout and Pin-GND of the 3.3V Voltage Regulator using a multimeter, the voltage should read 3.3 ± 0.3 V.