# Mini-Project I-LED Flasher

# Report Team 4:

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## Abstract

This report will explain the processes to synthesize a test and troubleshoot the system we had to build as well as the technique we had to implement and efficiently completing this as a team.

## Introduction

The mini project we built is an electronic system, like many others it uses an Input-Processing-Output structure. The first system had an output of a flashing LED. The second system, the output was a speaker. Both were processed by a 555 Integrated Circuit. The report explains how to build the circuit, the problems that may arise, and the lessons learned.

## Lessons Learned

From Felder's learning style inventory, when describing components and circuit functions, our team were more visual than verbal. The visual representations of the circuits [2] we built were a valuable aid in understanding the configurations [3] as well as the function. The organization of information we gathered adhered closely to the inductive method—that is to be given facts and observations. As a team, we progressed towards understanding sequentially rather than globally, following step-by-step procedural methods.


**FIGURE 1**
*The pyramid represents Bloom's six functions that represent the "Cognitive Domain".*

According to Benjamin Bloom [1], there exist domains of education activities. In regards to the **Cognitive domain** in **FIGURE 1**, we found that our team went through each level in order.

**Evaluation** – we focused on the materials we needed, as well as the instructions, and sorting it out in a manner which expedited different responsibilities to each team member.

**Synthesis –** putting together the circuit, and combining our equipment to make a different device.

**Analysis –** this step involved our team troubleshooting the kinks in our circuit when it wasn't functioning as it should.

**Application –** we observed that our circuit could be used with different outputs media.

**Comprehension –** understanding what various components do, where analysis assisted significantly in this understanding.

**Knowledge –** knowing how to build the circuit, learning the behavior of currents within, the function of new devices, and the ability to rebuild without instruction.

## Team Building

Leading a team requires excellent communication, organizing meeting times and expediting responsibilities to team members. As well as overseeing the overall progress of the project, our leader spent time in each task assigned to ensure the project would be complete in a timely manner.

Certifying the circuit required focus and determination, which meant building the circuit first hand. This gave a better intuition of the circuit's function and how it can be modified, as well as learning several common mistakes made in building it and how to troubleshoot for these mistakes. This task also required communication, in learning about components and explaining to the team how they work. This garnered a better comprehension of bridging the gap between theory and execution.

Reporting and preparing the presentation requires an extraordinary amount of attention to detail. This task meant gathering different information from the team and compiling it into something cohesive, uniform and presentable. The most important aspect of reporting is determining which information is relevant to the project, and how much of it to include.

Working together as a team allowed us to efficiently apply different skills to different parts of the project. Teamwork allowed us to successfully demonstrate, report, and prepare a presentation.

## Basics

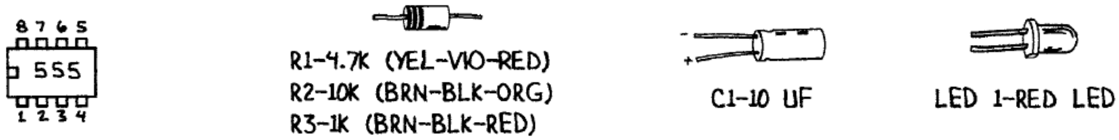
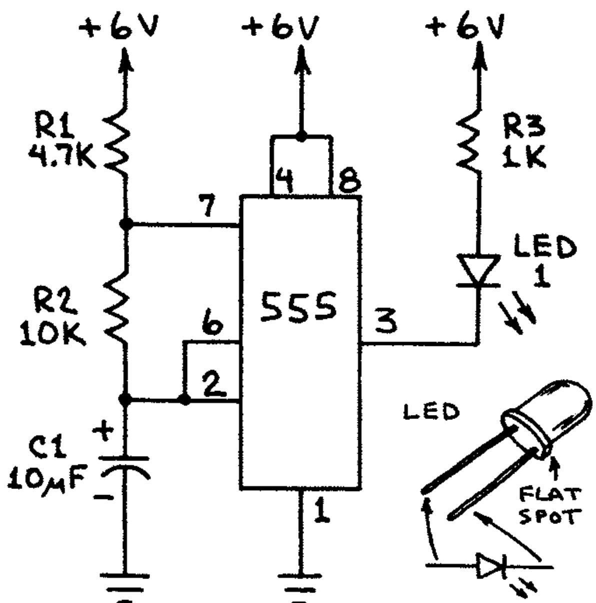



**FIGURE 2**
*(Left to right) 555 Integrated Circuit, (3) Resistors (4.7K, 10K, and 1K), C1-10 uF Capacitor, LED*

The components [2] in **FIGURE 2** used in the IPO process were placed on the breadboard of a RadioShack Electronics Learning Lab. For the input—we used a 6 Volt source which powered the circuit. The input was processed first through a series of resistors, which limit the electric current received from the power source. This current is then sent to the capacitor, which continually stores a **given amount of charge and will discharge once it's full. Once the capacitor is full it discharges** current into the 555 Integrated Circuit periodically (pulse rate) to time when the integrated circuit should output current itself. Then the circuit in **FIGURE 3** directs current to the LED output which flashes.

**FIGURE 3**
*A timed 555 Integrated Circuit powered by a 6 volt source with an LED output.*



## Analysis

The circuit works through an **Input-Processing-Output system**. Our “Input” was a 6 volt power source. The “Processing” involved a 555 Integrated Circuit, three resistors (1K, 4.7K, and 10K), and a 10 microfarad capacitor. Finally, the “Output” was a flashing light-emitting diode.

The frequency of the flashes is determined by three components on the left side of the circuit: R1, R2 and the capacitor. From an electrical standpoint, the timing of the Integrated Circuit is set by the frequency of the discharges from the capacitor. Since the resistance and capacitance are constant, the Integrated Circuit receives these current discharges from the capacitor at a constant rate which is the frequency. In turn, the Integrated Circuit outputs a signal for the LED to flash in sync with these pulses. The frequency can be calculated with this equation:

$$f = \frac{1}{t} = \frac{1}{0.69(R1 + 2R2) \times C} = \frac{1.44}{(R1 + 2R2) \times C}$$

**FIGURE 4**
*Frequency Equation*
*f = Frequency*
*R1, R2 = Resistors*
*C= Capacitor*

Based on the order of magnitude of the components that we’re using, the resistance of R2 affects the frequency the greatest, then R1 to a lesser degree and then the capacitance to an even lesser degree. In other words, with the same percentage increase in the capacitance as a decrease in resistance, the flasher frequency would alter in favor of the resistor’s changes within the same orders of magnitude. One can also see from the equation that both the resistance and the capacitance are inversely related to the frequency. This is because a larger resistance means that the current charging the capacitor will do so at a slower rate. Equivalently, a larger capacitor with the same current will also charge at a slower rate. Since R2 affects the frequency greater out of the two capacitors, you can replace it with a potentiometer so that you can easily change the frequency of the flashes of the diode.

Sometimes theory doesn’t always translate into application as well as we’d like, be it from human error or faulty materials. In one of those cases one can empirically measure the frequency of the pulses by using an oscilloscope. If you set one terminal at the output pin of the integrated circuit and the other terminal at the ground pin, you can set the range of the data you receive and measure the time difference between the crests of the square wave.

Once the desired timing is set through the RC configuration, the integrated circuit outputs a signal for the light emitting diode to draw current. The current it draws is determined by the power source used (6 volts) as well as the resistor in between (R3). With a higher current, the light emitting diode flashes brighter, therefore a lower resistance will yield the same result. Ideally there is no current going through the diode on the off flashes, but since there are residual currents from outside sources(electric & magnetic fields), a minimum current value is required to turn on the diode. When the Light Emitting

Diode flashes, the current going through it is strong enough to trigger the programmed “on current” value. However if the current is too high, it will melt the diode.

By knowing about the individual components in the circuit and the theory behind their functions, you can manipulate the circuit to output altered and different signals all together.

## Testing

We gathered all the components (555 Integrated Circuit, resistors, capacitor, wires, light-emitting diode) necessary, placed each one in its proper location on the breadboard. To test it thoroughly, once the light-emitting diode came on, we left it on to ensure it exhibited the same behavior for an extended period of time. Our team (3) tested the circuit 3 times each, it failed to flash twice with a rate of 2 fails per 3 attempts.

## Simulation in Multisim™

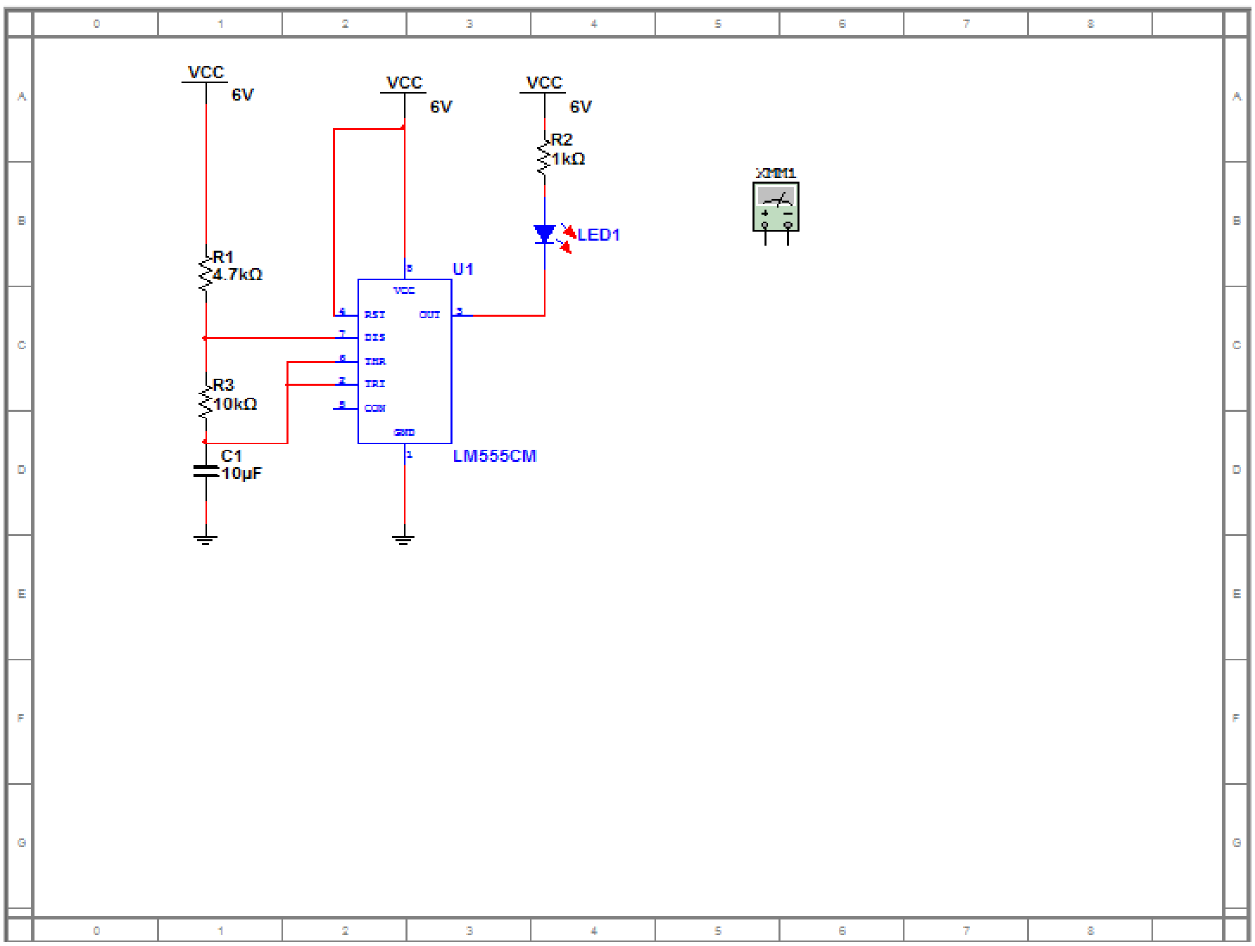



**FIGURE 5**
*Simulation in Multisim™ of the Timed 555 Integrated Circuit with an LED output*

We simulated the LED flashing system in Multisim™; the configuration of the circuit shown in **FIGURE 5** was identical to the physical circuit. Multisim™ allowed us to demonstrate the use of an oscilloscope to determine frequency. In building the circuit, we had to make sure that the polarized components were set in the right orientation, i.e., LED.

We ran into problems when we tried to simulate the circuit, even though everything was configured correctly, the LED was not flashing at all. We had to diagnose what the problem was using some of the simulated equipment. First, we used the oscilloscope around the LED itself so we could see what kind of signal was going into it, then we saw what signals were going through the entire integrated circuit by setting the terminals to ground and the output. Then, since everything looked fine from the oscilloscope we used a multimeter to measure the strength or the magnitude of the current going in the LED. Double-clicking on the LED component, we saw that the "on" current was set at 6 milliamps but we were only receiving a 3 milliamp signal into the LED. All we had to do to fix the circuit was set the "on" current of the LED to 3 milliamps so that it would react to the signal coming in.

## Other Applications

Following the diagram in **FIGURE 6**, we implemented a speaker by replacing the R2 resistor with a 100K Potentiometer. R2 controls the frequency of the tone. The higher resistance controlled by the potentiometer yields a higher frequency of the tone.

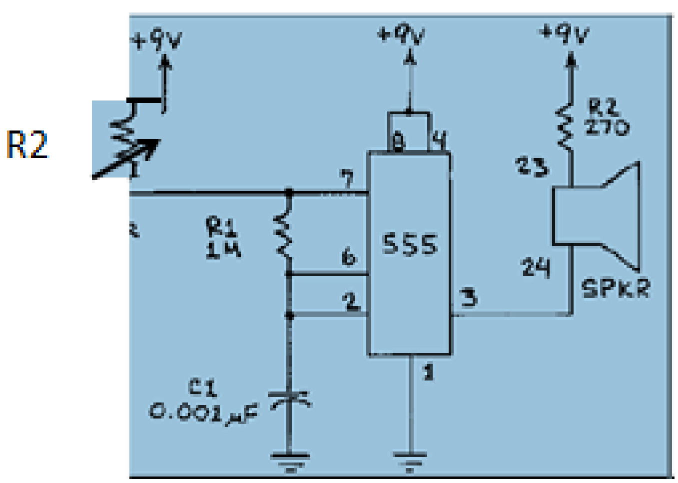



**FIGURE 6**
*A timed 555 Integrated Circuit with an audible output controlled by a 100K Potentiometer.*

## Conclusions

We learned the importance of time-management, how Felder's learning style inventory applied to how we approached the task. It was easy to build the circuit by using the workbook, which demonstrates how we lean more towards visual-style learning, rather than verbally. In Bloom's taxonomy, we actually went down the pyramid in order of the "Cognition" domain. Multisim™ allowed us to simulate the circuit without the potential of damaging any components in the process. Through teamwork, we learned about the components needed to construct two different IPO systems. The first was an LED flasher with a frequency controlled by a potentiometer. The second was a system using an audible output (speaker). The potentiometer in this system controlled the frequency of the tone. This project portrays

## References (and credits)

[1] Clark, D., "Bloom's Taxonomy of Learning Domains," http://www.nwlink.com/~donclark/hrd/bloom.html, Big Dog & Little Dog's Performance Juxtaposition.

[2] Mims III, F. M., "Basic Electronics Workbook I," RadioShack, Fort Worth, TX.

[3] Mims III, F. M., "Electronic Sensorlab Workbook," RadioShack, Fort Worth, TX.