Digital Engineering

RNG

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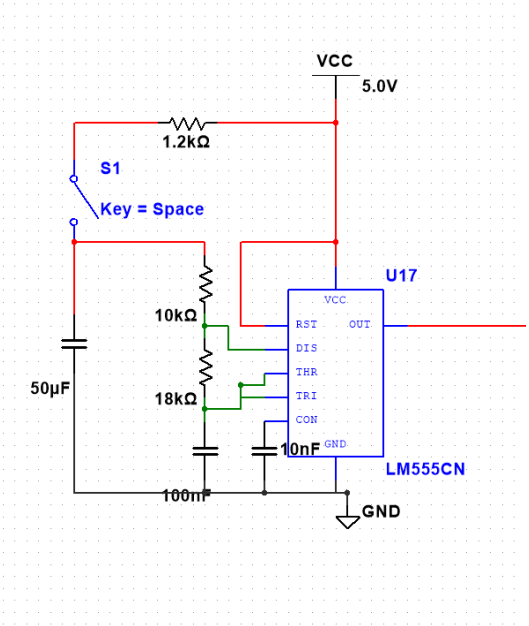
Introduction

In this project, we created a circuit using analog, digital, sequential, and combinational signals. We had to mock up these circuits on multi-sim and test their work. Only then could we begin to build this circuit in real life. It was a very rewarding experience since I learned how a basic circuit works.

The Project

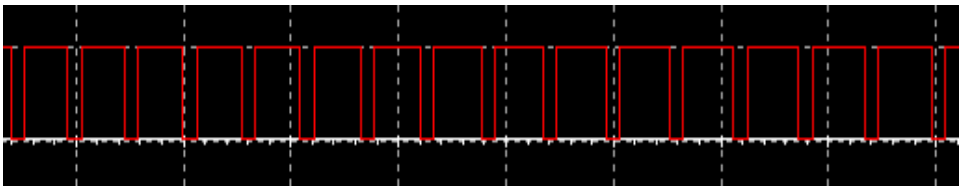
The 555 Clock



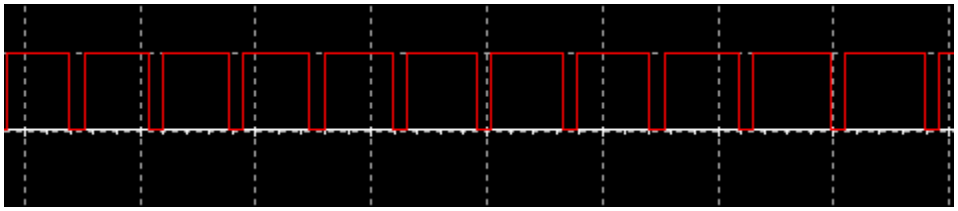
This was the clock signal for our project. Normally, it would have a button, but the multi-sim presents circuits perfectly, which results in an error of the same result every time. The way this works is that the capacitor charges up, temporarily powering the circuit, until it starts to run out of battery, leading to fading signals, which are the basis for randomness in our circuit. This is also known as the analog part due to the physical presence of a switch, capacitors, and resistors.

The 555 Signals

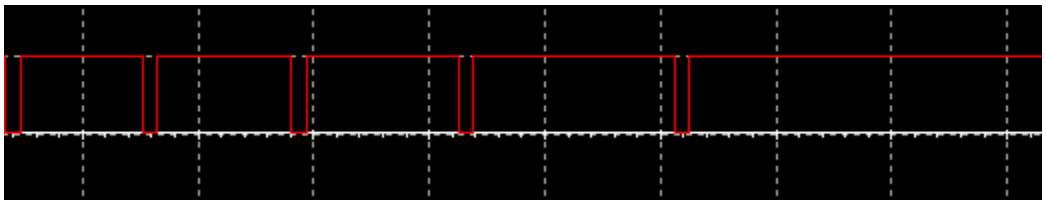
These three pictures show the signals as the capacitor's battery fades.



The above is at the start of the cycle, the frequency is very high, and the signal is getting outputted very often.

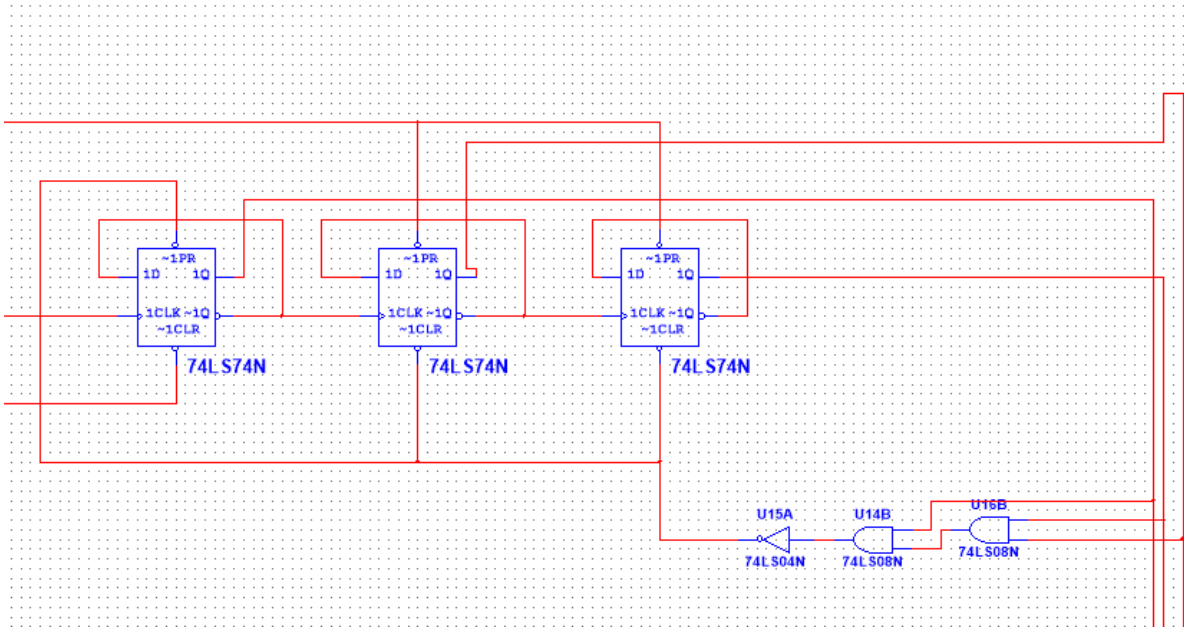


This is more towards the middle; the frequency has fallen, and the signal is not moving as fast.



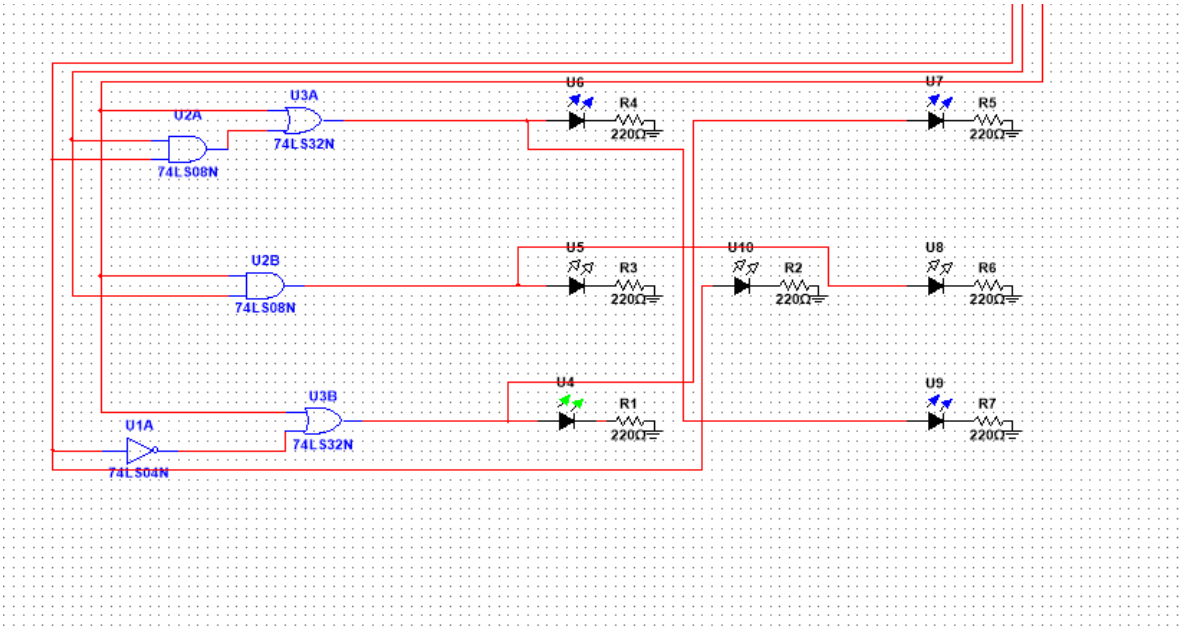
This is at the end; it is much slower, and the signal finally turns off at the last section, meaning there are no more 555 signals.

The Sequential Logic



This was the sequential logic for our project. It uses ICs and Gates to differentiate different signals from the starting clock signals. Because of this, we can make a bit counter that gives us enough bits for our clock. This means we have 8 different options we can make with the circuit that randomly change with the clock signal.

The Combinational Logic



This was the combinational logic for our project. It uses And, Or, and Not gates to establish 7 signals from the 3 we had. It is what gives us the different combinations of LEDs to produce the dice output. It's the final step in the process, and without it, the LEDs would only have three different variations, as opposed to the 7 this lets us do. This also means that when randomized, the lights will flash as the signal fades.

Sequential Truth Table

Line A	Line B	Line C
0	0	0
0	0	1
0	1	0
1	0	0
1	0	1
1	1	0
1	1	1

Combinational Truth Table

LED 1	LED 2	LED 3	LED 4	LED 5	LED 6	LED 7
0	0	0	0	0	0	0
0	0	0	1	0	0	0
1	0	0	0	0	0	1
0	0	1	1	1	0	0
1	0	1	0	1	0	1
1	0	1	1	1	0	1
1	1	1	0	1	1	1
0	0	0	0	0	0	0

Soldered RNG Board