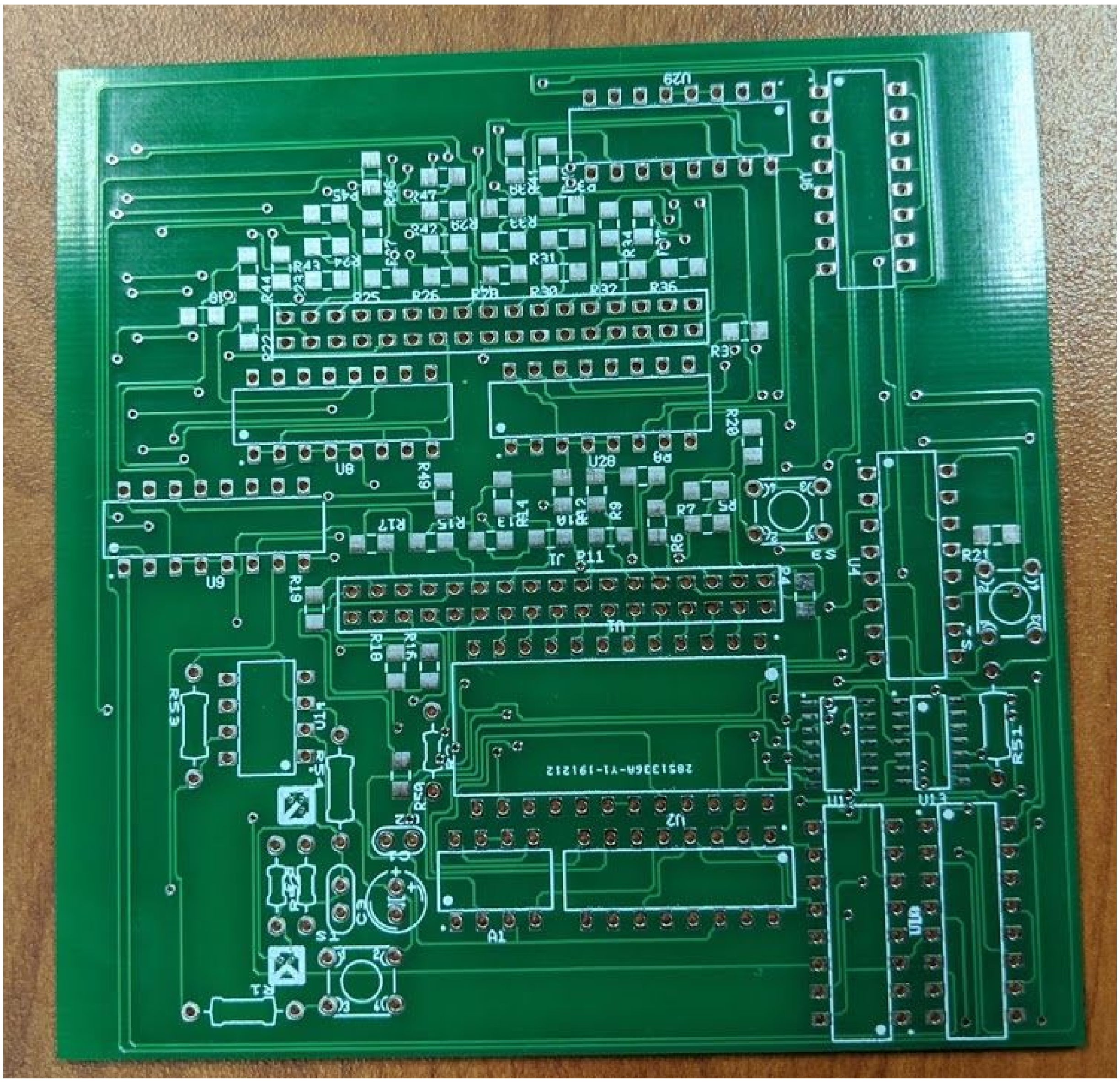
Experiment 41

Roulette Wheel



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11/25/19 - 12/11/19

Objectives:

The objective of this lab was to create a 16 bit roulette wheel with an output that slows itself down until it stops on an LED.

Materials:

- 1 - Timer IC (555) (Datasheet page 6)
- 1 - Demultiplexer (74154) (Datasheet page 7)
- 1 - 4-Bit Adder IC (7483N) (Datasheet page 8)
- 4 - BCD to 7 Segment Decoder IC (7448) (Datasheet page 6)
- 4 - LED 7 Segment Displays (FND500) (Datasheet page 7)
- 16 - 1,000Ω Resistors
- 2 - 470kΩ Resistors
- 1 - 100Ω Resistors
- 1 - 0.01 uf Disc Capacitor (103)
- 1 - 0.1 uf Disc Capacitors (104)
- 1 - 47 uf Electrolytic Capacitors
- 1 - N.O. Push Button Switch
- 16 - Green LED's

Procedure:

1. To begin this lab the objective was analyzed and it was determined that to create a working circuit a 555 timer and demultiplexer would be needed to create a circuit that would count binary numbers and display the output number on a corresponding LED. The datasheets for the two components were found online and placed in the lab on pages 8 to 10.

2. With these components an RC time constant is established by using a 555 timer IC RC time constant circuit and hooking that up to an electrolytic capacitor in parallel. The electrolytic capacitor is charged and discharged and as it charges and discharges the RC time constant will charge slower and this will result in the light on the roulette wheel slowing down and eventually stopping on a number. A multisim was made of the wheel as shown below in figure 2 and it uses said RC constant to, once activated, slow the wheel light on the wheel down gradually until it stops on a number.

3. After the multisim was constructed, we used this to create a working breadboard model, which is shown in Figure 1. This model was extensively tested and compared to the multisim model to ensure that our circuit worked in the real world. Additionally, we added a comparator to determine when the timing capacitor had reached its lowest point by comparing the voltage of the capacitor to a defined voltage around 3 volts which we measured to signify that the roulette spin had completed. This allowed us to only display a result to the player once the roulette wheel had gone full spin, rather than changing the result constantly while the roulette wheel was active.

4. Next, we refined our original multisim to account for design constraints. We wanted our logic board to be under 10cm by 10cm, so we used two 34 pin headers on the logic board to connect to our 17 LEDs and our four seven segment displays respectively. We then created a second multisim for user interface of the roulette wheel, which is shown in Figure 3. The ultiboard for this is shown in Figure 2 and Figure 4.

5. A 3D printed enclosure was designed for the circuit as shown in figure 6.

6. To construct our boards, we outsourced them to JLCPCB, a PCB construction company in China. These boards are shown in Figure 7.

Figure 1: Breadboard model of the roulette wheel

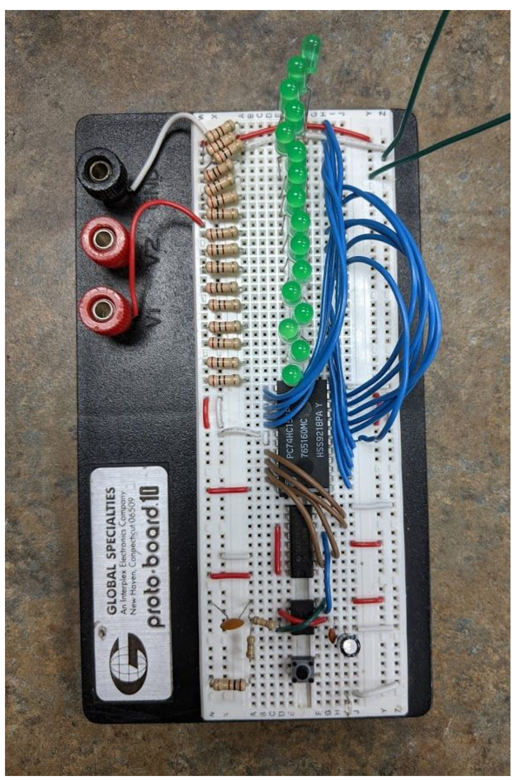


Figure 2: Multisim model of the roulette wheel

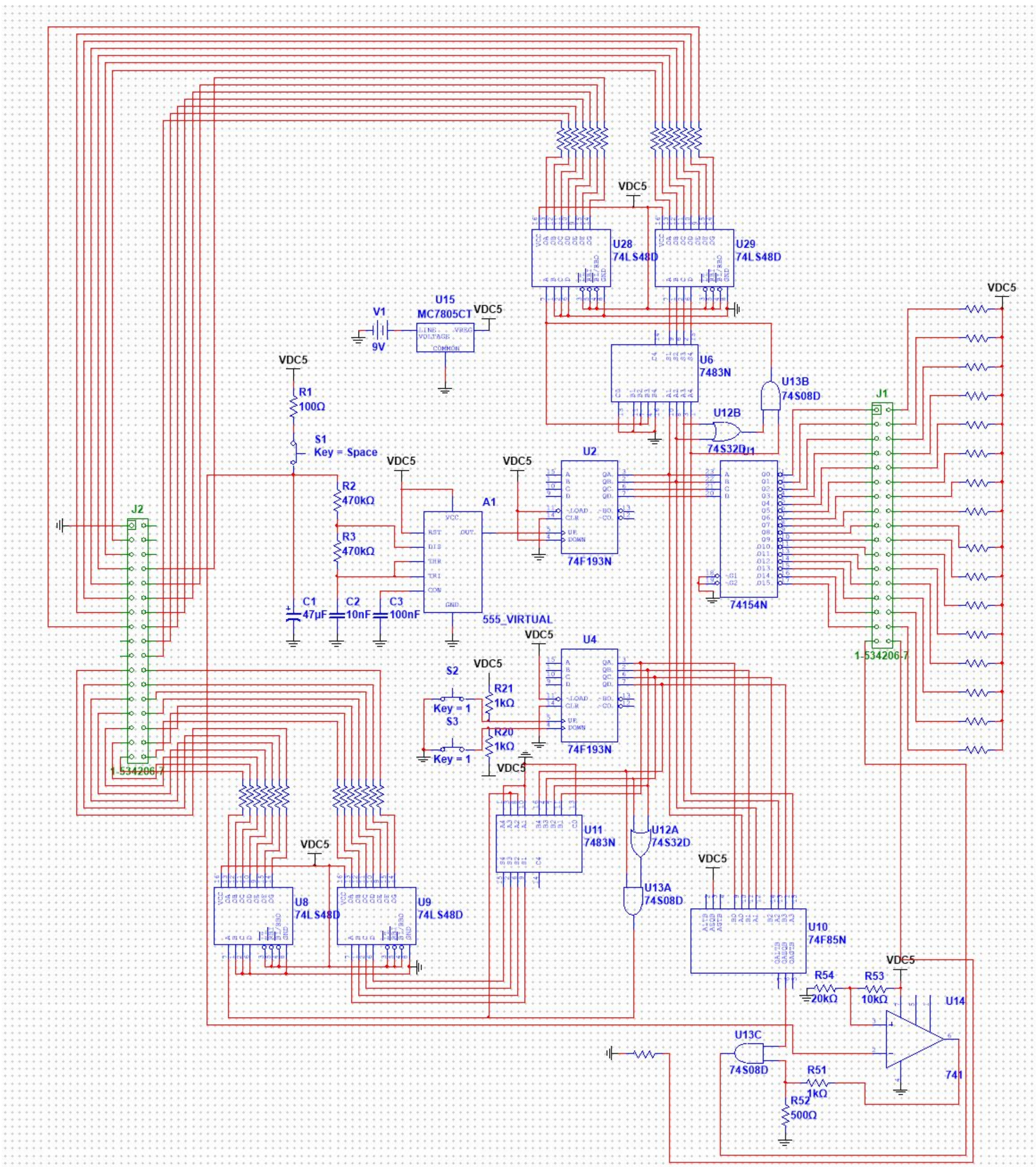


Figure 3: Ultiboard model of roulette wheel

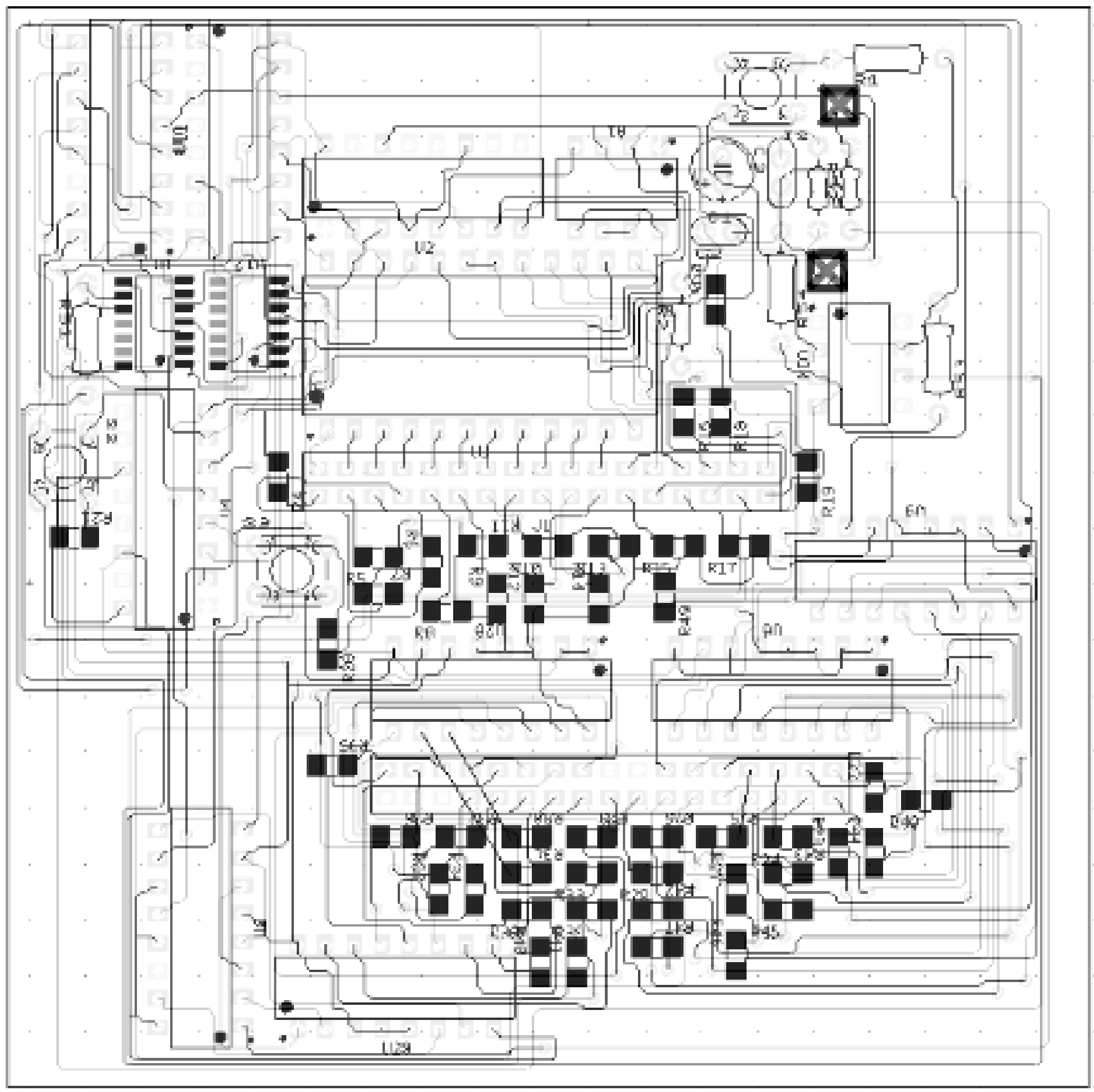


Figure 4: Multisim model of top of the Roulette Wheel

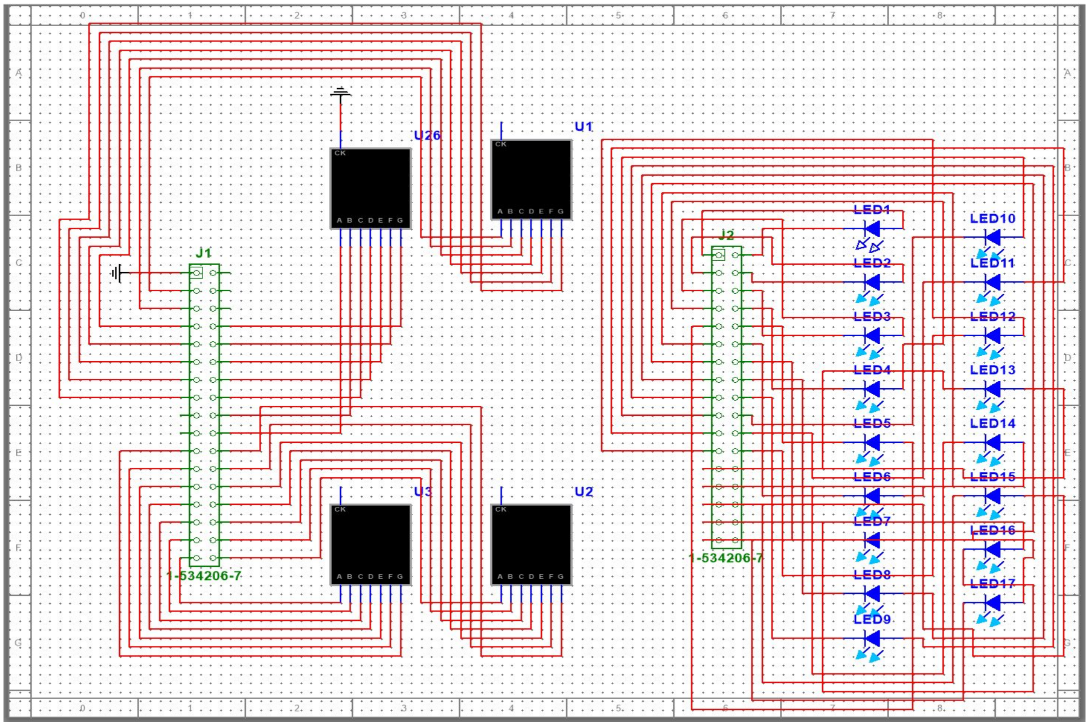


Figure 5: Ultiboard model of top of the Roulette Wheel

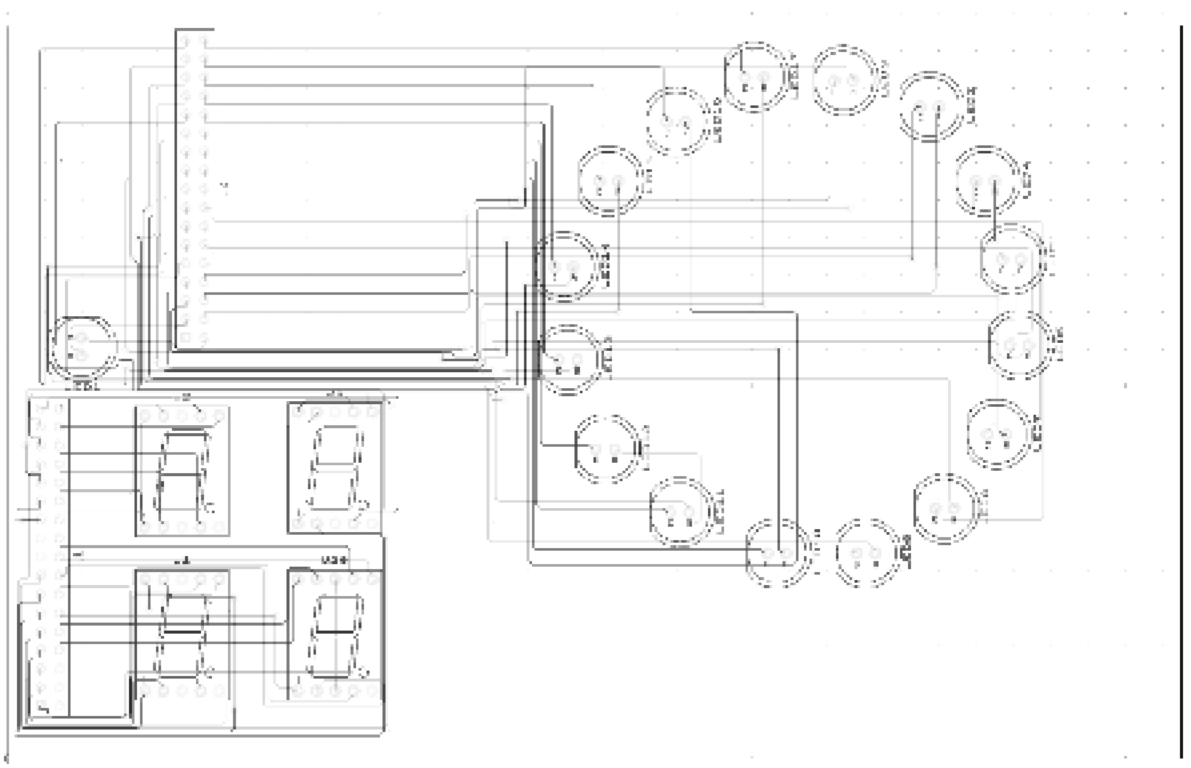


Figure 6: 3D printed enclosure designed in Inventor

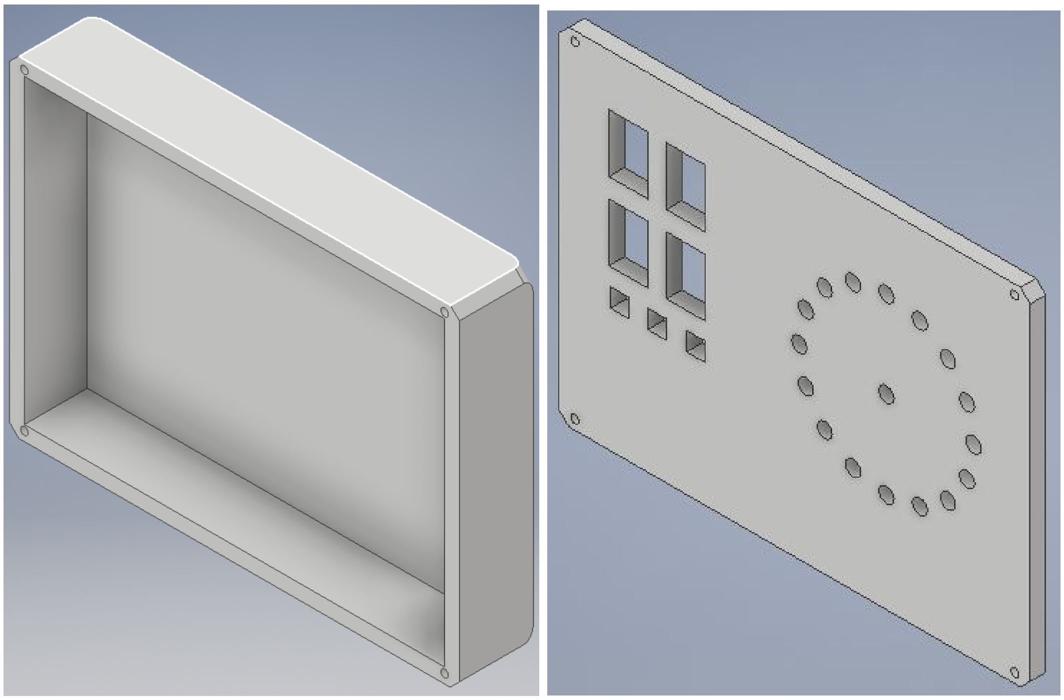
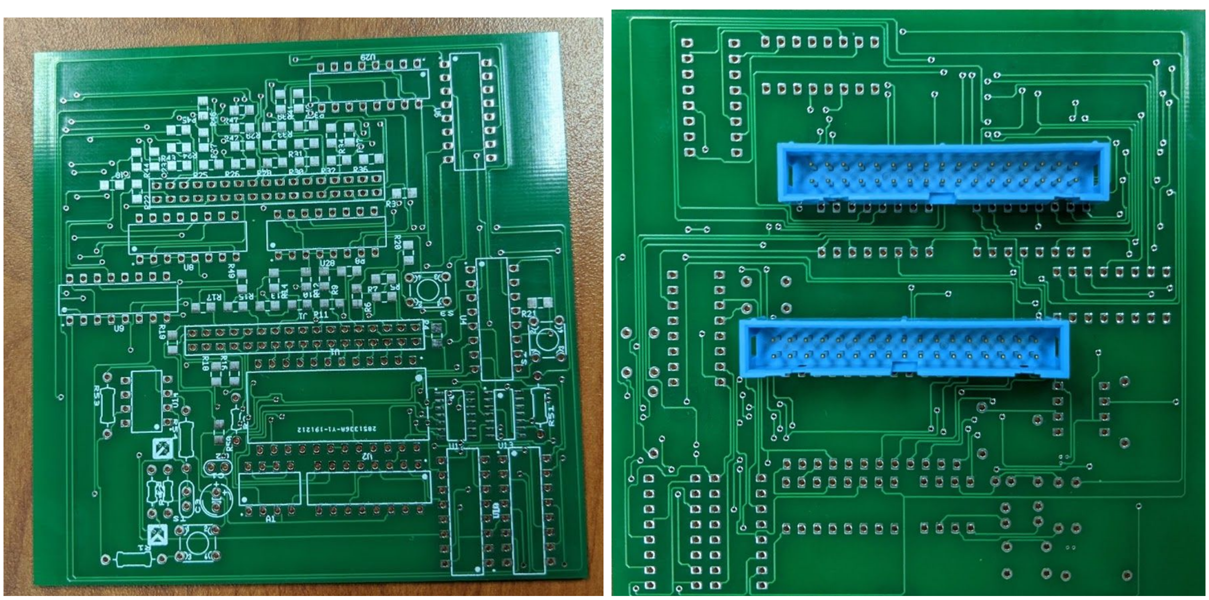


Figure 7: PCB



Discussion:

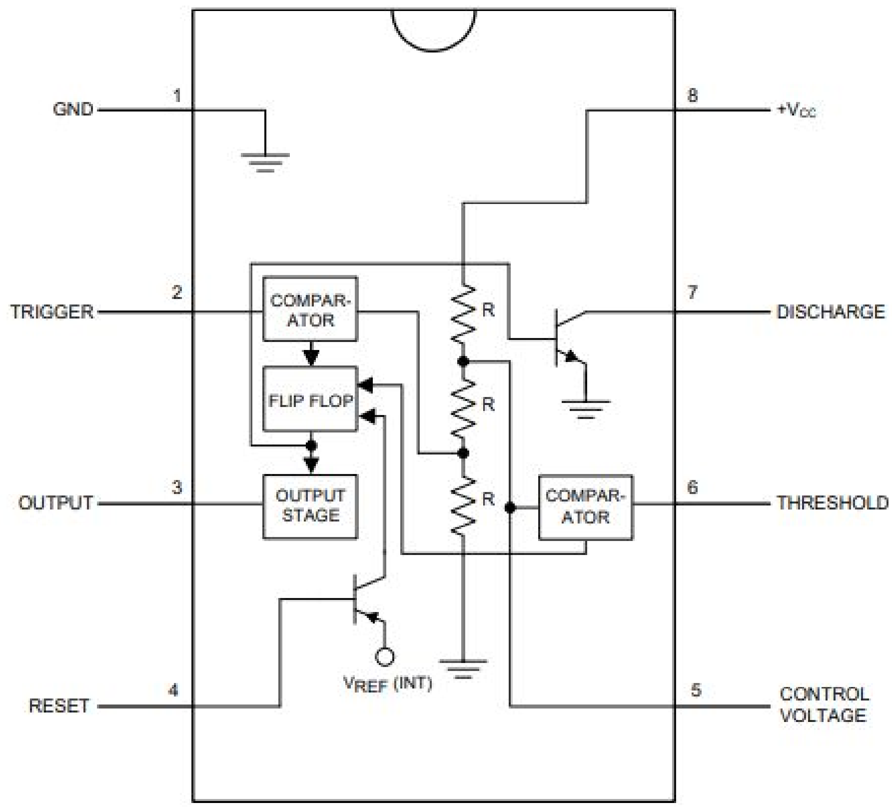
While designing the ultiboard for this project the first ultiboard was too large and was not compatible with any of the boards that we had in the shop. We then created a more compact design, this time removing the circular constraint and also placing very little importance on the position of the LEDs since it allowed our design to be more compact. While in the previous ultiboard design the LEDs were placed around a circle with the rest of the circuit inside of it, our new circuit is intended to work with the lid of our enclosure which will accommodate the LEDs in the shape of a circle and allow us to run wires from the LEDs to the headers on the newer version of the board. Additionally, the seven segment displays will be mounted on the lid of our enclosure and will be connected through cables to the internal board. Another issue we had was printing the circuit board. The Protomat machine would not start due to the extremely small diameter of some of our holes, and the speed required to drill these holes. To solve this, we made these holes larger so the machine would accept the design.

Conclusion:

The roulette wheel utilizes a 555 timer which controls the speed that the LEDs change, and the output of this 555 timer is next connected to a counter chip which will increment the outputs' value by one every time the clock input ticks. This counter output then goes to the selector bits of a demultiplexer. This allows us to light up each of our 16 LEDs individually based on the value of the selector bit that once it hits 15 resets back to 0. This whole circuit serves to create a roulette wheel effect where only one LED is lit at a time and these lights are lit in a circular pattern. Additionally, a larger sized electrolytic capacitor is added to the 555 timer as a time constant that will slowly discharge, and as it discharges the duty cycle of the 555 timer effectively increases, meaning that the leds move slower and slower emulating the physical effects of gravity on a roulette wheel when it is rolling around the roulette table.

5 Pin Configuration and Functions

D, P, and DGK Packages
8-Pin PDIP, SOIC, and VSSOP
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
5	Control Voltage	I	Controls the threshold and trigger levels. It determines the pulse width of the output waveform. An external voltage applied to this pin can also be used to modulate the output waveform
7	Discharge	I	Open collector output which discharges a capacitor between intervals (in phase with output). It toggles the output from high to low when voltage reaches 2/3 of the supply voltage
1	GND	O	Ground reference voltage
3	Output	O	Output driven waveform
4	Reset	I	Negative pulse applied to this pin to disable or reset the timer. When not used for reset purposes, it should be connected to VCC to avoid false triggering
6	Threshold	I	Compares the voltage applied to the terminal with a reference voltage of 2/3 Vcc. The amplitude of voltage applied to this terminal is responsible for the set state of the flip-flop
2	Trigger	I	Responsible for transition of the flip-flop from set to reset. The output of the timer depends on the amplitude of the external trigger pulse applied to this pin
8	V^{+}	I	Supply voltage with respect to GND

Function Table:

INPUTS						OUTPUTS															
G1	G2	D	C	B	A	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	L	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
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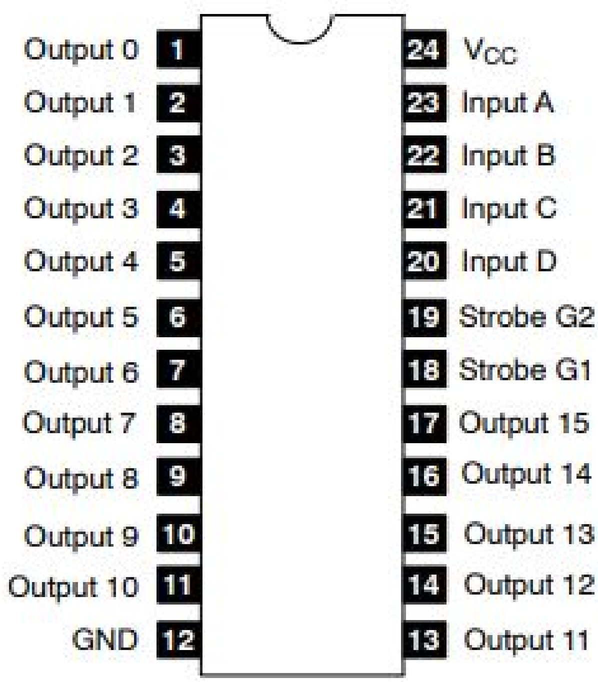
L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L
L	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	L	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

Note 5. H = High level, L = Low level, X = Irrelevant

Pin Connection Diagram:

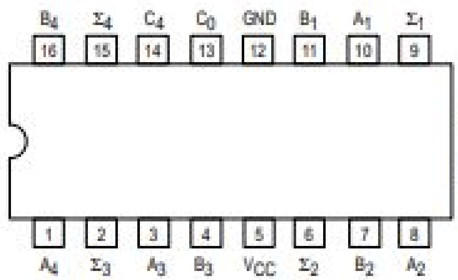


MOTOROLA

4-BIT BINARY FULL ADDER WITH FAST CARRY

The SN54/74LS83A is a high-speed 4-Bit binary Full Adder with internal carry lookahead. It accepts two 4-bit binary words ($A_1 - A_4$, $B_1 - B_4$) and a Carry Input (C_0). It generates the binary Sum outputs $\Sigma_1 - \Sigma_4$) and the Carry Output (C_4) from the most significant bit. The LS83A operates with either active HIGH or active LOW operands (positive or negative logic). The SN54/74LS283 is recommended for new designs since it is identical in function with this device and features standard corner power pins.

CONNECTION DIAGRAM DIP (TOP VIEW)



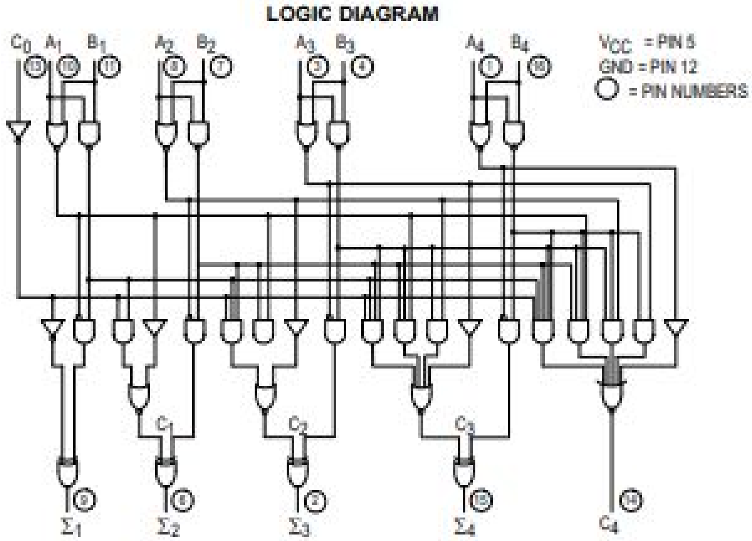
NOTE:
The Flatpak version has the same pinouts (Connection Diagram) as the Dual In-Line Package.

PIN NAMES

PIN NAMES		LOADING (Note a) HIGH	LOW
$A_1 - A_4$	Operand A Inputs	1.0 U.L.	0.5 U.L.
$B_1 - B_4$	Operand B Inputs	1.0 U.L.	0.5 U.L.
C_0	Carry Input	0.5 U.L.	0.25 U.L.
$\Sigma_1 - \Sigma_4$	Sum Outputs (Note b)	10 U.L.	5 (2.5) U.L.
C_4	Carry Output (Note b)	10 U.L.	5 (2.5) U.L.

NOTES:
a) 1 TTL Unit Load (U.L.) = 40 μA HIGH/1.6 mA LOW.
b) The Output LOW drive factor is 2.5 U.L. for Military (54) and 5 U.L. for Commercial (74) Temperature Ranges.

LOGIC DIAGRAM



SN54/74LS83A

4-BIT BINARY FULL ADDER WITH FAST CARRY

LOW POWER SCHOTTKY

J SUFFIX
CERAMIC
CASE 620-09

N SUFFIX
PLASTIC
CASE 648-08

D SUFFIX
SOIC
CASE 751B-03

ORDERING INFORMATION

SN54LSXXJ	Ceramic
SN74LSXXN	Plastic
SN74LSXXD	SOIC

LOGIC SYMBOL