EE 112 Project
Grab Circuit

Group 1

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1 Project Description

There are 4 players in a quiz competition. Each is given a push button and an LED to indicate when they are ready with the answer. There is a start button to start the timer which runs with a least count of 1 second, and displays the time on a 7-segment display in **SS** format; and a reset buttons which stops this timer and re-initializes the display to **00**.
When the Start button is pressed, the timer starts running, with the time being displayed in seconds. As soon as one of the players presses their push button, their corresponding LED will light up, and a buzzer will go off. The timer will stop and the display will show the time taken by the player to press the button. After this, even if another player presses their push button, it will have no effect: their LED will not glow. On pressing reset, the dipslay goes to **00** and the LED and the buzzer turn off. This entire process can be repeated as many times as required.
Also, if, by 60 seconds, no player has pushed their button, the display will reset to **00** and continue counting up.

2 Block Diagram

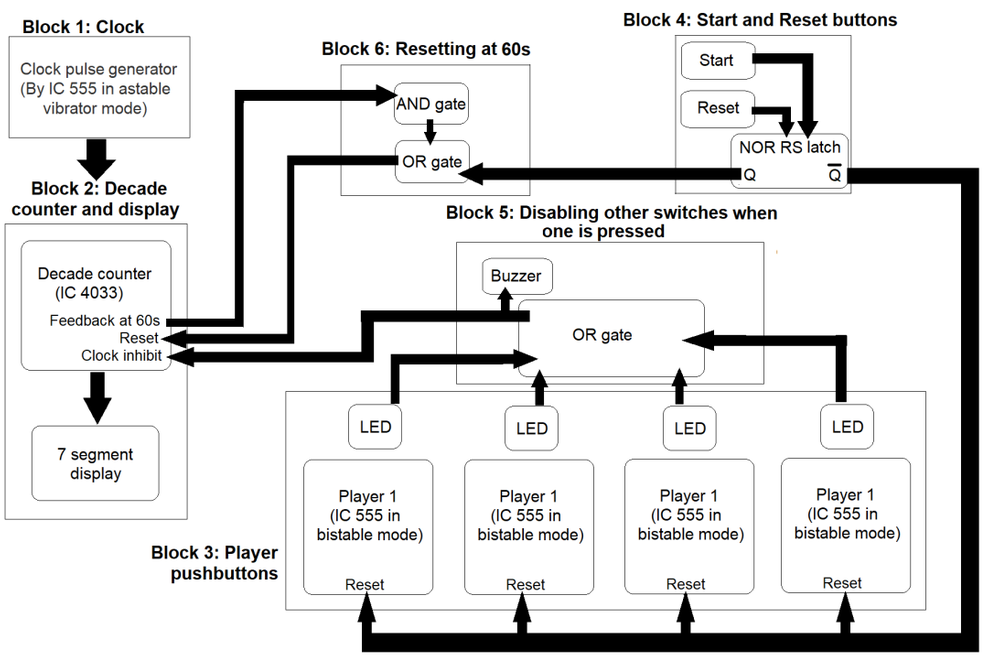

Figure 1: Block diagram of the entire circuit

3 Complete Circuit Schematic

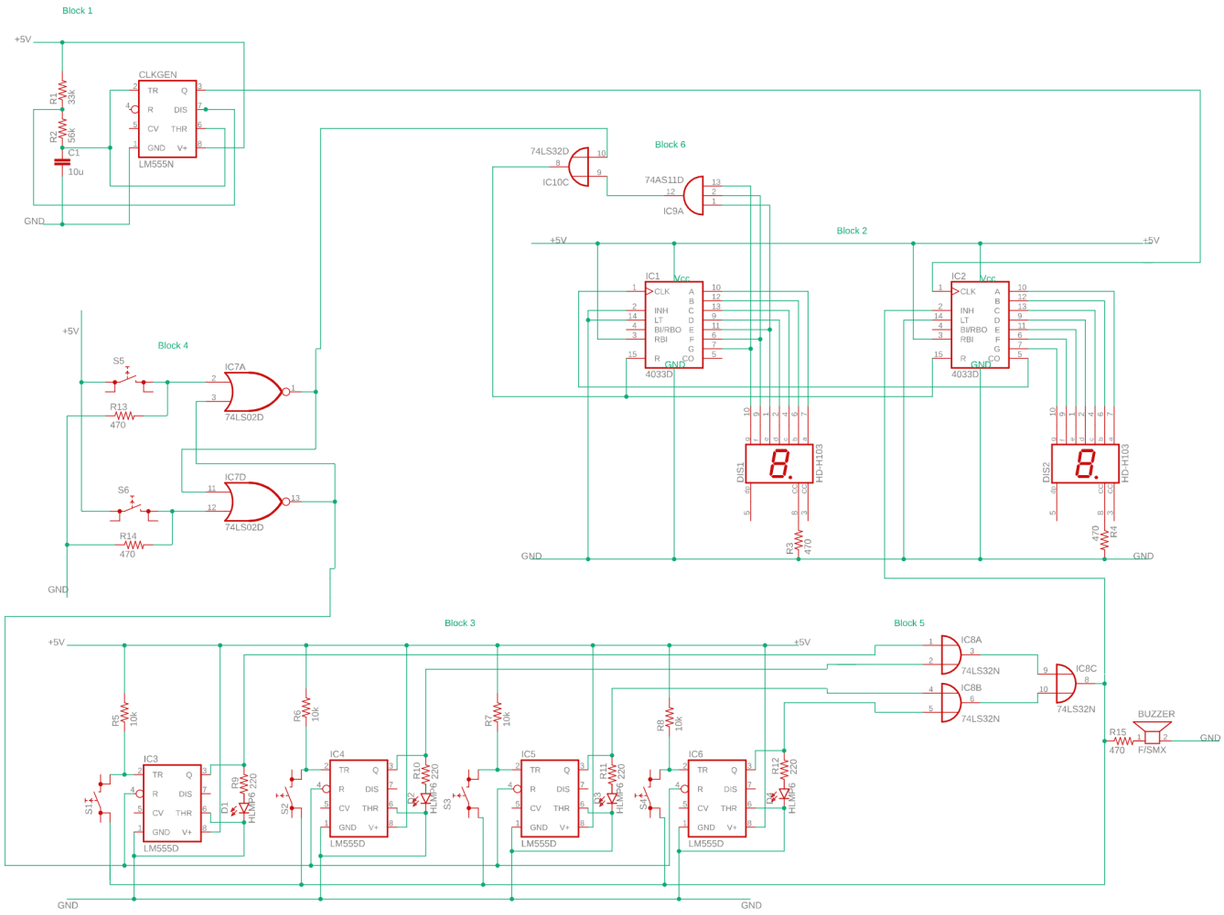

Figure 2: Complete schematic of the entire circuit

4 Schematic and Description by Blocks

Refer to Figure 1 and Figure 2 to see where each block is with respect to the others.

4.1 Clock from IC 555

This block generates the clock signal by using a 555 IC in its astable multivibrator form. It produces a signal of frquency approximately 1Hz, giving the circuit a resolution of nearly 1s. This is done by choosing R_a, R_b and C appropriately. The time period of the circuit, is given by

$$\tau = (R_a + R_b)C\ln(2) \approx (33k + 2 \times 56k) \times (10\mu) \times 0.693s = 1.00485s \approx 1.0s$$

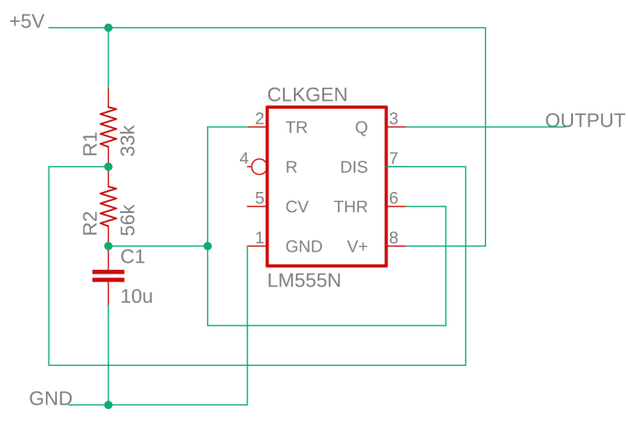

Figure 3: Block 1- IC 555 in astable mode, generating a clock output

4.2 Decade Counter and 7-Segment Display

The clock generated by the 555 drives a decade counter, a 4033 IC (connected to a 7-segment display), whose carry over drives another 4033 IC (connected to another such display), thereby giving us a two digit display. The counters can be stopped by the active high Inhibit pin, which is made active when a player pushes a button. It also has a Reset pin to reset the display to **00**; this pin is made active both when the Reset button of the circuit is pressed, and when the display hits 60s.

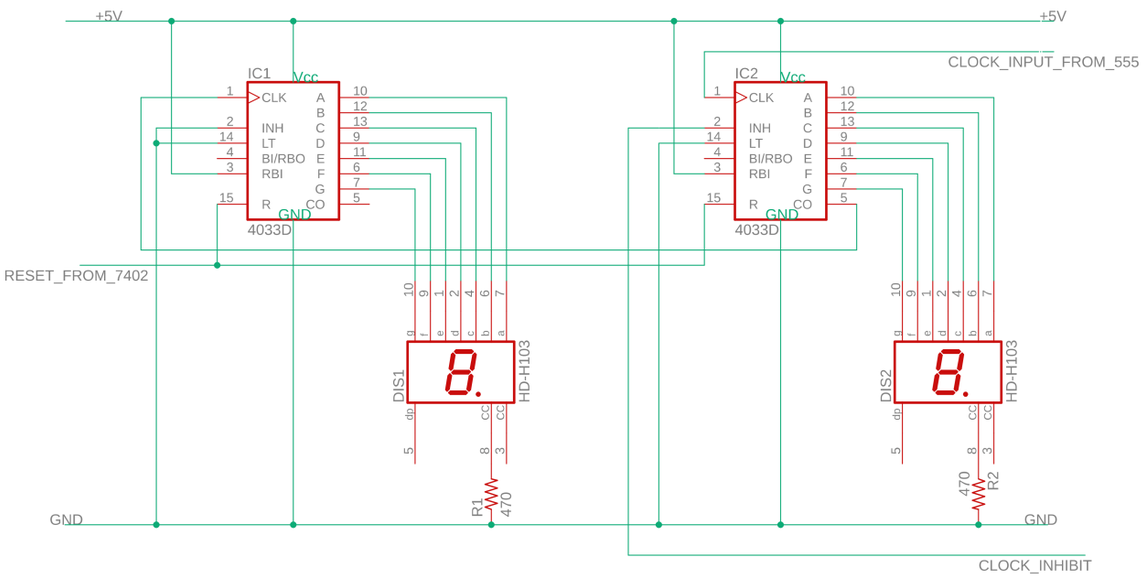

Figure 4: Block 2- IC 4033s as decade counters connected to two 7-segments displays

4.3 Player Buttons

This part of the circuit has the job of detecting who pressed their button first, and to light up that corresponding LED, which is done by using 555 IC in bistable mode, which effectively functions as an RS latch. Since the threshold is grounded, it is equivalent to having an RS latch with R always low. When the switch is pressed, the trigger gets a low input and hence, the output is high, resulting in the LED glowing. It remains in this state until the Reset button is pressed, thereby activating the Reset pin of this IC, which is active low.

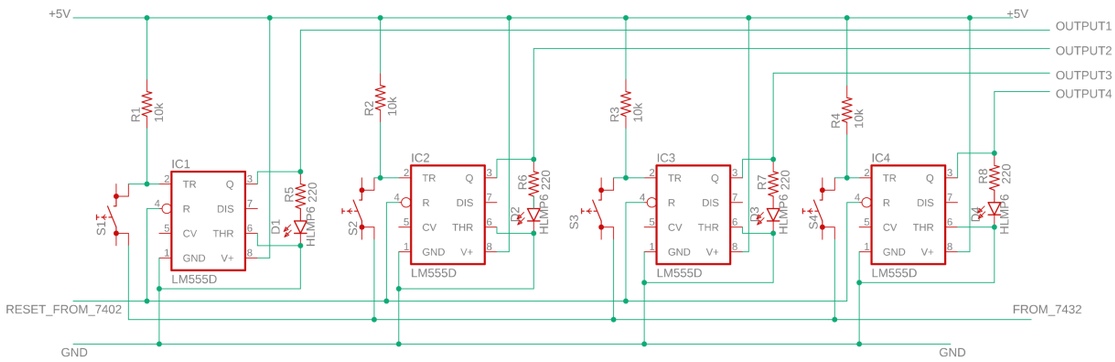

Figure 5: Block 3- The push button and LED for each player using IC 555 in bistable mode

4.4 Start and Reset Buttons

Before the Start button is pressed, the display reads **00**. As soon as it is pressed, it starts counting up. Pressing the Reset button resets the display to **00**. This is implemented by using an RS NOR latch, with Start as R and Reset as S. On pressing Reset, Q becomes high resetting the 4033s and $\overline{Q}$ becomes low resetting the player IC 555s.

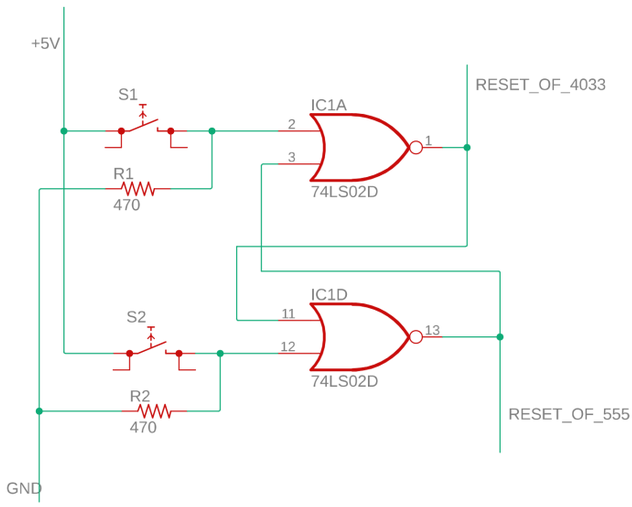

Figure 6: Block 4- Pressing Start button starts the timer and Reset sets the display to **00**

4.5 Mechanism to Disable Other Buttons as Soon as One Is Pressed

To ensure that only the first person to push their button will have their LED light up, we have taken the logical OR of the four outputs from the IC 555s, giving us a high output as soon as one of the buttons is pressed. Recall that for the LED to be turned on, the 555 in Block 3 has to receive a low trigger. We will connect the output of the OR gate to the button such that pressing the button will give suppply this output to the Trigger terminal of the 555. Hence, for the first person to press their button, the trigger gets a low input and the LED lights up, but if someone presses their button after that, the trigger will recieve a high input and the LED stays off. A buzzer is also connected to the output of the OR gate, to get the buzzing sound as soon as any button is pressed.

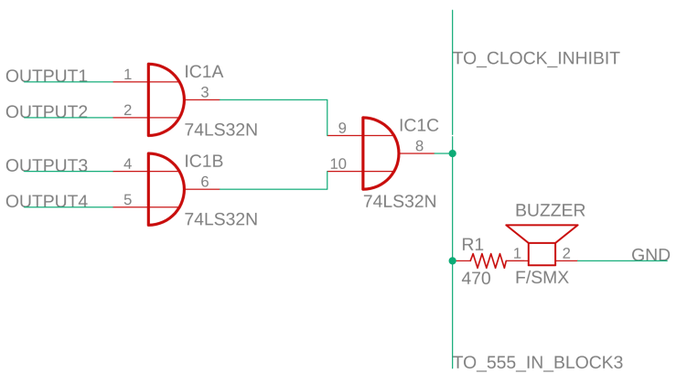

Figure 7: Block 5- Part which gives a high output when any one of the switches is pressed, leading to the buzzer turning on, and also disabling the other switches

4.6 Mechanism to Reset at 60 Seconds

In the 7-segment display, if we start from 0 and count up, note that the segments E, F and G all turn on simultaneously for the first time if the number is 6. Therefore, we first take the logical AND of these inputs from the ten's digit display, such that we get an ouput which is identically zero except at all values except when the number displayed is 6. Then, we take the logical OR of this output with the output from Block 4, which is to reset the 4033 when the Reset button is pressed, and pass it to the Reset pin of the 4033 IC. Hence, the dispplay will reset when the Reset button is pressed and when the counter reaches 60s.

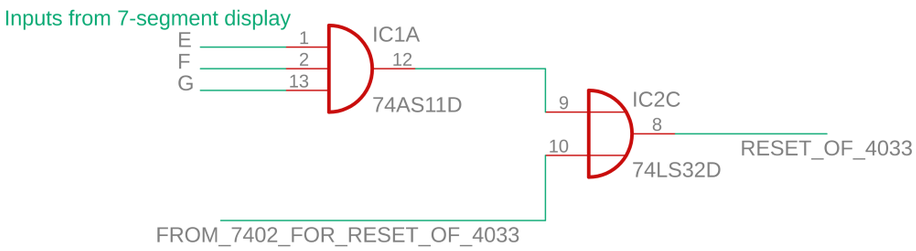

Figure 8: Block 6- Part which resets the display to **00** at 60s

5 Experience and Takeaway

This project was a wonderful experience in making a real world application of the theory covered in lectures. Coming up with a logic and debugging it to finally arrive at the finished product was rewarding. Further, we learnt to work with ICs and breadboards, and to use software like Autodesk Eagle and LaTeX to make this project.

6 Component List

- IC 555 $\times 5$
- IC 4033 $\times 2$
- IC 7402 $\times 1$
- IC 7432 $\times 1$
- IC 7411 $\times 1$
- Common cathode 7-segment display $\times 2$
- Push-button switch $\times 6$
- LED $\times 4$
- Buzzer $\times 1$
- Resistors
- Capcitors