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Mahendranagar, Kanchanpur

A MINOR PROJECT REPORT ON

"Digital Clock"

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ABSTRACT

This report describes the design and development of a digital clock using a 555 timer, a decade counter and a 7-segment display. The 555 timer is used as a time base to generate clock pulses, which are then fed into the decade counter. The decade counter counts the pulses and drives the 7-segment display to display the current time. The clock can be adjusted by adjusting the frequency of the 555 timer. The circuit is simple and easy to assemble, making it a great project for those new to electronics. The clock is accurate and reliable, making it a useful addition to any home or office.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude to all those who have supported and helped us throughout the duration of this project. We would like to extend our special thanks to our project guide Er. Kamal Lekhak, who has provided us with valuable guidance, support, and feedback throughout the project. We are also grateful to School Of Engineering for providing us with the necessary resources and facilities to complete this project. We also thank our friends and colleagues who have helped us with testing and debugging the circuit. Finally, we would like to acknowledge the contributions of the manufacturers of the 555 timer, decade counter, and 7-segment display for providing us with the necessary components to complete this project. Last but not the least we would like to thank to the department of computer engineering and HOD Er. Toran Prasad Bhatt for providing us with all facilities that was required.

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Introduction

The digital clock is a widely used device in our daily life. A digital clock is a type of clock that displays the time in numerical form, as opposed to an analog clock which displays time using hands on a dial. The clock presented in this report uses a 555 timer, a decade counter, and a 7-segment display to display the current time.

The 555 timer is used as a time base to generate clock pulses, which are then fed into the decade counter. The decade counter counts the pulses and drives the 7-segment display to display the current time. The clock can be adjusted by adjusting the frequency of the 555 timer. The circuit is simple and easy to assemble, making it a great project for those new to electronics. The clock is accurate and reliable, making it a useful addition to any home or office

Materials Used

1. 555 Timer IC
2. Decade counter
3. BCD to seven segment decoder
4. Seven segment display
5. Capacitors
6. Proteus simulator
7. DC Power Supply
8. 3 input AND gate

555 Timer IC

The 555 timer IC (Integrated Circuit) is a versatile and widely-used device in the field of electronics. It was first introduced in 1971 by Signetics Corporation and has since become a staple in the industry. The 555 timer is a simple, low-cost IC that can be used to generate a variety of different output waveforms, including square waves and pulses. It can also be used as a timer, oscillator, or flip-flop. The 555 timer has a wide range of applications including in a stable mode for generating clock pulses for the digital clock project, and in monostable mode for timing applications. The 555 timer consists of over 20 transistors, diodes and resistors integrated into a small 8-pin package, making it a very economical solution for many electronic projects.

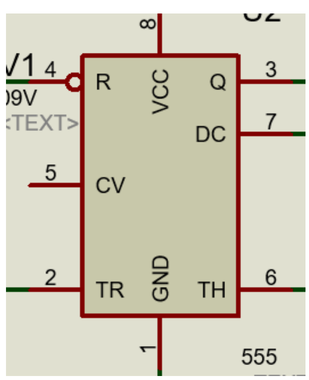


Fig 555 Timer

3 Input AND gate

A 3-input AND gate is a type of AND gate that has three inputs and one output. It performs a logical AND operation on all three input signals and produces an output of 1 (or "high") only when all of its inputs are 1 (or "high"). The output will be 0 (or "low") if any of the inputs are 0 (or "low").

The symbol and truth table for a 3 input AND gate are as follows:

The 3-input Logic AND Gate

Truth Table			
C	B	A	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

Fig: AND Gate and its Truth Table

Decade Counter

A decade counter is a type of digital counter that counts in decimal digits (i.e. 0-9) and then resets to zero and starts counting again. It is a type of synchronous counter, which means that all of its flip-flops change state simultaneously with the rising edge of the clock signal.

A decade counter IC is used to count the clock pulses generated by the 555 timer. The decade counter receives the clock pulses as input and increments its count by one with each rising edge of the clock pulse. The output of the decade counter is then used to drive the 7-segment display, which displays the current time.

There are many different types of decade counters available, including the 4017 and 74LS90. The 4017 is a CMOS decade counter that features a high noise immunity and a wide operating voltage range. The 74LS90 is a TTL decade counter that is known for its high speed and low power consumption. Both ICs have a decade counter built-in and can be easily interfaced with other digital logic circuits.

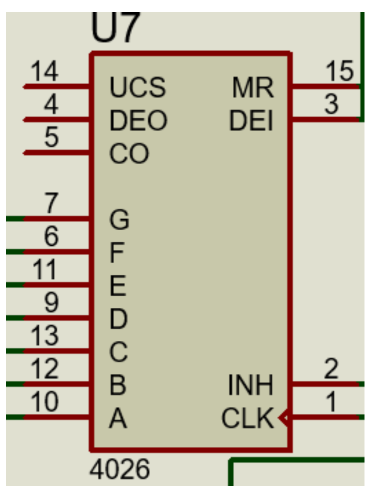


Fig: Decade Counter

7 segment Display

The A 7-segment display is a type of electronic display device that is widely used to display numerical information. It consists of seven individual segments, each of which can be lit up or turned off independently to form the digits 0-9 and a few alphabets. The segments are arranged in a rectangular shape, with one segment on the top, three segments on the sides and one segment on the bottom. Each segment is labeled with a letter (a, b, c, d, e, f, g) which indicates which segment is to be lit up in order to display a specific digit.

The 7-segment display can be found in a variety of electronic devices such as digital clocks, calculators, and electronic meters. They can be found in two types: common cathode and common anode. In common cathode, all the cathodes of the segments are connected together and in common anode, all the anodes of the segments are connected together.

7-segment display can be used in a wide range of applications including digital clocks, frequency counters, temperature displays, and other electronic devices where numerical information needs to be displayed.

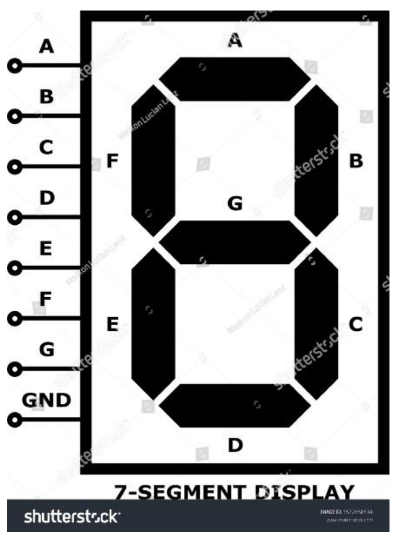


Fig: 7 Segment Display

Capacitor

A capacitor is a passive electronic component that stores electrical energy in an electric field. Capacitors are used in a variety of electronic circuits to filter out unwanted signals or to stabilize voltage levels. In the above-mentioned project, a capacitor may be used in conjunction with the 555 timer IC to stabilize the timing of the clock pulses. The capacitor is connected in parallel to the 555 timer IC and can be adjusted to change the duration of the clock pulses.

Resistor

A resistor is a passive electronic component that resists the flow of electrical current. It is used in electronic circuits to control the current flow, to divide voltage, and to create bias in active devices. In the above-mentioned project, a resistor may be used to limit the current flowing through the LED segments of the 7-segment display, protecting them from damage.

Voltage Source

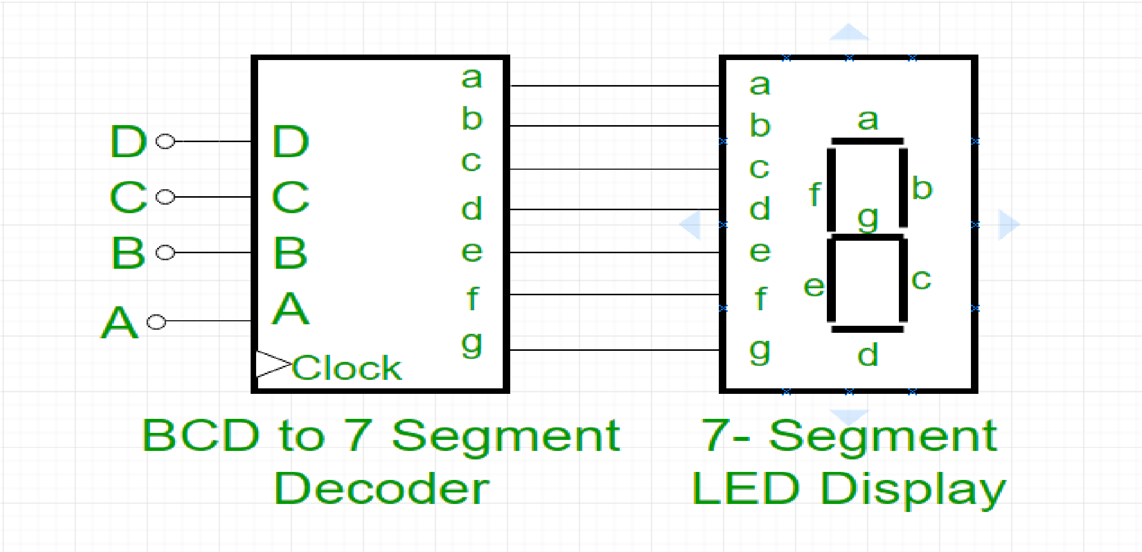
A voltage source is a device that provides a constant voltage to a circuit. Voltage sources can be classified into two types: DC voltage sources and AC voltage sources. In the above-mentioned project, a DC voltage source, such as a battery or power supply, is used to provide power to all the components of the circuit. The voltage source powers the 555 timer IC, the decade counter IC, and the 7-segment display.

In summary, the capacitor and resistor are used to stabilize and control the circuit signals and the voltage source is used to provide power to the circuit, making it possible for the digital clock to function correctly.

BCD to Seven Segment Decoder

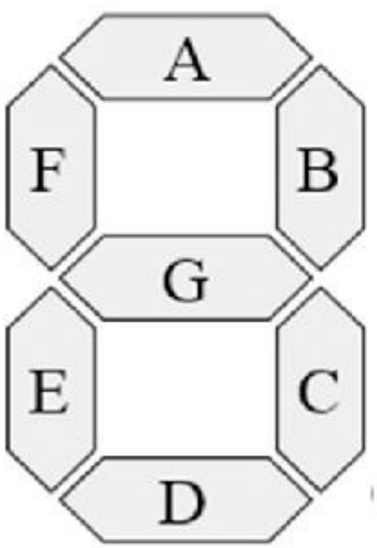
A BCD (Binary Coded Decimal) to 7-segment display decoder is used to convert the binary output of the decade counter IC into the appropriate signals for lighting up the segments of the 7-segment display. The decade counter IC counts the clock pulses from the 555 timer IC and generates a 4-bit binary output, where each bit corresponds to one decimal digit (0-9). This 4-bit binary output is in BCD format.

The BCD to 7-segment display decoder is a digital circuit that converts the BCD input into the appropriate signals for driving the 7-segment display. The decoder has 10 input lines, one for each decimal digit (0-9) and 7 output lines, one for each segment of the 7-segment display. When a specific BCD input is received, the decoder activates the corresponding output lines to light up the appropriate segments of the 7-segment display, showing the current time.



Truth Table – For common cathode type BCD to seven segment decoder:

A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1



Decimal	Segments
0	ABCDEF
1	BC
2	ABDEG
3	ABCDG
4	BCFG
5	ACDFG
6	ACDEFG
7	ABC
8	ABCDEFG
9	ABCDFG

Truth table for the BCD counter

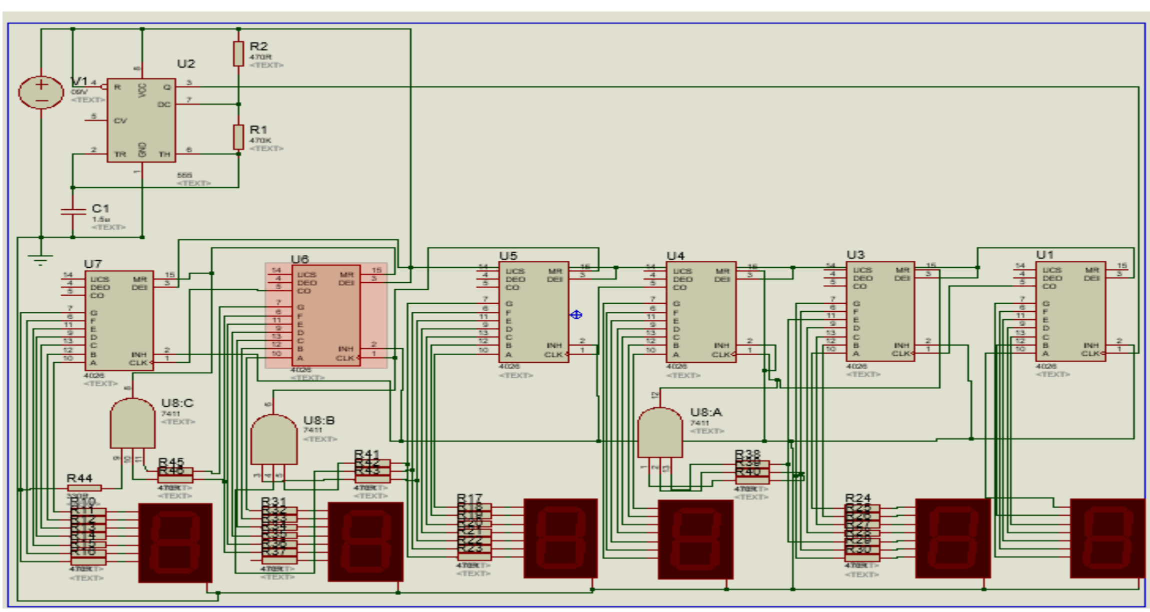
Inputs				Seven Segment Displays							
Q3	Q2	Q1	Q0	A	B	C	D	E	F	G	Decimal
0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	1	1	0	0	0	0	1
0	0	1	0	1	1	0	1	1	0	1	2
0	0	1	1	1	1	1	1	0	0	1	3
0	1	0	0	0	1	1	0	0	1	1	4
0	1	0	1	1	0	1	1	0	1	1	5
0	1	1	0	1	0	1	1	1	1	1	6
0	1	1	1	1	1	1	0	0	0	0	7
1	0	0	0	1	1	1	1	1	1	1	8
1	0	0	1	1	1	1	1	0	1	1	9
1	0	1	0	x	x	x	x	x	x	x	10
1	0	1	1	x	x	x	x	x	x	x	11
1	1	0	0	x	x	x	x	x	x	x	12
1	1	0	1	x	x	x	x	x	x	x	13
1	1	1	0	x	x	x	x	x	x	x	14
1	1	1	1	x	x	x	x	x	x	x	15

Working Mechanism

The working mechanism of the digital clock is based on the 555 timer IC, which is configured as stable multivibrator. A stable multivibrator generates a continuous stream of clock pulses, which are used to drive the clock. The frequency of the clock pulses is determined by the values of the resistors and capacitor connected to the 555 timer IC. The clock pulses are fed into the decade counter IC, which counts the pulses and increments its count by one with each rising edge of the clock pulse.

The decade counter IC has 10 outputs, one for each decimal digit. The output of the decade counter IC is connected to the inputs of the 7-segment display, which displays the current time. The 7-segment display is a device that consists of seven individual segments, each of which can be lit up or turned off independently to form the digits 0-9. The segments are arranged in a rectangular shape and are labeled with a letter (a, b, c, d, e, f, g) which indicates which segments are to be lit up to display a specific digit.

The 7-segment display is driven by the output of the decade counter IC, which is used to select which segment of the display should be lit up. The output of the decade counter IC is a binary code that corresponds to the current count. This binary code is decoded by the 7-segment display driver IC, which in turn lights up the appropriate segments of the display to show the current time. The digital clock continues to run by continuously counting the clock pulses from the 555 timer IC.



Proteus Software

Proteus is a software package that allows users to design and simulate electronic circuits. It offers a wide range of features and tools that are useful for designing and testing electronic circuits, including schematic capture, simulation, and PCB layout. The software is widely used in the field of electronics and electrical engineering, as well as in education and research.

One of the main uses of Proteus is to simulate and test electronic circuits before they are built in the physical world. This can save time and money by identifying and fixing any issues with the design before building the circuit. Proteus allows users to simulate a wide range of electronic components, including ICs, transistors, diodes, and other electronic devices. The software also allows users to simulate different operating conditions and test the circuit's behavior under different scenarios.

In addition to circuit simulation, Proteus also includes a PCB layout editor that allows users to create professional-quality printed circuit board layouts. This feature is particularly useful for designing custom PCBs for electronic projects. Overall, Proteus is a versatile and powerful tool for electronic design, simulation and PCB layout, it can also be used to develop and test control systems, embedded systems, and microcontroller-based applications.

Working of the Digital Clock

This is the 24-hour format digital clock. There are 6 decade counters, 6 decoders, 6 displays, one frequency generator. Each counters are used to count each digit of the time in hour, minute and second format; each display is used to display the output of each counter; each decoder is used to decode the output of counter for the display.

The digital clock can be broken down to the four parts:

a. 555 Timer:

555 timer IC is used to generate a regular square wave clock signal. The clock signal is used to drive the decade counter IC, which counts the number of clock pulses and generates a binary output in BCD format. The 555 timer IC works in a stable mode, where it generates a continuous stream of pulses.

The basic working of the 555 timer in a stable mode is as follows:

1) The 555 timer IC has two comparators, a flip-flop, and a discharge transistor. The two comparators are used to compare the voltage on the threshold pin (pin 6) and the trigger pin (pin 2) with a reference voltage (about 2/3 Vcc).

2) The flip-flop is used to switch the state of the output pin (pin 3) between high and low based on the comparator outputs.

3) The discharge transistor is used to discharge the capacitor connected to the control pin (pin 5) when the output is high.

4) The frequency of the clock signal is determined by the values of the timing components, the resistor (R1) and the capacitor (C1), connected to the control pin. The time period of the output square wave is given by the formula: $T = 0.693 * (R1 + R2) * C1$

5) When the power is applied, the capacitor C1 starts charging through resistor R1 and R2. When the voltage across the capacitor reaches 2/3 Vcc, the comparator on the threshold pin (pin 6) triggers, and the flip-flop changes the state of the output pin (pin 3) to high.

6) The discharge transistor is activated and the capacitor starts discharging through the resistor R2. When the voltage across the capacitor drops to 1/3 Vcc, the comparator on the trigger pin (pin 2) triggers, and the flip-flop changes the state of the output pin (pin 3) to low.

7) The cycle repeats and the output pin produces a continuous stream of square wave pulses. The frequency of the pulses can be adjusted by changing the values of the timing components, R1 and C1.

The 555 timer IC in the above project is wired in a stable mode, generating a continuous stream of pulses which is used as a clock signal for the decade counter IC. The output of the 555 timer IC is connected to the clock input of the decade counter IC, which counts the number of clock pulses and generates a BCD output.

b. Seconds:

- A 555 timer IC can be used to generate a regular square wave clock signal. The frequency of the clock signal can be adjusted by adjusting the values of the timing components (resistor and capacitor) connected to the 555 timer IC.
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c. Minutes:

Counting and displaying minutes in a 7-segment display can be achieved by using a combination of logic gates, a decade counter IC, and a BCD to 7-segment display driver IC. The following is a general mechanism for counting and displaying minutes:

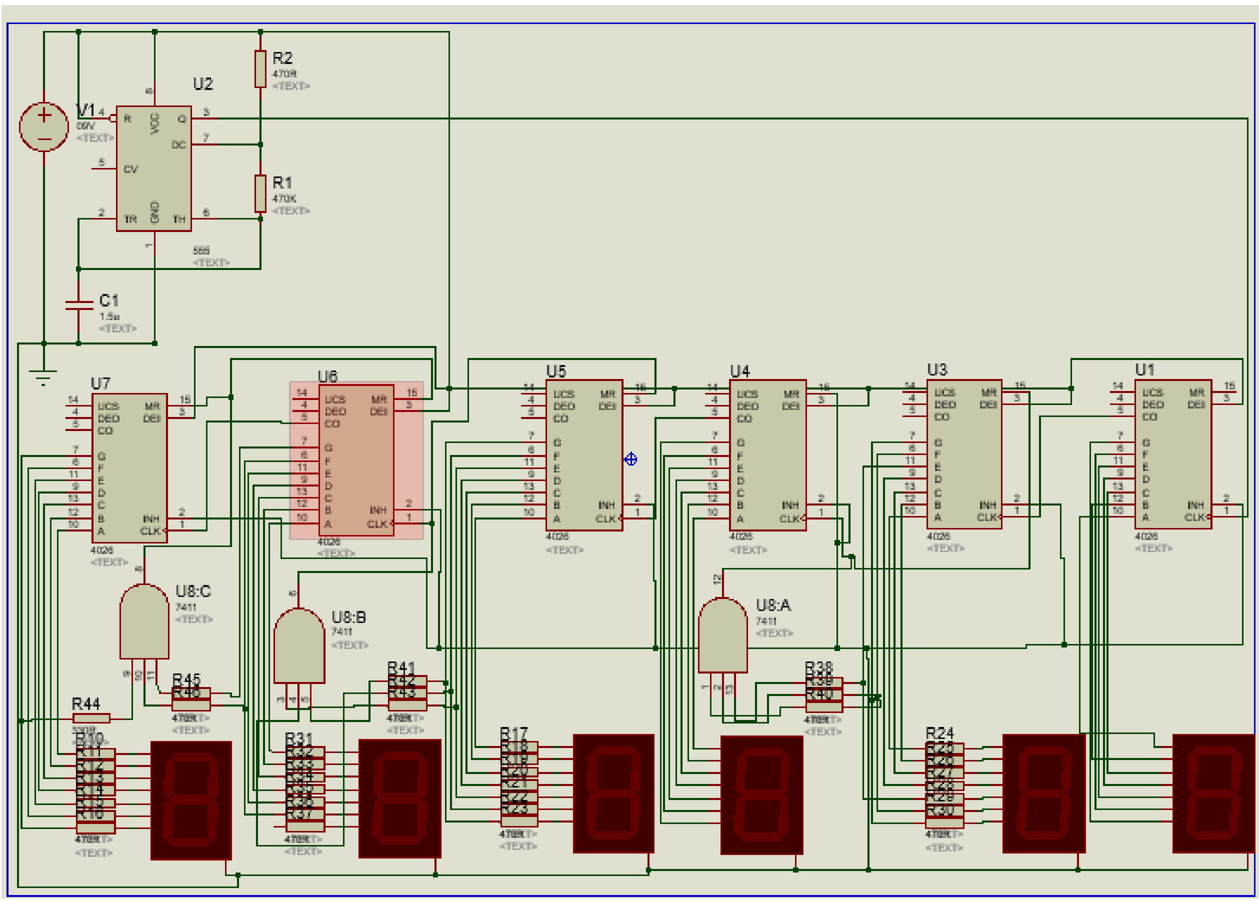
- The clock signal from the 555 timer IC is fed into the clock input of a decade counter IC, which counts the number of clock pulses and generates a binary output in BCD format.
- The BCD output from the decade counter IC is then fed into a logic gate circuit, which acts as a counter for minutes. For example, if we want to count minutes up to 59, we can use a 3-input AND gate circuit. The AND gate will only output a high signal when all three inputs are high, which corresponds to the count of 59 in BCD format.
- The output from the AND gate is then connected to the reset input of the decade counter IC, which resets the counter back to zero once the count reaches 59 minutes.
- The BCD output from the decade counter IC is then fed into a BCD to 7-segment display driver IC, which converts the BCD signal into a form that can drive a 7-segment display.
- The output from the BCD to 7-segment display driver IC is then connected to the 7-segment display, which displays the minutes in a digital format.
- As the clock signal continues to pulse and the decade counter counts, the minutes will be incremented and displayed in the 7 segment display. The circuit will only reset back to zero when the count reaches 59 minutes, allowing the circuit to count 60 minutes before resetting again.

d. Hours:

For Hour counting we have to count from 00 to 24. Counting and displaying hours in a 7-segment display can be achieved by using a combination of logic gates, a decade counter IC, and a BCD to 7-segment display driver IC. The following is a general mechanism for counting and displaying hours:

- The clock signal from the 555 timer IC is fed into the clock input of a decade counter IC, which counts the number of clock pulses and generates a binary output in BCD format.
- The BCD output from the decade counter IC is then fed into a logic gate circuit, which acts as a counter for hours. For example, if we want to count hours up to 12, we can use a 3-input AND gate circuit. The AND gate will only output a high signal when all three inputs are high, which corresponds to the count of 12 in BCD format.
- The output from the AND gate is then connected to the reset input of the decade counter IC, which resets the counter back to zero once the count reaches 12 hours.
- The BCD output from the decade counter IC is then fed into a BCD to 7-segment display driver IC, which converts the BCD signal into a form that can drive a 7-segment display.
- The output from the BCD to 7-segment display driver IC is then connected to the 7-segment display, which displays the hours in a digital format.
- As the clock signal continues to pulse and the decade counter counts, the hours will be incremented and displayed in the 7 segment display. The circuit will only reset back to zero when the count reaches 12 hours, allowing the circuit to count 24 hours before resetting again.

Final Circuit



Conclusion

In conclusion, the digital clock project described above is a great example of how various electronic components can be used together to create a functional and accurate timepiece. The 555 timer IC was used to generate a clock signal and the decade counter IC, logic gates were used to count and display hours, minutes, and seconds on a 7-segment display. The BCD to 7-segment display driver IC was used to convert the BCD output into a format that can be displayed on the 7-segment display.

The use of a Proteus simulator helped to validate the circuit design and ensure that it operates as intended. The project provides a practical application of fundamental electronic concepts and serves as a valuable learning experience for anyone interested in circuit design and digital electronics. Overall, this project demonstrates the importance of understanding the properties and capabilities of different electronic components and how to use them effectively in a circuit design. It also shows the importance of testing and validation to ensure that the circuit operates as intended.

In general, this project has been successfully carried out and satisfies the overall aim and objectives of the project. In this project, we learned time management and teamwork. We have also learned research methodology techniques.