ISSN: 2582-8118 *Volume 2, Issue 2; March 2022*

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYSIS IN SCIENCE AND ENGINEERING

Web: https://www.iarj.in/index.php/ijrase/index

5. A Study on Design and Construction of a Digital Clock System

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ABSTRACT

Instead of showing the time by moving hands as in an analogue clock, this project's digital clock displays it digitally, in numerical form (i.e., in numbers). Using 555 timers, this digital timer circuit was designed and implemented, and the results are documented. The project's initial design criteria were to have a digital output, and to count from seconds to minutes and then hours. Either an op-amp or a 555 timer should be included. Research into analogue electronic circuits of a similar nature led to the discovery of a good starting point for digital circuits. A digital timer circuit was built utilising a 555 timer, 74LS90 binary counters, 74LS47 IC, and 7 segment display outputs.

KEYWORDS

Design and Construction, Digital Clock, Digital Clock System, Digital Timer.

Introduction:

At a look, digital clocks can tell the time. They swiftly overtook the older sweep-hand clocks, now referred to as "analogue clocks," in terms of popularity. Pendulum or spring clocks were used to measure time. It is impossible to use a pendulum on a moving platform, like a ship, as springs unwind more slowly as they discharge accumulated tension. In order to depict these mechanical time bases, the employment of sweep hands was necessary. Electrical circuits that could accurately keep time under a wide range of settings were possible because to the development of multivibrator chips that had been refined. The time display had to be updated to reflect the change in the time base from mechanical to electrical. Time can be displayed numerically thanks to screens known as 7-segment displays. As a result of this, digital clocks were born. Due to the low cost of digital logic circuits, digital timers are now a better investment than mechanical or electromechanical timers. In a manner comparable to a wristwatch, individual timers are implemented using single-chip circuitry (Timer, 2006). Analogue and digital logic components combine to form the 555 timer in this project.

Theory: 555 timers and binary counter decimal (BCD) integrated counting circuits are used by electronic designers to construct timers. There is an easier way to implement three-digit timers than using programmable microcontrollers. In this context, BCDs are likewise acceptable.

555 Timer: One of the most common uses of the 555 timer is to provide clock pulses for other timer circuits. It is possible to use them to generate both oscillating and digital outputs. There is a choice between an astable output and a monostable, single-trigger output for the IC (Analogue Electronics, 2006).

THE 74LS90 IC: Four master/slave flip-flops in the 74LS90 provide a divide-by-two and divide-by-five portion, respectively, for the binary counter. The HIGH-to-LOW clock transition starts state changes in the counter in each sector. It is possible to set the number of outputs to nine by using the 74LS90's gated AND asynchronous Master Set (MS1•MS2).

The 74LS47 IC:

BCD to 7-segment decoding/driver IC. As an input, it accepts a binary-coded decimal and turns it into a pattern that drives a seven display to show zero through nine. Each digit of a number is encoded in its own binary sequence in binary coded decimal (BCD) (usually of four bits).

7 Segment Display:

Each of the seven LEDs of the 7-segment display is referred to as a segment because, when illuminated, each segment forms part of a numerical digit to be displayed, whether decimal or hexadecimal. When two or more 7-segment displays are linked to display numerals more than 10, an extra 8th LED is occasionally utilised within the same package, allowing the indication of a decimal point (DP).

Resistor:

Resistors are electrical devices that reduce current flow while also lowering voltage levels in circuits. V=IR is the equation that describes the relationship between the voltage across a resistor and the current flowing through it. Resistors can be used in a variety of ways. For example, resistors can be used to control the operating current and signal level in a circuit, reduce the voltage applied to the circuit, set the precise value of the gain in a precision circuit, shunt current and voltage metres, dampen oscillator signals, and act as bus or line terminations in digital circuits. The resistance of resistors can be fixed or variable, depending on whether they are dc-signed or not.

They can have variable resistance if they are dc-signed. It's possible that they've been exposed to heat or have had resistance, charge, or both (e.g. photo resistors, thermistors).

Capacitors:

Energy can be stored in this device's electric field. It is possible to have a fixed or variable capacitance in a capacitor. Polarized and non-polarized capacitors are the only two types of capacitors. Electrolytic and non-electrolytic capacitors, ceramic capacitors, and polyester capacitors are among the many varieties that fall under these two broad categories. When using non-polarized capacitors, the color-coding system is required. Coupling, decoupling and tuned circuits can all profit from the usage of capacitor (Wikipedia, 2016).

Review of Literature:

The idea of a digital clock for a project is not new. Prior to this semester, logic circuits were and still are a more difficult and complex topic for us to grasp. In our first year of college, we learned the fundamentals of circuitry. But this time, we have a greater task because this system has more intricate circuits and more logic gates and ICs to deal with.

We learned a lot more about this topic thanks to the internet. To help us with our review of the literature, we take EEEG 202 (digital logic). All that we learned about counters and flip-flops and other fundamental concepts came from our course. Digital circuits and sequential logic gates have a wide range of applications in electronics and computer science. Several enthusiasts in this subject have used the same approach to make several contributions to the field of digital clocks. We're just students and researchers trying to get involved and develop in the best way possible. As a result, our main goal is to put this circuit into motion using only what we already know about the behaviour of the different components and how they are connected.

Using microcontrollers on projects like this is a well-known method of saving the time. This is the foundation of the vast majority of internet circuits. In the same way, we found that IC 4026 would be suitable for our current endeavours. We couldn't use this IC since it couldn't be used to make a digital clock that shows time in 12-hour format. IC 7490 is a decade counter, and IC 7447 is a decoder driver with seven-segment displays to display the output counter.

When it comes to soldering and implementing on PCBs and circuit board, we have to be extremely careful because the final circuit is extremely complex. In order to accomplish this, we're working very hard.

Design:

Following are the project's design specifications:

1. A 555 timer is required in any design.
2. Allow for four-digit output.
3. Make the circuit count down the time and provide a reset.

As shown in "figure 1" below, the first stage in the design of any complex circuit is to determine the basic functions that must be performed. In accordance with above design parameters, the following block diagram was created:

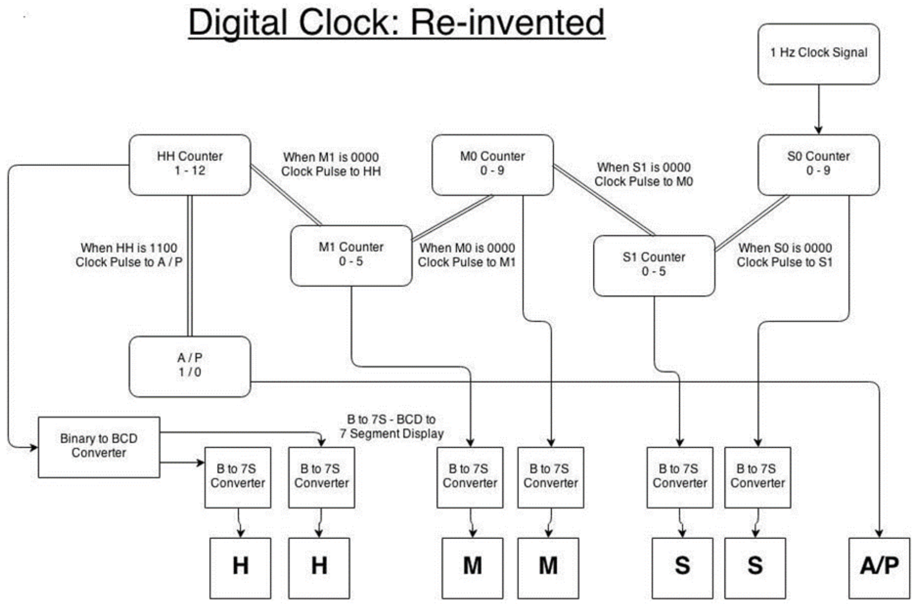

Figure 1: Block Diagram of a Digital Clock

Construction Process:

It is possible to break this circuit down into a series of distinct, testable blocks, as seen in the block diagram illustrated in Figure 1. Circuit blocks were developed and tested on a breadboard before being integrated into the circuit to build up to the final 4 digit implementation. In this order, the circuit was completed:

1. The 555 Timer.
2. 555 timer circuit testing.
3. The first set of 74LS90 and 74LS47 were built, and they were tested.
4. One 7-segment display output has been constructed.
5. The 555 timer, the first set of 74LS90 and 74LS47, and the first seven-segment output are all linked.
6. Visual testing of 555 timers, the first pair of 74LS90 and 74LS47, and 7-segment output counting from digit.
7. 0 to 9.
8. Placing the remaining 7 segment display outputs into the circuit and conducting tests as per standard procedure
9. (6).
10. The second set of 74LS90 and 74LS47 IC's were built.
11. From the first set of IC's and pins, the second set of 74LS90 and 74LS47 were supplied.

12. It was necessary to connect 9 and 8 to pins 2 and 3 in order to reset the counter to zero after a count of 0 to 6.
13. The circuit's visual test has been implemented in (9).
14. The four 7-segment displays were organised in the same manner as the third and fourth sets of ICs.
15. Using a common anode, they were linked together.
16. Visual test of (11)
17. Reset switch added.
18. The final circuit was visually tested.
19. Figure 2 shows the circuit diagram used, which was created using a life wire simulation.

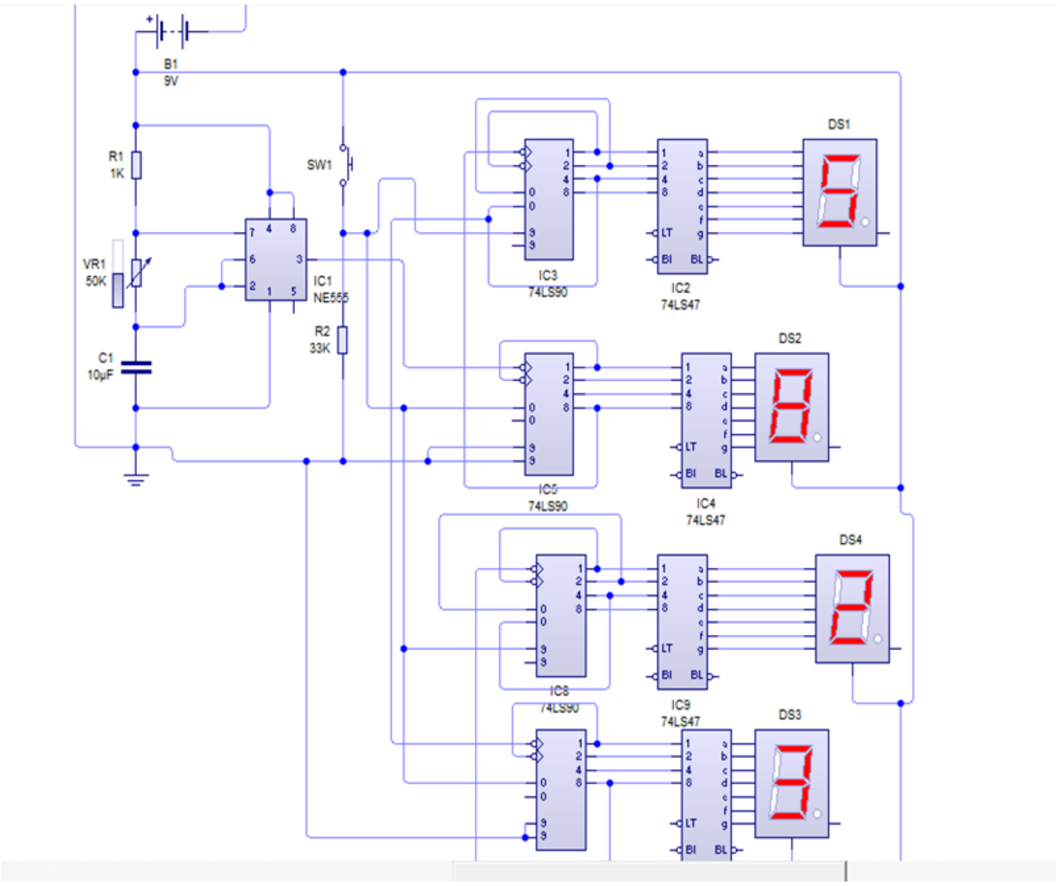

Figure 2: Circuit Diagram of Digital Clock

Methodology:

A systematic path was followed, integrating new blocks into the circuit once the regular operation of the current components had been confirmed. The group was able to demonstrate that the 555 timer, 74LS90, 74LS47 ICs, and 7-segment displays were all compatible before moving on to more intricate interconnections by starting with a full 0-9 count and examining the 7-segment display output.

The most difficult part of this circuit was connecting the ICs correctly. During implementation, the required datasheets were used to troubleshoot potential logic errors in the circuit design.

As originally planned, the project used a four-segment display timer to show the passing of the hours and minutes. A 555 Timer, a 74LS90 (BCD) counter, a 74LS47 counter, and a seven-segment display were used to construct this. An easy-to-implement decade counter timing circuit was selected because of its simplicity in design. Timer that counted from 0 to 9 and then back again was the basic idea seen above. Making use of a timer required some modification to this.

The basic design's code conversion component enables the counter to count from 0 to 6 and back again, and the BCDs were directly connected to their corresponding Seven Segment Decoding chips.

While the 555 Timer was kept as the circuit's primary driver, the pause switch was removed so that the circuit could be made simpler. It was possible to obtain a 1 Hz signal by replacing the 47kΩ resistor with a series combination of a 1kΩ resistor and a 50kΩ variable resistor.

The second 74LS90's clock input was connected to the 555 Timer's output (BCD2). In the timing circuit, the BCD2 was set up to count up from 0 to 9 and then reset 0, counting the minutes. Pulses are sent from pin 11 or the carry out pin when BCD2 resets itself. To ensure that the clock input of the first 74LS90 (BCD1) was triggered when BCD2 reset itself, a wire from pin 11 was attached to it.

To ensure that BCD1 was counting correctly, the timer was limited to six counts before being reset on the next input pulse from BCD2. By connecting the output pins 9 and 8 to the pins 2 and 3, this was accomplished. For a six, 0110 is a binary representation, so this connection allowed BCD1's reset pin to be triggered, allowing the initial seven segment display to move directly from six to zero.

The final BCD, BCD4, counts the hours in the timing circuit. When the connection between BCD1's wires 8 and 3 was activated, this happened. BCD3's clock input can be taken from BCD4's pin 11 at the same time as its reset, thus there is no need for additional circuitry in this case.

The 74LS47 chips were then connected to the BCDs' outputs to complete the circuit design. The seven-segment displays were then linked to the 74LS47 chips. Additionally, a reset switch was installed on each BCD's reset pin. When the switch is depressed the BCD's are prevented from counting by sending out a continuous high voltage signal.

The Seven Segment Displays were selected as the output of this circuit because of their small size and ease of installation. Seven-segment displays were explored as a replacement for LCD displays, but their cost and the ease with which they could be read outweighed this alternative. In addition, the 555 Timer is one of the most accurate IC timers ever developed. In addition to the fact that the 555 Timer was relatively inexpensive, it was considered the best timer available at the time.

In accordance with the diagram above, the components were put on the breadboard as shown. After arranging the device, it performed perfectly.

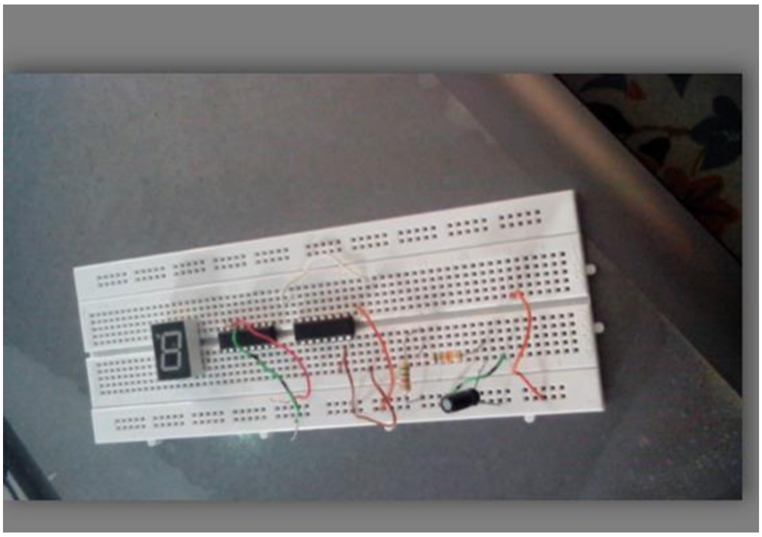

Figure 3: Bread Board Implementation

The Vero board was used for the implementation, and all of the components were properly soldered. After that, it was put to the test, and the results were as expected. Figures 3 and 4 below explain this.

Figure 3: Vero Board Implementation

Figure 4: Digital Clock

Conclusion:

A 555 timer, a 74LS90 IC, a 74LS47 Decoder, and a seven-segment display were combined to create a digital timer circuit. Once the optimum way for producing an efficient timer was determined, a circuit design was created using that method. Live wire simulation was used to confirm the chosen circuit's functioning. The concept was subsequently implemented and modified to meet the project's requirements. To ensure that the circuit satisfied the requirements of the project, it was analysed and fixed if necessary. So that it would be simpler to verify the circuit's correct operation, a vero board implementation was developed.

References:

1. Analogue Electronics, 2006. Retrieved on 20/06/16 from en.wikipedia.org/wiki/Analogue electronics.
2. Science and Technology Encyclopedia, Electronics. Retrieved on 21/06/16 from http://www.answers.com/topic/electronics .
3. Timer, 2006. Retrieved on 21/06/16 from en.wikipedia.org/wiki/Timer
4. Phillips, BCD Up/Down Counter, Retrieved on 22/06/16 from http://www.doctronics.co.uk/4510.htm .
5. Phillips, BCD to 7 segment Decoder, Retrieved on 22/06/16 from http://www.doctronics.co.uk/4511.htm .
6. Interfacing to 7-Segment Numeric Displays, Retrieved on 23/06/16 from http://www.thelearningpit.com/lp/doc/7seg/7seg.html .
7. Diode Logic, 2006. Retrieved on 23/06/16 from http://www.play- hookey.com/digital/electronics/dl_gates.html.
8. Wikipedia, 2016.
9. Wikipedia Contributors, “Digital clock,” Wikipedia, 18-Oct-2018. [Online]. Available: https://en.wikipedia.org/wiki/Digital_clock. [Accessed: 26-Dec-2018].
10. Elctronics course," [Online]. Available: http://electronics-course.com/digital-clock. [Accessed 02 october 2018].