

Designing a Binary Clock using logic gates

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Abstract—Wrist watches have been a common fashion accessory addition for several people. However, the concept of using a seven-segment digital display or sometimes, even an analog indicator hasn't changed for a number of years. This project aims to test and design a binary clock, also referred to as *A2, 16, 8, 4, 2, 1* clocks or even *8, 4, 2, 1* clocks (due to their display configuration), that could change this everlasting display for watches. Specifically, digital logic and design engineers would find interest in this topic due to sophistication involved in reading-out the time. This project will do so using a by showing each decimal digit of sexagesimal time as a binary value. This design will be primarily functioning on logic gates and would involve the use of several basic components that include, but are not limited to, integrated circuits (or ICs), Light emitting diodes (LEDs) and resistors.

Index Terms—binary clock, logic gates, bread board, sexagesimal, integrated circuits

I. INTRODUCTION

A. Standard Seven Segment Display

A seven-segment display, in digital electronics, is a form of electronic display device used as a means to represent a decimal digit using a seven individually lit segments. The image below shows a standard seven segment display without the decimal point:

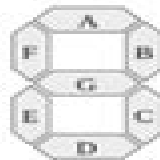


Fig. 1. A standard seven segment display without decimal point [6]

As shown in the figure, the segments of the display are illustrated and referred by the *A, B, C, D, E, F* and *G*. An engineer can choose to select for which set of inputs will each segment LED will light up for using these characterizing letters, *A-G*.

Using this concept, a binary clock or a "complete" clock can be represented using 3 seven segment displays, 1 two-decimal point/colon display and 1 two segment display. Time uses a sexagesimal concept which can also be referred to as the base 60 concept in digital technology. This is because the minutes and seconds part of a clock only ranges from 0-59, while repeating the cycle and incrementing the preceding place

by a value of 1. The first digit of the hours place can be represented by a two segment display as the most significant digit maximum value of hours (*i.e.* 12) is 1. Furthermore, since the minutes place can range from 0-59, 2 seven segments displays are required. Finally the colon or the two-decimal point display is used as a minutes to seconds separator. Hence, the final outcome for the display is as follows:

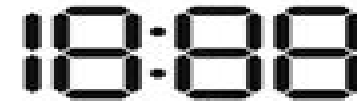


Fig. 2. A standard seven segment display of a 12-hour digital clock

Note: Although, The circuit designed in this project will utilize a hours place, a minutes place and a seconds place for this project, it is not displayed in the figure above. This is to allow for a less complicated explanation for the principle of the seven segment displays used in 12 hour digital clocks. Furthermore, majority of 12 hour digital clocks only employ a hours place and a minutes place.

B. Binary Clock Display

A binary clock displays the time of day in a binary format. It uses a similar concept of HH:MM:SS or an hours place, minutes place and a seconds place like standard 12 or 24 hour clocks usually do. However, each decimal digit of sexagesimal or base 60 time, will be represented as a binary value. Similar clocks based on gray code and BCD logic also exist, but our main focus is on the use of binary values.



Fig. 3. BCD on the left and traditional binary (as used in this clock) on the right displaying 11:45:38 in 12-hour format [7]

The binary clock in this project will be utilizing the traditional binary format (on the left image of Fig. 3). Time for seconds, hours and minutes are calculated by adding up the lit

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