Abstract

A Dot Matrix Oscilloscope is low cost versatile equipment for viewing and measuring simple periodic waveforms. It is perfect for learning and quick inspection of electronic systems because of its small size and simplicity. A prototype was made and tested. The prototype is a 7x8 Dot Matrix and with a range of 20Hz to 100Hz. The Resolution of the Matrix can be increased without increasing the complexity of the circuit, but like all other Digital Systems this causes reduction of the speed of the system which reduces the range of the Oscilloscope. The high frequency operation is also affected by the non-idealities of the components used. The system is built around one comparator whose comparison levels are constantly changing by a staircase generator which operates at the base frequency. The comparator outputs single bit of information about the input at that instant. This information is transferred to the correct dot on the matrix. For the waveform to hold the base frequency must be (no.of.rows*no.of.columns) times the input frequency or its harmonics. This is 64 times in case of a 7x8 matrix.

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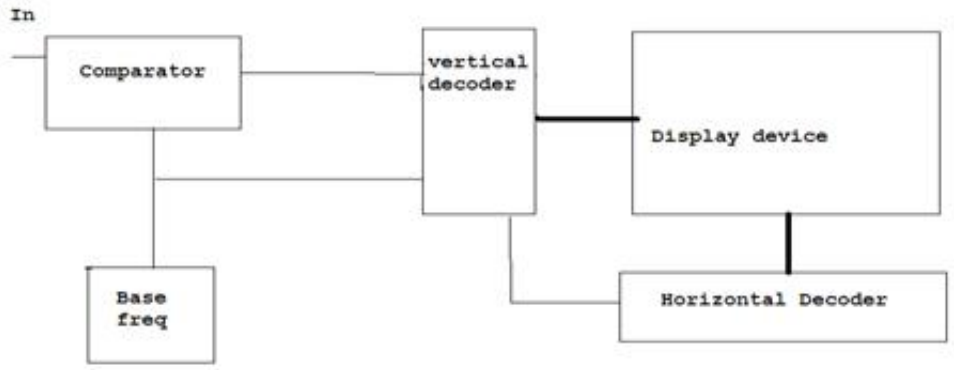
1. INTRODUCTION

1.1. Basic Model



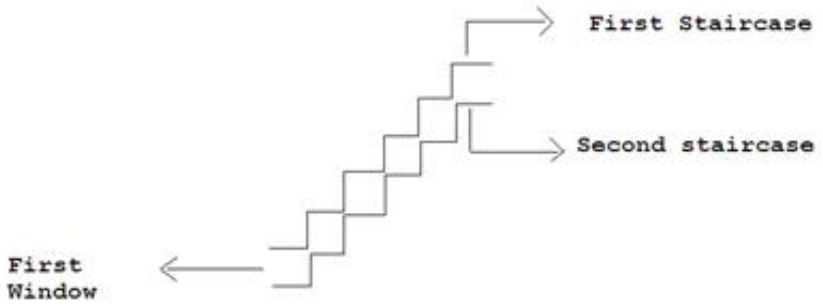
1.Basic Block Diagram

The Basic model has a comparator, base frequency generator, horizontal and vertical decoders and the display device.

The base frequency is given both to the comparator and the decoders to stair case generation and for vertical and horizontal sweeps respectively.

1.2. Working Principle

The base frequency generator drives the decoders in a way such that for every cycle of vertical movement there is one horizontal movement. Because of this movement every dot in the display has a time slot to indicate the information present on the comparator output. A single window comparator is used to compare the input waveform for it's presence within the window. The window changes for every single period of the base frequency. The varying window is obtained by two staircases with offset equal to the window width.



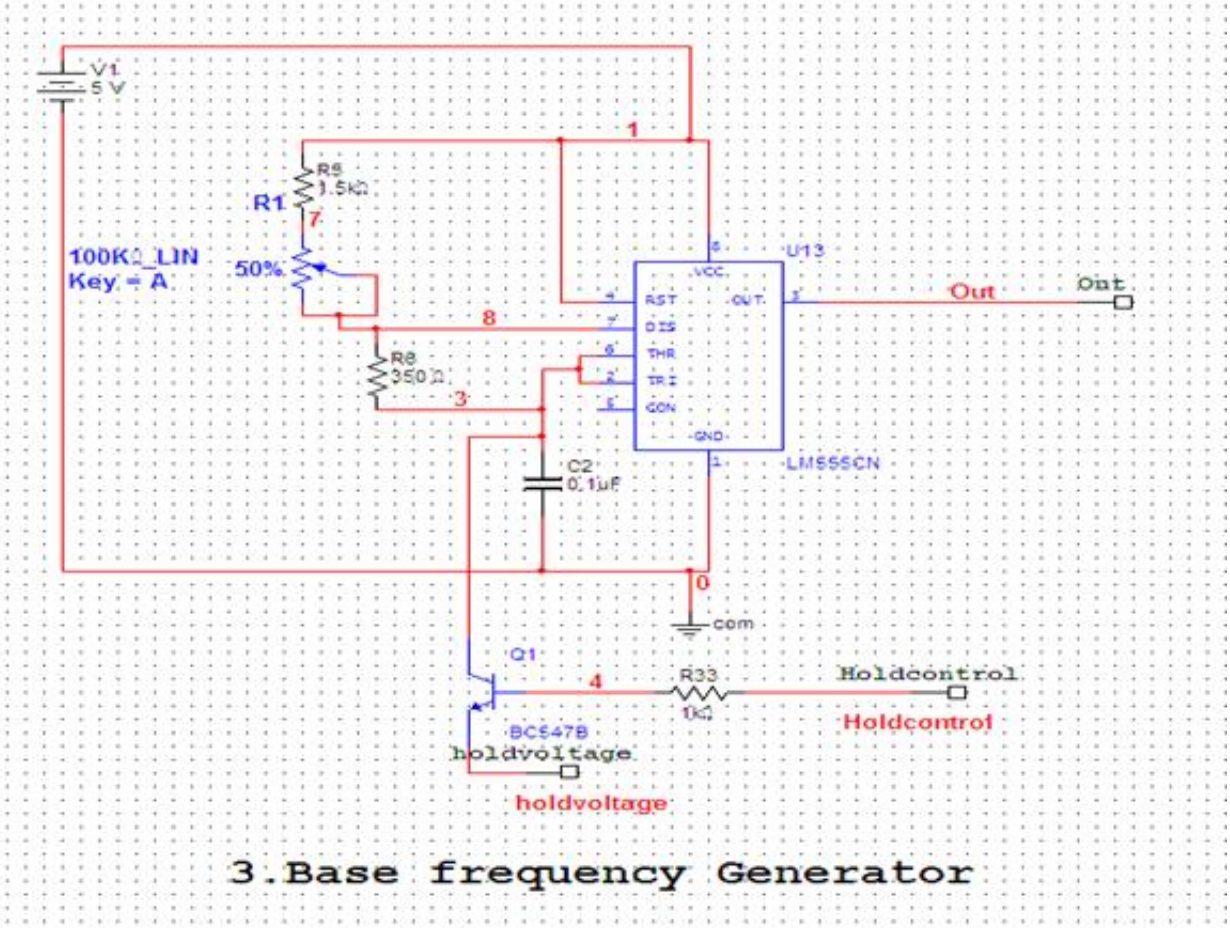
2.The comparision staircase

The varying window has a period eight times of the base frequency after which it is repeated. It has seven windows representing the seven rows in the matrix. The comparator outputs single bit of digital information about the input is in the window or not. The dot which is active at that instant will modify that information into a light signal (i.e. it glows for presence of the input in that window or else not). Then the same process is repeated for all the columns. As the whole process is repeated several times a second a wave form appears on the dot matrix which is the input waveform.

Varying the base frequency is equal to the Times/division control in a classic Oscilloscope. A wave conditioner is used for volts/division control.

The Staircase waveform's parameters control the brightness and offset of the display.

2. Base Frequency generation



3.Base frequency Generator

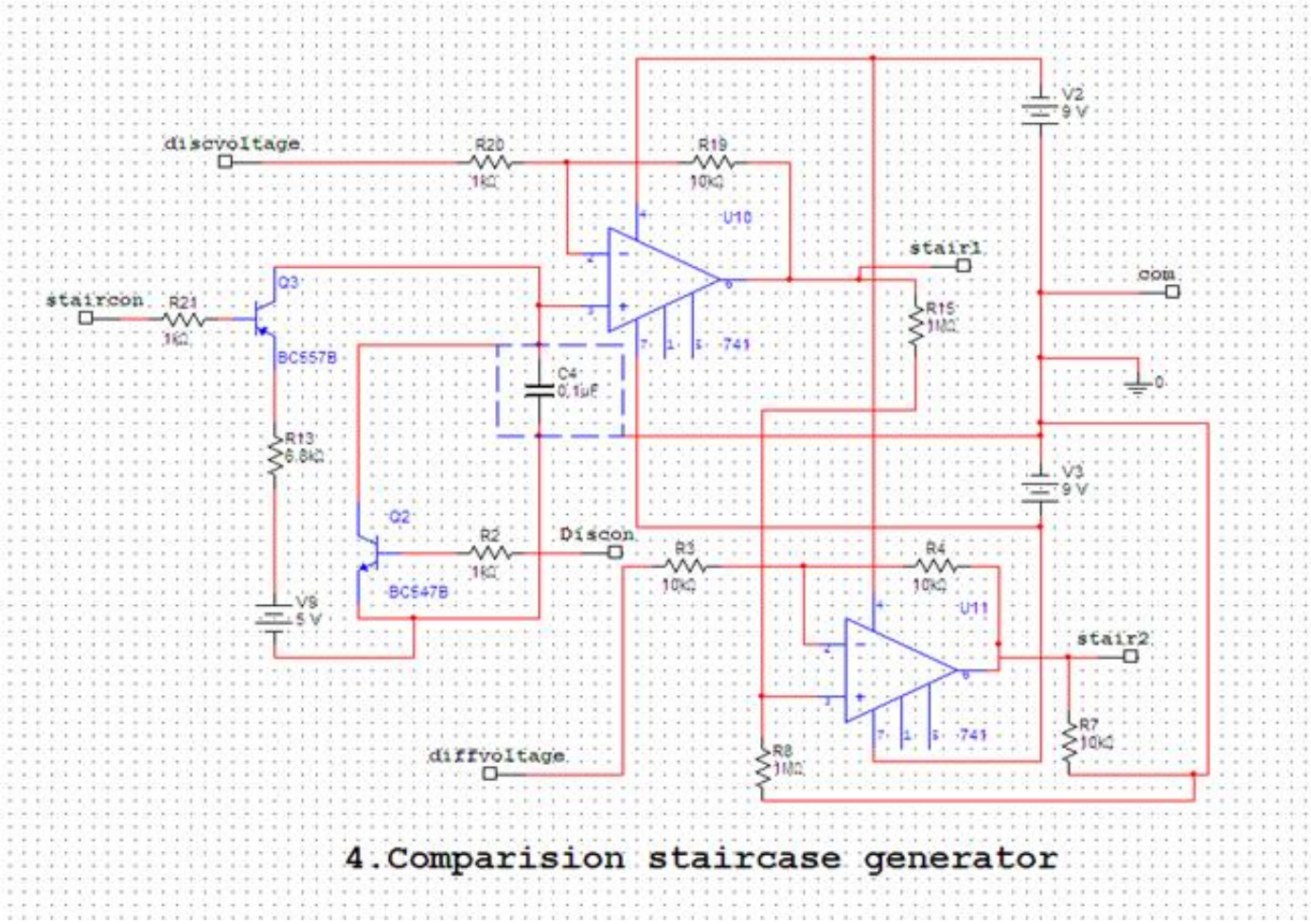
The base frequency generator is built around a 555 Timer in astable mode.

The 100K Potentiometer varies the ON period of the timer but leaves the OFF period unchanged this also varies the frequency. The reason for this variable duty cycle operation will be explained later on the stair case generator's explanation. The resistors R5 and R6 on Fig.3 set the upper and lower ends of the frequency range. The capacitor can be varied for varying the frequency range through several decades. The npn transistor used in the circuit is for stopping the oscillator for triggering purposes. When the hold control is active the oscillator is stopped and the voltage is forced at hold voltage as a result of the saturation of the transistor. The output of this oscillator is used for staircase generation and also horizontal and vertical sweeps.

3. Comparison Staircase generator

The main purpose of the comparison staircase is for providing various comparison levels for the comparator. The main components are the capacitor C4 and the pnp transistor Q3

and the npn transistor Q2 in Fig.4. The pnp transistor acts as a constant current source and npn transistor acts as a switch to discharge the transistor. The main principle is that when a capacitor is delivered a constant current it's voltage increases linearly with time with a slope equal to (The current through the capacitor/The value of the capacitance). The Stair control is the basic frequency which has a constant OFF period and variable ON period. Hence when the stair control voltage is zero the pnp transistor is in it's active region and so delivers a



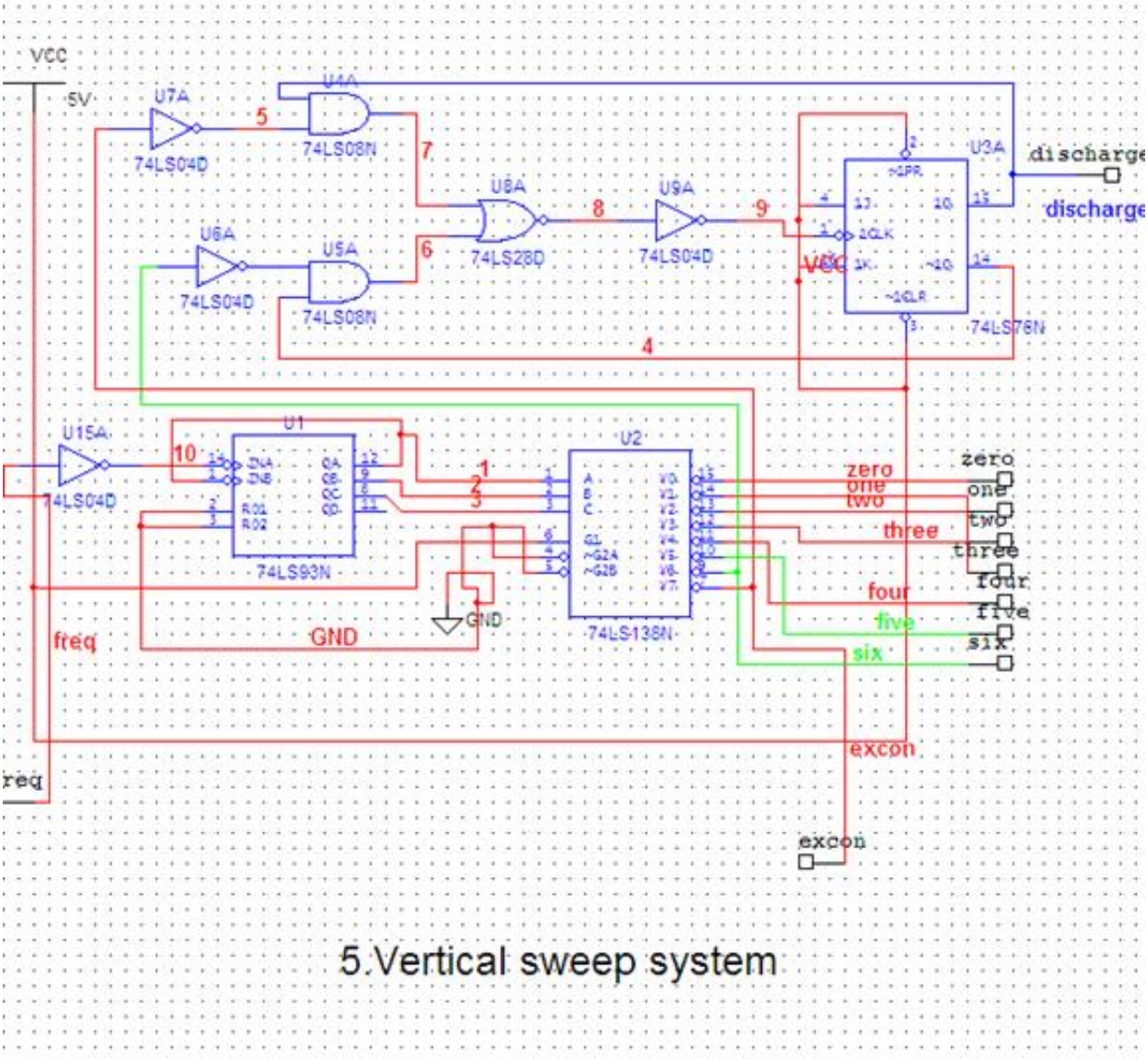
4.Comparision staircase generator

constant current which is proportional to the value of the emitter resistor of the transistor. This makes the voltage of the capacitor rise linearly with time.

This produces a stair case which starts from zero and has a low level. So the capacitor voltage is amplified and offseted by the opamp U10. The amount of offset is set by the value of the voltage at discvoltage. Then the staircase is offseted by some amount to produce another stair case which is offset to the original one by the value of voltage given at diffvoltage. This varies the brightness of the waveform in the display as it sets the total time for which the input wave will be in the window produced by these two staircases. The

two staircases are obtained from stair1 and stair 2 respectively.

4. Vertical Sweep System

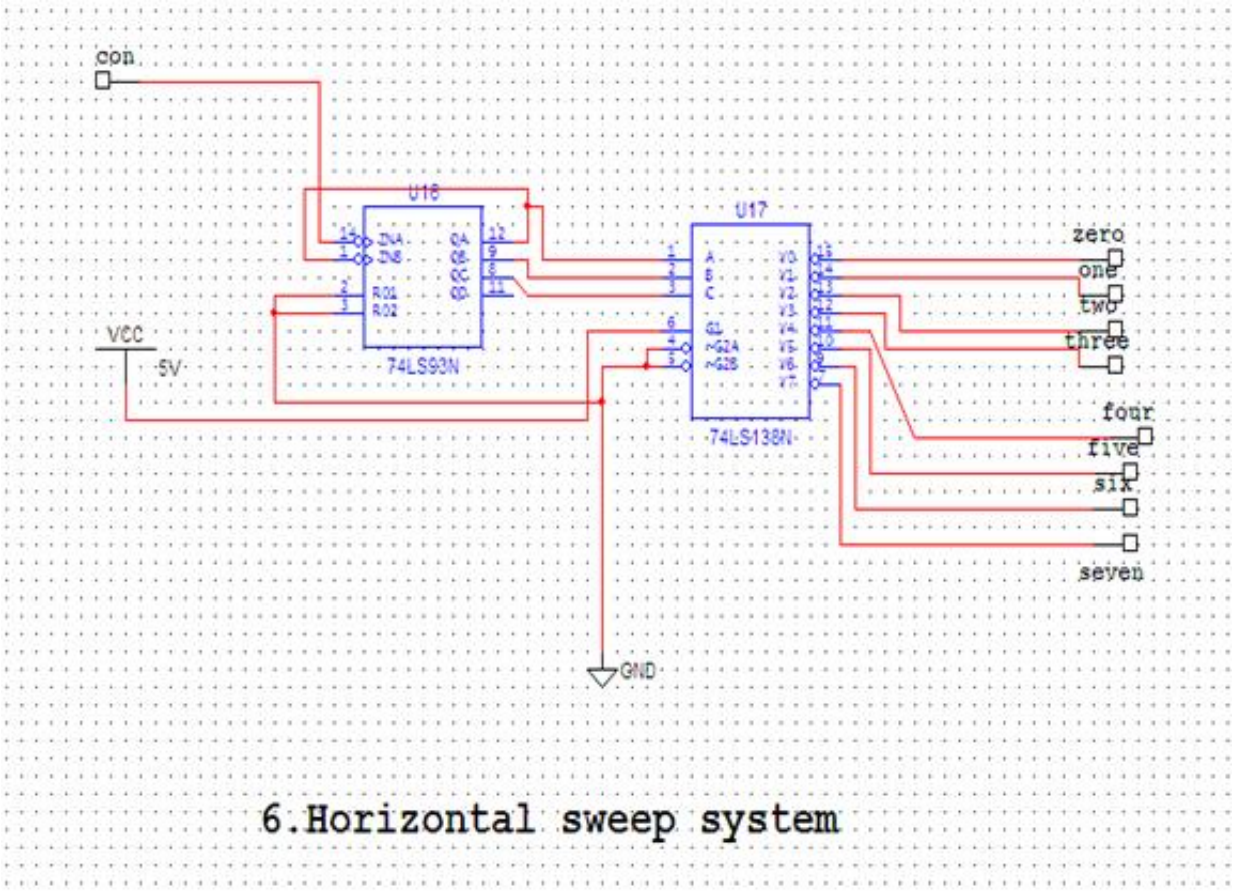


5.Vertical sweep system

The vertical sweep system is basically a counter followed by a Decoder. Here the 7493 counter is used as a 3-Bit counter with the clock pulse as the inverted form of the basic frequency pulse. The output of the counter is decoded using the 74138 3-8 Decoder. The and or gate assembly and the one half of the JK flip flop is used to send a discharge signal to the staircase generator to discharge the capacitor. The flip flop is weird as a toggle flip flop. The flip flop is set by the falling of the number seven output of the decoder and

resets by the falling edge of the number eight output of the decoder.

5. Horizontal sweep system

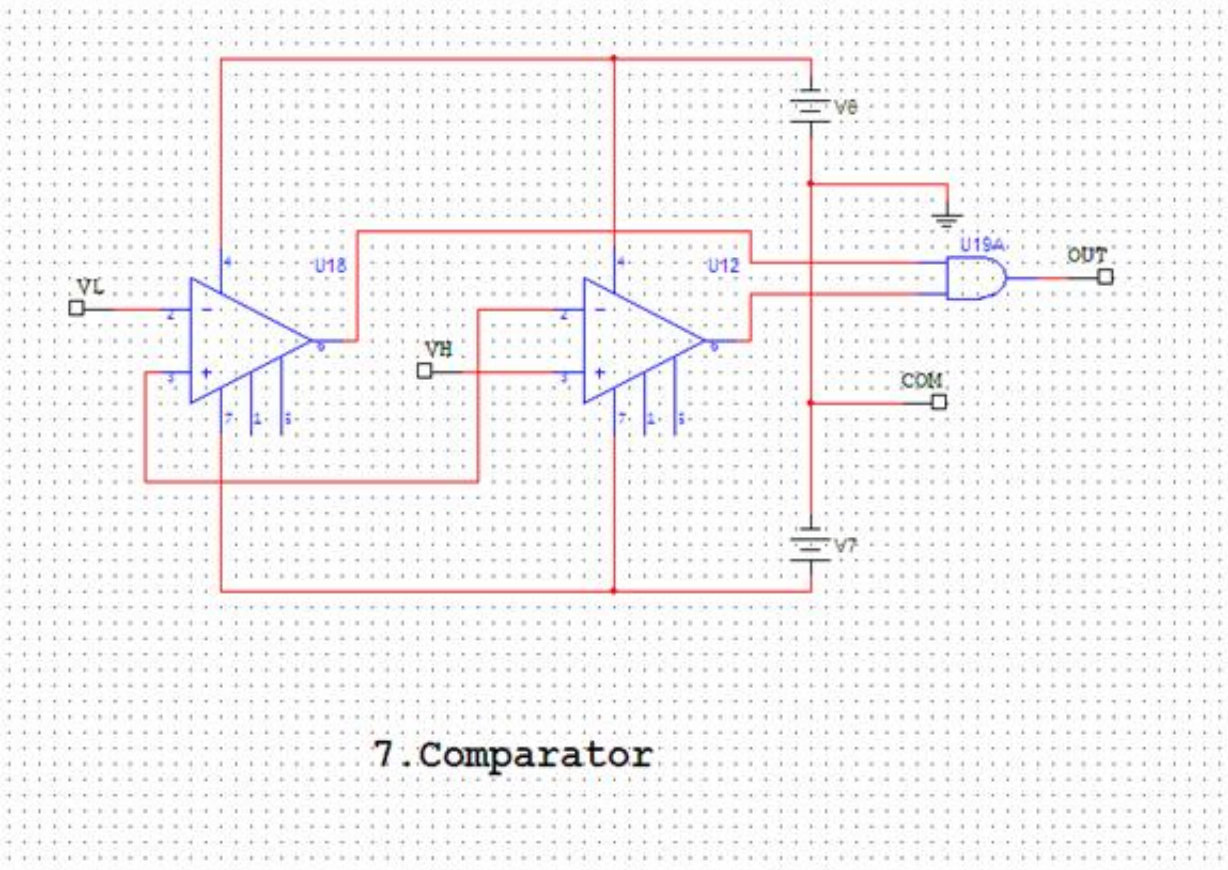


6.Horizontal sweep system

The horizontal sweep system is same as the vertical one as it incorporates a 3-Bit counter and 3-8 Decoder.

6. Comparator

The comparator used here is a window comparator which outputs a one whenever the input is within the band between The low and upper threshold

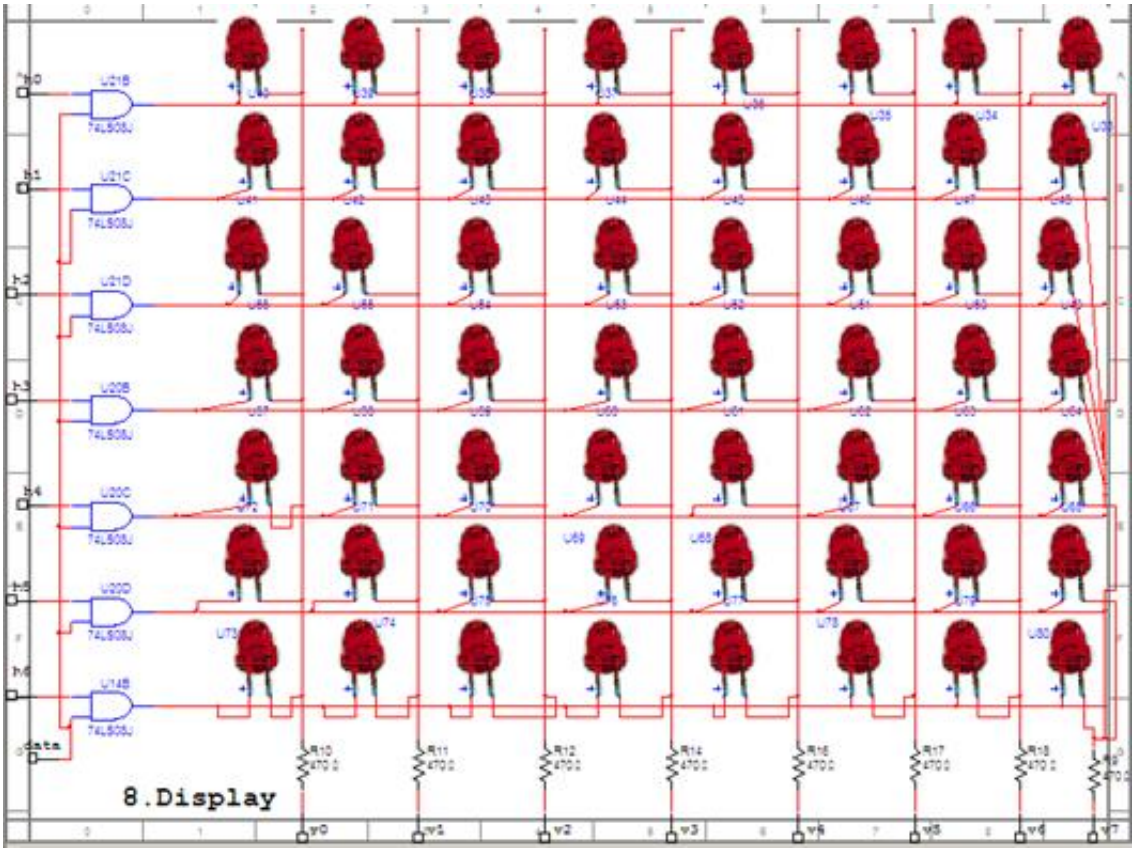


7.Comparator

The two basic opamp comparators are wired differently so that the lower comparator outputs one when the input is greater than Vl. The upper comparator outputs one whenever the input is less than Vh. These two outputs are ANDed together so that the resulting arrangement outputs one only when the input is between the specified band. The speed of the comparator Depends upon the speed of the active device used. The speed of the comparator is the main factor determining the range of the oscilloscope.

7. Display

The display used is a matrix of L.E.D.s. The Outputs of the horizontal Display system is connected to the cathode for the common cathode of the column L.E.D.s. The outputs of the vertical sweep system are inverted and ANDed together the data from the comparator to the common anode of the row L.E.D.s through a current limiting resistor.



8. Power

The circuit is powered by a dual 9 volt supply and a single positive 5 volt for the digital circuitry. The dual supply is formed by a full wave rectifier and two 7809 regulators and crisscrossing them. A 7805 regulator is used to produce the 5 volt positive supply. The various variable voltages required for controls are produced by potentiometers and buffers.

9. Conclusion

The whole circuit when wired together produces the Dot Matrix Oscilloscope. The resolution of the dot matrix can be further increased by simply varying the number of bits in the counter and the corresponding decoder. This decreases the speed of the system and hence the range but the problem can be decreased by increasing the number of

comparators i.e. increasing the complexity of the system.