

# Design and Implementation of Window Comparator Circuit Using Operational Amplifier

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**Abstract:** The output only turns on when the input voltage is within two reference voltages called the 'window', circuit which produce window by comparing input voltage with reference voltages is window comparator. In this paper opamp is used as comparator and window comparator is designed by using two opamp and voltage divider concept is used to produce lower and upper reference voltages. Window comparator design with high CMRR and SNRR. Circuit which produce high throughput with less offset problems. Output of the circuit have different number of windows depending on supply voltage

**Key Words:** Comparator, opamp, window comparator.

## 1. INTRODUCTION:

A comparator finds its importance in any circuits, by that two voltage inputs are to be compared and to be prominent on which is stronger. The device that consists of two input terminals, in which reference input signal is fed to one terminal and the actual signal value is fed to another terminal. Output signal or value is produced at the output terminal based on the difference between the two input signals applied to the two input terminals. This output signal is either low or high. The comparators having high-gain differential amplifiers and we can use opamp as comparator circuit.

## 2. OPAMP COMPARATOR:

Opamp can be defined as DC coupled electronic voltage amplifier with high gain, which consists of two input terminals. The differential input is fed to the two input terminals named as inverting input terminal and non-inverting input terminal of the op amp and it produces a single output. Thus, potential difference of two input terminals is amplified and gives an amplified output. 741 operational amplifiers are basic operational amplifiers that can be used as a comparator circuit in electronics related circuits shown in figure 1.

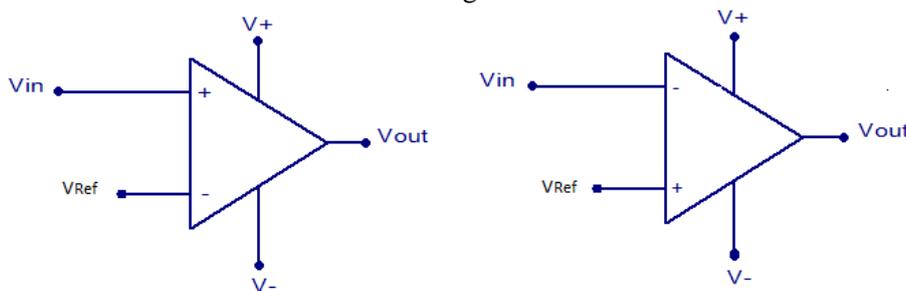


Figure 1: Noninverting and Inverting opamp comparators

Opamp output fluctuates positive and negative voltage that is approximately equal to the supply capacities. Any op-amp operates mainly on analog input signals. The opamp comparator compares one analogue voltage level with another analogue voltage level, or some preset reference voltage ( $V_{REF}$ ) and produces an output signal based on this voltage comparison. The op-amp voltage comparator compares the magnitudes of two inputs voltage and determines which is the main of the two. Voltage comparators either use positive feedback or no feedback at all to switch its output between two saturated states.

## 3. WINDOW COMPARATOR:

A window comparator circuit that works within a certain frame or window of voltage. When the voltage rises above a certain level at the inverting terminal, the output turns on. Any voltage above the reference level retains the output on. In window comparator circuit, if the voltage rises above a certain level called the  $V_{REF-LOW}$  level, it turns on but if it rises above the  $V_{REF-HIGH}$  level, it turns off. So, the output is only on for voltages in between the low and high

reference voltage levels. This is a window comparator, because the output only turns on when the input voltage is within this window of voltage.

Some of the major advantage of the circuit which rises the quality of window comparator like circuit switches at a good speed between the saturation levels. The comparator circuit have a high voltage gain that results in the requirement of reduced hysteresis voltage. The common mode input voltage parameters like noise is rejected with high CMRR. A small amount of Input Offset Current and Input Offset Voltage origins a lesser amount of offset problems.

A Window Comparator is essentially the inverting and the non-inverting comparators combined into a single comparator stage. The window comparator detects input voltage levels that are within a specific band or window of voltages, instead of indicating whether a voltage is greater or less than some preset or fixed voltage reference point.

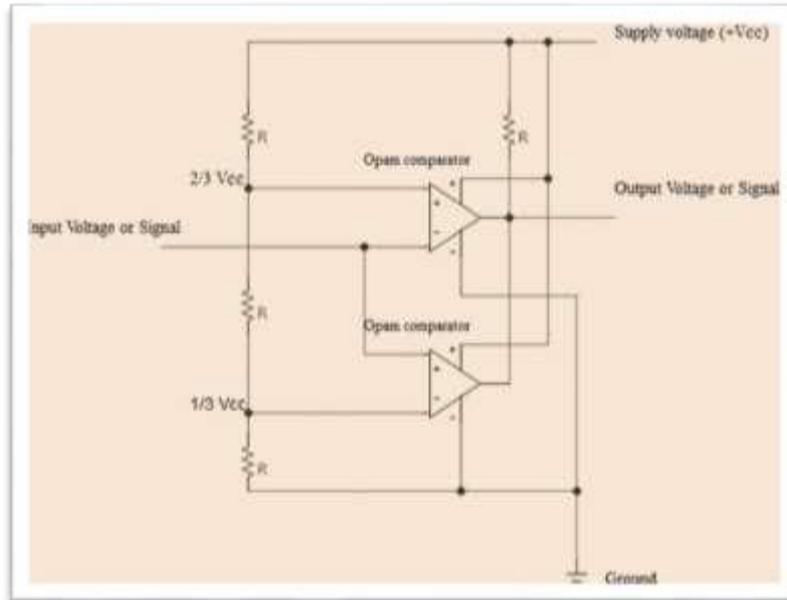


Figure 2: Window comparator circuit using 741 opamp

Instead of having just one reference voltage, window comparator has two reference voltages implemented by a pair of voltage comparators. One which triggers an op-amp comparator on detection of some upper voltage threshold,  $V_{REF-HIGH}$  and one which triggers an op-amp comparator on detection of a lower voltage threshold level,  $V_{REF-LOW}$ . Then the voltage levels between these two upper and lower reference voltages is called the 'window'. In order to generate a window comparator circuit, 2 comparators are required. Using a voltage divider network, use three equal value resistors  $R$  we can create a very simple window comparator circuit. The resistive values are all equal, the voltage drops across each resistor will also be equal at one-third the supply voltage  $\frac{1}{3}V_{cc}$ . The upper reference voltage becomes  $\frac{2}{3}V_{cc}$  and the lower reference voltage becomes  $\frac{1}{3}V_{cc}$ . If the reference voltages are derived from the same resistor-divider string, hysteresis can't be added without having the trip levels interact. The reference voltages are independently derived then they can drift in different directions. This sources the window to widen or disappear. The figure 2 shows the window comparator design using opamp. When input voltage is below the lower voltage level  $\frac{1}{3}V_{cc}$ , the output will be LOW. When input voltage exceeds this  $\frac{1}{3}V_{cc}$  lower voltage level, the first op-amp comparator detects this and switches the output HIGH to  $V_{cc}$ . As input voltage continues to increase it passes the upper voltage level  $\frac{2}{3}V_{cc}$  and the second op-amp comparator detects this and switches the output back LOW. Then the difference between  $\frac{2}{3}V_{cc}$  and  $\frac{1}{3}V_{cc}$  creates the switching window for the positive going signal. As input voltage decreases it passes the upper voltage level of the second op-amp comparator which switches the output HIGH. As input voltage continues to decrease it passes the lower voltage level of the first op-amp comparator once again switching the output LOW.

Then the difference between  $V_{REF-HIGH}$  and  $V_{REF-LOW}$  creates the window for the negative going signal. If we used a dual power supply and set the upper and lower trip levels to say  $\pm 5$  volts and input voltage of sinusoidal waveform, then we use this window comparator circuit as a zero crossing detector of the sinusoidal wave which produce an output, HIGH or LOW every time the sine wave crossed the zero volts line from positive to negative or negative to positive. Each single comparator detects the common input voltage with one of two reference voltages, generally upper and lower limits.

#### 4. RESULT:

The window comparator circuit is designed practically with +5V supply voltage by considering same value of resistors in voltage divider network. This circuit which produces two window and one window at the output depending upon the supply voltage given to the circuit. The figure 3 shows window comparator circuit output which is observed in CRO. The input can be considered as sine wave or triangular wave for the proper observation of window in the output. The figure shows the window produced for the circuit and that window is ON only between upper and lower threshold or reference values.

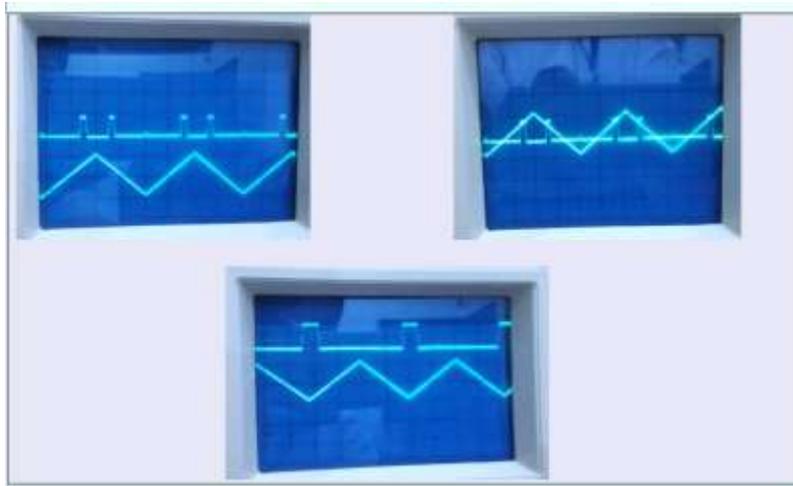


Figure 3: Output of window comparator circuit observed in CRO

#### 5. CONCLUSION:

The design of window comparator circuit is practically successful with proper window at the output by considering triangular wave as a input. Circuit which gives noise free output with high throughput and CMRR. window comparator can be designed with different opamp or with different design which finally needs proper window concept at the output.

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