Experiment No. 11

COMPARATOR AND SCHMITT TRIGGER CIRCUIT USING OP-AMP

AIM

(i) Study of AC comparator circuit using op amp
(ii) Study of Schmitt trigger using op amp

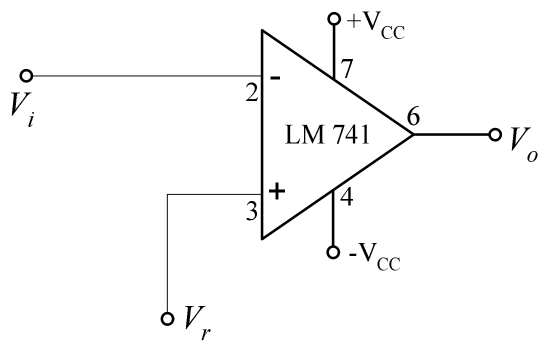
THEORY

Comparator

A voltage comparator is a two-input circuit that compares the voltage at one input to the voltage at the other input. Usually one input is a reference voltage and the other input a time varying signal. If the time varying input is below or above the reference voltage, then the comparator provides a low or high output accordingly (usually the plus or minus power supply voltages, since the op-amp is used in the open loop configuration, a small difference $(V_{+} - V_{-})$ makes the output to saturate). For the comparator circuit shown in Figure 1, the output will be at its negative saturation value when the input is greater than the reference and at its positive saturation value when the input is less than the reference. If V_r is zero, the comparator can be used as a zero-crossing detector. If V_r is not zero, the comparator can be referred to as a level detector. One problem encountered with the simple comparator is the instability of its output resulting from noise when the input is in the neighborhood of V_r. The Schmitt trigger provides a method for dealing with this problem.

Schmitt Trigger

Schmitt Trigger circuits are designed with feedback that provides hysteresis in the transfer characteristics. It is basically a comparator with +ve feedback. Figure 4 shows a typical Schmitt trigger circuit along with its transfer characteristic. As the input voltage increases it reaches a threshold voltage (the upper threshold point - UTP) at which the output voltage goes to negative saturation. As the input voltage decreases it reaches another threshold voltage (the lower threshold point - LTP) at which the output voltage goes to positive saturation. With the voltage difference between UTP and LTP larger than the noise, the output remains stable (ie avoids noise triggered oscillation around V_r).



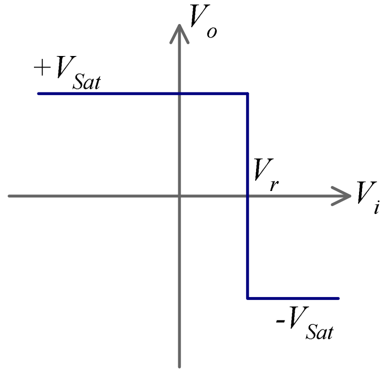


Fig 1: Comparator circuit and transfer characteristics

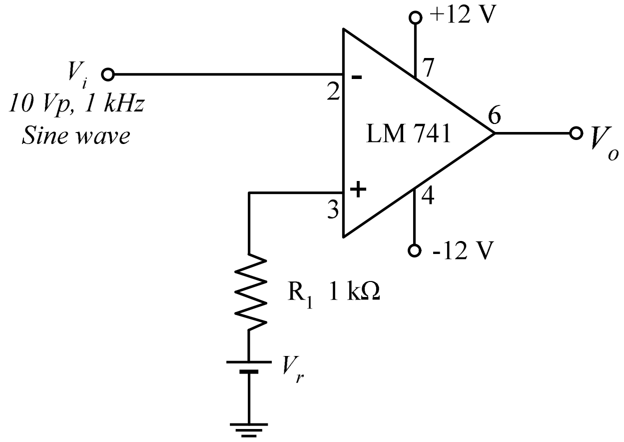


Fig 2. Circuit diagram of comparator

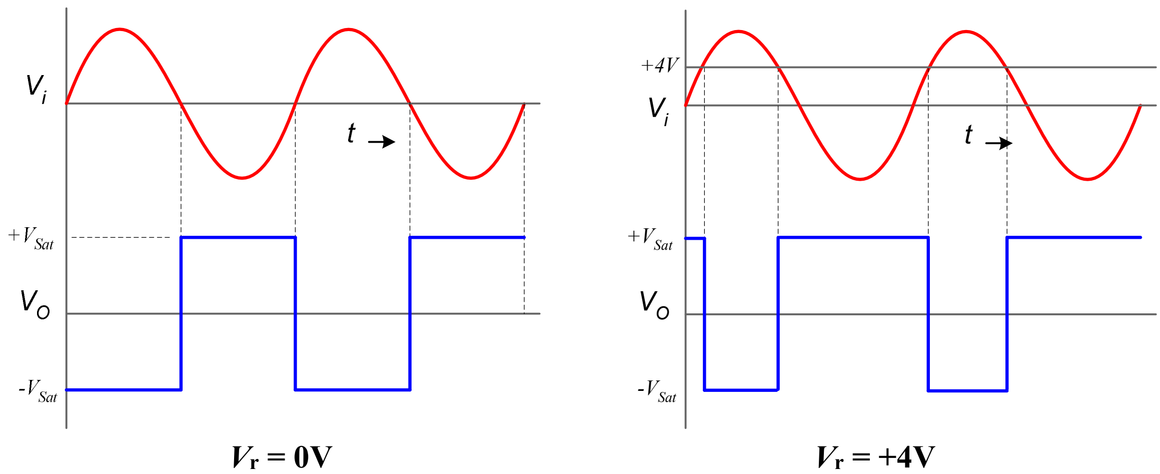


Fig 3. Waveforms comparator

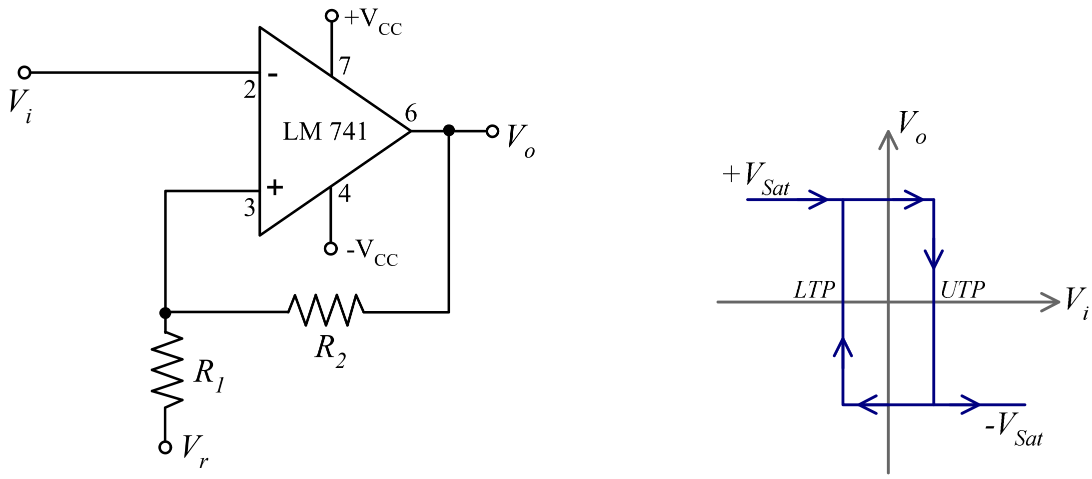


Fig 4: Schmitt trigger and transfer characteristics

SCHMITT TRIGGER DESIGN

Choose LTP = 2V & UTP = 3V. Use a reference voltage source V_r to make polarity of LTP & UTP same (For LTP & UTP with opposite polarity there is no need of V_r).

V_{sat} = 10 V and therefore $V_{out} = \pm 10$ V

Use superposition theorem to create the following equations:

$$UTP = 3 = \frac{+V_{sat}\,R_1}{R_1 + R_2} + \frac{V_r\,R_2}{R_1 + R_2}$$

$$LTP = 2 = \frac{-V_{sat}\,R_1}{R_1 + R_2} + \frac{V_r\,R_2}{R_1 + R_2}$$

Choose R_2 = 22 kΩ and solve the above equations for R_1 and V_r, we get

R_1= 1.15 kΩ Choose standard value of 1.2 kΩ

V_r = 2.6 V

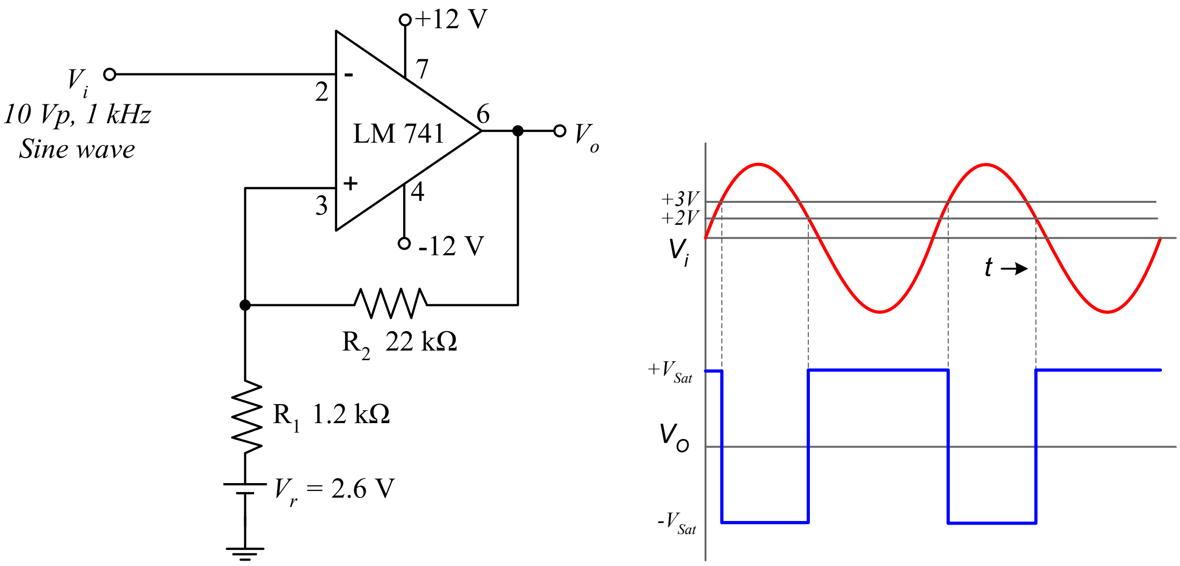


Fig 5. Circuit diagram of Schmitt trigger circuit and waveforms

PROCEDURE

1. Set up circuit as shown in the connection diagram
2. Set the input voltage 20 V peak to peak, 1 kHz in function generator, and apply input signal to the circuit.
3. Observe the output waveform in CRO.
4. Obtain the response for different V_r (for comparator circuit only).

RESULT

AC Comparator and Schmitt trigger circuits were designed and set up. And the output waveform is observed on CRO.