2.7 SCHMITT TRIGGER: [SQUARE CIRCUIT]

This circuit converts an irregular shaped waveform to a square wave or pulse. The circuit is known as Schmitt Trigger or squaring circuit. The input voltage V_{in} triggers (changes the state of) the o/p V_0 every time it exceeds certain voltage levels called the upper threshold V_{UT} and lower threshold voltage.

These threshold voltages are obtained by using the voltage divider $R_1 – R_2$, where the voltage across R_1 is feedback to the (+) input. The voltage across $R_1$is variable reference threshold voltage that depends on the value of the output voltage. When $V_0 = +V_{sat}$, the voltage across R1 is called upper threshold voltage V_{UT}.Figure 2.7.1 shown below is the circuit diagram for Schmitt Trigger.

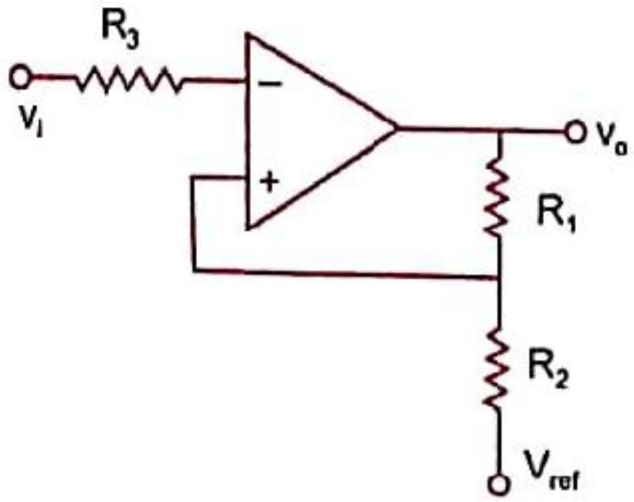

Figure 2.7.1Schmitt Trigger circuit

[source:“Linear Integrated Circuits”by D.Roy Choudhry, Shail Bala Jain, Page-237]

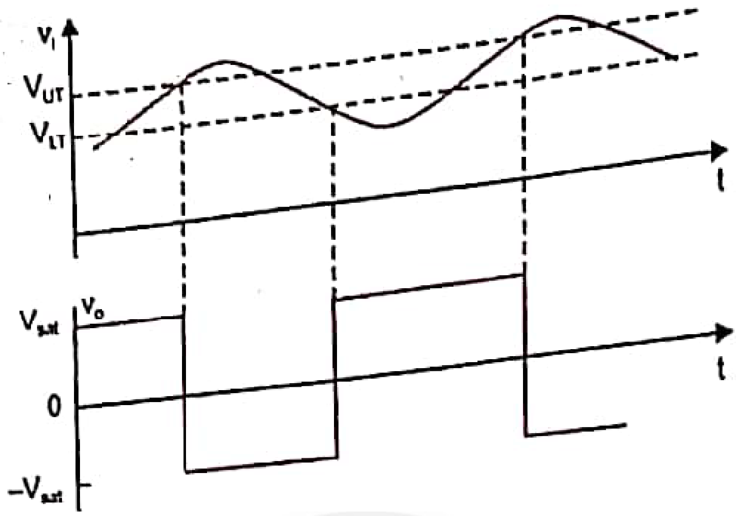

Figure 2.7.2 Schmitt Trigger used as Squarer

[source:"Linear Integrated Circuits"by D.Roy Choudhry, Shail Bala Jain, Page-238]

Figure 2.7.2 shown above is the waveform of Schmitt Trigger as squarer.When $V_0 = +V_{sat}$, the voltage across R_1 is called upper threshold voltage V_{UT}.

$$V_{UT} = \frac{V_{ref}\ R_1}{R_1+R_2} + \frac{R_2 V_{sat}}{R_1+R_2}$$

- As long as $V_i < V_{UT}$, the output remains constant at $+V_{sat}$.
- When $V_i > V_{UT}$, the o/p regeneratively switches to $-V_{sat}$.
- When $V_0 = -V_{sat}$, the voltage across R_1 is called lower threshold voltage V_{LT}.

$$V_{LT} = \frac{V_{ref}\ R_1}{R_1+R_2} - \frac{R_2 V_{sat}}{R_1+R_2}$$

- The difference between the two threshold voltages are called hysteresis width .

$$V_H = V_{UT} - V_{LT}$$

$$V_H = \frac{2R_2 V_{sat}}{R_1+R_2}$$

- If V_{ref} is chosen as zero ,then

$$V_{UT} = -V_{LT} = \frac{2R_2V_{sat}}{R_1+R_2}$$

If the threshold voltages V_{UT} and V_{LT} are made larger than the input noise voltages, the positive feedback will eliminate the false o/p transitions.Also the positive feedback, because of its regenerative action, will make V_0 switch faster between $+V_{sat}$ and $–V_{sat}$.Resistance $R_{comp}=R_1 \parallel R_2$ is used to minimize the offset problems.

The comparator with positive feedback is said to exhibit hysteresis, a dead band condition. (i.e) when the input of the comparator exceeds V_{UT} its output switches from $+V_{sat}$ to $–V_{sat}$ and reverts to its original state, $+V_{sat}$ when the input goes below V_{LT}. The hysteresis voltage is equal to the difference between V_{UT} and V_{LT}. Therefore

$$V_H = V_{UT} – V_{LT}.$$

Figure 2.7.3 b),c) shows the transfer characteristics of V_i increasing and decreasing and Figure 2.7.3 d) Composite input-output curve.

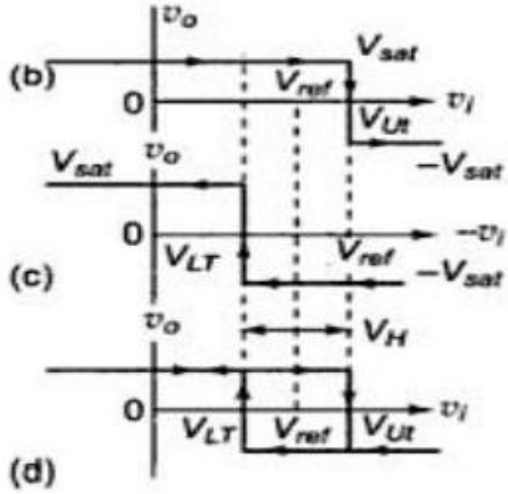

Figure 2.7.3(b,c). Transfer characteristics of Vi increasing & decreasing

Figure 2.7.3 d) composite i/p –o/p curve