6.)

Schmitt trigger

From fig ① it is an inverting comparator with positive feedback and is capable of converting any irregular shaped input into a square wave output fig ②.

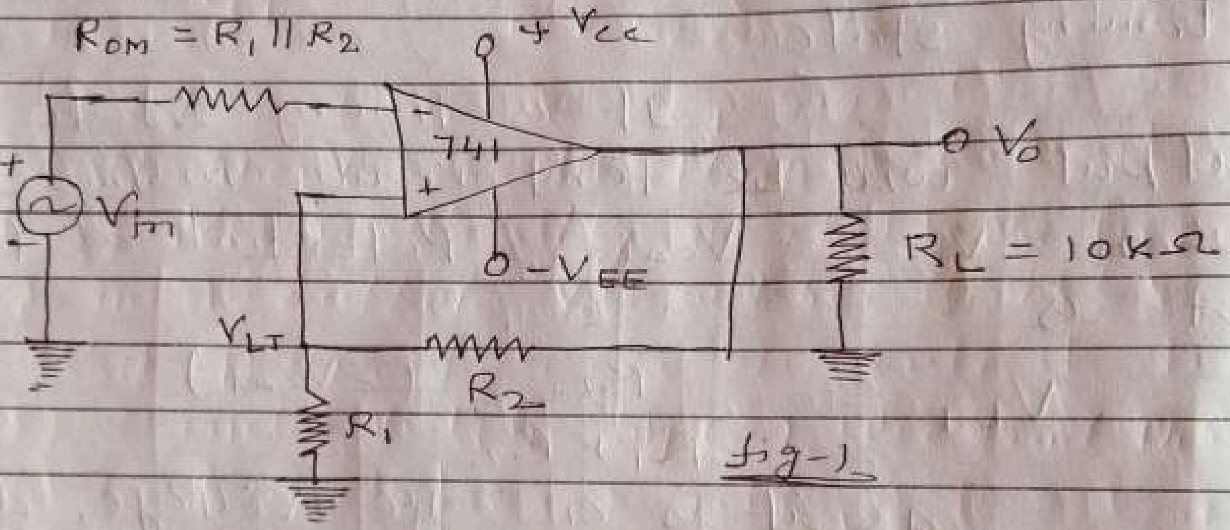


fig-1

Schmitt trigger, inverting comparator with positive feedback.

There will be two voltage levels - one will be called the upper threshold voltage, V_{UT} and the other as lower threshold voltage, V_{LT}. Every time the input voltage, V_{in}, will exceed these voltage levels, the output V_o will change the state and attain $\pm V_{sat}$ value. These threshold voltages are obtained by using a potential divider $R_1 - R_2$ network fig ①. The voltage across R_1 is feedback to the non-inverting input.

VKSU

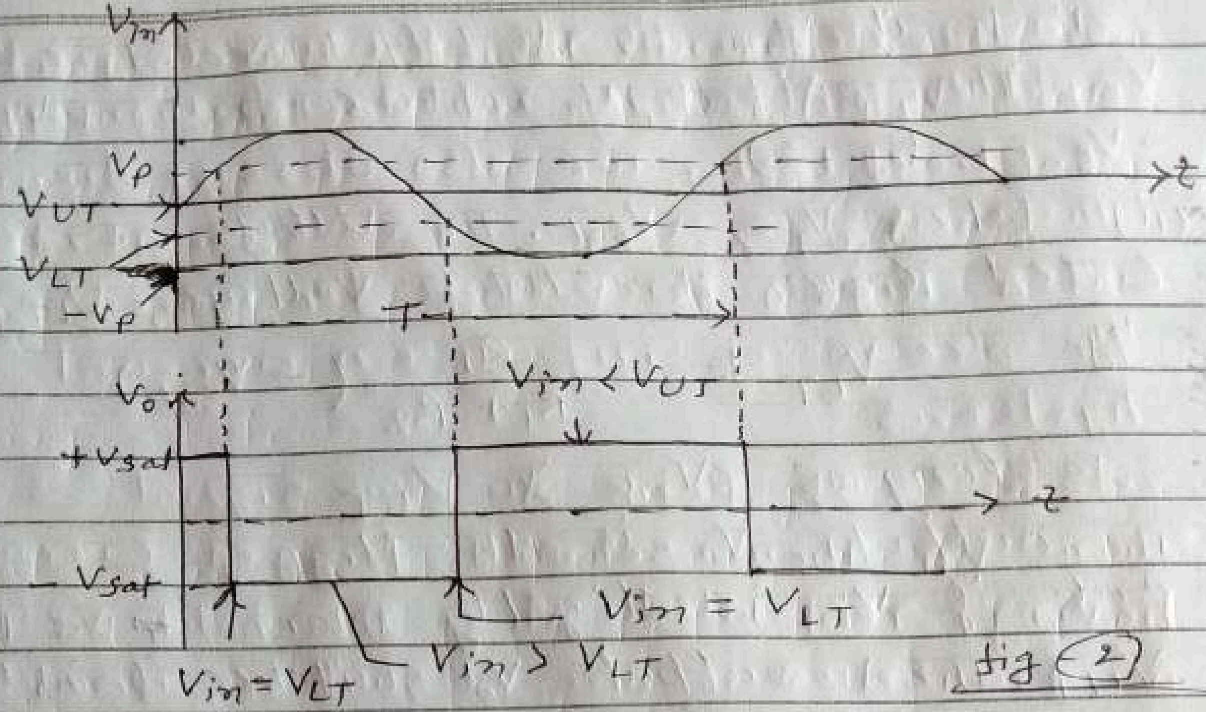


fig (2)

Input output waveforms. Note that if $R_1 = 100$ ohm $R_2 = 56K$ ohm and $V_{in} = 1$ Volt PP then $V_P = 0.5$ Volt, $V_{UT} = 25$ mV & $V_{LT} = 25$ mV.

The Voltage across R_1, which is fedback to the non-inverting terminal is a Variable reference ~~the~~ threshold Voltage that depends on the Value and Polarity of the output Voltage V_o.

(i) When $V_o = +V_{sat}$, the Voltage across R_1 is called upper threshold voltage, V_{UT}, given by

$$V_{UT} = \frac{R_1}{R_1 + R_2}(+V_{sat}) \quad \text{--- (1)}$$

As long as $V_{in} < V_{UT}$, output V_o is at $+V_{sat}$ }

But if V_{in} is slightly more +ve Than V_{UT} Then output, V_o Switches from $+V_{sat}$ to $-V_{sat}$. fig (2)

(ii) When $V_o = -V_{sat}$ The Voltage across R_1 is called lower Threshold Voltage, V_{LT}, given by

$$V_{LT} = \frac{R_1}{R_1 + R_2}(-V_{sat}) \quad \text{--- (2)}$$

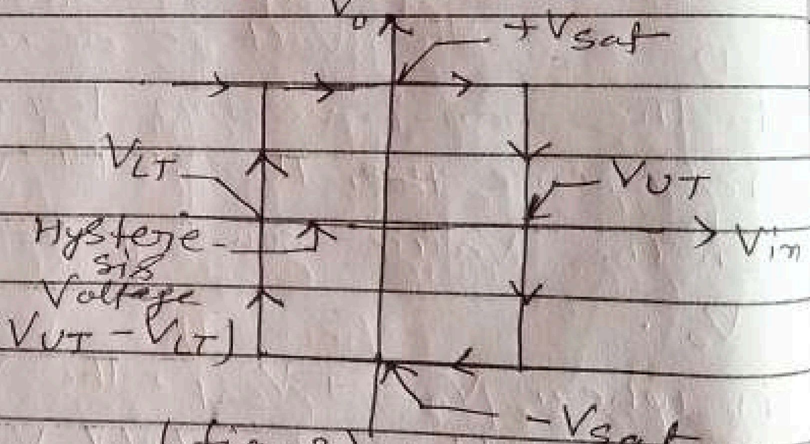
As long as $V_{in} > V_{LT}$ } output V_o is at $-V_{sat}$ }

But if V_{in} is slightly more -ve Than V_{LT} Then output V_o switches from $-V_{sat}$ to $+V_{sat}$ [fig-2]

Thus as indicated in fig (2), we find That

⇒ at $V_{in} = V_{UT}$, when input Voltage V_{in} is increasing, output Voltage V_o switches to $-V_{sat}$.

⇒ at $V_{in} = V_{LT}$, when input Voltage V_{in} is decreasing, output Voltage V_o Switches to $+V_{sat}$ — (3)



(fig-3)

V_o vs V_{in} Plot of The hysteresis Voltage

Whenever any Circuit changes from one state to a 2nd state at Some input Signal and Then reverts from the second to the first state at a different input signal, the Circuit is said to exhibit hysteresis.

There exists a hysteresis zone or a dead bad condition fig(3). When input of comparator exceeds V_{UT}, The output switches from $+V_{sat}$ to $-V_{sat}$ and Then reverts back to original state, $+V_{sat}$, when input goes below V_{LT}. The hysteresis Voltage is equal to the difference between V_{UT} and V_{LT}.

i.e. $$V_H = V_{UT} - V_{LT}$$

$$= \frac{R_1}{R_1 + R_2} \cdot [+V_{sat} - (-V_{sat})]$$

For OP-Amp 741, $+V_{sat}$ = 14 Volt, $-V_{sat}$ = −14 Volt. if $R_1 = 100\,\Omega$ and $R_2 = 56\,K\Omega$ with V_{in} = 1 volt Peak to Peak Sine wave in fig ①, Then

$$V_{UT} = \frac{100}{56100}(14) = 25\,mV$$

$$V_{LT} = \frac{100}{56100}(-14) = -25\,mV$$

So That hysteresis Voltage will be

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

$$= 25 - (-25) = 50\,mV$$

VKSU

So the different Threshold Voltages (V_{UT} and V_{LT}) at the input result in hysteresis or backlash. We also observe from fig (3) That $V_{UT} > V_{LT}$. i.e. circuit triggers at a higher Voltage for increasing Than for decreasing inputs on account of hysteresis.

If Peak to Peak Signal is Smaller Than V_H Then schmitt trigger circuit, having responded at a Threshold Voltage by a transition in one direction, would never reset itself, i.e. once the output has jumped to $+V_{sat}$, it would remain at This level and never returns to $-V_{sat}$.