2.5 VOLTAGE CONTROLLED OSCILLATOR

The timing capacitor c_T is linearly charged or discharged by a constant current source/sink.The amount of current can be controlled by changing the voltage v_c applied at the modulating input (pin 5) or by changing the timing resistor R_T external to the IC chip.The voltage at pin 6 is held at the same voltage as pin 5.Thus, if the modulating voltage at pin 5 is increased, the voltage at pin 6 also increases, resulting in less voltage across R_T and thereby decreasing the charging current. Pin configuration of VCo is shown in figure 3.5.1.

Figure 3.5.2 shown below is the block diagram of VCO.A small capacitor of 0.001µf should be connected between pin 5 & 6 to eliminate possible oscillations.A VCO is commonly used in converting low frequency signals such as EEG,ECG in to an audio frequency range.These audio signals can be transmitted over telephone lines or a two way radio communication system for diagnostic purposes or can be recorded on a magnetic tape for further references.

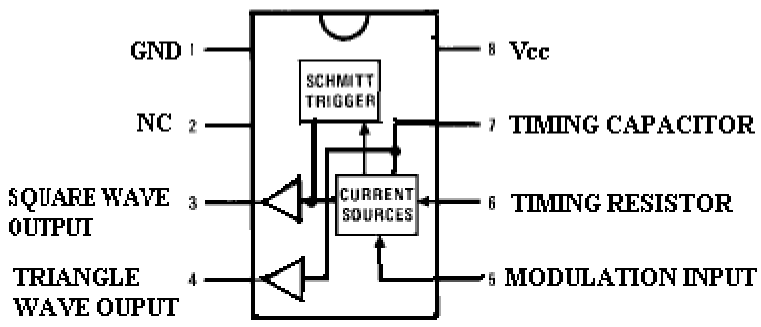

Figure 3.5.1.Pin configuration

[source: https://www.elprocus.com/voltage-controlled-oscillator-working-application/]

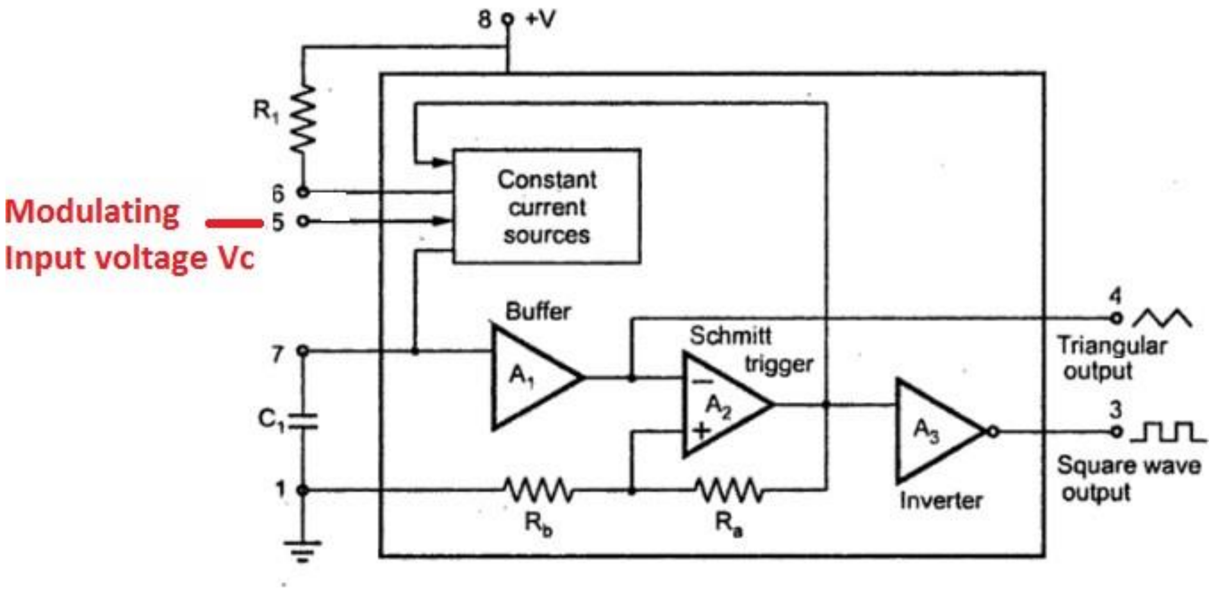

Figure 3.5.2 Voltage controlled oscillator Block diagram

[source: https://sthcphy.files.wordpress.com/2015/09/vco-566.pdf]

The voltage across the capacitor C_T is applied to the inverting i/p terminal of Schmitt trigger A_2 via buffer amplifier A_1 .The o/p voltage swing of the Schmitt trigger is designed to V_{cc} & 0.5 V_{cc} .If R_a=R_b in the +ive feedback loop, the voltage at the non-inverting i/p terminal of A_2 swings from 0.5V_{cc} to 0.25V_{cc}.Figure 3.5.3 a). when the voltage on the capacitor C_T exceeds 0.5V_{cc} during charging, the o/p of the Schmitt trigger goes low(0.5V_{cc})The capacitor now discharges & when it is at 0.25V_{cc}.The o/p of Schmitt trigger goes high(V_{cc}).Since the source & sink currents are equal, capacitor for the same amount of time.This gives a triangular voltage waveform across CT which is also available at pin 4.The square wave o/p of the Schmitt trigger is inverted by inverter A3 & is available at pin 3.The inverter A3 is basically a current amplifier used to drive the load.

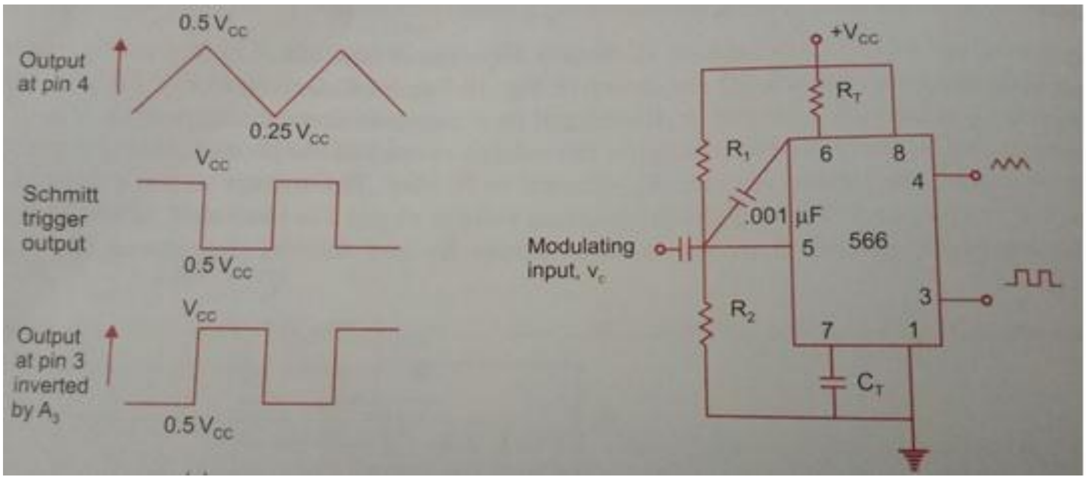

Figure 3.5.3 a)output waveform b)Typical connection diagram

[source:"Linear Integrated Circuits"by D.Roy Choudhry, Shail Bala Jain, Page-386]

The total voltage on the capacitor changes from $0.25V_{cc}$ to $0.5V_{cc}$.Thus $\Delta v=0.25V_{cc}$ The capacitor charges with a constant current source.

$$\frac{\Delta v}{\Delta t}=\frac{i}{C_T}$$

$$\frac{0.25V_{cc}}{\Delta t}=\frac{i}{C_T}$$

$$\Delta t=\frac{0.25V_{cc}C_T}{i}$$

The time period T of the triangular waveform =2Δt.The freq of oscillator f_o is

$$f_o=\frac{1}{T}=\frac{1}{2\Delta t}=\frac{i}{.5V_{cc}C_T}$$

$$But\ i=\frac{V_{cc}-V_c}{R_T}$$

$$Where\ V_c \rightarrow Voltage\ at\ pin\ 5$$

$$f_o=\frac{2(V_{cc}-V_c)}{C_T R_T V_{cc}}----(1)$$

The o/p freq of VCO can be changed either by (i)R_T (ii)C_T or (iii) the voltage V_c at the modulating i/p terminal pin 5. The voltage vc can be varied by connecting a R_1R_2 circuit as shown in the figure 3.5.3 b). The components R1 and c1 are first selected so that VCO output frequency lies in the centre of the operating frequency range. Now the modulating input voltage is usually varied from 0.75 V_{cc} to Vcc which can produce a frequency variation of about 10 to 1.

The signetics NE/SE 560 series is monolithic phase locked loops. The SE/NE 560, 561, 562, 564, 565 & 567 differ mainly in operating frequency range, poser supply requirements & frequency & bandwidth adjustment ranges.

With no modulating i/p signal .if the voltage at pin 5 is biased at $\frac{7}{8}V_{cc}$ (1) gives the VCO o/p frequency

$$f_o = \frac{2(V_{cc} - {}^7/_8 V_{cc})}{C_T R_T V_{CC}} = \frac{1}{4R_T C_T} = \frac{0.25}{R_T C_T} --- (2)$$

VOLTAGE TO FREQUENCY CONVERSION FACTOR

Voltage to frequency conversion factor K_v & is defined as

$$K_v = \frac{\Delta f_o}{\Delta C}$$

$$\Delta V_c \rightarrow modulation\ voltage\ required\ to\ produce\ the\ frequency\ shift\ \Delta f_o\ for\ a\ VCO$$

Original frequency is f_o & the new frequency is f_1 then

$$\Delta f_o = f_1 - f_o$$

$$= \frac{2(V_{cc} - V_c + \Delta V_c)}{C_T R_T V_{cc}} - \frac{2(V_{cc} - V_C)}{C_T R_T V_{cc}}$$

$$= \frac{2\Delta V_c}{C_T R_T V_{cc}}$$

$$\Delta V_c = \Delta f_o \frac{CTRTVcc\Delta fo}{2} \text{-----(3)}$$

From (2)

$$f_o = \frac{0.25}{R_T C_T}$$

$$R_T C_T = \frac{0.25}{f_o}$$

$$\Delta V_c = \Delta f_o \frac{V_{cc}}{8f_o}$$

$$K_v = \frac{\Delta f_o}{\Delta V_c} = \frac{8f_o}{V_{cc}}$$