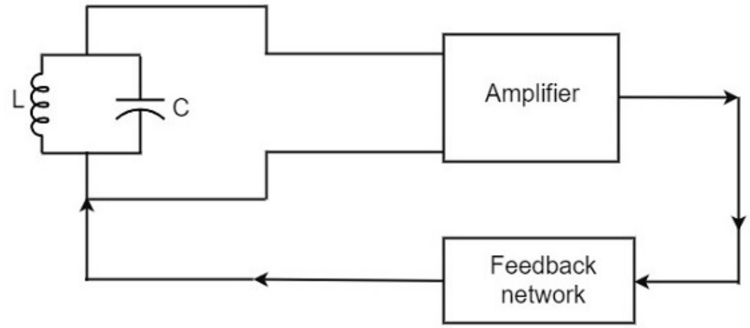
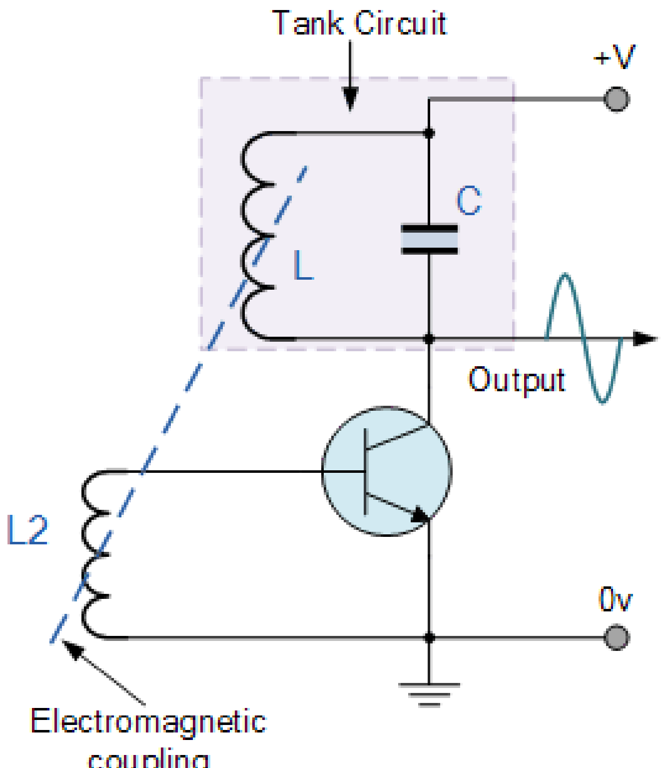
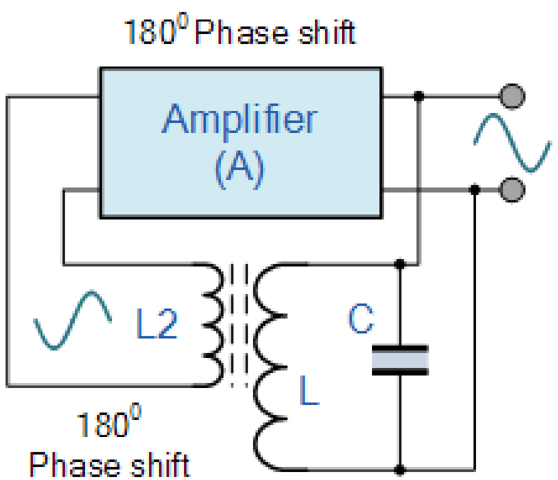
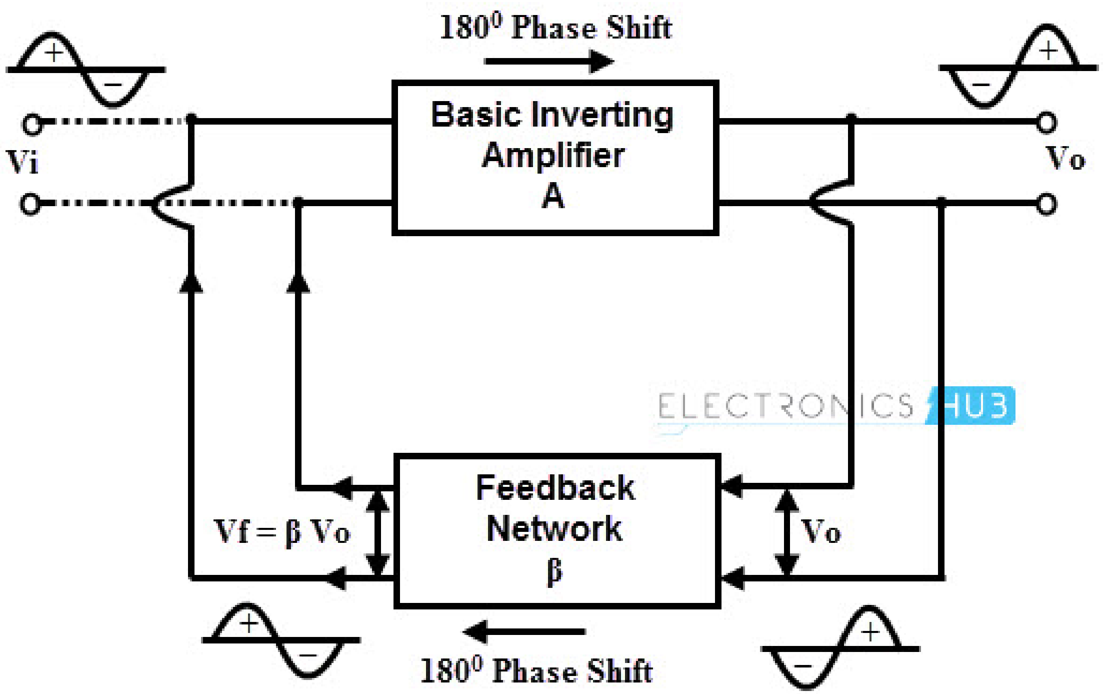
Oscillators

Practical Oscillator Circuit

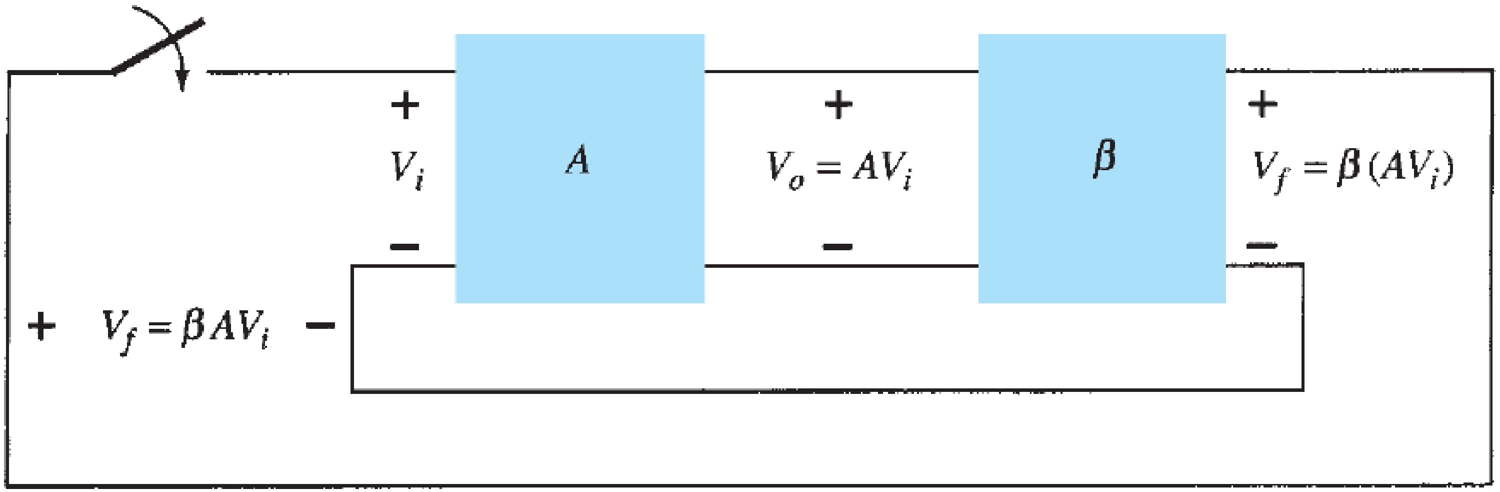








Oscillators are nothing but the amplifier circuits which are provided with a positive or regenerative feedback wherein a part of the output signal is fed back to the input. Here the amplifier consists of an amplifying active element which can be a transistor or an Op-Amp and the back-fed in-phase signal is held responsible to keep-up (sustain) the oscillations by making-up for the losses in the circuit.

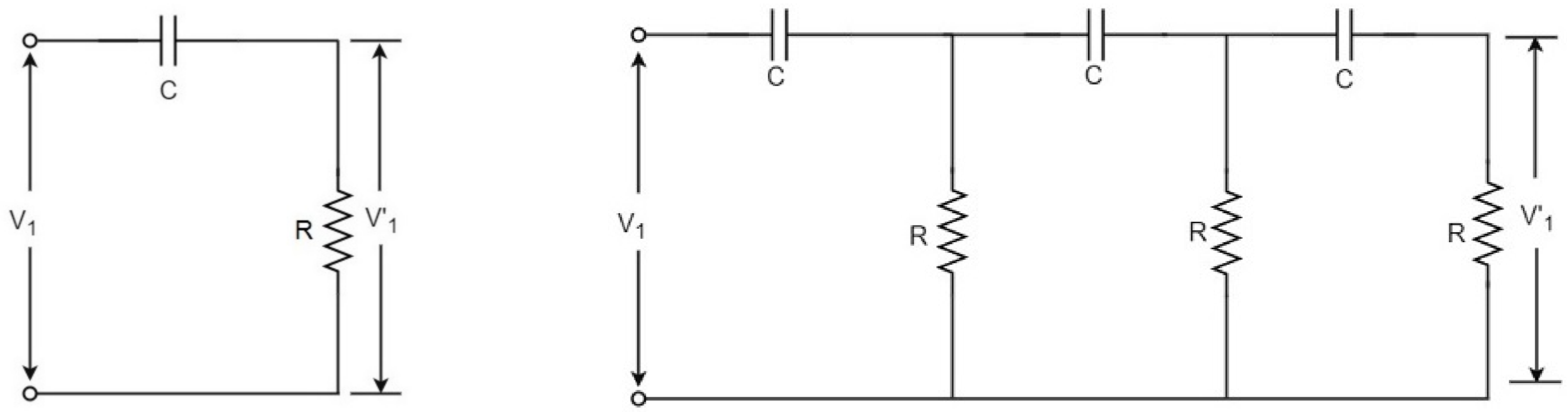


When the switch at the amplifier input is open, no oscillation occurs. Consider that we have a *fictitious* voltage at the amplifier input V_i . This results in an output voltage $V_o = AV_i$ after the amplifier stage and in a voltage $V_f = \beta(AV_i)$ after the feedback stage. Thus, we have a feedback voltage $V_f = \beta AV_i$, where βA is referred to as the *loop gain.*

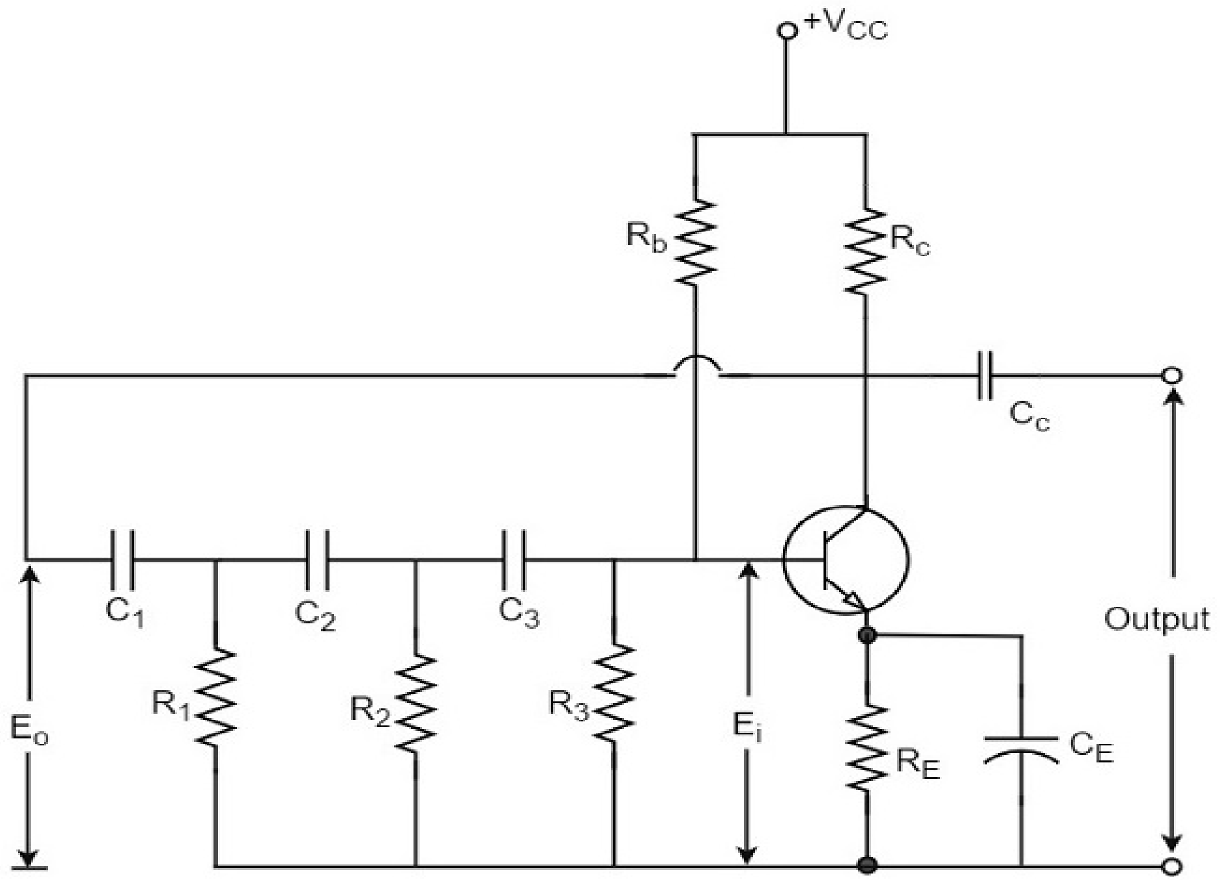
The output waveform will still exist after the switch is closed if the condition $\beta A = 1$ is met. This is known as the B*arkhausen criterion* for oscillation.

R-C or Phase shift Oscillator

We know that the output voltage of an RC circuit for a sinewave input leads the input voltage. The phase angle by which it leads is determined by the value of RC components used in the circuit.

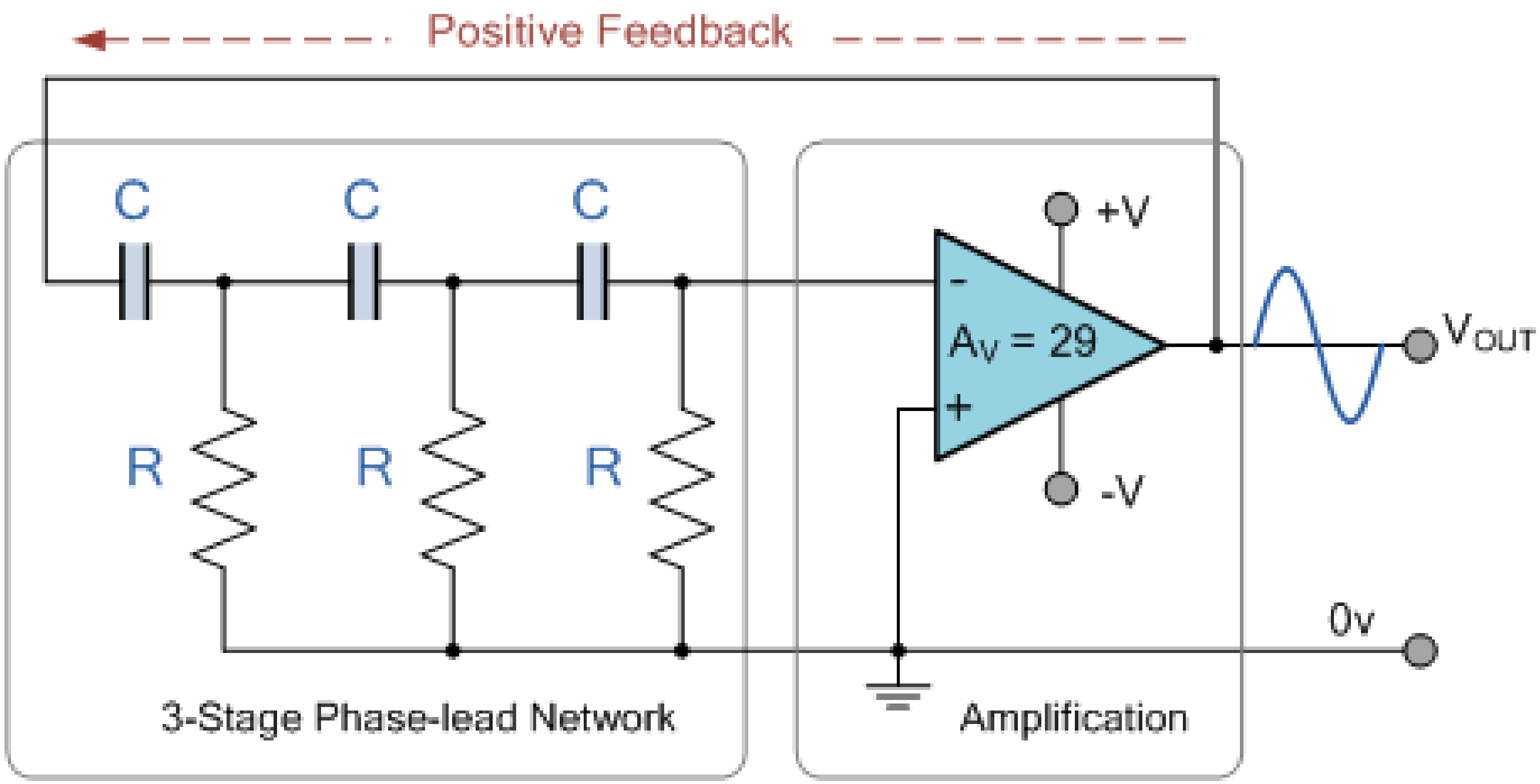


The output voltage V_1' across the resistor R leads the input voltage applied input V_1 by some phase angle ϕ^o. If R were reduced to zero, V_1' will lead the V_1 by 90^o i.e., $\phi^o = 90^o$. However, adjusting R to zero would be impracticable, because it would lead to no voltage across R. Therefore, in practice, R is varied to such a value that makes V_1' to lead V_1 by 60^o. So the right side figure will produce total phase shift of 180^0.

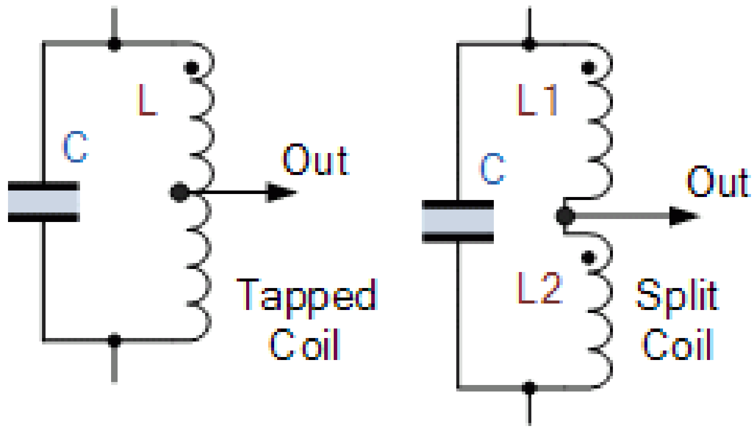


If the three resistors, R are equal in value, that is $R_1 = R_2 = R_3$, and the capacitors, C in the phase shift network are also equal in value, $C_1 = C_2 = C_3$, then the frequency of oscillations produced by the RC oscillator is simply given as:

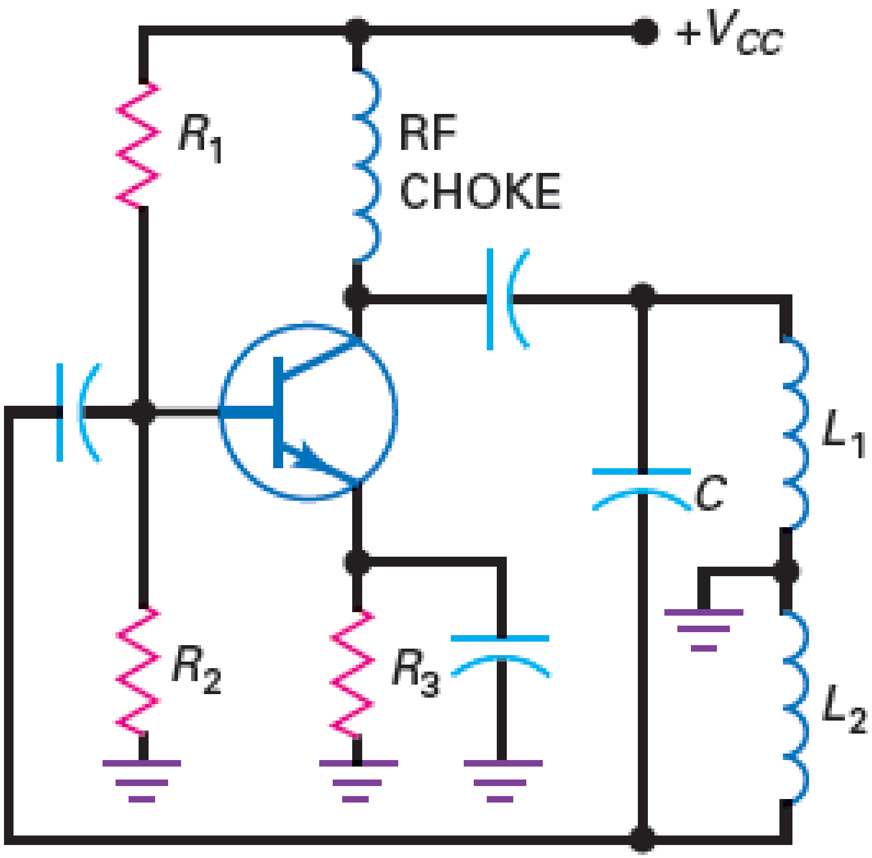
Op-amp Phase-lead RC Oscillator Circuit



Hartley Oscillator

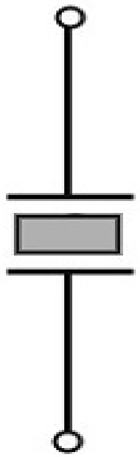


The Hartley Oscillator design uses two inductive coils in series with a parallel capacitor to form its resonance tank circuit producing sinusoidal oscillations and typically tuned to produce RF waves. The tuned LC circuit is connected between the collector and the base of a transistor amplifier. As far as the oscillatory voltage is concerned, the emitter is connected to a tapping point on the tuned circuit coil. The feedback part of the tuned LC tank circuit is taken from the center tap of the inductor coil or even two separate coils in series which are in parallel with a variable capacitor.

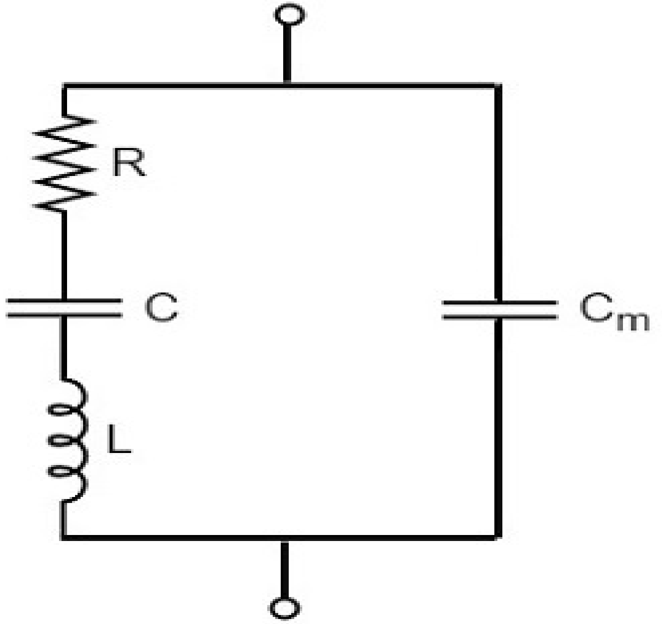

+VCC
R1
RF
CHOKE
L1
C
R2
R3
L2

Crystal Oscillators

In RC and LC oscillators the values of resistance, capacitance and inductance vary with temperature and hence the frequency gets affected. In order to avoid this problem, the piezo electric crystals are being used in oscillators. When a piezo electric crystal is subjected to a proper alternating potential, it vibrates mechanically. The amplitude of mechanical vibrations becomes maximum when the frequency of alternating voltage is equal to the natural frequency of the crystal. Crystal Oscillators are used to improve the accuracy and stability of the oscillation frequency.

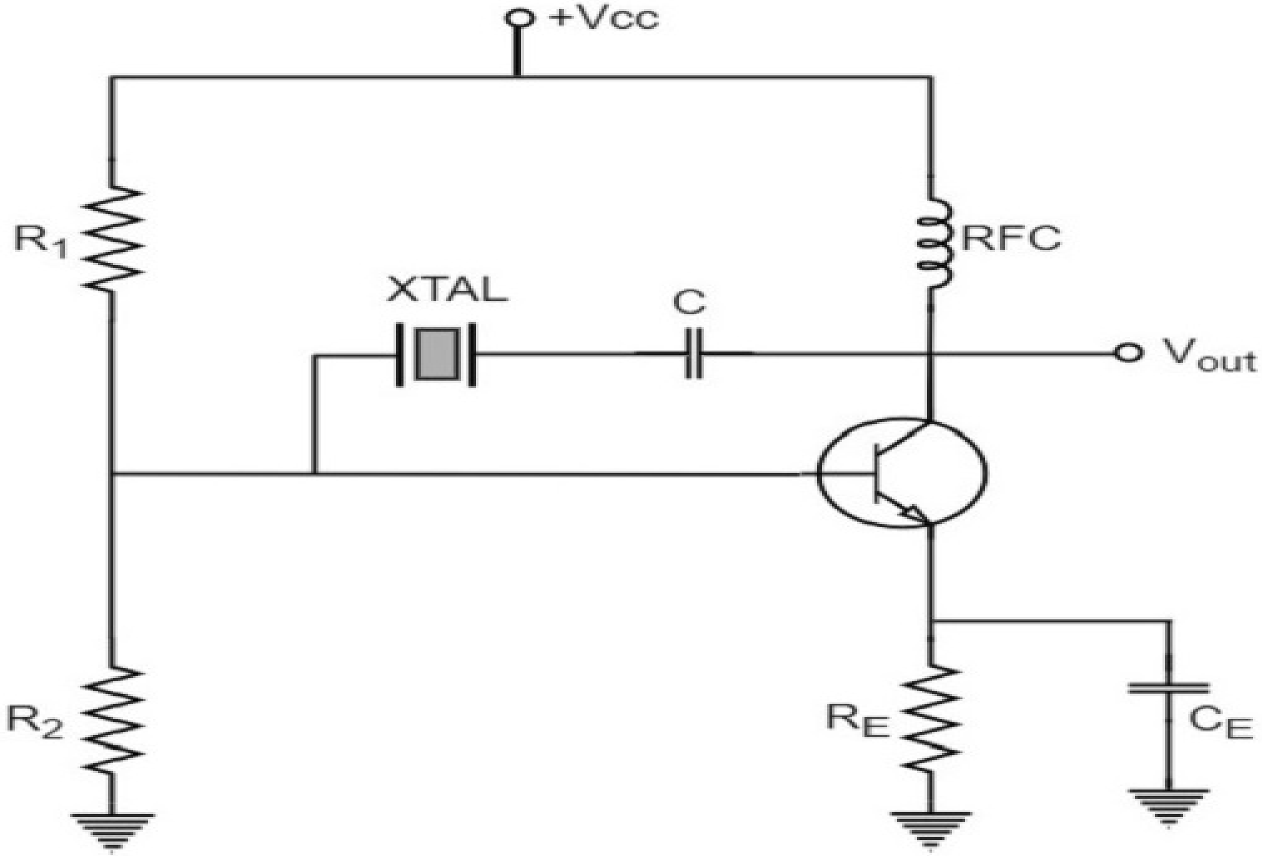


Symbol of a Crystal



Equivalent circuit of a crystal

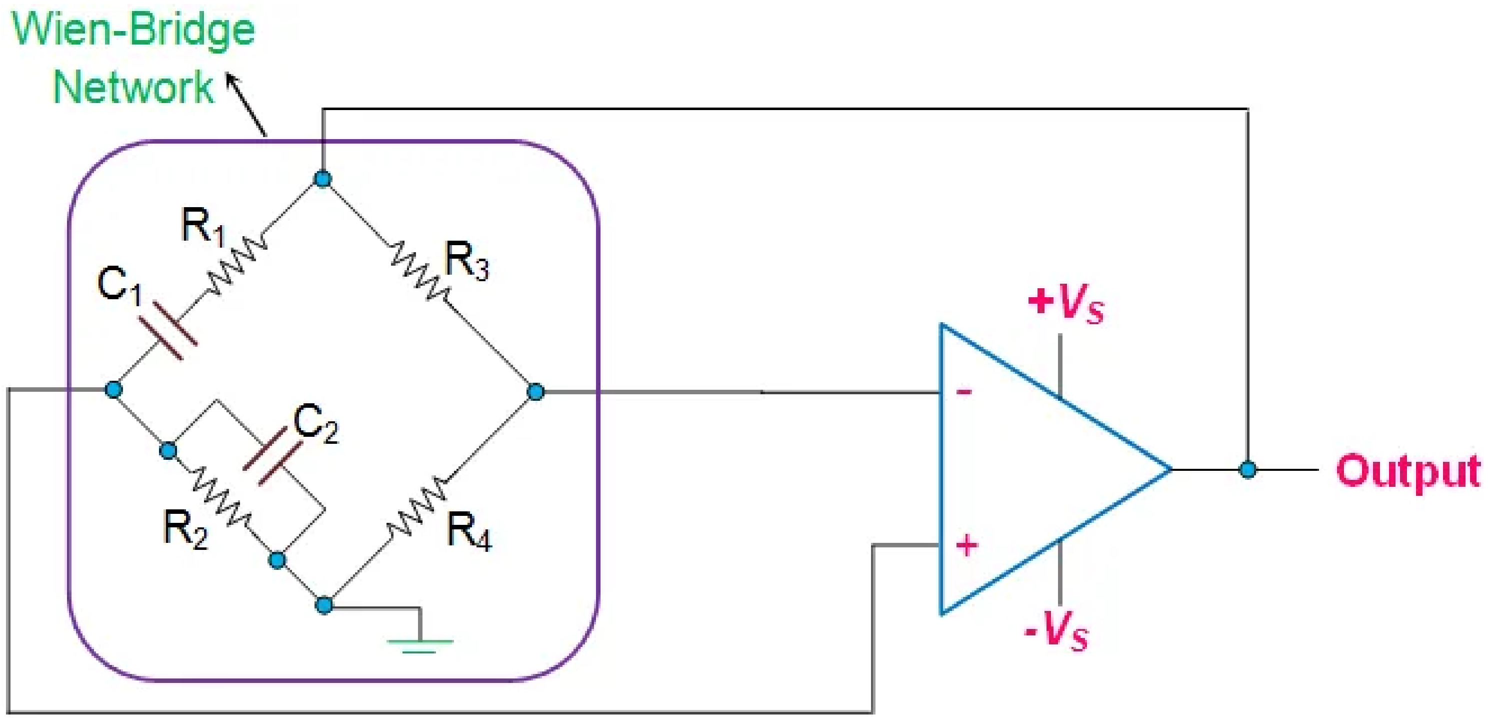
The above equivalent circuit consists of a series R-L-C circuit in parallel with a capacitance C_m. When the crystal mounted across the AC source is not vibrating, it is equivalent to the capacitance C_m. When the crystal vibrates, it acts like a tuned R-L-C circuit.



The crystal (XTAL) is connected as a series element in the feedback path from collector to the base. The crystal acts like a large inductor in series with a small capacitor. The circuit frequency of oscillation is set by the series resonant frequency of the crystal and its value is given by the relation,

$$f_o = \frac{1}{2\pi\sqrt{LC}}$$

Wien Bridge Oscillator



The Wien Bridge Oscillator is so called because the circuit is based on a frequency-selective form of the Wheatstone bridge circuit. Wien-Bridge networks are low frequency oscillators which are used to generate audio and sub-audio frequencies ranging between 20 Hz to 20 KHz.