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Colpitts Oscillator: Working and Applications

Electronic Oscillator:

- An electronic oscillator is an electronic circuit that produces a periodic, oscillating electronic signal, often a sine wave or a square wave.
- Oscillators convert direct current (DC) from a power supply to an alternating current signal. They are widely used in many electronic devices.
- Oscillators can be classified into different types generally based on their output frequency.

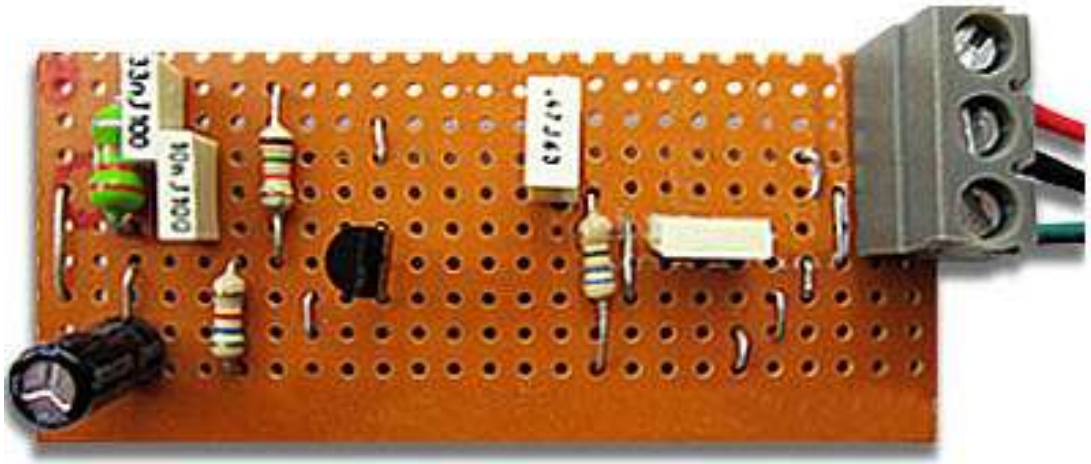
Introduction:

- Electronic oscillators can be termed as voltage controlled oscillators as their frequency of oscillations can be controlled by their input voltage.
- Foremost electronic voltage controlled oscillators can be considered as two types namely: Linear Oscillator and Nonlinear Oscillator.
- LC oscillators can be designed by using different methods. The well known LC oscillators are Hartley oscillator and Colpitts oscillator.
- Among these two, the frequently used design is Colpitts Oscillator designed by and named after an American Engineer Edwin H Colpitts in 1918.

Colpitts Oscillator :

- Oscillator is an amplifier with the positive feedback and it converts DC input signal into AC output waveform with certain variable frequency drive and certain shape of output waveform (like sine wave or square wave, etc) by using the positive feedback instead of input signal.

- Oscillators which utilizes the inductor L and capacitor C in their circuit are called as LC oscillator which is a type of linear oscillator.



Colpitts Oscillator Theory:

- It consists of a tank circuit which is an LC resonance sub circuit made of two series capacitors connected in parallel to an inductor and frequency of oscillations can be determined by using the values of these capacitors and inductor of the tank circuit.

- This oscillator is almost similar to Hartley oscillator.

- It is termed as electrical dual of Hartley oscillator and is designed for the generation of high frequency sinusoidal oscillations with the radio frequencies typically ranging from 10 KHz to 300MHz.

- The major difference between these two oscillators is that it uses tapped capacitance, whereas the Hartley oscillator uses tapped inductance.

Circuit Explanation:

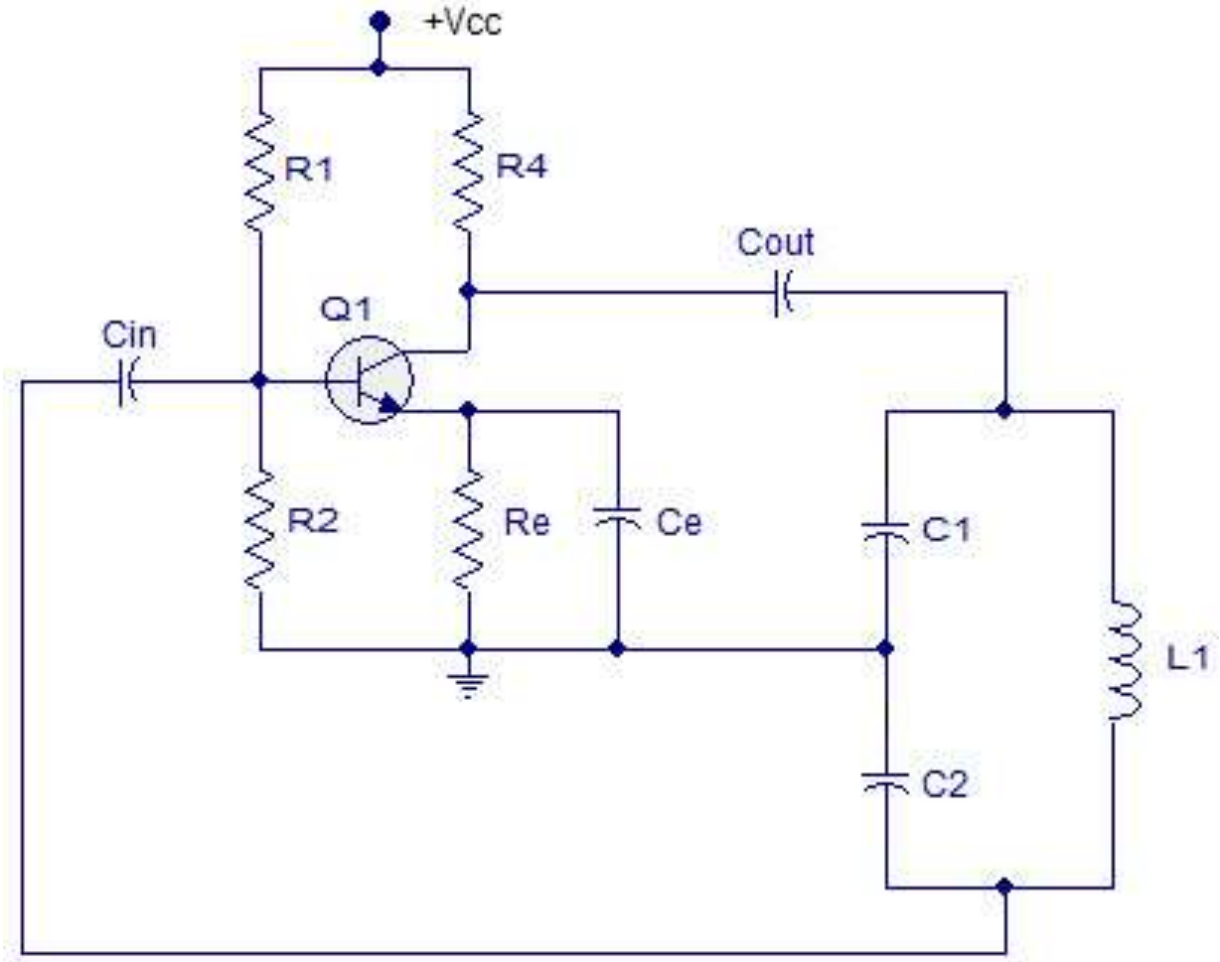
- Every other oscillator circuit which generates sinusoidal waveforms utilizes the LC resonant circuit except a few electronic circuits such RC oscillators, Wien-Robinson oscillator and a few crystal oscillators which don't require additional inductances for this purpose.

- It can be realized by using gain device such as Bipolar Junction Transistor(BJT), operational amplifier and field effect transistor(FET) as similar in other LC oscillators also.

- The capacitors C1 & C2 forms potential divider and this tapped capacitance in the tank circuit can be used as the source for feedback and this setup can be used to provide better frequency stability compared to the Hartley oscillator in which tapped inductance is used for feedback setup.

- RE resistor in the above circuit provides stabilization for circuit against variations in temperature.

Circuit Diagram:



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Circuit Explanation(Continue…)

- The capacitor CE connected in the circuit which is parallel to the RE, provides low reactive path to the amplified AC signal acting as Bypass capacitor.
- The Resistors R1 and R2 form voltage divider for circuit and provide bias to the transistor.
- The circuit consists of a RC coupled amplifier with common emitter configuration transistor.
- The coupling capacitor Coutblocks DC by providing an AC path from the collector to the tank circuit.

Colpitts Oscillator Working:

- Whenever power supply is switched on, the capacitors C1 and C2 start charging and after the capacitors get fully charged, the capacitors starts discharging through the inductor L1 in the circuit causing damped harmonic oscillations in the tank circuit.

- Thus, an AC voltage is produced across C1 & C2 by the oscillatory current in the tank circuit.

- While these capacitors get fully discharged, the electrostatic energy stored in the capacitors get transferred in the form of magnetic flux to the inductor and thus inductor gets charged.

Working(continue…)

- Similarly, when the inductor starts discharging, the capacitors start charging again and this process of energy charging and discharging capacitors and inductor continues causing the generation of oscillations and the frequency of these oscillations can be determined by using the resonant frequency of the tank circuit consisting of inductor and capacitors.

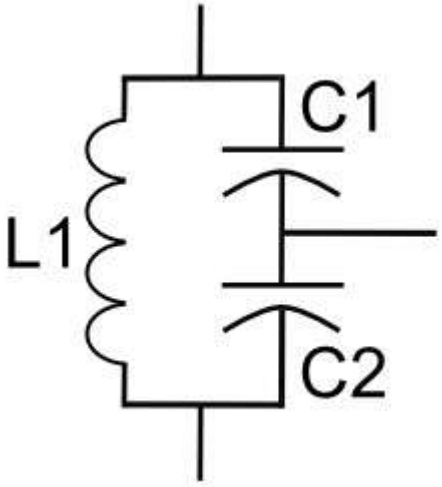
- This tank circuit is considered as the energy reservoir or energy storage. This is because of frequent energy charging and discharging of the inductor, capacitors that part of LC network forming the tank circuit.

- The continuous undamped oscillations can be obtained from the Barkhausen criterion.

Working(continue…)

- For sustained oscillations, the total phase shift must be 3600 or 00. In the above circuit as two capacitors C1 & C2 are center tapped and grounded, the voltage across capacitor C2 (feedback voltage) is 1800 with the voltage across capacitor C1 (output voltage).

- The common emitter transistor produces 1800 phase shift between the input and output voltage. Thus, from the Barkhausen criterion we can get undamped continuous oscillations.



Formulas:

- The resonant frequency is given by

  $f_r = 1/(2\pi\sqrt{(L1*C)})$

- Where f_r is the resonant frequency
- C is the equivalent capacitance of series combination of C1 and C2 of the tank circuit.

- It is given as

  $C = (C1*C2)/((C1+C2))$

L1 represents the self-inductance of the coil.

Applications :

- It is used for generation of sinusoidal output signals with very high frequencies.
- The Colpitts oscillator using SAW device can be used as the different type of sensors such as temperature sensor. As the device used in this circuit is highly sensitive to perturbations, it senses directly from its surface.
- It is frequently used for the applications in which very wide range of frequencies are involved.
- Used for applications in which undamped and continuous oscillations are desired for functioning.
- This oscillator is preferred in situations where it is intended to withstand high and low temperatures frequently.

Applications(Continue…)

- The combination of this oscillator with some devices (instead of tank circuit) can be used to achieve great temperature stability and high frequency.
- It is used for the development of mobile and radio communications.
- It has many applications used for the commercial purposes.

Conclusion:

- We explained about the Colpitts oscillator theory, working, applications and along with its tank circuit.
- The Colpitts oscillator is very useful to Electrical and Electronic Students.
- We hope that this explanation will clear your doubts and it is the best presentation on Colpitts oscillator.

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