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Oscillators and Signal’s Frequency

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ABSTRACT

An electronic circuit is made of many other different electrical or electronic components or circuits. Oscillator is one of them. There are many applications and need of it where we need a signal of any particular frequency with a fixed amplitude. So, oscillators are designed in that way as per the need.

CONTENTS

1 INTRODUCTION

An oscillator is a circuit which produces a continuous, repeated, alternating waveform without any input. It converts unidirectional current flow from a DC source into an alternating waveform which is of the desired frequency, as decided by its circuit components. Generate timing signals for your ICs which serves as a clock for the circuit. They are also used as a modulating or demodulating signals in communication systems. So, they are used as a key component in radio communication devices. Some modern oscillators like crystal oscillator are widely used in computers, instrumentation, digital systems, in phase-locked loop systems, modems, marine, telecommunications, in sensors and also in disk drives.

2 WORKING AND PRINCIPLES

As we can see in the circuit that we haven’t given any input signal and we are getting a sinusoidal signal as an output of our desired frequency. The reason is that as every electronic component has a random signal called noise which consists of all differnet kinds of frequencies. So, we design our ciruict in such a way that the ciruict produces or passes a particular frequency and blocks all the other frequency signal.

The main principle of working of an oscillator is the oscillation of charges on the capacitor to the resistor or inductor based on its type. But as we know that due to the resistance of the wires and different electrical components present in the circuit the voltage on the capacitor keeps on decreasing and we call this as damped oscillation. So, we need an amplifying circuit which keeps the gain of the circuit to be one. And does not change the phase of the signal. These two conditions are known as barkhausen criteria.

$$
\begin{aligned}
G &= A/(1 - A\beta) \\
&where \\
A\beta &= 1 \\
&and \\
\angle(A\beta) &= 0
\end{aligned}
\tag{1}
$$

where;
A = Open loop gain of amplifier used
B = gain from the external circuit
G = closed loop gain of the oscillator.

These two conditions must be fulfilled to get the complete gain of the circuit to be 1.

DIFFERENT KINDS OF OSCILLATOR

1. RC Phase Oscillator.
2. Colpitts Oscillator.
3. Hartely Osclillator.
4. Crystel Oscillator.
5. Relaxation Oscillator.

3 RESULTS

1. RC Phase Oscillator

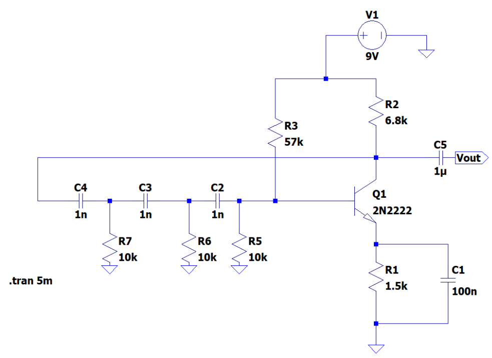

Figure 1. RC Phase Oscillator Circuit

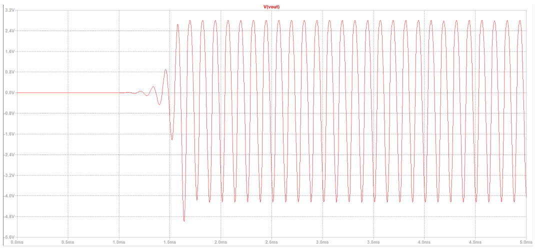

Figure 2. RC Phase Oscillator Plot

Theoretically;

$$f = 1/2 * \pi * RC * (N)^1/2 \qquad (2)$$

and for this circuit we have three pairs of resistors and capacitors. So, the value of N=3.
f is the frequency of the signal generated.
R and c is the value of resistance and capacitance of the individual network in the feedback.

2.Collpits Oscillator

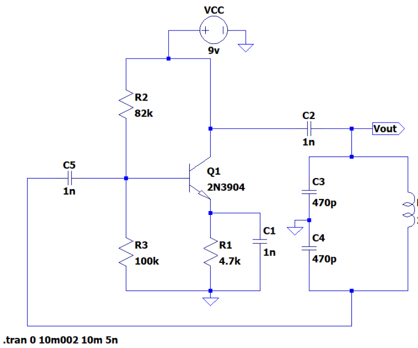

Figure 3. Collpit Oscillator Circuit

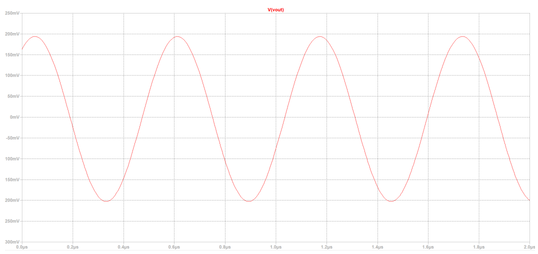

Figure 4. Collpit Oscillator Plot

Here the frequency of the signal generated is ;

$$f = 1/2 * \pi * (LC)^1/2 \qquad (3)$$

The feedback circuit which consist of capacitor and inductor is called the Tank circuit and frequency of generated signal depends on the value of capacitor and inductor of this Tank circuit.

f is the frequency of signal generated.

3. Hartely Oscillator

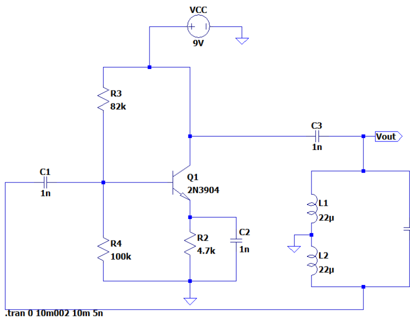

Figure 5. Hartely Oscillator Circuit

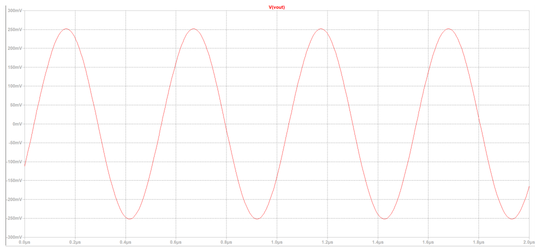

Figure 6. Hartely Oscillator Plot

This is somewhat similar to the collpits oscillator. Produces a constant amplitude output throughout a frequency ranging from 20khZ to 30MhZ.for this circuit too, theoretically;

$$f = 1/2 * \pi * (LC)^1/2 \qquad (4)$$

where
f is the frequency of signal generated.

4 CONCLUSION

The result that we got by checking the output on oscilloscope was approximately same as that we got on ltspice. The signal is a bit different due to noises like system noise or environment noise. The RC phase oscillator is used to produce low frequency sinusoidal wave. As the range of R is in Kohm and C in microfarad. They are built using inverting Opamps. Colpitts and Hartely are used to produce high frequency sinusoidal wave. As because the value of capacitance of the capacitor is in microfarad and the inductance is in milihenry. So, as per our need of the signal in our circuit we can decide the type of oscillator we want to design or use.

There is a different type of oscillator which produces non sinusoidal waves and these oscillators are called as Relaxation Oscillator.