الجامعة الألمانية الأردنية
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Communication Circuit Lab Manual

Experiment 5

Colpitts Oscillator

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Introduction

Oscillators are circuits that produce specific, periodic waveforms such as square, triangular, sawtooth, and sinusoidal. They can be made from some of the active or passive devices like transistors, FETs and Op-Amps in combination with devices such as resistors, capacitors, and inductors, to generate the output.

There are two main classes of oscillator; relaxation and sinusoidal. Relaxation oscillators generate the triangular, sawtooth and other nonsinuoidal waveforms. Sinusoidal oscillators consist of amplifiers with external components used to generate oscillation, or crystals that internally generate the oscillation. The focus here is on sine wave oscillators. Sine wave oscillators are used as references or test waveforms by many circuits.

An oscillator is a type of feedback amplifier in which part of the output is fed back to the input via a feedback circuit. If the signal fed back is of proper magnitude and phase, the circuit produces alternating currents or voltages. Two requirements for oscillation are

1. The magnitude of the loop gain $A_V B$ must be at least 1, and

2. The total phase shift of the loop gain $A_V B$ must be equal to 0^o or 360^o. If the amplifier causes a phase shift of 180^o, the feedback circuit must provide an additional phase shift of 180^o so that the total phase shift around the loop is 360^o.

Colpitt's Oscillator:

The **Colpitt's Oscillator** is one of the simplest and best known oscillators and is used extensively in circuits, which work at radio frequencies. Figure1 shows the basic **Colpitt's Oscillator** circuit configuration. The transistor is in voltage divider bias which sets up Q-point of the circuit. In the circuit note that V_{out} is actually the AC voltage across C2. This voltage is fed back to the base and sustains oscillations developed across the tank circuit, provided there is enough voltage gain at the oscillation frequency.

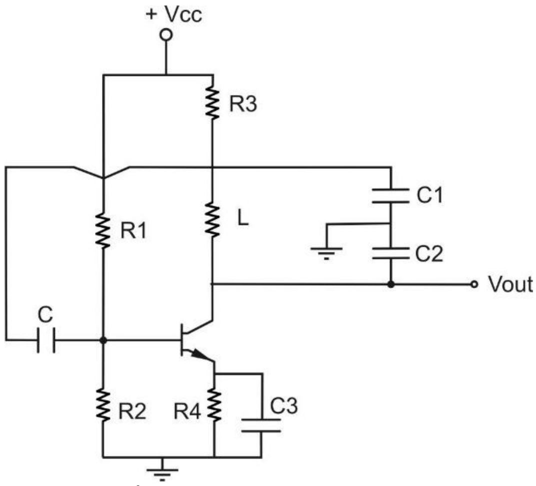

Figure 1

The resonant frequency of the **Colpitt's Oscillator** can be calculated from the tank circuit used. We can calculate the approximately resonant frequency as

$$f_r \frac{1}{2\pi\sqrt{L_T C}}$$

Here, the capacitance used is the equivalent capacitance the circulating current passes through. In **Colpitt's Oscillator** the circulating current passes through the series combination of C_1 and C_2. Therefore equivalent capacitance is,

$$f_r = \frac{C_1 C_2}{C_1 + C_2}$$

Starting condition for oscillations is

AB>1

Where,

B is approximately equal to C_1/C_2.

The feedback should be enough to start oscillations under all conditions as different transistors, are used at varying, temperatures, voltages, etc. But the feedback should not be so large that you lose the required output. The resonant frequency can be changed by either changing the value of inductor or changing the value of capacitor but the combination of the three components should satisfy the above given two conditions for oscillation.

Experiment

Objective:

Study of operation of Colpitt's Oscillator

Equipments Needed:

1. Analog board **AB67**
2. DC Power Supplies +12V from external source or **Scientech 2612** Analog Lab
3. Scientech Oscilloscope 801,803 or equivalent
4. 2mm Patch Cords

Circuit diagram: Circuit used to study the operation of **Colpitt's Oscillator** is as shown in figure 2.

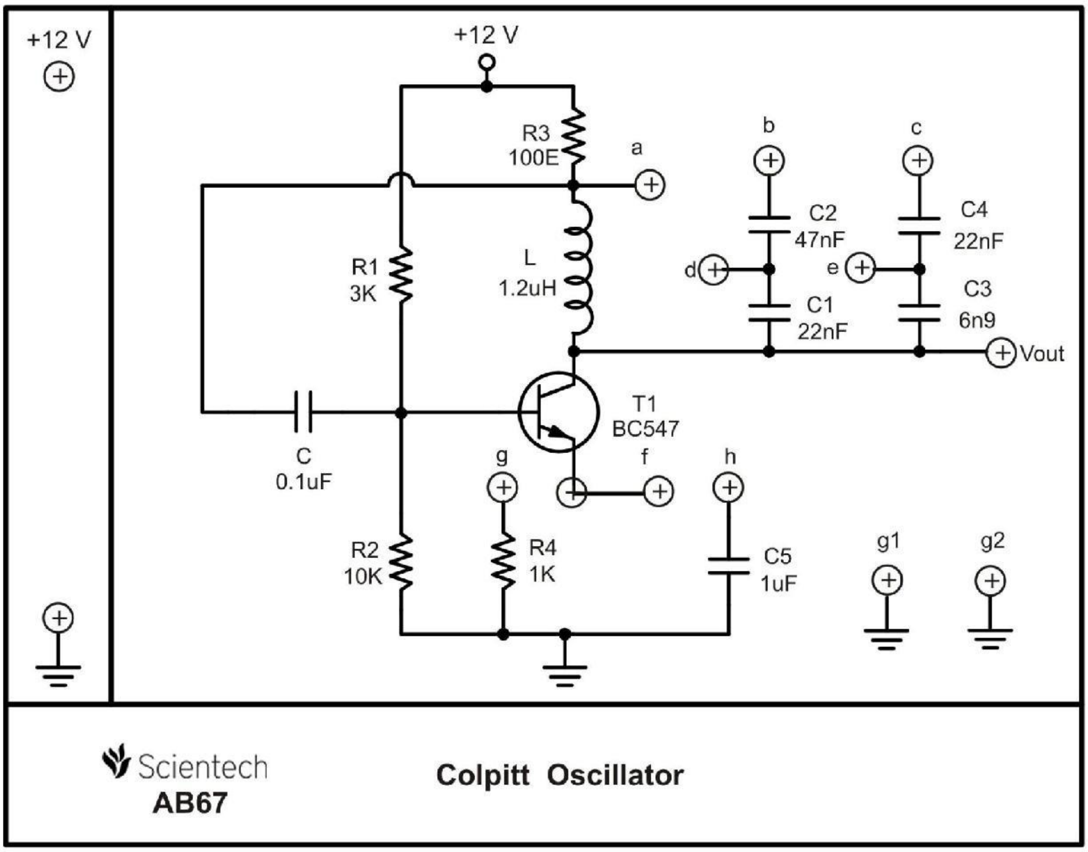

Figure 2

Procedure:

- Study of **Colpitt's Oscillator** proceed as follows:

1. Connect +12V DC Power Supply at their indicated position from external source or Scientech 2612 Analog Lab.

2. Connect a patch cord between points a and b and another patch chord between points d and g1.

3. Connect patch chord between points f and h and another patch chord between points g and emitter of transistor T1.

4. Switch 'On' the Power Supply.

5. Connect oscilloscope between points V_{out} and g2 on AB67 board.

6. Record the value of output frequency on oscilloscope.

7. Calculate the resonant frequency using equation 1.

8. Compare measured frequency with the theoretically calculated value.

9. Switch 'Off' the supply.

10. Remove the patch chord connected between points a and b and connect it between points a and c.

11. Remove the patch chord connected between points d and g1 and connect it between points e and g2.

12. Follow the procedure from point 4 to 8.

13. Connect +5V Supply instead of +12V Supply and follow the procedure from point 2 to point 11.

Result:

When patch chord connected across C1 and C2

- Practically calculated Output frequency (on CRO): …………………….
- Theoretically calculated values Cequ: …………………….
- Resonant frequency: …………………..
- Output voltage amplitude: ……………………

When patch chord connected across C3 and C4

- Practically calculated Output frequency (on CRO): …………………….
- Theoretically calculated values Cequ: ………………………………...
- Resonant frequency: …………………..
- Output voltage amplitude: ……………………

Record above results separately for +12V input voltage and +5V input voltage