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Communication Circuit Lab Manual

Experiment 4
Hartley Oscillator

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Theory

Oscillators are circuits that produce periodic waveforms without input other than perhaps a trigger. They generally use some form of active device, lamp, or crystal, surrounded by passive 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, created using operational amplifiers Op-Amps. Sine wave oscillators are used as references or test waveforms by many circuits.

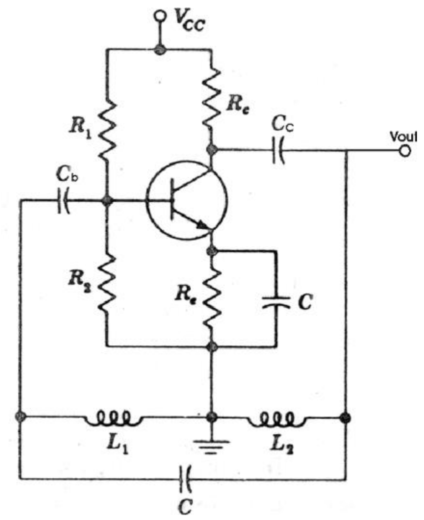
An oscillator is a type of feedback amplifier in which part of the output is fed back to the input via a feedback circuit. If the signal fed back is of proper magnitude and phase, the circuit produces alternating currents or voltages. Two requirements for oscillation are:

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° or 360°. If the amplifier causes a phase shift of 180°, the feedback circuit must provide an additional phase shift of 180° so that the total phase shift around the loop is 360°.

Hartley Oscillator:

The Hartley oscillator is one of the simplest and best known oscillators and is used extensively in circuits, which work at radio frequencies. Figure 1 shows the basic Hartley oscillator circuit configuration. The transistor is in voltage divider bias which sets up Q-point of the circuit. The output 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.



Hartley Oscillator

Figure 1

The resonant frequency of the Hartley oscillator can be calculated from the tank circuit used. We can calculate the approximately resonant frequency as

$$f_r = \frac{1}{\sqrt{L_T C}}$$

Here, the Inductor used is the equivalent Inductance. In Hartley oscillator the circulating current passes through the series combination of L1 and L2. Therefore equivalent Inductance is,

$$L_T = L_1 + L_1 + 2M$$

Where, M is the mutual inductance between two inductors.

$$M = K\sqrt{L_1 L_2}$$

Where, K is the coefficient of coupling, lies between 0 to 1.The coefficient of coupling gives the extent to which two inductors are couple.
Starting condition for oscillations is

$$AB > 1$$

Where,
B is approximately equal to L2/L1.
The feedback should be enough to start oscillations under all conditions as different transistor, temperature, voltage, etc. but it should not be much that you lose more output than necessary. 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 the operation of Hartley Oscillator

Equipments Needed:

1. Analog board of **AB68**.
2. DC power supplies +12V from external source or **Scientech 2612 Analog Lab**.
3. Scientech Oscilloscope 801/803 or equivalent
4. 2 mm patch cords.

Circuit diagram:

Circuit used to study the operation of Hartley Oscillator is as shown in figure 2.

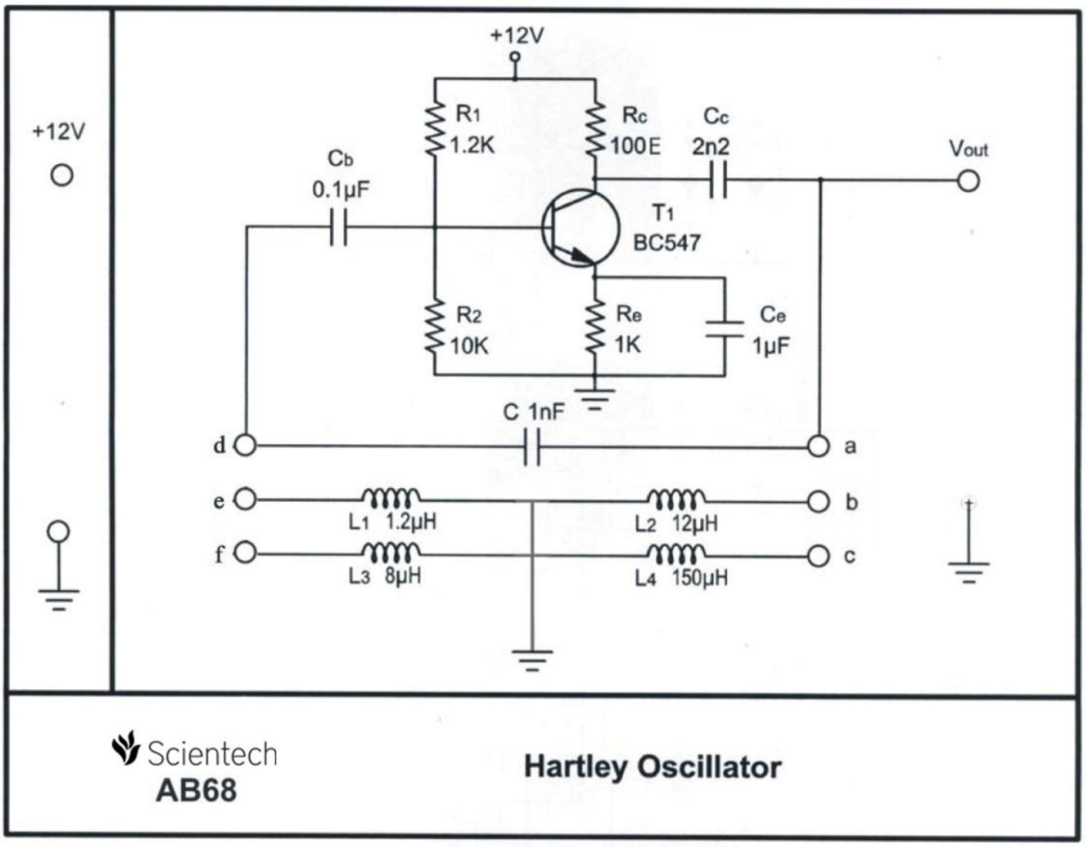


Figure 2

Procedure:

- Connect +12V DC power supplies at their indicated position from external source or **Scientech 2612 Analog Lab**.

1. Connect a patch cord between points a and b and another patch cord between point d and e.
2. Switch on the Power Supply.
3. Connect Oscilloscope between Vout and ground on **AB68 board**.
4. Record the value of output frequency on oscilloscope.
5. Calculate the resonant frequency using equation 1.
6. Compare measured frequency with the theoretically calculated value.
7. Switch off the supply.
8. Remove the patch cord connected between points a and b and connect it between points a and c.
9. Remove the patch cord connected between points d and e and connect it between point d and f.
10. Follow the procedure from point 4 to 7.

Results:

- *When patch cord connected across a and b*
  - Practically calculated Output frequency (on CRO):......................
  - Theoretically calculated values………………………
  - L_T: ……………………………………
  - Resonant frequency (fr): ……………….
  - Output voltage amplitude: ……………...   Vp-p
- *When patch cord connected across a and c*
  - Practically calculated Output frequency (on CRO): ....
  - Theoretically calculated values: ……….........................
  - L_T: ……………………………………
  - Resonant frequency (fr): ……………….
  - Output voltage amplitude: ……………...   Vp-p.