Hartley Oscillator

Aim :-   To construct Hartley oscillator using a transistor, to find out the frequency of oscillation and comparing it to that of theoretical frequency.

Apparatus :- n-p-n transistor, Carbon resistors (as shown in circuit), two inductors, capacitors, dc power supply, CRO and connecting terminals.

Formulae :-   The frequency of oscillation of the oscillator $f = \dfrac{1}{2\pi\sqrt{LC}}$ Hz

Where $L = L_1 + L_2$ = Resultant inductance of the series combination.

L_1, L_2 = Self inductances of the two coils (H)

C = Capacitance of the condenser (F)

Description :-The Hartley oscillator is designed for generation of sinusoidal oscillations in the R.F range (20 KHz - 30 MHz). It is very popular and used in radio receivers as a local oscillator.

The circuit diagram of Hartley oscillator (parallel or shunt-fed) using BJT is shown in Figure. It consists of an R-C coupled amplifier using an n-p-n transistor in CE configuration. R_1 and R_2 are two resistors which form a voltage divider bias to the transistor. A resistor R_E is connected in the circuit which stabilizes the circuit against temperature variations. A capacitor C_E is connected in parallel with R_E, acts as a bypass capacitor and provides a low reactive path to the amplified ac signal. The coupling capacitor C_C blocks dc and provides an ac path from the collector to the tank circuit. The L-C feedback network (tank circuit) consists of two inductors L_1, and L_2 (in series) which are placed across a common capacitor C and the centre of the two inductors is tapped as shown in fig. The feedback network (L_1, L_2 and C) determines the frequency of oscillation of the oscillator.

THEORY :- When the collector supply voltage V_{cc} is switched on, collector current starts rising and charges the capacitor C. When this capacitor is fully charged, it discharges through coils L_1 and L_2, setting up damped harmonic oscillations in the tank circuit. The oscillatory current in the tank circuit produces an a.c. voltage across L_1 which *is* applied to the base emitter junction of the transistor and appears in the amplified form in the collector circuit. Feedback of energy from output (collector emitter circuit) to input (base-emitter circuit is) accomplished through auto transformer action. The output of the amplifier is applied across the inductor L_1, and the voltage across L_2 forms the feedback voltage. The coil L_1, is inductively coupled to coil L_2, and the combination acts as an auto-transformer. This energy supplied to the tank circuit overcomes the losses occurring in it. Consequently the oscillations are sustained in the circuit.

The energy supplied to the tank circuit is in phase with the generated oscillations. The phase difference between the voltages across L_1 and that across L_2 is always $180°$ because the centre of the two is grounded. A further phase of $180°$ is introduced between the input and output voltages by the transistor itself. Thus the total phase shift becomes 360^0 (or zero), thereby making the feedback positive or regenerative which is essential for oscillations. So continuous undamped oscillations are obtained.

Procedure :-The circuit is connected as shown in figure. Connect the CRO across the output terminals of the oscillator. Switch on the power supply to both the oscillator and CRO. Select proper values of C, L_1 and L_2 in the oscillator circuit and get the sine wave form on the screen of CRO. The voltage (deflection) sensitivity band switch (Y-plates) and time base band switch (X-plates) are adjusted such that a steady and complete picture of one or two sine waveform is obtained on the screen. The horizontal length (l) between two successive peaks is noted. When this horizontal length (l), is multiplied by the time base (m) i.e. sec/div , we get the time-period (T = l x m).The reciprocal of the time-period(1/T) gives the frequency (f). This can be verified with the frequency, calculated theoretically by using the above formula. The experiment is repeated by changing C or L_1 or L_2 or all. The readings are noted in the table given.

Precautions :- 1) Check the continuity of the connecting terminals before going to connect the circuit.

2) Identify the emitter, base and collector of the transistor properly before connecting it in the circuit.

3) The horizontal length between two successive peaks should accurately be measured.

Results :-
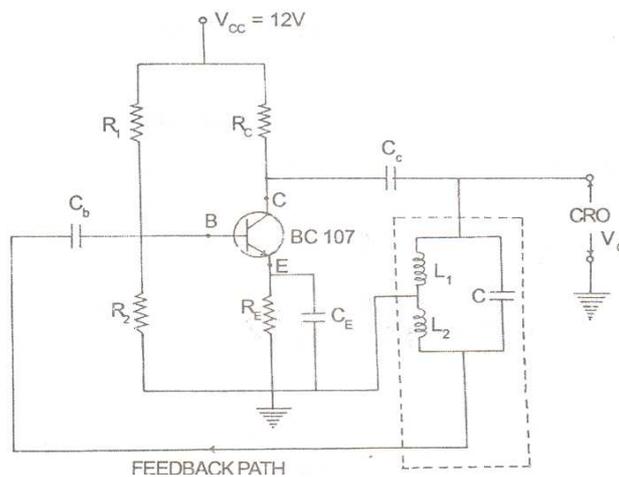
Figure

Table

S.No	Capacitance (µF)	Inductance (mH)			Measurement of time period			Frequency (Hz)	
	C	L_1	L_2	$L = L_1 + L_2$	Peak to peak (Horizontal) length (Div) (l)	Time-base Sec/Div (m)	Time-period $T = mxl$ Sec.	$f = \dfrac{1}{T}$	$f = \dfrac{1}{2\pi\sqrt{LC}}$

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