Dual-Frequency Oscillator Design

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OSCILLATORS capable of oscillating at two different frequencies simultaneously provide outputs that are a linear addition of two sine waves. Frequency ratios of 20:1 have been obtained, and the two output frequencies need not be harmonically related.

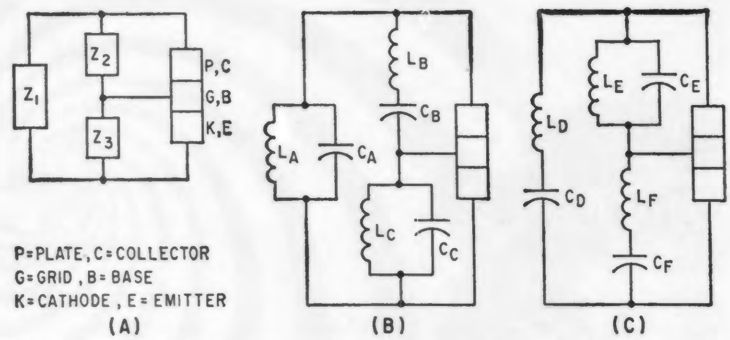


FIG. 1—Generalized dual-frequency oscillator is shown at (A). Lower of two frequencies is produced by Hartley oscillator at (B) and by Colpitts oscillator at (C)

Theory

Qualitative operation of the oscillators is relatively simple to understand, but quantitatively they are quite difficult. Synthesis of the circuit is much simpler than analysis.

The generalized dual-frequency oscillator configuration is shown in Fig. 1A. Neglecting effects of the active element, oscillator frequency is $Z_1 + Z_2 + Z_3 = 0$. The circuits in Fig. 1B and 1C are simultaneous dual-frequency oscillators.

The circuit shown in Fig. 2A is a conventional Hartley oscillator and that in Fig. 2B is a Colpitts oscillator. If capacitors and inductors were interchanged, the Hartley oscillator would become a Colpitts oscillator and the Colpitts oscillator would become a Hartley oscillator. Two networks capable of appearing capacitive at one frequency and inductive at another are shown in Fig. 3.

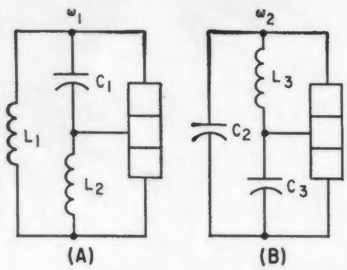


FIG. 2—Hartley oscillator (A) and Colpitts (B)

Design

Assume two properly designed single-frequency oscillators, a Hartley and a Colpitts. Angular velocity ω_1 of the Hartley oscillator is less than angular velocity ω_2 of the Colpitts oscillator. A network configuration is required that appears as a Hartley oscillator at ω_1 and as a Colpitts oscillator at ω_2. These conditions are satisfied in Fig. 1B.

At ω_1, network L_AC_A appears as L_1; and at ω_2, it appears as C_2. Network L_BC_B appears as C_1 at ω_1 and L_3 at ω_2. Network L_CC_C appears as L_2 at ω_1 and as C_3 at ω_2.

The equations for circuit values are:

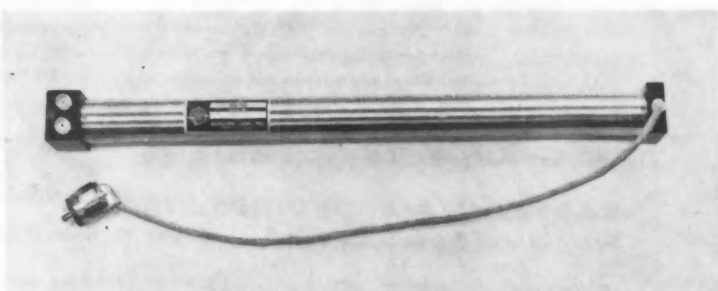
$$(-1/\omega_1L_A) + \omega_1C_A = -1/\omega_1L_1 \text{ and}$$
$$(-1/\omega_2L_A) + \omega_2C_A = \omega_2C_2;$$
$$\omega_1L_B - (1/\omega_1C_B) = -1/\omega_1C_1 \text{ and}$$
$$\omega_2L_B - (1/\omega_2C_B) = \omega_2L_3;$$
$$(-1/\omega_1L_C) + \omega_1C_C = -1/\omega_1L_2 \text{ and}$$
$$(-1/\omega_2L_C) + \omega_2L_C = \omega_2C_3.$$

The dual-frequency oscillator in Fig. 1C is for ω_1 greater than ω_2. The equations are:

$$\omega_1L_D - (1/\omega_1C_D) = \omega_1L_1 \text{ and}$$
$$\omega_2L_D - (1/\omega_2C_D) = -1/\omega_2C_2;$$
$$(-1/\omega_1L_E) + \omega_1C_E = \omega_1C_1 \text{ and}$$
$$(-1/\omega_2L_E) + \omega_2C_E = -1/\omega_2L_3;$$
$$\omega_1L_F - (1/\omega_1C_F) = \omega_1L_2 \text{ and}$$
$$\omega_2L_F - (1/\omega_2C_F) = -1/\omega_2C_3.$$

The number of frequencies at which an oscillator can oscillate

Electrostatically Focused TWT



One-watt twt is one of many developments to be shown at the 1960 International IRE convention. Developed by Huggins Laboratories, it operates over the range of 500 to 1,000 Mc with minimum small-signal gain of 28 db simultaneously is not limited to two. Three single-frequency oscillators could also be combined to form a triple-frequency oscillator. It would combine a Hartley oscillator at ω_1, a Colpitts at ω_2 and a Hartley at ω_3. Three-element networks would appear as C_{11} at ω_1,

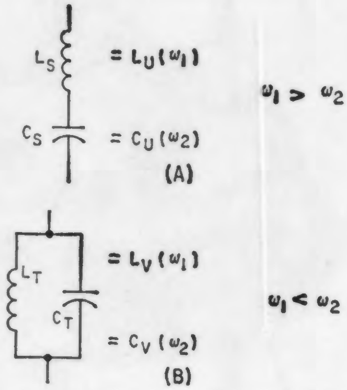


FIG. 3—Networks appear capacitive at one frequency and inductive at the other

L_{11} at ω_2 and C_{22} at ω_3; or L_{22} at ω_1, C_{33} at ω_2 and L_{33} at ω_3.

In the dual-frequency oscillator, adjustment or control of either of its operating frequency is difficult because the value of each component in the circuit is a function of the two frequencies.

Thin-Film Memories

Each of 64 magnetic thin film dots on 2-inch square glass contains one piece of information. Minneapolis-Honeywell scientists have placed as many as 1,024 dots on same size glass hoping to replace ferrite core memories like that shown at left