4

Other Resonators

Chapter 3 treated piezoelectric resonators in detail. This chapter will briefly describe other types of resonators.

4.1 INDUCTANCE CAPACITANCE CIRCUITS (*LC* RESONATORS)

This resonator is used in low- and medium-performance oscillators and is probably the most popular. It is useful from very low to extremely high frequencies. The application of the *LC* resonator is covered in detail in Chapters 5 to 10.

The physical form of the resonator is principally determined by the oscillator's frequency and function. As the name indicates, it consists of a capacitor and inductor. The inductor and capacitor may be combinations of fixed and/or variable elements depending upon whether the oscillator is fixed or variable frequency.

A tremendous amount of information on the construction and performance characteristics of inductors and capacitors suitable for use as oscillator resonators has been published and is readily available. This information will not be repeated here.

The most important performance characteristics are:

1 Stability as a function of time and environmental conditions.
2 The Q of the resonator which limits the operating Q of the oscillator. The Q of the resonator approximates the Q of the inductor since the Q of the capacitor normally greatly exceeds that of the inductor. In order to increase the resonator Q, considerable study has been made of their use at cryogenic temperatures where the Q is increased by many orders of magnitude.

In designing *LC* oscillators, it is important to choose values of *L* and *C* and configure the circuit so that the contributions of the transistor to the operating frequency is very small compared to that of the resonator.

4.2 ELECTROMECHANICAL RESONATORS

The performance of this class of resonators is intermediate between that of the *LC* and piezoelectric resonators. It is mostly of historical interest since it has been almost completely superceded by the crystal oscillator, with frequency dividers if necessary, and *RC* type of oscillators where the superior performance crystal oscillator is not required.

Typical examples of this class of resonators are the vibrating reed and the tuning fork equipped with driving and pickup coils. The frequency is determined by the dimensions and material of the device. In order to simplify the driving and pickup processes, the material usually has magnetic properties.

The oscillator circuit block diagram is that of Fig. 1.16*a* where the resonator is the β network.

4.3 THE MAGNETROSTRICTION RESONATOR

The magnetrostriction effect is the expansion or contraction of magnetic materials as the result of magnetization, and the converse change of magnetization as the result of strain. This effect may be used as the basis for a resonator. The performance approaches that of low-performance crystal resonators. The practical range of oscillation frequency is within the audio and supersonic frequency bands. The oscillator block diagram is similar to that of the electromechanical resonator described above. The magnetrostriction resonator is only of historical importance as it has been supplanted by the crystal oscillator, combined with frequency dividers if necessary.