DROs, Part 1

UNDERSTAND DRO DESIGN METHODS AND OPERATION

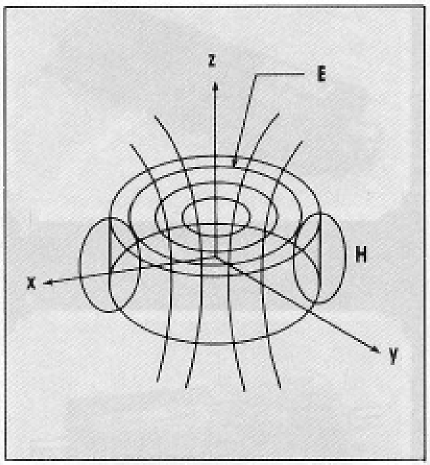
Material selection and coupling configurations can greatly enhance the electrical performance of a dielectric resonator oscillator.

DIELECTRIC resonator oscillators (DROs) are ubiquitous microwave sources. Desirable as low-phase-noise, fixed-frequency local oscillators (LOs) in a variety of communications systems, DROs fill the gap between a free-running oscillator and a synthesized source. This opening installment of a four-part series will examine DRO fundamentals and basic operating principles.

The DRO represents a good compromise of cost, size, and performance compared to alternative signal sources, such as high-quality-factor (Q) cavity oscillators, microstrip oscillators, or multiplied crystal oscillators. Dielectric resonators, since they can be easily integrated in microwave integrated circuits (MICs), can be used directly as the frequency-determining element for stable microwave sources.

The primary characteristics of the ceramic material to be used for dielectric resonators are:

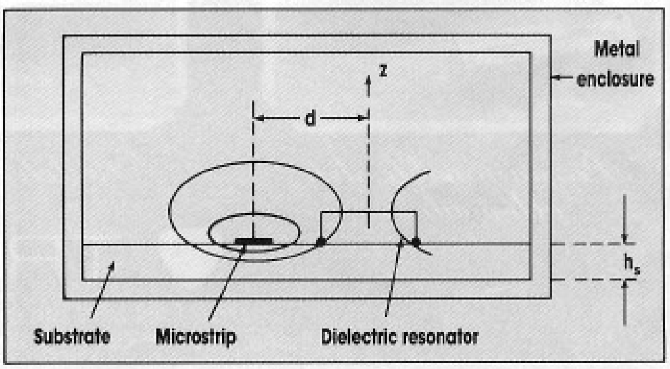
- Q, which is approximately equal to the inverse of the loss tangent;
- the temperature coefficient of the resonant frequency (τ_f), which includes the combined effects of the temperature coefficient of the dielectric constant and the thermal expansion of the dielectric resonator and the shielding package;
- the dielectric constant (ϵ_r).



1. The $TE_{01\delta}$ mode is the most commonly used mode in cylindrical dielectric resonators, with the electric (E) and magnetic (H) fields appearing in this fashion.

The values of Q, τ_f, and ϵ_r required for various applications differ, and, in general, satisfactory oscillator operation under most conditions can be achieved by choosing an appropriate material composition. Until several years ago, the lack of suitable materials (i.e., materials possessing acceptable combinations of Q, τ_f, and ϵ_r) severely limited dielectric resonator applications. Materials such as rutile-phase TiO_2, which has an unloaded Q of about 10,000 at 4 GHz and ϵ_r of 100, were most often used. However, TiO_2 has a resonant-frequency value of 400 PPM/°C, which makes it impractical for most applications.

At present, several ceramic compositions have been developed offering excellent dielectric properties.



2. A dielectric resonator is placed on top of a microwave substrate to induce coupling.

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