

APPLICATION NOTE

Microwave Dielectrics: General Notes

Trans-Tech, Inc., a wholly-owned subsidiary of Skyworks Solutions, uses the term “dielectric constant” instead of the term “permittivity” which is cited in other documents. In reality, the dielectric constant is not constant. The dielectric constant varies somewhat with the blend that is used to determine a ceramic’s temperature coefficient, and it varies slightly from lot-to-lot, and changes perceptibly with temperature. We compensate for these effects by offering its Dielectric Resonators (DRs) sized to frequency, and provides customized temperature coefficients when necessary.

Dielectric microwave materials are commonly assigned a loss tangent to permit an estimate of signal losses. Because ceramic DRs operate at a specific frequency in a specified geometry, they allow direct measurement and specification of the Unloaded Quality Factor (Qu). The Qu is a fundamental resonator parameter that is particularly appropriate (and more useful than loss tangent) for filter and oscillator applications.

Ceramics do not:

- Age perceptibly—Any change in the resonant frequency of a DR over time can be attributed to a change in the measurement cavity or measurement technique.
- Absorb moisture noticeably—Moisture condensation on the surface of the DR can affect the Qu. The Qu can recover when the moisture is driven off, for example, by self-heating of the DR in a transmitter filter.

Because the Qu of ceramic resonators can be degraded by finger oils, pencil marking, tape, and a host of other contaminants, cleanliness is important.

Ceramics can chip easily when coming into contact with hard surfaces. Most tiny chips do not affect the electrical performance. Surface roughness is not particularly important as there are no currents in a ceramic DR, only stored energy in the form of fields. Smooth surfaces are preferable from the standpoint of avoiding trapped contaminants.

Ceramics are created in kilns at temperatures over 1000 °C. Ceramics can stand much higher temperatures than the electronic equipment they are used with, and far exceed soldering temperatures, but conduct heat much more slowly than metals. A large enough temperature gradient through a ceramic part can cause failure due to differential expansion, which is called “thermal shock.” Sudden application of heat on one side of a thick ceramic part invites fracture.

Adhesives used to mount DRs must be chosen carefully. Because adhesives always degrade a DR’s Qu, we have developed bonding systems to minimize Qu loss while guaranteeing bond strength. Refer to the *Adhesives for Dielectric Resonator Assemblies* Application Note (Document Number 202824), located on our website.

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