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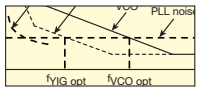

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AMPLIFIERS & OSCILLATORS ISSUE

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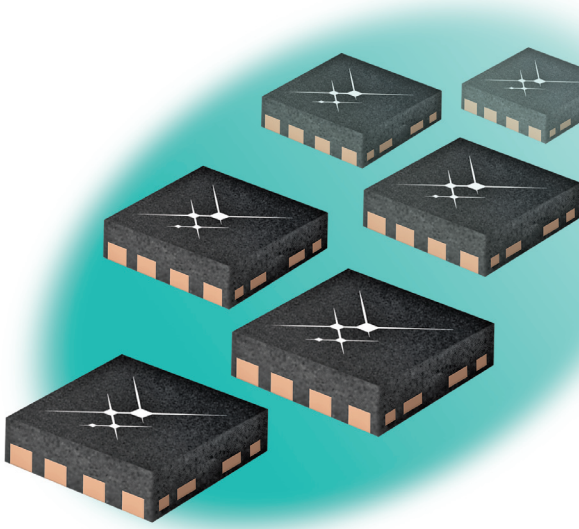

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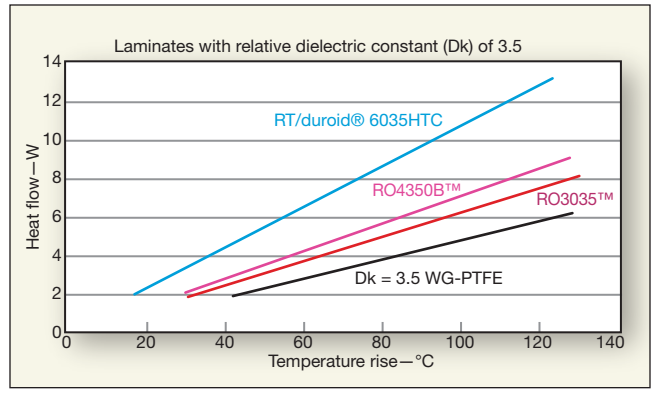
Circuit Laminate Keeps The Heat Out

The best approach to proper thermal management of high-frequency PCBs is to choose a laminate material that does not convert RF/microwave power into unwanted heat energy.

THERMAL MANAGEMENT of printed-circuit boards (PCBs) begins with the choice of laminate material. Especially at high signal power levels, a number of laminate characteristics—including dissipation factor (loss), dielectric constant, and even the surface roughness of the conductor metal—can impact how much of a high-power RF/microwave input signal to a PCB is converted into unwanted heat.

So fortunately, RT/duroid® 6035HTC laminate material from Rogers Corporation (www.rogerscorp.com/acm) has been engineered not only for superior electrical and mechanical performance, but for effective thermal management even at RF/microwave power levels of hundreds of watts.



The high thermal conductivity of RT/duroid 6035HTC laminate translates into less heat generated at higher RF power levels.

RT/duroid 6035HTC is a high-thermal conductivity (thus, the HTC) laminate formed of a ceramic-filled PTFE composite dielectric topped with standard and reverse-treated, electrodeposited copper foil. It has a thermal conductivity of 1.44 W/(m-K) at +80°C—a value considerably higher than that of other PCB laminates with similar relative dielectric constant (Dk) values (**see figure**).

RT/duroid 6035HTC features a relative dielectric constant of 3.50 at 10 GHz in the material's z-axis (the thickness); it is maintained with ± 0.05 consistency across a board. The material also boasts low loss, characterized by a dissipation factor of 0.0013 at 10 GHz. The laminate is suitable for a wide range of high-frequency circuits, including high-power amplifiers, couplers, power dividers, and filters.

In a high-power RF/microwave circuit, proper thermal management involves transferring as much RF/microwave energy with as little heat generation as possible. This can not only ensure the higher reliability and longer operating lifetime of the circuitry, but also contribute to enhanced performance in many high-power designs, such as solid-state amplifiers.

The combination of high thermal conductivity and low dissipation factor in the RT/duroid 6035HTC material minimizes heat buildup in the circuit and around sensitive devices, such as transistors, but also allows the active devices to operate at lower temperatures for higher efficiencies and gain, so that more bias energy at the input of the amplifier is converted to signal energy at the output of the amplifier.

The RT/duroid 6035HTC material is well behaved in terms of thermal characterization, with its low thermal coefficient of dielectric constant, -66 ppm/°C, indicating negligible deviation in dielectric constant over temperature. The material is mechanically stable with temperature, with coefficient of thermal expansion at 19 ppm/°C in both the x and y axes and 39 ppm/°C in the z-axis from -55 to +288°C.

These excellent electrical, mechanical, and thermal properties come without processing penalties, since the RT/duroid 6035HTC's unique filler does not put undue wear on machine tools; the RT/duroid 6035HTC laminate can be manufactured with standard lead-free processes. The laminate is designed for ease of drilling and extended tool life compared to alumina.

RT/duroid 6035HTC laminate is available in a variety of dielectric thicknesses and cladding options. There are many complexities to how a circuit material may perform in a circuit fabrication environment as well as the end-use performance, and there may be some possible interactions. Therefore, a user must determine the fitness for use of the selected materials by conducting appropriate short-term and long-term reliability testing.—*JB*

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