Circuit board materials may like it hot (or not)

9 June 2006

Electrical circuits may act differently in Arizona than they do in Alaska--potentially affecting the performance of computers and other electronics. A new technique identifies and quantifies an important cause of this temperature sensitivity.

Researchers at the National Institute of Standards and Technology and DuPont Electronic Technologies (Research Triangle Park, N.C.) have demonstrated a nondestructive method for measuring how temperature affects the electrical properties of three common circuit board materials (ceramic, polymer and glass).

The work, described at a recent conference,* provides manufacturers with an accurate technique for measuring high-frequency electrical properties of substrates without cutting up the material--enabling faster, less expensive and easier testing--as well as a tool for designing circuits and substrates with improved performance.

NIST has been working with ceramic and printed-wiring board manufacturers for five years to develop the technique. They previously have used the method to measure changes in electrical properties as substrates are subjected to different electromagnetic frequencies. The work is important to the electronics industry because the performance of electrical circuits depends in part on the electrical properties of the substrate.

The apparatus used in the experiments, the split-cylinder resonator, was originally designed elsewhere, but NIST developed a mathematical model that improves its accuracy and extends its frequency range. The model has been approved as an industry standard. A thin piece of substrate is placed between two halves of a cylindrical cavity--smaller than a coffee mug--inside an environmental chamber.

A computer analyzes the changes in the microwave-range resonant frequency as the chamber temperature changes from -50 to 100 degrees Celsius (-58 to 212 degrees Farenheit). As the temperature rose, an important electrical property called loss tangent (a measure of electrical losses in an insulating material) fell in glass, generally increased in the organic substrate, and remained stable in one type of ceramic while rising slightly in another.

*M.D. Janezic, T. Mobley, and D. Amey. 2006. Temperature-dependent complex permittivity measurements of low-loss dielectric substrates with a split-cylinder resonator. Presented at IMAPS/ACerS International Conference and Exhibition of Ceramic Interconnect and Ceramic Microsystems Technologies (CICM), April 24-27, 2006, Denver, Colo.

Source: NIST