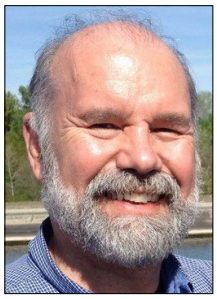
SEMI-THERM 36

Evening Tutorial

Tuesday, March 17 7:30 p.m. - 9:00 p.m.

Realistic Thermal Model for Human Skin in Contact with a Wearable Electronic Device



Presenter: Bruce Guenin, Ph.D.

Makers of electronic devices try to provide as much performance and functionality in them as possible, consistent with certain limits for internal chip temperatures. For wearables, the external temperatures of these devices are also critical for user comfort and safety. For accuracy in a thermal model for the wearable device, it is necessary to accurately account for the transfer of heat into human skin. The commonly used ad hoc assumption of an isothermal boundary condition representing the region of contact between a wearable device and human skin is no longer adequate.

In the medical and biological fields, modeling the transfer of heat into or out of living tissue is a mature area of study. The dominant methodology in this regard is referred to as the Pennes biothermal model, named after its creator. It is a conduction model supplemented by a mechanism for cooling the tissue by blood flow, which Pennes called "perfusion." The application of the Pennes model requires that certain specified material properties be measured for each of the different tissue types involved in the heat flow, namely: thickness, thermal conductivity, specific heat, and perfusion rate. In the case of human skin all three layers (epidermis, dermis, and hypodermis) are separately represented.

Despite its wide use in the life sciences, the Pennes biothermal model is virtually unknown in the electronics cooling sector. It's the intent of this presentation to provide sufficient background information and details in its implementation that the attendees will be able to apply it immediately to their work.

Dr. Bruce Guenin has spent many years in the electronics and computer industries, which has given him a broad perspective on macro trends in these fields. His previous affiliations include Oracle, Sun Microsystems, and Amkor. He is a past chairman of the JEDEC JC-15 Thermal Standards Committee and the Semi-Therm Conference. He has been an editor of Electronics Cooling since 1997. His contributions to the thermal sciences have been recognized by receiving the Harvey Rosten Award in 2004 and the Thermi Award in 2010. He received the B.S. degree in Physics from Loyola University, New Orleans, and the Ph.D. in Physics from the University of Virginia. He has authored and co-authored over 90 papers and articles in the areas of thermal and stress characterization of microelectronic packages, electrical connectors, solid state physics, and fluid dynamics and has been awarded 18 patents in these areas.