## 18. Electronics Cooling Technologies for Handheld Devices, Computing, and High Power Electronics

***Course Leaders: William Maltz and Guy Wagner – Electronic Cooling Solutions***

**Course Objective:**
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**Course Outline:**

1. Cooling of Handheld Devices
   - Cooling Limits drive by Touch Temperature
   - Convection
   - Radiation
   - Use of Heat Spreaders and Heat Pipes
   - Use of Micro-Blowers
   - Importance of Solar Radiation
2. Cooling of Computers, Servers, Datacom Equipment
   - When to Use Air Movers
   - Axial Flow Fans vs. Centrifugal Blowers
   - Testing and Fan Acoustics
   - Fan Location: push vs pull
   - Limits of Air Cooling
3. Liquid Cooling of Very High-Power Electronics
   - Advantages and Disadvantages of Liquid Cooling
   - When and where to consider liquid over air cooling
   - Coolant Types
   - Limits of Single-Phase Liquid Cooling

**Who Should Attend:**
Engineers and technical managers who are involved in packaging technology development that necessitates an understanding of heat sink design and optimization in the context of the thermal management of electronics should attend.
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**Bio**:
**William Maltz,** President and founder of Electronic Solutions, has over 30 years of experience in thermal management of electronic systems. Mr. Maltz has worked on the design of thermal solutions for products that range from low power consumer products to high performance multiprocessor computer systems and high-end core routers. His technical responsibilities include managing multiple projects and working closely with engineering management at a number of companies.

**Guy Wagner,** Director, ECS Rocky Mountain Office has over 45 years of R&D experience in the electronics industry. His experience includes: IC and system cooling and packaging technology, disc drive design, thermal design of computer systems, medical and aerospace equipment, telephone switching systems, and consumer electronic products.

His experience includes both electronic systems cooling as well as cooling of IC packages. Guy has authored and presented more than 40 papers at international technical conferences and has 29 patents. Prior to joining ECS, Mr. Wagner was Chief Scientist at HP in Fort Collins and a member of the Technical Staff at Bell Laboratories. Mr. Wagner received his MS in Mechanical Engineering at Iowa State University.