THERMAL TEST SYSTEM SELECTION CONSIDERATIONS

The selection of a thermal test system requires more than just a comparison of capabilities and specifications. The key questions are –

A. Does the system perform measurements in conformance to industry or military standards?
B. Can the system perform these measurements accurately?
C. Does the system provide the data in a complete and useable format?
D. Is the system easy to use in collecting thermal data?
E. Are there any productivity issues in using the system?
F. What about system maintenance and calibration?

The answers to these questions given below are based on TEA's Thermal Test System (TTS) product line.

A. Does the system perform measurements in conformance to industry or military standards?

All TEA thermal test systems conform to United States Department of Defense Military Standards (Methods 750 and 883), EIA JEDEC JESD51, and various SEMI specifications in performing thermal measurements on almost any kind of semiconductor device. TEA's founder and president, Bernie Siegal, was intimately involved in the creation of most of the standards and, in fact was the primary author for several of the standards. Not all manufacturers of thermal test systems strictly conform to the thermal measurement standards, preferring to implement their own measurement approach instead. As a result, getting even though claiming conformance to standards, their thermal test results may not agree with results obtained from equipment that actually does conform to the standards.

It should also be noted that measurement standards, by virtue of the way they are established by committees, almost always lag the actual implementation of the latest thermal measurement technology. For example, the use of infra-red technology to measure junction and chip-surface temperature has existed for many years but no standard describing the measurement methodology exists. A list of existing thermal measurement standards can be found on the TEA website.

B. Can the system perform these measurements accurately?

There are two aspects of this question. First, what the system can do in terms of measurement accuracy. One system may claim forcing and measurement function accuracy's of 0.1% or better while a second system may claim 1% or better. Is the first system necessarily the best one for the job in spite of its potential increased cost? Not typically because of the second aspect.

Second, what is practical in terms of overall thermal measurement accuracy. The air velocity in wind tunnels used for forced convection (θ_{JMA}) measurements can typically held to not better than a few percent of the desired velocity. Thus, the advantage of a 0.1% accurate thermal measurement system,

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as compared to a 1% system, is lost. Similarly, when making junction-to-case (θ_{JC}) measurements on a high power transistor, the interface force between the case and the reference cold plate typically can not be set and/or repeated to better than a few percent at best. Thus, requiring the thermal measurement system to force the heating or measurement conditions to better than 0.1% doesn't make sense.

As a general industry-wide rule-of-thumb, thermal measurements are expected to produce data with best-case accuracy of about ±5%. All TEA thermal measurement systems can force and measure to better than 1% accuracy.

C. Does the system provide the data in a complete and useable format?

There is a tendency in current test equipment designs to provide only summary (i.e., statistical values) and/or resultant (i.e., values computed from unreported measured values) data. The data file is typically in a format unique to the system vendor, typically making access to the data inconvenient and difficult to read or interpret, especially if the data appear questionable.

TEA's approach provides the user with control over all the data collected. The thermal test system's setup screen allows selection of the desired measurement data to be displayed, printed and included in data files. Then the selected data is available in two different data file formats – a tabular, tab delimited text file (with a ".tdf" filename suffix) and a Microsoft Excel™ spreadsheet file (with a ".xls" filename suffix). Included with the test data are all the test header (date, filename, device type, etc.) and setup (heating conditions, measurement conditions, etc.) information.

D. Is the system easy to use in collecting thermal data?

Two important tools in the thermal measurement area are Cooling Curves[1] and Heating Curves[2]. Both of these tools require that the thermal test system collect the appropriate data in a specific manner and then display and save the data in a properly formatted fashion. All TEA thermal test systems provide for the automatic collection, display, printing and saving of data for these important curves. For the comparison of Heating Curves generated for different devices or measurement conditions, the TTS equipment now has multi-plot viewing and printing built into the operating software.

The user interface screens[3] for TEA's TTS equipment make using the systems extremely easy. The system's login capability allows for three levels of users – operator, engineer and administrator. The latter two can create and save test setups so that the operator can perform the thermal measurements but can not change any setup parameters. This feature helps to insure that the thermal data is correctly collected. After login, the four basic system operations – test setup creation/modification (SETUP), data collection (RUN), data display (VIEW), and system self-check (CALIBRATE/VERIFY) – each have separate screens.

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E. Are there any productivity issues in using the system?

Thermal measurements typically take a long time. A natural convection (θ_{JA}) measurement on a single integrated circuit package usually takes between 1,000 and 3,000 seconds. During this time, an "all-in-one" thermal test system can not be used for any other measurements. Thus, if the same system is used for calibrating the device's temperature sensitive parameter as well as making thermal measurements, it can only perform one task at a time which reduces overall measurement productivity. If, however, two systems – one for thermal measurements and one for temperature calibration – are used, then temperature calibration can performed while long-duration thermal measurements are underway. Similarly, a single "all-in-one" thermal test system capable of measurements of transistors, diodes and integrated circuits can only test one device at a time. Having multiple thermal test systems, each dedicated to a specific device type, can greatly improve measurement productivity in facilities that have to provide thermal testing for a wide variety of devices at the same time.

TEA offers separate products for calibration of the temperature sensitive parameter and for thermal testing of different types of devices.

F. What about system maintenance and calibration?

One of the most common situations in thermal testing occurs when the measured results do not agree with expected values. The performance of the thermal test system immediately becomes suspect. Because of the complex interactions between the various portions of the thermal test system, it us usually not sufficient to check each portion separately. For example, the voltage measurement portion of the system may work as required in a static mode but not perform well when making dynamic measurements. The same is true for current and voltage sources used forcing the test conditions.

TEA solves this problem by providing (at no extra cost) Calibration Verification Fixtures (CVFs) with each thermal test system and by integrating into the system software the routines to automatically check out the various portions of the system in a dynamic mode. The CVFs can be independently calibrated by the customer's metrology laboratory and then used with the system to perform a Verification (confirms system performance) or a Calibration (makes internal adjustments to meet system accuracy specifications). If the Verification operation shows that everything is within specification limits, no further action is required. If Verification shows out of tolerance values, then either a re-Calibration or maintenance is required. The Calibration is software-driven and does not require operator intervention except for plugging the fixture into the system and for operation initiation. Should maintenance be required, the system is a modular design with each module being easily replaced with backup units stocked by TEA.

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[1] Refer to TB-06 COOLING CURVES CORRECT MEASUREMENT DATA
(available at http://www.thermengr.com/TB/)

[2] Refer to TB-04 HEATING CURVES AID THERMAL CHARACTERIZATION
(available at http://www.thermengr.com/TB/)

[3] Review the TTS screens at http://www.thermengr.com/Screens/TTS_Screens.html