TEA

TTS-1010

Thermal Test Systems

The *TTS-1010* thermal test system combines the test and measurement capability of dedicated instruments with the ease of operation and data collecting capability offered by graphical-user-interface-driven software operating on an integrated computer. This unique combination provides the following features and benefits:

- Accurate implementation of the Electrical Test Method for Thermal Resistance Measurements of single and multi-junction (i.e., stacked) diodes in accordance with Mil-Std 750 thermal test methods
- Automated Thermal Measurement Operation for Heating Curve and Cooling Curve data collection, reduction and graphical presentation
- Multi-Mode operation for steady-state and transient measurements in:
  - Single-shot **Manual Mode**
  - **Automatic Mode** Heating and Cooling Curve Generation
- Kelvin Contact configuration for precise power dissipation forcing and accurate temperature measurement
- Integrated Heating Power Supply simplifies setup and operation
- Windows 2000 Professional™-based, integrated computer capable of controlling other equipment for automation of thermal environmental conditions - available in optional software version
- Mouse-driven graphical user interface simplifies test program creation, editing and storage
- Graphical data presentation on screen display and hardcopy printout
- Built-in compatibility with RS-232C, IEEE-488, SECS II and network interfaces - available as plug-in options
- Built-in power supplies and switching circuitry optimized for proper testing and minimal potential device damage
- Different control modes ("Engineer" & "Operator") insure test program and data security
- Broad Heating Time range for Thermal Transient (Die-Attachment and Thermal Response) Testing and Thermal Resistance (θ_{JC}, θ_{JA}, θ_{JMA}, θ_{JB}, Ψ_{JT}, Ψ_{JL}, Ψ_{JB}, etc.) measurements
- Multiple independent Temperature Sensitive Parameter (TSP) forcing and measurement channels for full device characterization - available option at time of order or factory retrofit; base system has single channel
- Integrated 4-channel Thermocouple Measurement Capability for monitoring case, lead and/or environment temperatures

Thermal Data Made Simple ---

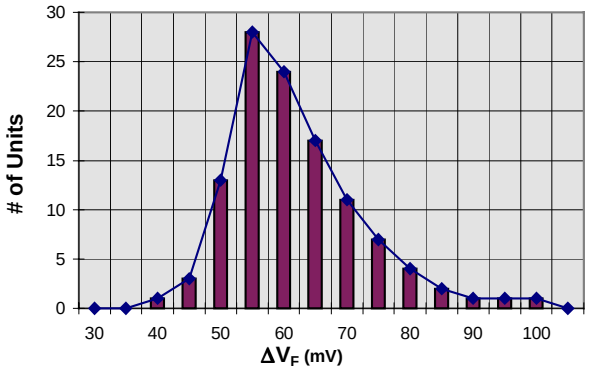
TABULAR DATA LISTING

Test #	DUT #	t_H (ms)	ΔV_F (mV)	θ_{JX} (°C/W)	ΔT_J (°C)	CU (mV/A)	I_H (A)	Temp i (°C)	Temp f (°C)	Bin #
1	1	300	27	17.9	13.5	179	0.151	23.7	23.7	1
1	2	300	28	18.3	14.0	183	0.153	23.7	23.7	1
1	3	300	27	17.5	13.5	175	0.154	23.7	23.7	1
1	4	300	29	19.2	14.5	192	0.151	23.7	23.7	2
1	5	300	25	16.4	12.5	164	0.152	23.7	23.7	1
1	6	300	27	17.6	13.5	176	0.153	23.7	23.7	1
1	7	300	28	18.4	14.0	184	0.152	23.7	23.7	1
1	8	300	27	17.9	13.5	179	0.151	23.7	23.7	1

Tabular Data Presentation

In screen display, hardcopy output or disk file, this format provides all the data collected in a simple to use manner. The screen display allows the user to see the data as it is collected. When testing is completed, the same data can be printed out for archival and analysis purposes. The disk file, in comma delimited ASCII format, is available for archival purposes or for import to the user's favorite data base, spreadsheet or analysis software.

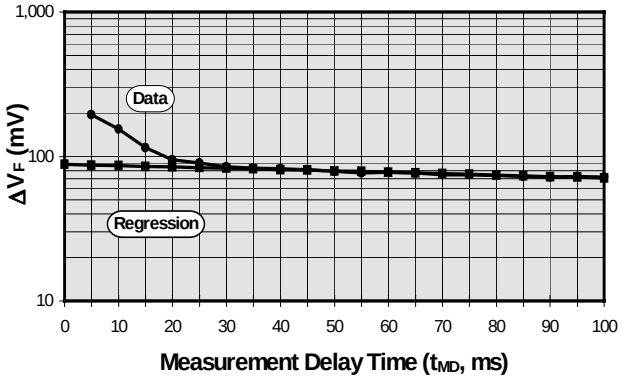
HISTOGRAM



Histograms for Production /Engineering Testing

When testing for a single data results, as in thermal response (die attach evaluation) or θ_{JC} measurements, depressing a single key allows the user to switch from a tabular listing to a histogram graphical display with statistical information (average, median, mode and standard deviation) shown in text form.

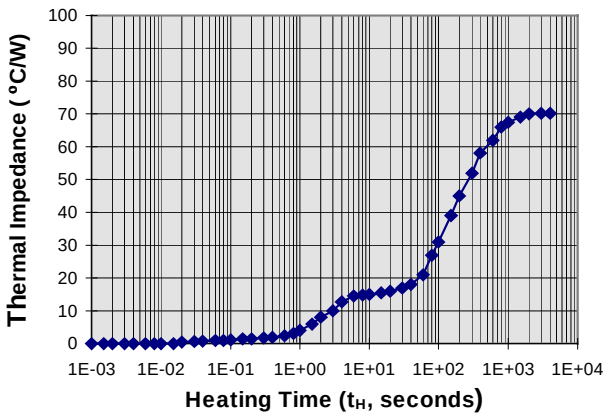
COOLING CURVE



Cooling Curve for Test Setup and Data Correction

The automatic generation of Cooling Curve data and graph display simplify the task of accounting for junction cooling effects. The graph display includes a user-controlled best-fit straight line algorithm for zero Measurement Delay Time determination and, if enabled by the user, automatic on-line data correction to further enhance the data measurement accuracy. From either display, another key stroke produces a hardcopy printout of the displayed information.

HEATING CURVE



Heating Curve for Device Thermal Characterization

The automatic generation of Heating Curve data and graphical display allows the user to fully thermally characterize a device for the given thermal environment of the test setup. Analysis of this curve provides the user with significant thermal information on the device's thermal structure and allows the user to pick the appropriate Heating Time for specific measurement purposes. A single key stroke switches the display from a tabular data listing to the graphical curve. From either display, another key stroke produces a hardcopy printout of the displayed information.

What to look for in a Thermal Test System ---

TEST FEATURES:

With over 30 years service to the thermal test market, *TEA* has incorporated into the *TTS-1010* system the key features that users need --

- ⇒ Carefully designed integrated testers dedicated to the proper thermal testing of devices with built-in device, system and operator protection - not a computer with general-purpose plug-in cards and external power supplies
- ⇒ Test automation for the most commonly required test types, with flexibility to perform "custom" tests as required - not limited to perceived notations of data interpretation or presentation
- ⇒ Strict conformance to existing and proposed military and industry test method standards to insure the generation of accurate and comparable data

While competitors concentrate on fancy software to dazzle the user, *TEA* 's goal is to assist the user in collecting the best data possible in a simple, proven manner.

"ALL IN ONE" IS NOT ALL GOOD:

Thermal testing is usually done in two parts. First, the temperature sensitive parameter (TSP) is calibrated so that the relationship between temperature and diode voltage is accurately known. Experience has shown, and the test method standards recommend, that the calibration is best performed on a batch of devices - not one at a time. *TEA* offers a separate low-cost instrument for this purpose. Second, after the calibration, the devices are individually tested on the *TTS-1010* system for thermal response and thermal resistance. This two step partitioning allows for greater equipment utilization and reduced overall test time.

DEDICATED APPROACH

Using its long history of working with semiconductor devices, *TEA* 's line of thermal parametric test systems have be designed for specific testing requirements over a wide enough dynamic range to accommodate most requirements. Designing systems for specific dynamic ranges allows for more optimum circuitry to increase measurement accuracy, to maximize device-under-test protection and to greatly simplify system operation. So called "expandable" systems offered by competitors have built-in trade-offs that put the burden of tester integration and operation on the user and often do not adequately address very specific testing requirements of certain semiconductor devices.

MEASUREMENT ACCURACY AND FLEXIBILITY

TEA 's *TTS-1010* system's measurement circuitry has been optimized for the difficult task of accurately determining small voltage difference on top of large voltage signals at high speed. Software algorithms for digital filtering augment the hardware's inherent capability to insure accurate data results. The user interface software for system control, data collection, and data presentation has been designed for greatest user flexibility without sacrificing ease of use. While capable of providing all collected data in tabular or graphical form, the software also allows the user to restrict the display so that only certain parameters are presented on the screen, saved in data files, or printed to the system's printer. The data files are setup in tab-delimited format for easy import into many commercially available spreadsheet programs.

INSTRUMENTATION ARCHITECTURE

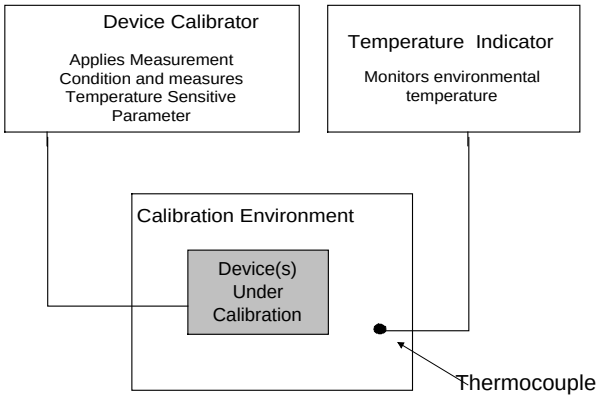
The *TTS-1010* system's architecture is instrumentation based and includes 16-bit analog-to-digital and 16-bit digital-to-analog convertors to maximize measurement capability and accuracy. All timing functions are referenced to a microprocessor-controlled, hardware-based crystal oscillator circuitry. The system is of modular design to allow for simple upgrades and to minimize maintenance and repair activities. A set of Calibration/Verification Fixtures are included with each system; these fixtures simplify system calibration and allow very quick system performance verificaiton.

THERMAL MEASUREMENT ACCESSORIES

TEA offers a full line of accessory products to simplify the thermal measurement/test process. Whether for engineering characterization or production testing, test fixtures are offered for most standard discrete and integrated circuit package styles in ambient (still-air), moving air, liquid and heat sink environments. Statistical Process Control software is available for engineering and production data analysis.

How to set up a Thermal Test Capability ---

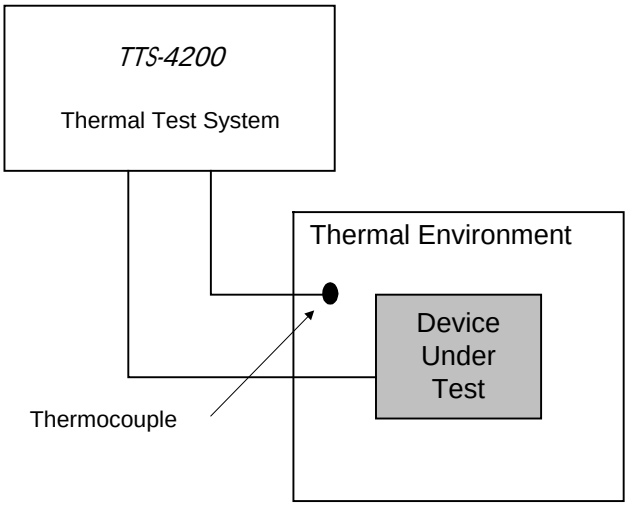
Calibration Setup



TEA supplies an integrated instrument for determining the relationship between the temperature sensing voltage and the junction temperature in accordance with the requirements of EAI/JEDEC JESD 51-1 and Mil Std 883. This instrument has contains the precision constant current supply for the Measurement Current (I_M), a digital voltmeter for TSP Forward Voltage (V_F) measurement, and a thermocouple measurement circuit with 0.1 °C resolution and 2% or better accuracy. The thermocouple is used to monitor the Calibration Environment Temperature. Usual practice is to calibrate devices in batches of 10 or 12 units. The thermocouple is usually attached to the case of the center device.

Usual practice is to use a small oven for batch testing of several devices. A liquid bath is often used for calibration of single devices.

Thermal Measurement Setup



The integrated *TTS-1010* system contains everything needed for making thermal measurements. Hard copy of raw data, test programs tabular data and data in graphical form is available from the printer supplied with the system.

The thermal environment, whether it be just an electrical contact fixture for thermal transient measurements (i.e. thermal response, die attachment evaluation, etc.), still-air chamber for θ_{JA}-type measurements, moving-air wind tunnel for θ_{JMA}-type measurements, or heat sink for θ_{JC}-type measurements, connects directly to the system. The system's built-in thermocouple circuitry provides real-time measurement of the thermal environment temperature. The thermo-couple data can be used for automatic correction of the device thermal data in certain circumstances to further improve the device thermal data accuracy and to calculate Ψ_{JT} as well.

All *TEA* thermal test systems are supplied compelete with 15" color high resolution video monitor, color high resolution ink-jet printer, keyboard and mouse.

TEA offers a broad range of different thermal test fixtures and environments for handling most standard semiconductor package styles. Custom- designed fixtures and environments are available for special, non-standard package styles and thermal environments.

Thermal Measurement Systems that make Sense ---

TEA offers the *TTS-1010* Systems configured to suite various thermal testing requirements of application and thermal test die without purchasing more capability than needed.

	Specifications	**Tolerance/Comments**
Device Capability		
	Stacked Rectifiers & HiV LEDs	
Heating Conditions		
Heating Time (t_H) Range	1 ms to 5,000 sec	
Heating Time (t_H) Setting	Manual – Single t_H value Automatic Curve Modes - Single t_H end value	Cooling Curve Mode collects data for t_{MD} varying from 5 µs to 100 µs in 5 µs steps for a fixed t_H setting Heating Curve Mode collects data at rate of 7 points per time decade from 1 ms to set t_H end point (end point must be one of 7 points)
Number of Heating Supplies	1	
Heating Current (I_H) Supply Setting 15 V Compliance 50 V Compliance	 50 mA to 5.00 A, 10 mA steps 50 mA to 2.00 A, 10 mA steps	 ±0.1% of setting ±5 mA ±0.1% of setting ±5 mA
Heating Voltage (V_H) Compliance	≤15 V & ≤50 V	
Supply Configuration	negative at system ground	
Measurement Conditions		
Number of TSP channels	1	
Type	4-wire Kelvin	
Measurement Current (I_M) Setting	1 to 100 mA, 1 mA steps	±0.1% of setting ±0.2 mA
Measurement Voltage (V_M) Compliance	≤15 V & ≤50 V	
Measurement Delay Time (t_{MD}) Setting	5 to 100 µs, 1 µs steps	
K Factor Setting	0 to 0.999 °C/mV	
Thermocouple Measurement		
Number of Thermocouple channels	4	
Thermocouple Type	T	Other types optionally available
Thermocouple Connector	Subminiature 2-prong	Supplied with system
Measurement Data Available		
TSP Voltage Change (ΔV_F) 15 V Compliance 50 V Compliance	 4.000 V (max) 12.00 V (max)	 ±0.025% of fs ±1 mV ±0.025% of fs ±5 mV
Thermal Resistance (θ_{JX})	999.9 °C/W (max)	±0.25% of fs ±0.5 °C/W
Heating Voltage (V_H)	15.00 V (max) & 50.00 V (max)	±0.1% of fs ±5 mV
Junction Temp Change (ΔT_J)	399 °C (max)	±0.05% of fs ±0.5 °C
Comparison Unit (**CU**)	9999 mV/V (max)	±0.2% of fs ±5 mV/V
Thermocouple Temp (**T**)	299.9 °C (max)	±0.05% of fs ±0.5 °C

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