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SOLUTIONS**

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# Micred Hardware Products

## Key Features:

Scalable equipment with a rich set of hardware add-on options:

- JEDEC compliant thermal resistance measurements;
- real-time measurement;
- continuous development, solid scientific background and worldwide consulting services;
- measurement control from any desktop or notebook computer;
- T3STER has the highest figure-of-merit among thermal test appliances available on the market.

What distinguishes T3STER from all other thermal characterization equipment on the market is its:

- speed and ease of use;
- wide applicability;
- accurate temperature measurement (0.01°C resolution); and
- one micro-second measurement resolution in time; resulting in
- highest available signal-to-noise ratio.

## Applications:

Applications include:

- heat-flow path reconstruction;
- die attach qualification;
- study of stacked die packages and other laminated structures;
- characterization of power LEDs;
- test-based compact thermal model generation packages for CFD analysis;
- in-situ, non-destructive failure analysis;
- material property identification (i.e., thermal conductivity of TIM);
- thermal model verification;
- in-situ thermal testing of parts in application environment, in live systems;
- test-based multi-domain modeling of LEDs for hot lumen calculations;
- combined power cycling and thermal testing for failure and reliability analysis.

## INTRODUCTION

Today Micred's hardware portfolio covers the thermal characterization of all kinds of semiconductor devices, and TIM thermal conductivity measurements. A family of measurement stations are also available, which combine T3STER (pronounced "tris-ter") measurements and active power cycling, to measure both electrical and structural degradation during accelerated testing, enabling the analysis of thermally-induced failure modes during reliability studies.

Micred's testing technology is based on high precision thermal transient measurements completed by sophisticated post-processing which yields a detailed thermal capacitance/thermal resistance maps of the junction-to-ambient heat-flow path. This technology allows in-situ qualification of thermal interfaces such as die attach layers and thermal interface materials (TIMs).

**ACCURACY, RELIABILITY, VERSATILITY, SCALABILITY**

[www.siemens.com/eda](http://www.siemens.com/eda)  
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T3STER (thermal transient tester) is an advanced hardware solution for thermal characterization of semiconductor device packages. T3STER has been designed to produce fast, repeatable and accurate thermal characteristics from a wide range of ICs, including stacked-die and system-in-package devices as well as other semiconductor components. Aside from measurement of existing packages, T3STER results can be used to create thermal models for use in thermal design software, such as Mentor Graphics Flotherm software, to predict device performance in various applications. T3STER results can also be read into Flotherm and used to automatically calibrate a detailed thermal model of a chip package, ensuring the model's predictive accuracy for both steady and transient simulations. Hence together, T3STER and Flotherm, enable engineers and developers to take full advantage of an unparalleled thermal design solution and underpin the accuracy of their thermal modeling activity.

### THE T3STER SYSTEM

T3STER's multi-channel architecture enables most package varieties (single or multi-die packages) to be characterized with the minimum number of measurements, including stacked-die packages, MCMs and RGB LED modules. Semiconductor manufacturers and packaging companies are the clear beneficiaries, but end-users of packages can also use T3STER to produce their own highly accurate thermal models. As a result, system-builders can quickly create an in-house library of validated thermal models resulting in a significant competitive advantage in thermal design.

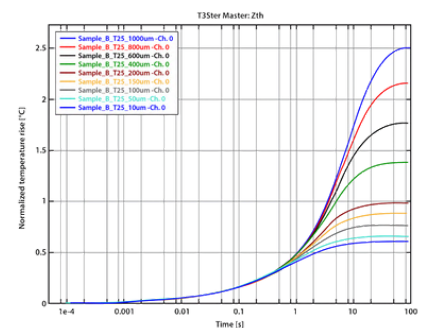
### T3STER TECHNOLOGY EXPLAINED

T3STER technology comprises of a flexible range of hardware, including the thermal transient tester itself and numerous accessories. These include a thermostat for calibration, high current and high voltage boosters, thermocouple preamplifiers, a JEDEC standard still-air chamber, cold plates, test-boards and special fixtures e.g. DynTIM for TIM thermal conductivity measurements). Measurements are controlled through a USB port allowing control from any computer, and the advanced results post-processing software enables easy viewing and comparison of the results. TeraLED provides the connection to the world of lighting, allowing the combined optical and thermal testing power high power and high brightness LEDs.

Using a smart implementation of the JEDEC JESD51-1 static test method, the thermal tester forces a packaged semiconductor chip from a steady "hot" state to a steady "cool" state using a single step change in input power, and uses the measured internal transient temperature response to generate a complete thermal characterization of the package. Following the latest testing standards such as the JEDEC JESD51-14 "transient dual interface method", measurements take just a few minutes.

### REAL-TIME MEASUREMENT

T3STER carries out real-time measurements in conformance with the static test method described in the JEDEC JESD51-1 standard. This "continuous measurement" technique combined with precision hardware results in capturing very accurate and almost noise-free real-time thermal transient curves at high time resolution. The JEDEC JESD51-1 dynamic test method is also available with T3STER. T3STER complies with the latest JEDEC thermal testing standards such as JESD51-14 "transient dual interface method" for the measurement of the junction-to-case thermal resistance of power semiconductor packages or the JESD51-5x series of LED thermal testing standards. Compliance to MIL standard 750E for testing transistors is also provided.



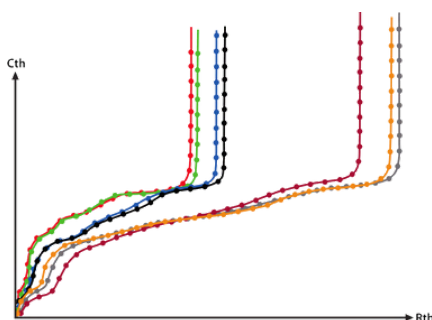
Thermal impedance curves captured at different bond line thicknesses

## STRUCTURE FUNCTIONS

Structure Function analysis is one of the most important and unique features of the T3STER-based measurements. Structure functions are the representation of the thermal structure as a thermal resistance versus thermal capacitance profile. This representation provides detailed thermal information of each layer the heat passes through, from junction to ambient.

Structure functions are ideal means for the identification of:

- junction-to-ambient thermal resistance and other JEDEC standard thermal metrics such as junction-to-case thermal resistance (using the latest JEDEC standard JESD51-14);
- partial thermal resistances and related thermal capacitance values along the heat-flow path;
- material properties and geometrical dimensions of the heat-flow path; and
- structural degradation over time (e.g. during power cycling).



Structure Function curves showing shift due to degradation

## KEY ELEMENTS OF THE PORTFOLIO

T3STER, T3STER MASTER, ADD-ONS  
The T3STER hardware and its PC (Windows) based control software (T3STER Control) are the core of the T3STER-based measurement set-ups. The main hardware unit includes the following functions: a power driving module for heating up the components to be measured, sensor current sources, up to eight measurement channels and interface to the controlling PC and the add-on units. By itself this is capable of basic powering, and measuring the thermal response and additional values (e.g. temperatures) on up to 8 channels.

The thermal responses captured by T3STER can be post-processed by T3STER Master software, which is a separate software package running on a PC (Windows). Post-processing includes:

- handling the thermal impedance curves
- presenting the device response to pulsed periodic excitation (pulse thermal resistance);
- presenting the device responses to periodic excitation shown in frequency domain (complex loci);
- calculating time constant spectra; and
- computing the structure function and its derivative;

all of which are derived from the measured thermal impedance curves. Post-processing also provides a way to analyze and compare Structure Functions, e.g. to check for deviations from a known good sample, or over time, or to obtain specific  $Z_{th}$  values.

The T3STER portfolio includes the following hardware add-on options:

- additional measurement channels;
- power boosters to raise the power driving capability of the main system unit from 100 W to multiple kilowatts;
- extension of the main system unit to provide additional power driving channels for simultaneous powering of multiple junctions;
- thermocouple pre-amplifiers to interface J, K or T type thermocouples to the measurement channels of the main system unit;
- a Peltier-based dry thermostat used as a device calibrator or as a cold-plate with automated temperature control from within the T3STER measurement software;
- test environments such as JEDEC standard 1ft3 still-air chamber or dual cold-plates;



For further information on the T3STER, please visit: [plm.sw.siemens.com/en-US/simcenter/physical-testing/t3ster/](http://plm.sw.siemens.com/en-US/simcenter/physical-testing/t3ster/)

### MEASURING LEDs – TeraLED

Applying the T3STER technology in a combined thermal and optical test, measurement and characterization of Light-Emitting Diode (LED) components and Solid State Lighting (SSL) arrays is possible with the TeraLED add-on. With its integrating sphere available in two different sizes for different optical power ranges, the combined system implements the JEDEC JESD51-51 and 51-52 compliant LED test setup. The optical measurement on one hand is used to calculate the thermal characteristics, while on the other hand the temperature dependence of the light output parameters is also captured.

Besides obtaining the optical parameters (such as Color Coordinates, Scotopic Flux, Radiant Efficiency, Luminous Efficacy, Efficacy of Radiation, Correlated Color Temperature) in a temperature controlled environment the TeraLED system also provides the LED package compact thermal model completed with the light output model, which allow the FloEFD LED module to perform accurate thermal simulation.

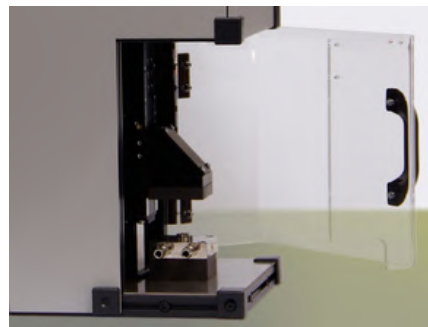


For further information on the Simcenter Micred LED Tester, please visit:  
[plm.sw.siemens.com/en-US/simcenter/physical-testing/micred-led-tester/](http://plm.sw.siemens.com/en-US/simcenter/physical-testing/micred-led-tester/)

### ANALYZING THERMAL INTERFACE MATERIALS – DynTIM

Thermal Interface Materials (TIMs) are a specific element of the total heat path, and require separate, and often more frequent thermal characterization to measure or confirm their thermal conductivity value, which can be batch dependent. DynTIM (with T3STER) is unique in that it is designed to measure soft TIM materials (greases, gap pads), as well as harder TIMs such as adhesives and solids.

Providing the thermal conductivity value of a large variety of ASTM Type I, II and III Materials is done by precise control of thickness in an accurate, automated and repeatable process for Type I & II materials, and pressure for Type III materials.



For further information on the Simcenter Micred LED Tester, please visit:  
[plm.sw.siemens.com/en-US/simcenter/physical-testing/micred-tim-tester/](http://plm.sw.siemens.com/en-US/simcenter/physical-testing/micred-tim-tester/)

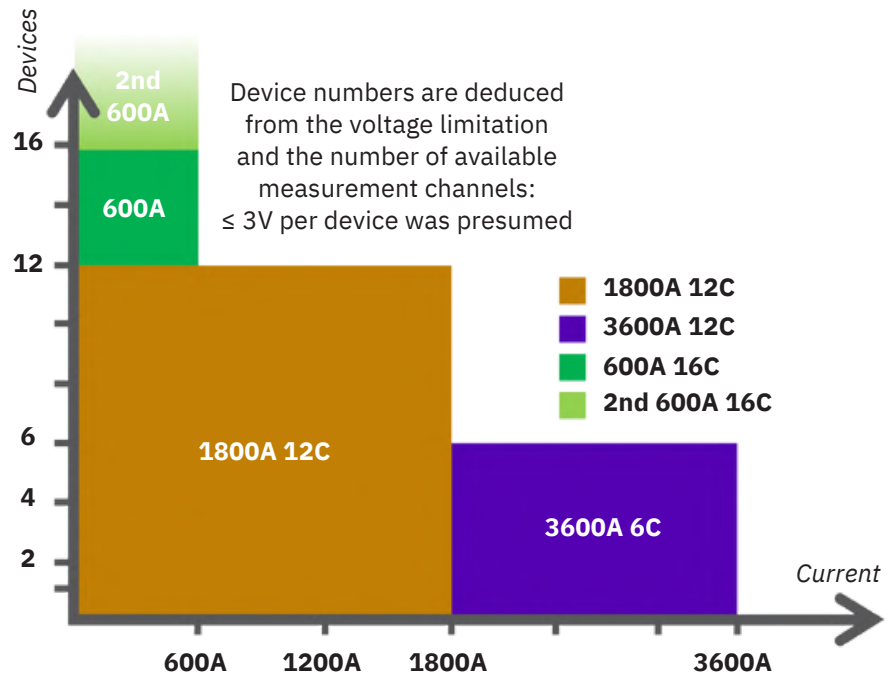
### Micred INDUSTRIAL POWER TESTER FAMILY

The Micred Industrial Power Tester combines both active power cycling and T3STER-based thermal transient measurements with automated structure function analysis within the same machine. The active power cycling is able to replicate a range of realistic operating conditions through the wide choice of available cycling strategies. The thermal analysis is done regularly during the cycling, allowing any structural changes resulting from thermally-induced degradation to be captured.

Multiple Power Tester configurations are available to support the different power electronics applications. Systems with output currents up to several thousand Ampere, are available to test high power devices used in rail traction, energy conversion and similar applications. Alternatively, up to 16 parts can be connected in series in a system that is itself scalable by chaining up to 8 systems together, so that up to 128 parts can be tested concurrently under the control of a single ruggedized touchscreen computer, exceeding the requirements of the automotive industry for reliability testing of components used in electric power-train.

**PROCESS ORIENTED USER INTERFACE**

The user interface of the Micred Industrial Power Tester supports the use of the T3STER technology combined with power cycling within different parts of an organization dealing with such measurements of power semiconductors and their modules. Integrated touch screen control supports having predefined templates for measurement projects and devices under test, making it simple for test engineers and technicians to set up repeatable measurements. Once a power cycling and testing strategy is defined, the Power Tester performs the defined power cycling until set stop criteria are met. The measurement results can be then viewed, analyzed or post-processed depending on the use case.



For further information on the Micred Industrial Power Tester series, please visit: [plm.sw.siemens.com/en-US/simcenter/physical-testing/powertester/](http://plm.sw.siemens.com/en-US/simcenter/physical-testing/powertester/)

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