TIM Measurement System

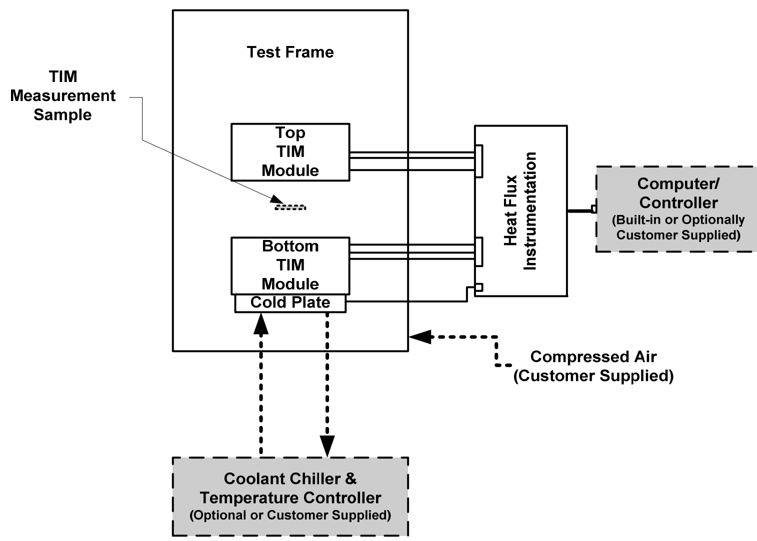
The TIM Measurement System it specifically designed for thermal conductivity measurements on a wide range of materials used in electronic system thermal management applications. The system consists of four parts:

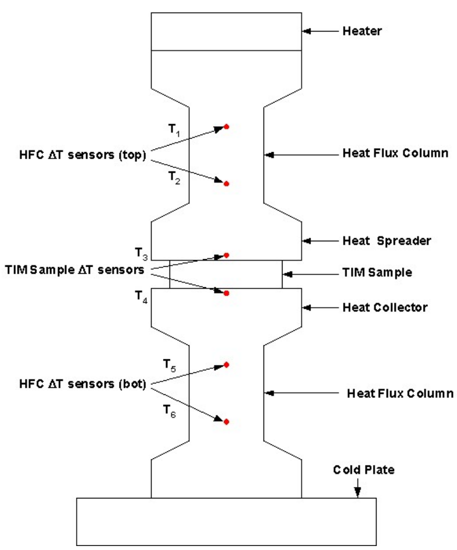

System shown with optional 100mm air cylinder and without optional computer and thickness set/measurement apparatus.

- The Thermal Test Frame (TTF) apparatus is the mechanical portion that applies the pressure and provides the cold plate reference temperature.
- The TIM Measurement Modules (TMMs), top and bottom units that plug into the TTF, provide the heat flux to the test sample and contain the sensors for temperature measurement across the integral heat flux columns and across the test sample.
- The Heat Flux Instrumentation (HFI) box is a stand alone unit that contains measurement and heat flux-generation electronics and the USB computer interface.
- The computer/controller, which is either provided by TEA or optionally customer-supplied, contains all the software that drives the system and collects, displays and saves the data produced by the system.

Measurements made in general accordance with the ASTM 5470 standard.

The System block diagram on the right shows how all the parts are inter-connected. The Compressed Air for driving the TTF pneumatic cylinder and the Coolant Chiller & Temperature Controller for driving the cold plate are normally provided by the System installation facility. A system facilities cart that provides compressed air and recirculating liquid coolant is optionally available from TEA.





The TIM Measurement System operation is based on the dual Heat Flux Column (HFC) approach shown on the left. The heat flux generated by the heater at the top passes through the top HFC column and is applied to the top of the TIM Sample. The temperature differential across two precisely placed thermistors measures the actual heat flux. Similarly, the bottom HFC measures the sample bottom temperature and the heat flux coming through the sample. The average value of the measured top and bottom heat flux is divided into the sample differential temperature to determine the thermal resistance value. A series of these measurements are used to derive the actual thermal conductivity of the TIM Sample.

Thermal Engineering Associates, Inc.
3287 Kifer Road, Santa Clara, CA 95051 USA
Phone: 650-961-5900
FAX: 650-227-3814
E-Mail: sales@thermengr.com

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	Specifications	Comments
TIM Measurement Modules		
Heater Power Capability	Up to >100W	
Sample Heat Flux Measurement Type	Heat Flux Column	
Heat Flux Cross-Section	Circular – 30mm (1.18") dia	
Heat Flux Measurement	Temperature Differential across length of column	Two sensors placed at a precise distance (12.7mm) apart
Absolute Temperature Sensors	- Top Heat Flux Column bottom - Bottom Heat Flux Column top	Embedded 0.5mm from interface surface
Sample Size	Square or Circular	Square: 20mm X 20mm Circular: 25.4mm ϕ
Sample Force	500N (112lbs) maximum	Standard 40mm Ø cylinder (Other cylinder sizes/sample force combinations are available)
Heat Flux Instrumentation		
Heater Power Programming Range	5W to >100W	1W setting capability
Heating Duration Modes	- Fixed time in 1s to 5,000s - Steady-State excursion limit	1s setting capability User determined
Cold Plate Temperature Range	10 to 50°C (Type-T thermocouple)	Dependent on chiller and power
Heat Flux Column Differential Temperature Measurement	0 to 10°C (thermistor)	0.01°C resolution, ±0.1°C accuracy
Test Sample Differential Temperature	0 to 10°C (thermistor)	0.01°C resolution/±0.1°C accuracy
Test Sample Temperature Range	20 to 80°C (thermistor)	0.01°C resolution/±0.1°C accuracy
Thermal Conductivity Measurement	≤ ±7% accuracy worst case*	≤ ±5% accuracy typical* * Requires correction for Bond Line Resistance
Data Display	(see screen shot below)	
Data Storage	Comma delimited text file	Easily imported into Excel™ spreadsheet
Thermal Test Frame		
Compressed Air:	Input Pressure Connectors	60 psi nominal (80 psi max) CDA 1/4" OD, Quick Connect
Pneumatic Cylinder:	Bore Diameter Stroke	40mm (standard; other sizes available) 50mm (standard; other sizes available)
Coolant:	Liquid Flow Rate Connectors	Mineral-free water or glycol solution 45.5 lph (12 gph) 1/4" OD, Quick Connect
Controls: (mounted on front panels)	AC Mains Switch Air Pressure Display Air Pressure Regulator Cylinder Up/Down Switch Coolant Flow Control	

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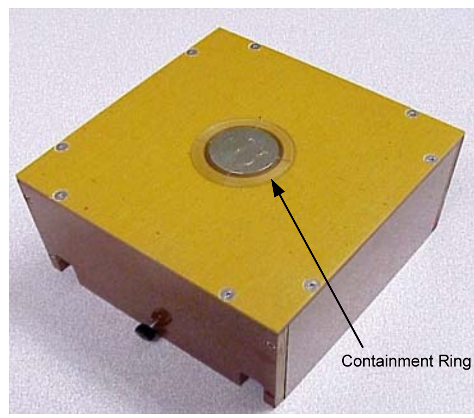
System		
Power Main Requirements: HFI TTF	 100 - 240 VAC, 50/60HZ 100 - 240 VAC, 50/60HZ	 650W 25W
Size (approximate): TTF HFI	 44cm W X 26cm D X 54cm H 31cm W X 26cm D X 13cm H	 17” W X 10” D X 21” H 12” W X 10” D X 5” H
Weight (approximate): TTF HFI	 9.9Kg 4.1Kg	 26.5 lbs 11 lbs
Computer Requirements:	- Intel P4 PC or equivalent - Windows™2000 Pro SP4 or XP Pro SP3 - 512MB RAM - 1024 X 768, hi-color display - 40MB Hard Disk space - USB port (version 2.0 or higher) - Printer (color preferred)	Only required if optionally ordered without the built-in system computer.

Handling of Non-Solid Test Samples

Grease-type materials can be measured using one of the containment rings supplied with the system. The rings are designed to tightly slip over the HFC_{Bot} and sit flush on the top guide plate. The HFC_{Top} tightly slides into the ring so that either pressure can be applied to the material contained by the ring or a gap can be set (see below) to a preset material thickness. The test sample area becomes the inner area of the ring – 706.86mm^2 (1.0956inch^2). The excess material contained in the ring can flow out along the four slots cut into the top of the ring surface. These slots may need to be increased in width depending on the viscosity of the grease material.



Optional Test Sample Thickness Setting/Measurement Capability

The TTF can be optionally fitted with a micrometer-based apparatus shown at right. The micrometer has 0.05000” (1270µm) range and can resolve down to 0.00001” (0.254µm); a metric micrometer is available with a similar range and resolution.

With this optional capability, either a preset thickness can be established and the force being whatever it takes to result in the preset thickness or some desired force can be applied and the thickness measured. A precision cap fits over the reference stud to allow handing of test samples greater than 0.050” (1270µm) thick.

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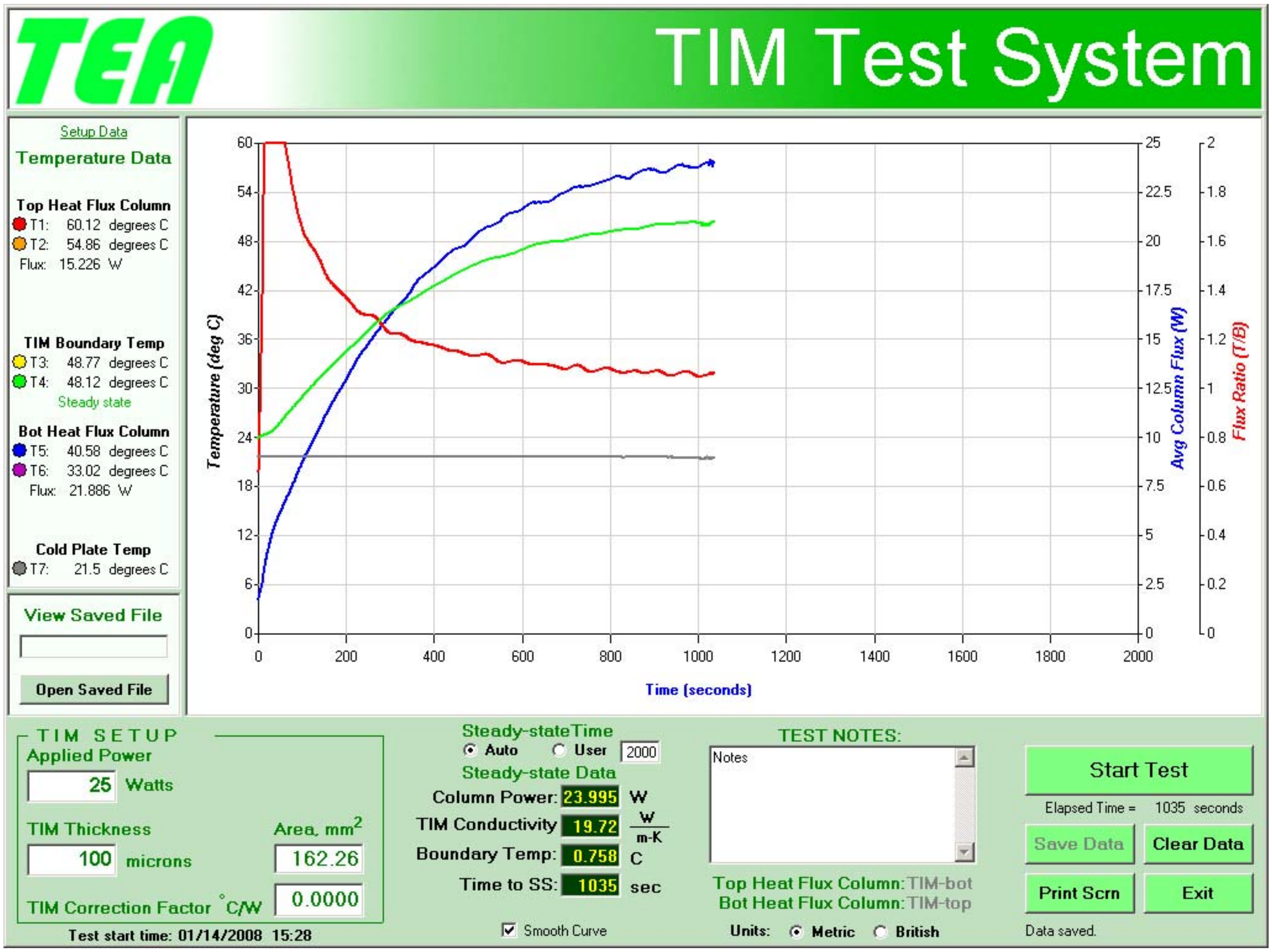
The system main user interface screen is shown below. The left vertical pane provides all the temperature measurement information (see the Heat Flux Column diagram above). The center section chart shows several measurement parameters as a function of time after measurement initiation. The key measurement parameters are entered and display in the TIM SETUP box in the lower left. The clickable buttons in the lower right provide control of the system operation. The center bottom area contains the measurement results and a box for entering measurement run notes. This area also contains Steady-state Time setting for either automatic determination of when the measurement run is completed or a user-entered fixed measurement time.



If the TIM Correction Factor is known prior to the start of the measurement run, the value can be entered in the TIM SETUP box area so that the displayed TIM Conductivity value is already corrected.

The system has built-in calibration capability for zeroing out the temperature differential between thermistor measurement pairs (see Heat Flux Column diagram above).

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