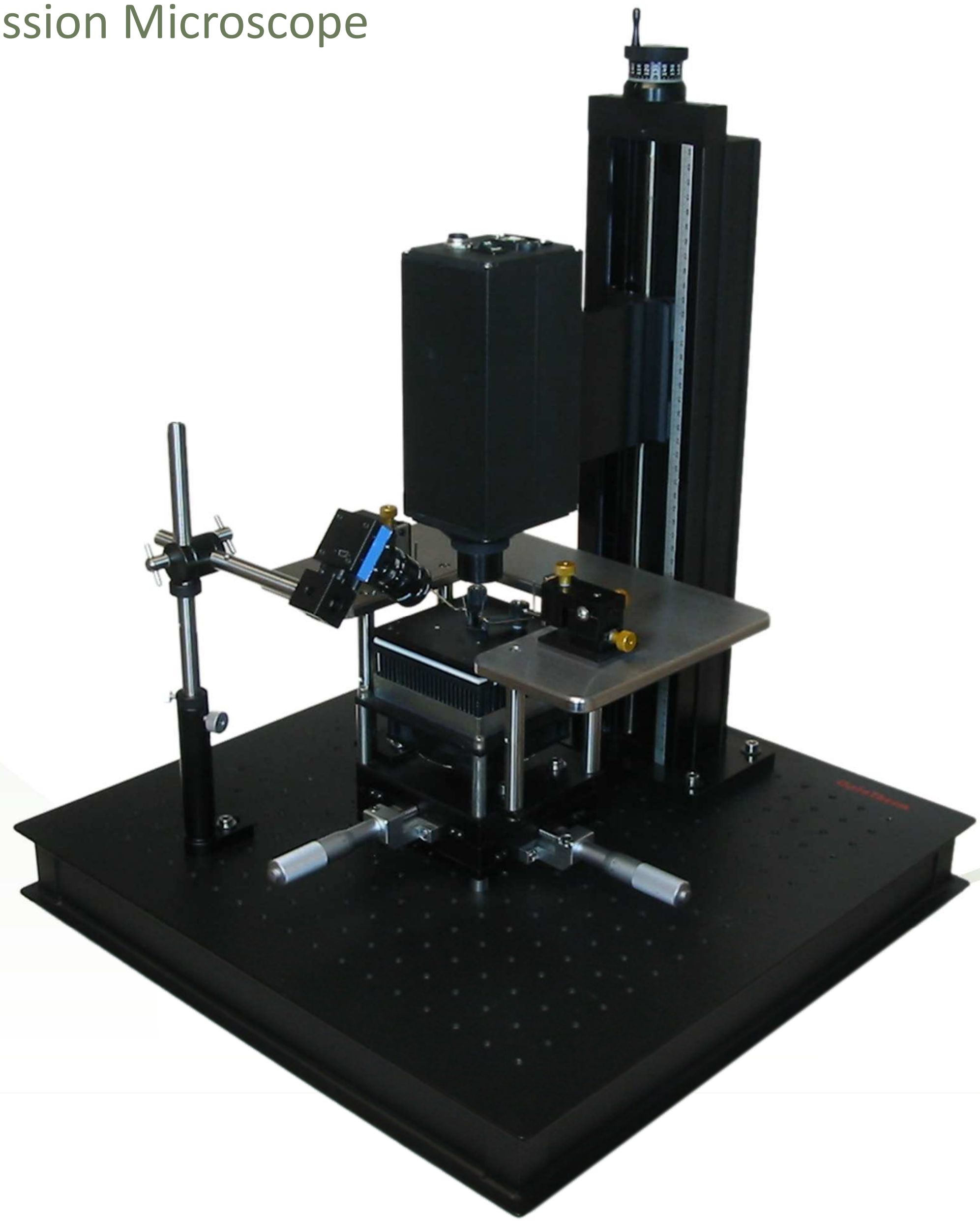
OPTOTHERM
THERMAL IMAGING

Sentris

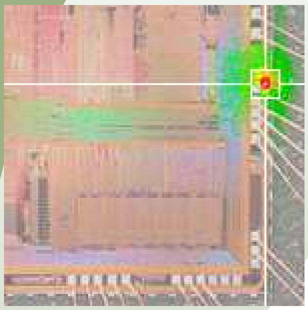
Thermal Emission Microscope



Semiconductor Device Fault Isolation

Sentris

Thermal Emission Microscope for Semiconductor Device Fault Isolation



Due to the continued decrease in integrated circuit feature size and supply voltages, detecting and locating the miniscule amount of heat generated by failure sites has become increasingly difficult. The Sentris thermal emission microscope pinpoints the low-level infrared energy emitted by faults on semiconductor devices such as short circuits and leakage current.

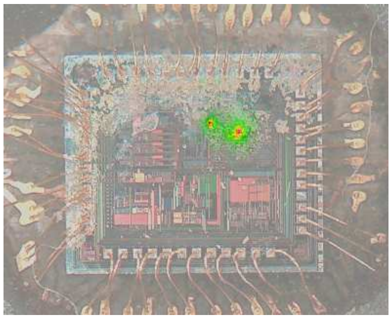
Using lock-in thermography analysis, failures can be isolated on both bare (front or backside) and packaged devices and no surface coating is required. Sentris can also locate low-power fail sites on SMD components, such as capacitor leakage. The x, y position of defect sites can be located, as well as defect depth. Depth analysis can be very helpful when isolating faults in stacked die packages.

In addition to fault isolation, Sentris also includes thermal analysis tools for the following applications:

- True temperature mapping
- Junction temperature measurement
- Die attach evaluation
- Thermal resistance evaluation

Lock-in Thermography Fault Isolation

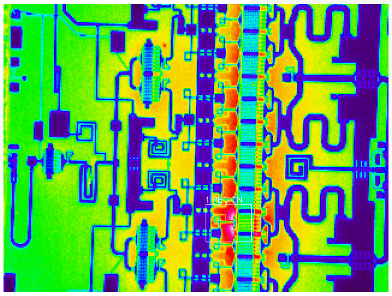
Lock-in thermography is a process of automatically and repeatedly powering a device at regular intervals using a laboratory power supply and solid-state relays while the temperature response of the device is analyzed over time. Using this technique, hot spots that heat up less than 1mK (0.001°C) and dissipate below 100 µW can be detected. Weak sources of heat arising during normal operation of the device can even be detected.



In addition to identifying the x, y location of a defect, fault depth within a stacked-die can also be determined by analyzing the phase angle between device power and subsequent surface heating.

True Temperature Mapping

When imaging semiconductor devices, much of the image contrast is due to differences in emissivity, not to temperature variations. Measuring true temperature requires compensating for emissivity variations according to the following procedure:



1. First, the unpowered device is placed on the thermal stage so that its temperature can be precisely controlled.
2. After it has reached thermal equilibrium, the Emissivity Tables software tool is used to automatically create an emissivity map of the device.
3. Finally, the emissivity map is applied to thermal images to obtain accurate temperature measurements at any point on the device.

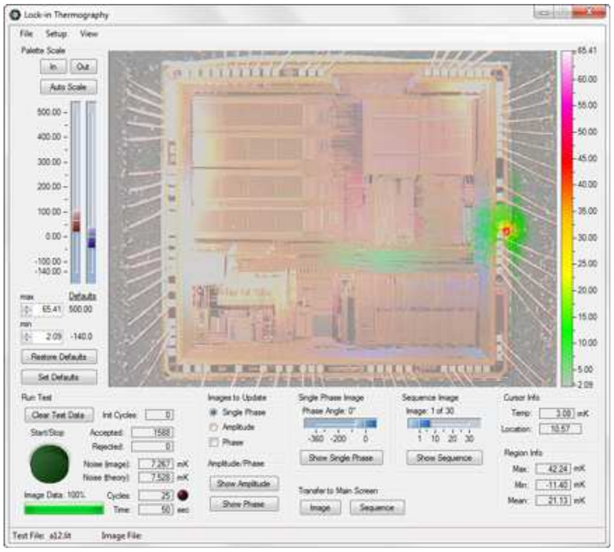
How it Works

Lock-in Thermography

Sentris employs sophisticated Lock-in Thermography software and hardware to dramatically improve detection sensitivity and fail site spatial resolution. While performing a lock-in test over many power cycles, the sum of thermal images captured while the device is unpowered are subtracted from the sum of thermal images captured while the device is powered, resulting in test images displaying localized heating.

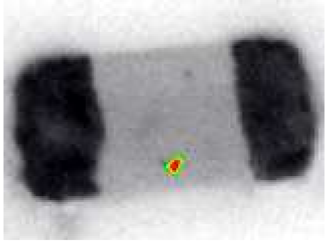
Cycle Frequency can be selected for optimal results. Performing lock-in tests at lower frequencies improves test signal/noise due to higher device heatup. Higher frequency tests improve hot spot spatial resolution by reducing thermal diffusion into adjacent areas of the device.

Test sensitivity is directly dependent upon lock-in test time. Increasing the number of test cycles improves test sensitivity. As a test continues to run, lower and lower power dissipation levels can be detected. There is no limitation regarding how long a Sentris lock-in test can be performed. Consequently, finding an extremely small heat signature is only a matter of time.



max 65.41 Defaults 500.00
min 2.09 -140.0
Int Cycles: 0
Accepted: 1588
Rejected: 0
Noise (image): 7.267 mK
Noise (theory): 7.528 mK
Image Data: 100%
Cycles: 25
Time: 50 sec
● Single Phase
○ Amplitude
☐ Phase
Phase Angle: 0°
Image: 1 of 30
Temp: 3.08 mK
Location: 10.57
Max: 42.24 mK
Min: -11.40 mK
Mean: 21.13 mK
Test File: a12.lit
Image File:

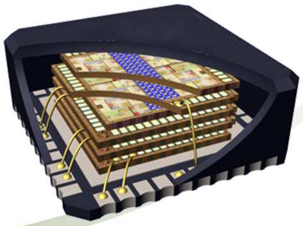
Test Procedure



1. The semiconductor device is placed on the Thermal Stage so that its temperature can be raised for ease of focusing. In cases of very low leakage current, the temperature of the device can be raised further in order to increase leakage current to improve the likelihood of detection.
2. Device biasing is accomplished via exposed leads, package pins, or by probing the device using the Probe Positioners. One or more of the biasing leads are routed through the Relay Module so that the Sentris software can control the timing of applied power. If possible, the applied voltage level is set so that at least 1 mW is dissipated within the defect. This level of power is generally sufficient to localize the fault within seconds or minutes. Lower applied power levels will require longer test times.
3. During the Lock-in test, thermal images are captured while device power is cycled until the fail site is located.
4. A visual picture, schematic, or thermal image of the device is superimposed over the Lock-in results to precisely locate the defect.

Defect Depth

Determining fault depth in 3-dimensional system-in-package (3D SiP) devices is becoming increasingly important due to their expanding complexity and decreasing dimensions. As the number of stacked die in 3D SiP devices grows, isolating the root cause of defects within the package becomes more challenging. Sentris provides a proven, non-destructive technique to localize the depth of faults through 3D SiP packages.



Sentris Components

Sentris is supplied as a complete, fully-tested system that includes all of the following hardware and software components:

Thermal Imaging Camera
- Optotherm Infrasight MI320
- Microscopic 20 micron lens
- Macroscopic lens

Software
- Optotherm Thermalyze thermal image analysis software

Device Mounting
- Mounting platform
- Vertical focusing stage
- XY device positioning stage

Device Temperature Control
- Thermal stage (0-80°C)
- Thermal stage controller

Device Probing
- Probing platform
- Probe positioners
- Visual camera
- LED spot lights
- Solid-state relay module

Computer
- Dell PC with monitor
- CameraLink video board

Sentris Accessories

- Microscopic 10 micron lens
- Microscopic 5 micron lens
- High temperature thermal stage (0-130°C)
- Emissivity coating kit

Sentris Specifications

Measurement Range:	-40 to 500°C
Measurement Accuracy:	+/-2°C or +/-2% of measurement (whichever is greater)
Image Capture Rate:	30 frames/sec
Detector:	Uncooled LWIR (7-14 µm) microbolometer: 320x240 pixels
Lenses Available:	Macroscopic: focusable 50x37.5° FOV†, min 25mm WD‡, 0.05°C NETD
	Microscopic 20 micron: fixed-focus, 6.4x4.8mm FOV, 19mm WD, 0.15°C NETD
	Microscopic 10 micron: fixed-focus, 3.2x2.4mm FOV, 15mm WD, 0.20°C NETD
	Microscopic 5 micron: fixed-focus, 1.6x1.2mm FOV, 15mm WD, 0.25°C NETD

†Field-of-view
‡Working distance

Specifications subject to change. Please see our website for current specifications.

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