Circuit Scan 1000:

Frequently Asked Questions

What is the Circuit Scan 1000?

The Circuit Scan 1000 (CS1000) is a non-invasive diagnostic tool for the semiconductor and electronic industry. It is a sensitive, high-resolution magnetic imaging tool which is used to map out current flow in integrated circuits and semiconductor packages.

What is it good for?

By allowing the user to visualize the flow of electrical current throughout a current-carrying IC, package, or PCB, the Circuit Scan 1000 can aid failure analysis engineers to localize and diagnose common failures, such as short circuits and current-voltage anomalies. The CS1000 can also aid chip designers by providing quantitative measurements of current flow at sub-micron scales. These data can then be checked against design specifications. Most importantly, the CS1000 operates completely non-invasively and ignores even intervening metal layers, and therefore requires no sample preparation other than powering.

How does it work?

All electrical currents create magnetic field signatures according to the Biot-Savart law of electromagnetism. The CS1000 uses an ultra-sensitive and high-resolution magnetic sensor to measure these magnetic fields at or above the surface of a current-carrying sample (such as an operating IC). The system then uses algorithms to convert this information into a "map" of current flow inside the chip, which is automatically overlaid on a high-resolution optical or infrared camera image of the device under test. Some examples of these current density maps are shown in our **image gallery**.

What sample preparation is required before using the CS1000?

In general, powering the sample is the only sample preparation required.

The CS1000 measures magnetic fields, which are only affected by ferromagnetic materials (Fe, Co, Ni, and certain of their alloys). Because almost all ICs and packages are non-magnetic, these magnetic fields are unaffected by any encapsulation or even intervening metal layers. Therefore, the CS1000 can "see" all the magnetic fields from the device without the need to de-layer, polish, or otherwise process the sample.

Is the CS1000 a good approach for my specific problem/fault? Will it be a valuable approach to use for my current issue?

Since the CS1000 maps out current flow in the plane of the device under test, two good questions to ask yourself when considering the use of this system are:

Is there a change in the distribution of electrical current between this device and a known good device?

If I were able to see the paths of current flow in this device, would it help me to better understand or localize the problem?

If the answer to either of these questions is yes, the CS1000 can likely find the problem or at least narrow down the area of interest.

How do I register the magnetic or current density images created by the CS1000?

The CS1000 features a high-resolution optical navigation system which allows the user to click-and-drag on an optical image of the DUT to define the extent of a scan. Scans are automatically registered and overlaid on the optical image when completed. Some example overlaid scans are available in our **Image Gallery**.

Will the CS1000's sensor probe touch/damage my device?

The CS1000 includes a surface level sensing system which automatically stops the sensor when it comes in contact with any physical object. The sensor cartridge itself is mechanically flexible and should not damage the device under test. In addition, the software has been designed and tested with many features specifically intended not to allow the user to physically damage the sensor or any other object in the scan area.

My device is very small, has obstructions, or has limited access. Will I still be able to use the CS1000?

The MTJ sensor used as the CS1000's primary sensor is mounted in a vertical probe arrangement, where the bottom tip of the sensor probe has a footprint of only about 100 x 300 m. Because the sensor is located at one edge of this footprint, the sensor can be brought to within 40 m of wire bonds or other obstructions. The full sensor probe itself is quite narrow and is able to fit into small cavities of only a mm or less. We recently obtained a full image of current flow in a die with an area less than a millimeter square, which was surrounded by bond wires.

What are the different scan modes?

The CS1000 features several methods for scanning a device. In non-contact mode, the sensor probe follows the surface of the sample at a fixed separation, which is specified by the user. Sample tilt is automatically corrected for by the motion control software and the sample need not be physically adjusted. In light-contact mode, the sample and sensor maintain light physical contact using closed-loop feedback.

Explain the types of magnetic sensors available for use with the CS1000.

The CS1000 has two standard types of magnetic sensors: magnetic tunnel junction (MTJ) sensors and giant magnetoresistive (GMR) sensors. The magnetic tunnel junction sensors have better current

sensitivity (in general, down to the single microamp level), while the GMR sensors can obtain highest spatial resolution (down to 100 nm in some cases).

How long does a scan take?

An initial scan of a chip (10k-40k pixels of data) generally takes 5-15 minutes, depending on the area to be imaged and on the amount of current flow. A higher-resolution scan (100k-500k pixels of data) requires an hour or two. The CS1000 software allows the operator to adjust a number of parameters which trade-off speed for sensitivity and displays the estimated scan time as these parameters are changed.

What's the smallest amount of current the CS1000 can detect?

The CS1000 using an MTJ sensor can readily detect a current of 1 A inside a die. For samples with more intervening material, such as IC packages and printed circuit boards, current thresholds can vary from 5 to 30 microamps.

What's the spatial resolution of the system?

The spatial resolution of the system depends somewhat on what is meant by this term, but as a general rule the spatial resolution of the CS1000 can be as small as 100 nanometers when a standard GMR sensor is used. The spatial resolution is quite dependent on the distance between the surface of the sample and the current-carrying layer. Therefore, spatial resolution is highest for a bare die and reduced for a full packaged assembly or PCB.

What if the sample surface isn't level?

The CS1000 is equipped to automatically correct for any tilt in the sample surface, without the need to physically adjust anything. Using the CS1000's sample surface sensor, the sample surface is automatically measured. If the surface is sufficiently planar (which is almost always the case), the system moves in such a way as to automatically follow the surface of the sample, even without touching it.

I need more information or would like to do an evaluation. Who do I contact?

Tool evaluations can be done either by a site visit to Micro Magnetics or simply by sending us a device. To schedule an evaluation, please contact us at admin@micromagnetics.com or 508-672-4489.

More detailed information about the technique of magnetic imaging for fault isolation is included in various technical articles written by Micro Magnetics employees. These articles are available for download from the the **Publications Page** of our site.

To receive a free video demonstration of the CS1000 on a CD, please send your contact information, including email and physical address, company, and phone number, to Micro Magnetics, Inc. (admin@micromagnetics.com or call 508-672-4489).

Do you offer scanning services using the CS1000?

Yes, we offer scanning services – which includes operator time and the CS1000 tool time -- on an hourly or daily basis. Please feel free to contact us (admin@micromagnetics.com or at 508-672-4489) to check system availability or to discuss your application.