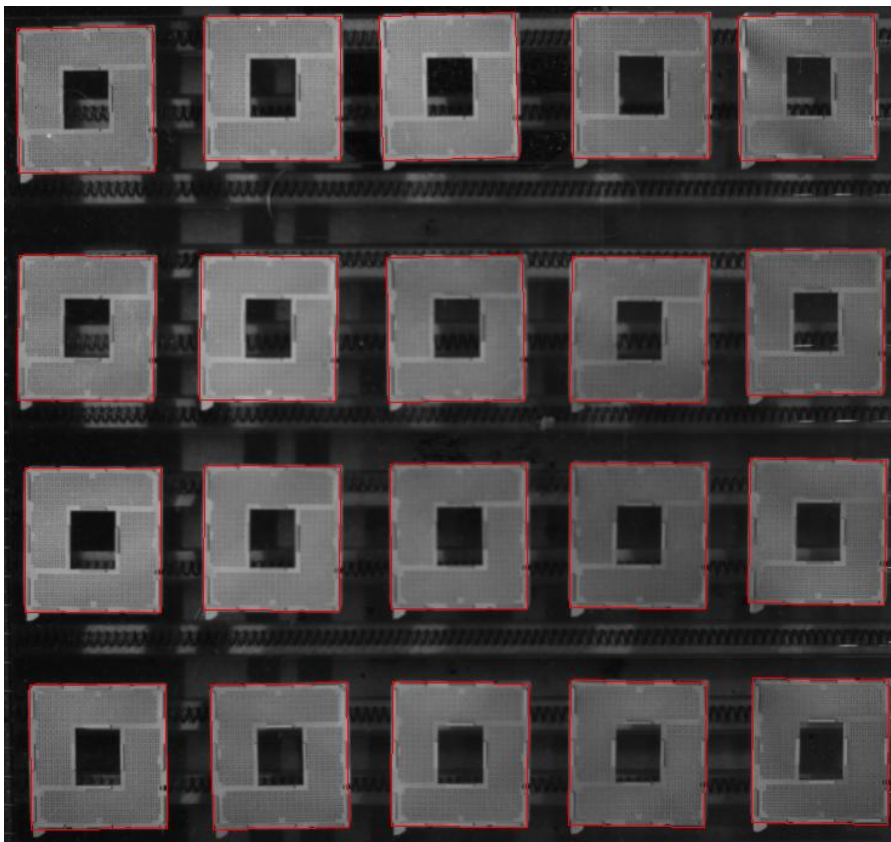


Introduction to High Volume Testing with Part Tracking™ in Akrometrix Studio 6.0



(Twenty sockets automatically located and partitioned
in Akrometrix Studio with Part Tracking™)



Imagine never partitioning another phase image to extract data for multiple components. Imagine never cropping another oversized ROI. Imagine using existing equipment to deliver 5X the number of results, in 1/5 the current time. Imagine capturing enough warpage data to develop a statistical distribution of thermal deformation, while all analysis for each part happens automatically upon acquisition. With the release of Akrometrix Studio 6.0, these imaginings are quickly becoming a reality for TherMoiré users.

This paper describes enhancements to Akrometrix Studio Surface Measurement and Thermal Profiler that enable TherMoiré users to measure significantly more sample parts at once than was previously feasible, while also decreasing the amount of time required to process results for reporting.

To explain the revolutionary nature of these new capabilities and potential applications of TherMoirés equipped with Akrometrix Studio, the following subjects are covered in this document, for both users of non-Studio-upgraded equipment and those with a Studio-equipped AXP, PS200, PS400, or PS600:

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1 Traditional Surface Measurement Terms

These terms describe aspects of using a TherMoiré with either Studio or pre-Studio software. (The items described are affected when implementing the High Volume Testing capabilities in Akrometrix Studio.)

1.1 Measurement Related Terms

Sample – a package, substrate, or other component to be measured. This can be a subregion of a larger object, or the entire component. This is sometimes called a 'part'.

ROI – a single Region of Interest, defined by a movable box in TherMoiré software, which outlines the area to be measured.

Camera FOV – the Field of View or extents of what can be measured based on the optical technique used in the TherMoiré. When not using a zoom lens, the FOV usually includes a portion of the machine surrounding the oven window.

Sample Support/Fixture – Akrometrix or Customer-built holding devices for positioning samples. Edge support rails are used for the majority of testing, but there are other methods and accessories available.

1.2 Analysis Related Terms

Partition – a user-defined and applied section of the data captured in the original ROI. Multiple partitions can extract data from a single ROI.

Crop – a user-defined and applied subset of the initial ROI that discards data outside the crop boundary.

Mask – a user-defined and applied filter that excludes areas of the ROI from analysis.

Rotate – in Studio, this function allows a user to rotate data collected in the ROI or in an extracted partition. Usually used for manual correction of sample/part movement due to warpage during a thermal cycle.



2 Traditional TherMoiré Work Flow

TherMoiré users' work flow varies, but a simplified way to describe it is: Acquire, Analyze, then Report. The process steps usually include some form of the following:

2.1 Acquire

1. Samples are prepared. For high contrast and to collect the best possible data, components are often painted white. For complex partitioning/cropping, sometimes the samples are marked with lines or other fiducials that can be used for masking purposes later.
2. Samples are placed in the TherMoiré oven, perpendicular to the camera to avoid manual image correction. A sample fixture may be used to fixture multiple parts as close to perpendicular as possible. A thermocouple is attached to a sample to drive the thermal profile.
3. In the camera FOV, an ROI is chosen larger than the extents where the sample(s) are positioned, to allow for part motion due to thermal expansion.
4. A thermal profile is chosen and started. The TherMoiré automatically collects data at user-defined temperature or time points and saves the measurement data from the ROI to disk.

2.2 Analyze

5. A user reviews the data, then manually partitions/crops the data gathered at each temperature point. For a single sample that moves little during the thermal profile, a user may apply batch processing to the entire data set, cropping each of the results to the same dimensions. When measuring multiple samples, additional steps such as partitioning and manual masking may be required. If marker lines or other fiducials were used for identifying areas to measure, these are reviewed and used for making masks. 'Surface Image' is a feature in Studio that allows users to view the sample itself rather than the phase image, when cropping/masking/partitioning the ROI manually. Traditionally, all the different methods and requirements related to processing data manually combine to make this the most time-consuming phase of the Warpage Measurement process, especially when multiple samples are measured.
6. A 'Rotate' option is also available in Akrometrix Studio that may be applied manually or in batch processing as needed to correct for sample motion due to warpage or fixture expansion.

2.3 Report

7. After manually processing data with various operations into appropriate folders, a user selects data to create visual reports from, and/or process for gauges or other analysis.

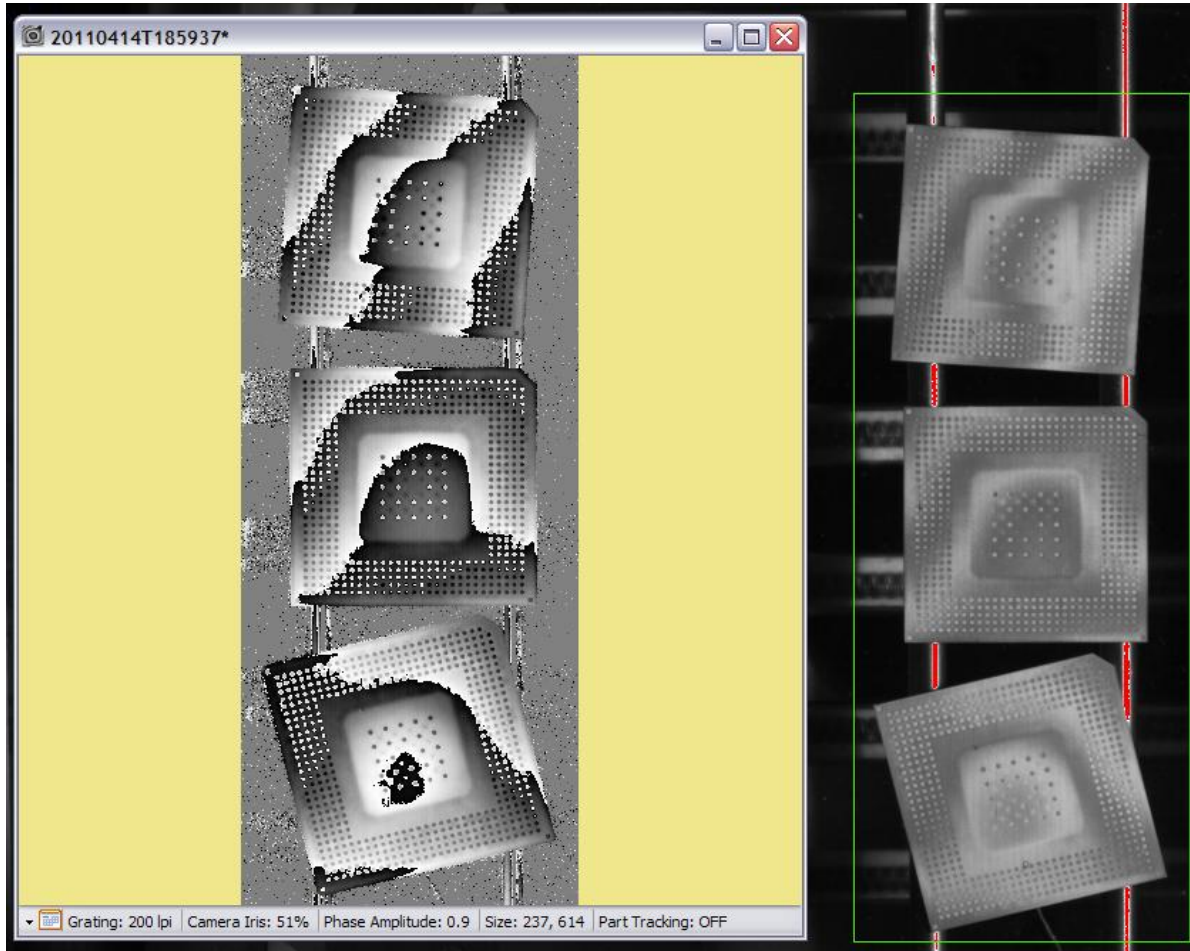


Figure 1. Example of a Single ROI (green outline) covering multiple parts, resulting in a single phase image (shown left) that must be manually processed to get warpage results (traditional TherMoiré usage)



3 New 'High Volume Testing' Terms

Advances in Akrometrix Studio now allow users to leverage powerful automatic recognition and analysis capabilities to increase the volume of samples tested while reducing the amount of time needed to process data, resulting in dramatic improvements in productivity and capacity.

These concepts are introduced with Akrometrix Studio for High Volume Testing:

Part Tracking – the term used to describe how Akrometrix Studio automatically recognizes samples in the oven, and takes measurements for each sample separately, to eliminate most manual processing.

Model – a shape defined to represent what samples look like to the camera in the oven. A model is typically a white rectangle that simulates how a high contrast package or other component appears in the FOV.

Edge Recognition – the method used by Studio to recognize parts and properly identify their individual boundaries.

Search Area – the user-defined section of the camera FOV that identifies where Studio will look for parts.

Multiple Regions of Interest (ROIs) – Studio automatically assigns an ROI for each sample, for each measurement acquisition. This ROI is typically the same size as the sample and always matches the model's dimensions.

Automatic Rotation – samples may be placed in the oven non-perpendicular to the camera FOV, and Part Tracking™ rotates the collected data for each ROI back to a 'square' XY orientation.

Automatic Partitioning/Cropping – measurements for up to 99 samples in a single FOV are individually cropped and saved to disk for each acquisition point.

Multiple-ROI Review – during thermal processing, users can click on an automatically generated map of the samples measured, to check phase and displacement results as the test progresses.

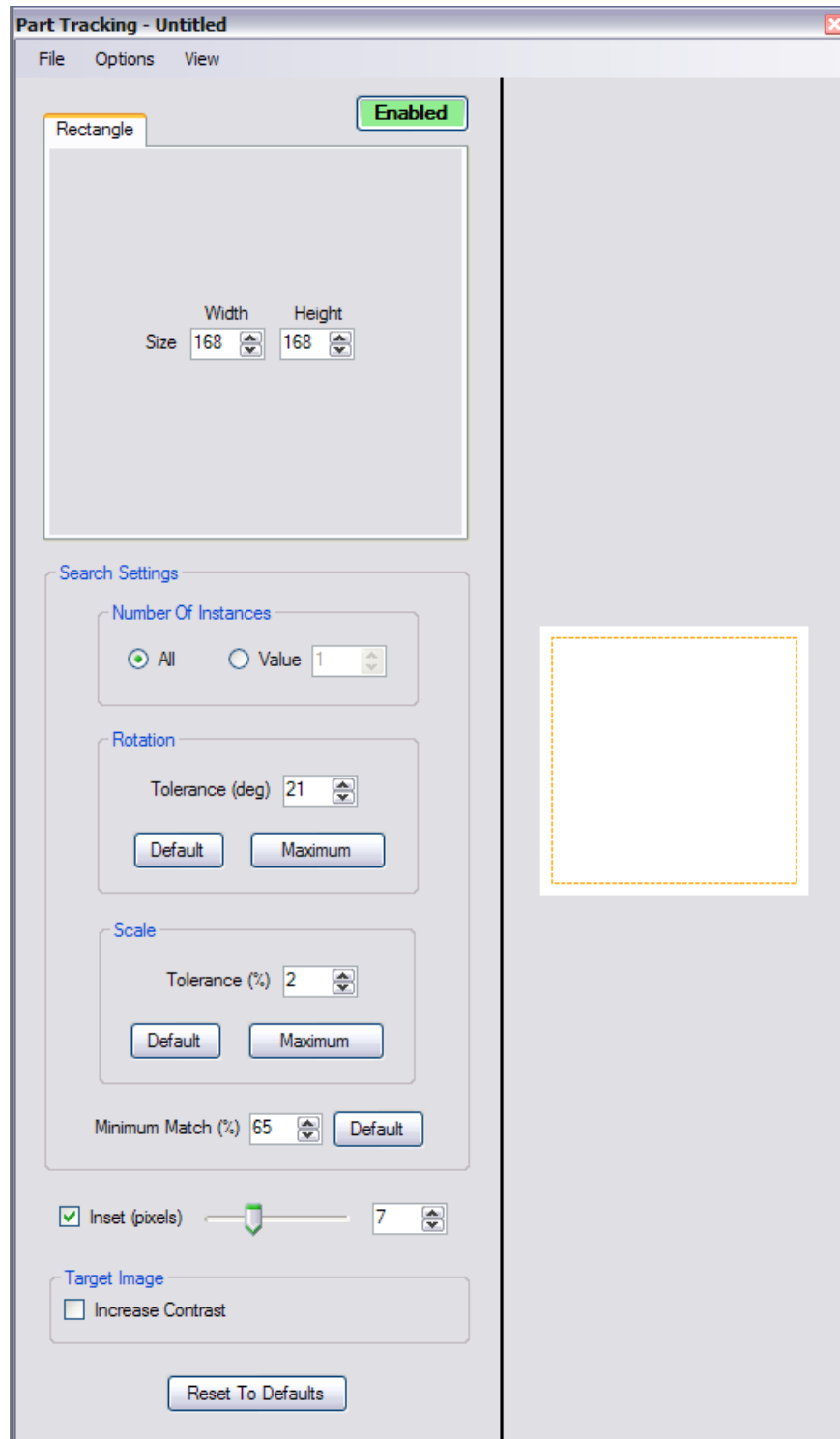


Figure 2. The main Part Tracking™ control window in Surface Measurement

4 New TherMoiré 'High Volume Testing' Work Flow

The work flow is still Acquire, Analyze, then Report. With Part Tracking™ enabled in Studio, much or all of the analysis is done automatically in the background, meaning once a thermal cycle is complete, a user may skip time-consuming manual analysis and move directly to Reporting.

Internal Akrometrix users and Semiconductor Industry beta testers report the following typical process for High Volume Testing with Automatic Analysis:

4.1 Acquire

1. Sample preparation is simple, with high contrast white being the best surface to make samples recognizable for Part Tracking™.
2. Samples are placed in the oven, with almost any orientation. Part Tracking™ compensates for rotation up to 30 degrees, so fixturing parts perpendicular to the camera FOV is not necessary. Sample supports such as the Uniform Area Support fixture from Akrometrix can be used, since part motion is no longer a concern for multiple samples. Motion due to thermocouple wire attachment is also no longer a concern.
3. The Part Tracking™ window is opened in Akrometrix Studio Surface Measurement, and a model size and search area are set, with the mouse. A quick check that all samples are found verifies edges are properly recognized.
4. Thermal Profiler is started.
5. Akrometrix Studio measures each sample, compensating for rotation and saving phase image and displacement measurement results to disk, by temperature point and ROI number. The end result is folders full of cropped, rotated, partitioned data, ready to be used in a report or exported for further gauge analysis. Using the Multiple-ROI selection feature new in Thermal Profiler, a user can monitor collected results during the thermal cycle, guaranteeing that what is saved will be usable.

4.2 Analyze

6. If the collected measurements need to be processed further, they are available in organized folders, so specific samples or the entire collection of data can be processed as needed.

4.3 Report

7. High Volume Testing enhancements affect the Acquire and Analyze-related processes only.

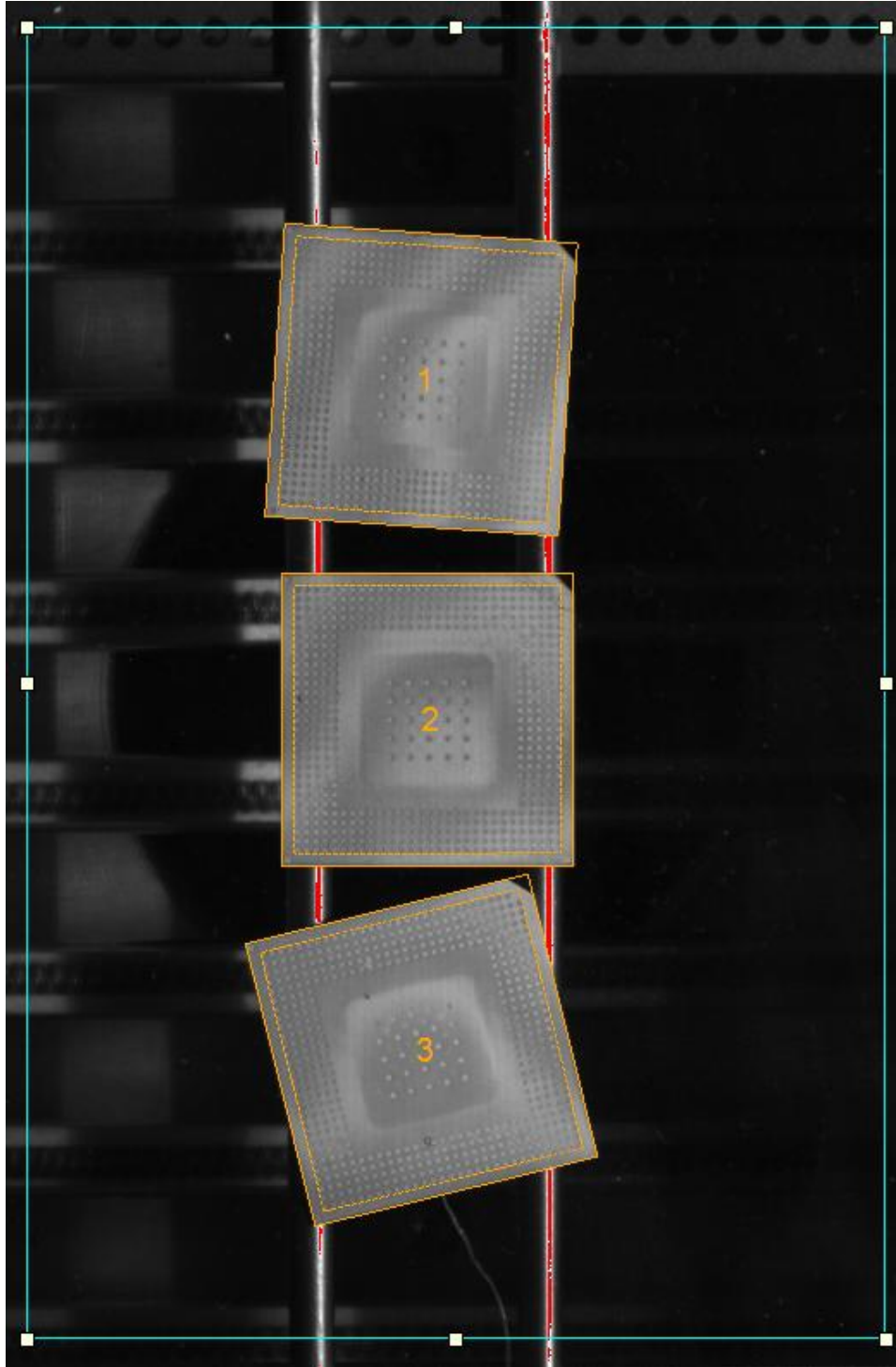


Figure 3. Search Area, a new Part Tracking™ feature, is shown with a blue outline. Tracked parts are shown outlined in orange, and automatically assigned numbers.

5 Example of Productivity Improvement

To begin quantifying how Akrometrix Studio with Part Tracking™ can help companies measuring multiple components at once, a test was performed with a Semiconductor Industry customer's current application. The customer TherMoiré user followed the traditional manual method of measurement and analysis, and Akrometrix tested the same set of five samples with Part Tracking™ enabled. As expected, the automated processing of Part Tracking™ reduced the analysis stage time required by more than 90%, resulting in an overall productivity improvement of 75%. A comparison table for reference is shown below.

Work Performed	Traditional Method Time (minutes)	Studio with Part Tracking™ Time (minutes)	Percentage of Time Saved
Thermal Profile creation	10	8	20%
Test and Sample Setup	20	6	70%
Data Analysis	40	3	92.5%

Part Tracking™ improves work flow and productivity even when only one sample is used and moves due to thermal expansion. The more samples tested at once, the more productivity will be improved.

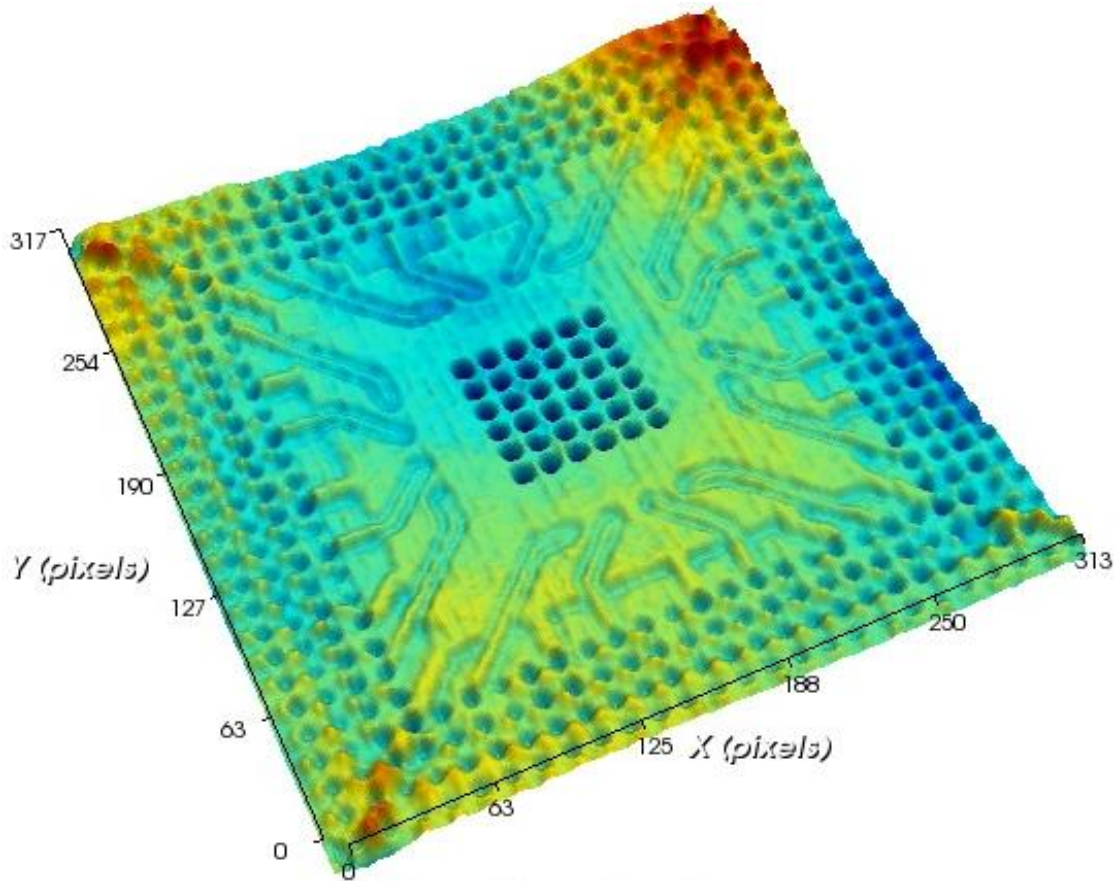


Figure 4. Example of a displacement plot generated from an ROI automatically tracked, partitioned, cropped, inset, smoothed, and saved by Akrometrix Studio with Part Tracking™

6 New 'High Volume Testing' Controls and Capabilities

In addition to the powerful automatic part location and analysis features already mentioned, other related controls and options are available to Akrometrix Studio users.

6.1 In Surface Measurement

Scale Tolerance – used to control maximum and minimum sizes allowed for sample ROIs. Useful for setting standards for measuring a particular design, to ensure setups and data densities at different facilities correlate properly. Located parts can vary from the size specified in the model dimensions by no more than this amount.

Rotation tolerance – like scale tolerance, this is useful for setting limits on how much angle differences and corresponding data resampling is allowable.

Inset – for cases when the entire sample surface is not needed, inseting allows a user to define an edge offset where data will not be taken, so only usable surface data is collected automatically.

Full Field Data Save – Akrometrix Studio Surface Measurement contains a feature that, when enabled, saves phase image data for the entire camera FOV at every acquisition point. In effect, no data can ever be lost, since with this feature enabled a user can always go back and manually extract useful data in areas not measured automatically.

Increase Contrast – an option that allows better Edge Detection in cases where shape and/or surface contrast are not ideal.

6.2 In Thermal Profiler

Number of Instances Found – a prompt registers at the beginning of each Part Tracking™-enabled thermal cycle, noting how many samples are recognized. Confirming the number of parts found is correct starts the thermal profile.

Multi-ROI Review – a window showing parts found and numbered allows users to review all ROIs' phase and displacement results during and after the thermal cycle.

ROI Data Labels – options for labeling the individual ROI phase and displacement results.

Saved Data Organization – options for saving results during a thermal profile, either by temperature point, by ROI label, or all together in one folder. Phase and Displacement files' names and metadata also contain details about conditions under which they were generated.

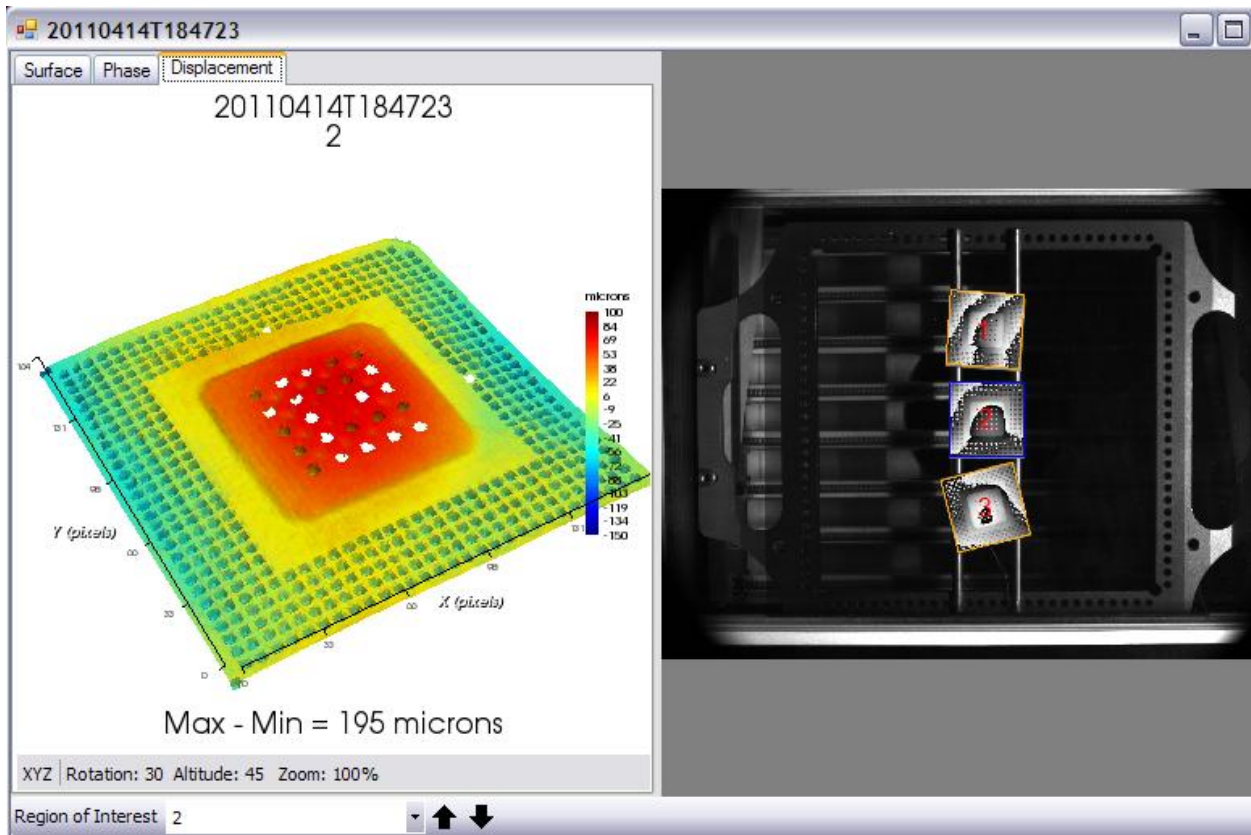


Figure 5. Multi-ROI Review, in Thermal Profiler, allows users to check phase and displacement results in real-time during the thermal cycle, and after the cycle completes. By clicking in an ROI on the right side of the window, the Surface Image, Phase Image, and Displacement Plot are viewable on the left, for any acquisition point.



7 New 'High Volume Testing' Applications

At Akrometrix R&D and at customer beta test sites, the potential applications for Akrometrix Studio with Part Tracking™ are increasing. Sockets, substrates, outlined sections of strips, and painted PWB/PCB areas are examples of early users leveraging the power of edge detection and automatic analysis to improve their work flow and get more results, faster.

In addition to its traditional role as a Design, R&D, FEA Model Validation, and Failure Analysis tool, a TherMoiré can now support modern enterprise-critical efforts such as New Product Introductions, Safe Launch Sampling, and HVM Ongoing SPC, because of increased capacity and analysis speed.

This year, the Akrometrix Studio software platform has expanded, and now powers the TherMoiré PS200S and PS600S, in addition to the flagship TherMoiré AXP and PS400 with Studio Upgrade. Since Studio Upgrades are now available for the PS200, PS400, and PS600, owners of all types of TherMoirés can benefit from the added productivity, capacity, repeatability, and reproducibility delivered by Akrometrix Studio with Part Tracking™.

8 Future Applications

Akrometrix solicits feedback and suggestions from customers, developing added functionality and features that benefit the broad base of Semiconductor Industry TherMoiré users. Related to Part Tracking™, additional model shapes, more automatic analysis options, automatic 'warpage outlier' notification, and customized reports are all enhancements that have been suggested and will likely appear in future releases of Akrometrix Studio.

9 Conclusion

This document describes a revolutionary change in the way Warpage Measurement equipment can and should be utilized. By expanding the number of possible measurement regions from 'One' to practically 'Unlimited', and automatically locating those regions through advanced image recognition, TherMoiré users' worlds have improved significantly. If you are interested in discussing how you and your company can get the most from your TherMoiré Warpage Measurement system, or for a demonstration of Part Tracking™, please contact your local Akrometrix representative.