

Visual Test Gamma Reticle

Users Guide

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1. Floppy Disk Contents

4INVTW:

5INVTW:

6INVTW:

4", 5", and 6" reticle data for producing a Visual Test Wafer. This wafer contains both horizontal and vertical patterns used to visually determine stepper focus and repeating defect checks

4INHORIZ:

5INHORIZ:

6INHORIZ:

4", 5", and 6" reticle data for producing a Visual Test Horizontal Patterned Wafer. This wafer contains horizontal patterns used to visually determine stepper focus and repeating defect checks

4INVERT:

5INVERT:

6INVERT:

4", 5", and 6" reticle data for producing a Visual Test Wafer. This wafer contains vertical patterns used to visually determine stepper focus and repeating defect checks

4INGAMMA:

5INGAMMA:

6INGAMMA:

4", 5", and 6" reticle data to be used with the built in Run mode #3, Focus and Exposure matrix.

This wafer will contain a 10x10 (5" and 6"), or 9x9 (4") 5mm clearfield pattern, to be used to determine exactly at what energy the resist clears on the wafer.

2. Introduction:

Stepper Equipment Inc. is proud to present the Visual Test/Gamma Reticle (VTGR). The VTGR is designed to provide a twofold use of creating a visual focus test plus having the ability to generate a 10x10mm (5" + 6") or 9x9mm (4") grid of 5mm square clearfield cells, to be used concurrently with the UTS diagnostic run mode #3, Focus and Exposure matrix. Both of these functions can be produced on a simple resist coated ultraflat wafer. This manual is dedicated to provide you (the user) information to effectively generate a visual focus test that saves time with daily stepper checkouts and the ability to generate a gamma wafer with 90 to 100 cells to choose from in run mode #3.

The VTGR has three fields. Fields 1+2 each covering the maximum area rectangle (30mm X 10mm) on an Ultratech widefield lens. The first and second fields contain horizontal and vertical line and space dimensions specified to match the resolution capability of your lens*. The third field contains a 5 millimeter square Clearfield that is designed to be loaded when you run the Focus and Exposure Matrix, Run mode #3, in your stepper software.

* Lens specification determines which critical dimension VTGR should be used (i.e. A lens specified at 1.25 micron should use the 1.25 micron Visual Test Gamma Reticle – P/N = VTGR-1.25A).

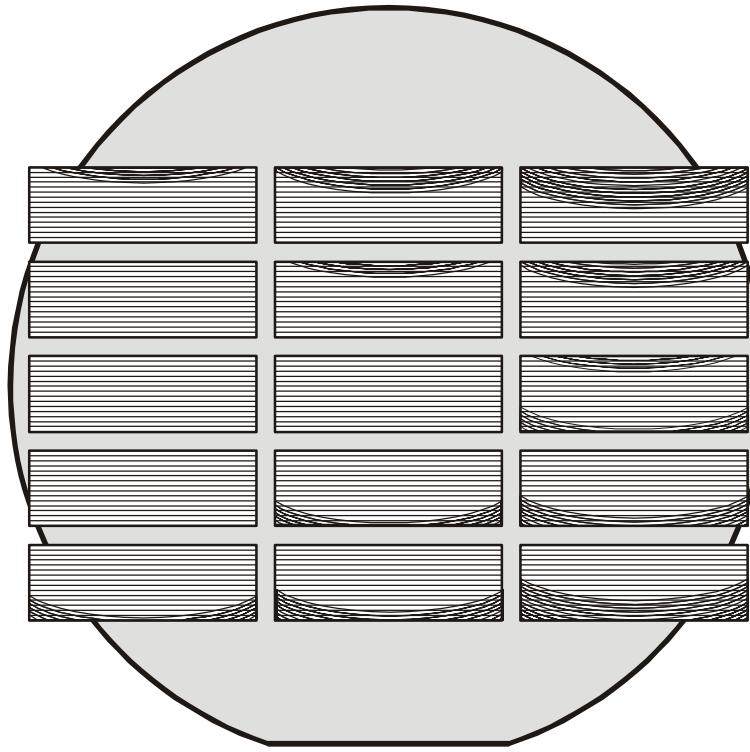
3. About the Visual Test:

Visual Test images are diffraction grating patterns that show focus variation when printed on a resist coated wafer. As stepper focus drifts away from nominal, the Visual Test wafer image will become non-uniform showing discoloration that is easy to determine. Unlike Short Step Focus, these images show focus variation not only across an exposure field but also across an entire wafer.

Inspection is performed without a microscope (visual 1X inspection); as a result, the user can determine focus quality of a stepper within seconds of having the test wafer developed (thus saving considerable test time). With proper training, the user can define focus failures and follow up with appropriate corrections in minimal time having the assurance stepper focus is nominal when complete.

4. How to characterize the Visual Test:

Characterization must begin by choosing a reference stepper and optimizing machine focus (focus centered using SSF to within +/- .5 um). Chuck flatness must also be optimal to maintain consistent images across the entire wafer as the focus plane passes through the useable depth of field. Once accomplished, focus/exposure matrix tests can be run to identify depth of focus generated by the chosen exposure energy. The following figure is a typical example of how a focus/exposure matrix pattern will look with a horizontal field Visual Test image:



Focus / exposure matrix
using VTgR reticle

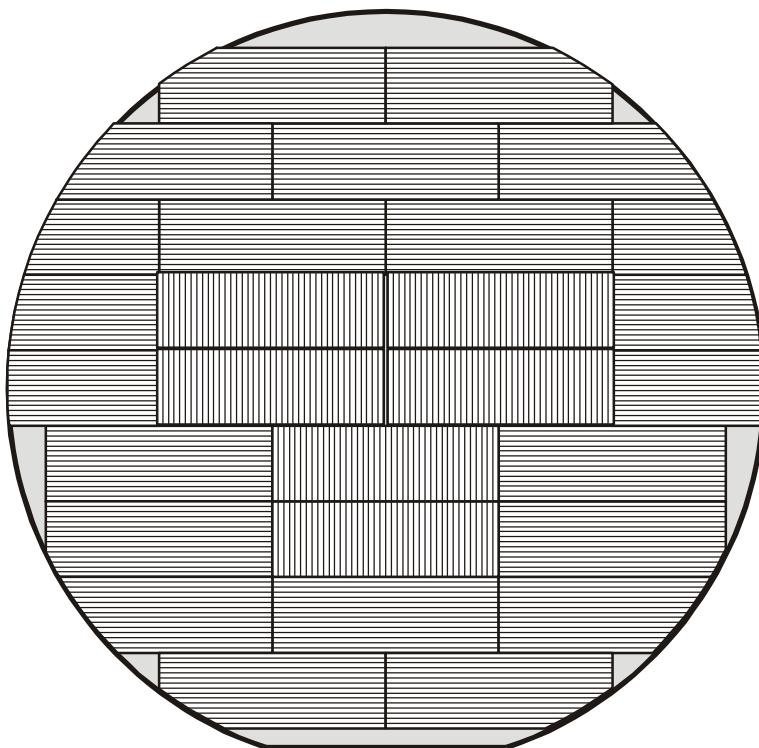
5. A note about setting exposure for the Visual Test:

Establishing proper exposure is vital in determining operational “boundaries” of the VTGR. The individual beginning development of the Visual Test must establish an exposure energy that closely matches critical layer CD’s. Ideally, exposure should be set to generate a 1:1 image on the wafer (i.e. reticle CD’s match wafer CD’s). If the Visual Test image is overexposed, the useable depth of field is greatly reduced. In other words, slight changes in focus (less than spec) will cause the Visual Test image to look unacceptable. Underexposing the Visual Test wafer usually makes interpretation much more difficult to determine. Therefore, it is very important to come up with an exposure that allows the Visual Test image to look acceptable through its operational depth of focus.

6. Combining images on a Visual Test wafer:

The VTGR contains vertical and horizontal features to help with identifying astigmatic effects of a stepper lens. Lens astigmatism causes horizontal and vertical lines to come into focus at different planes. Combining both features can reduce the overall depth of field that is printed.

By combining images of the VTGR on a single test wafer, several functions can be accomplished at the same time. Printing horizontal and vertical fields on one wafer will identify if focus is within tolerance for both features. Additionally, by adding a Light Scattering image, reticles can be loaded using the frosty wafer routine (see Light Scattering image description in succeeding paragraphs). The following figure is what the combined Visual Test/Light Scattering wafer looks like:



Normal VTGR Wafer

Another useful feature of combining images on the same wafer is helping the user locate any printable repetitive defects. Repetitive defects are typically caused by particles, scratches, or contamination located on the reticle or prism surface. The Visual Test image will show any of these defects and can be seen by 1X inspection.

7. The “Gray Area”

Generally, Visual Test images are easy to determine if stepper focus is acceptable or unacceptable. However, there are times a wafer may become difficult to interpret due to the Visual Test image being in the “gray area”. The gray area is a point that wafer focus approaches an out of tolerance condition yet is still acceptable to process critical features. At this position of focus, the image does not look pristine as it would if perfectly centered. However, attempting to correct focus may prove to be futile and yield no less image quality. To eliminate potential interpretation problems, it is necessary to establish boundary Visual Test wafers that define acceptable and unacceptable focus outside the gray area.

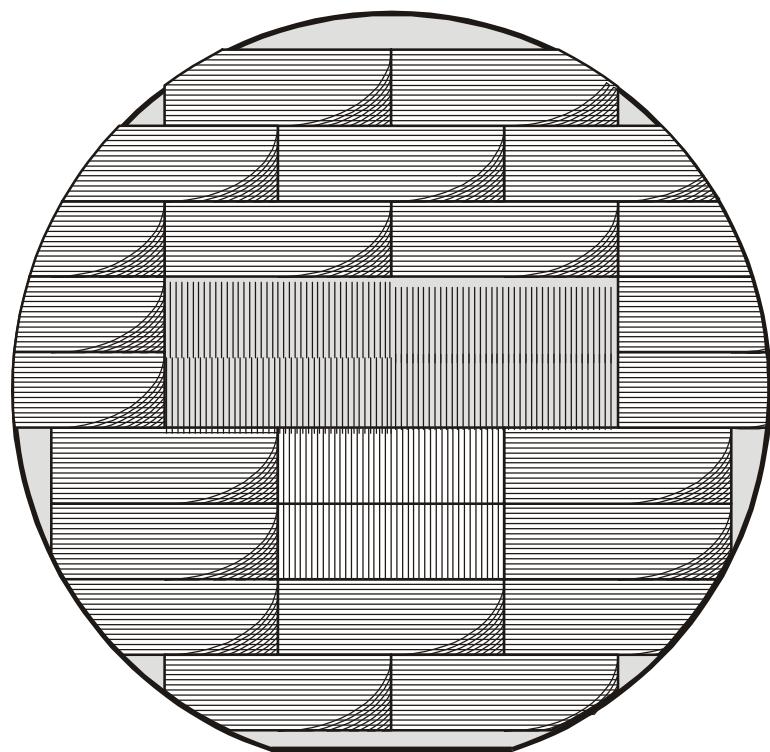
To create boundary or limit wafers:

- Optimize stepper focus as previously described.
- Expose Visual Test images using nominal exposure.
- Optimize the Visual Test wafer (correct as necessary).
- Expose series of Visual Test wafers using .5 micron focus offsets passing through useable depth of field (typically starting with -2.5 micron offsets to +2.5 micron offsets)
- Retain wafers that exhibit acceptable focus boundaries (user defined).
- Place boundary wafers in a location that can be viewed by the personnel performing regular Visual Test checkouts.

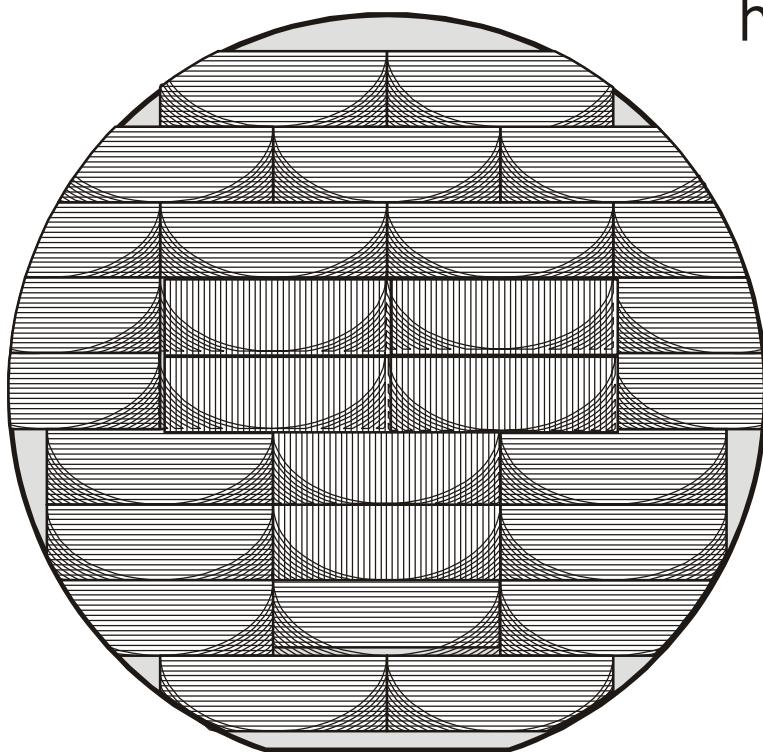
Production operators and technicians can use the boundary wafer examples to determine whether Visual Test passes on any given stepper being tested.

8. How to interpret Visual Test wafers:

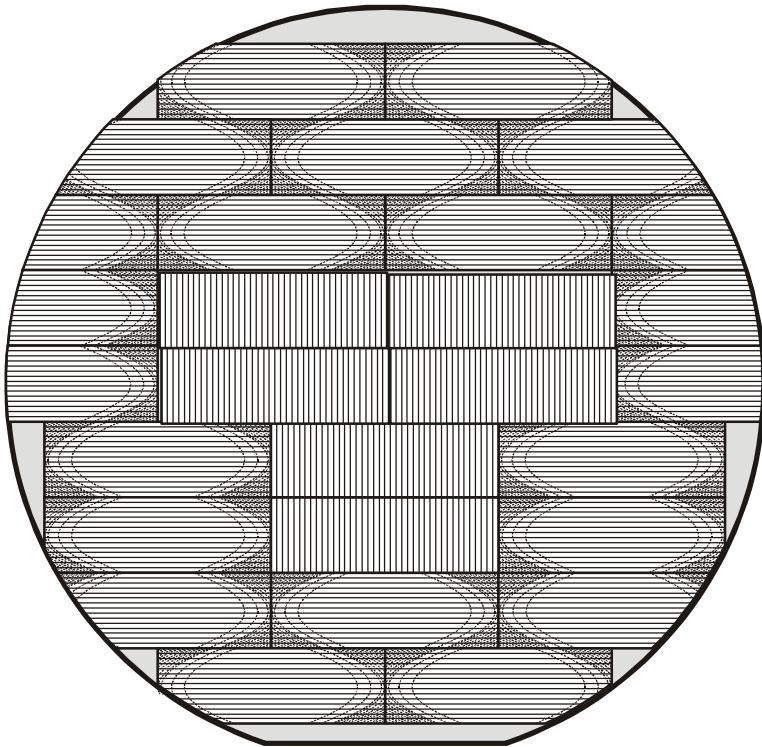
Interpreting Visual Test wafers is a subjective method of determining focus. As a result, it is important to learn the necessary skills to accurately assess image quality of the Visual Test wafer. Using a vacuum wand, hold the wafer in a position that reflects an image of a light source (usually an overhead fluorescent bulb). Tilt the wafer to a position that highlights the Visual Test images (rotating the wafer 90 degrees can also improve images being viewed). Compare the Visual Test wafer with boundary wafers (if available) to determine whether focus is acceptable or unacceptable (also inspect for focus tilt, offsets, contamination on chuck, repeaters, etc.). The following examples are what Visual Test images look like during out of focus conditions:



VTGR Wafer with
horizontal tilt



VTgR Wafer with
Front / Back Tilt



VTgR Wafer with focus offset, No tilt

The following summarizes inspection criteria:

- Compare Visual Test wafer to known good and bad reference wafers.
- Make determination of acceptable or unacceptable focus condition.
- Retain passing wafer on stepper for future reference.**

**One advantage of retaining the test wafer by the stepper being tested is having a fingerprint of focus performance visually available for any user to observe.

9. Implementing Visual Test:

After the initial characterization is complete, systematically test your remaining steppers to establish best and worst focus conditions (this will also allow you to collect reference wafers showing specific failures). Take the most chronic performing stepper and make the necessary corrections to optimize the printed image. Continue with each stepper until all systems are performing to the desired standards and develop the necessary documentation to integrate the Visual Test into your daily checkouts. During the correction phase, document what was done to improve the Visual Test. Append the documented corrective actions to a reference wafer library and display in a location for the maintenance and production personnel to refer to. Doing so will improve the learning curve of Visual Test dramatically.

10. About the Gamma Field:

The second function of the VTGR is to provide the reticle data and exposure field used to produce a focus/exposure wafer using the built-in run mode #3, Focus and Exposure matrix. The Gamma field, #3 on the VTGR reticle, contains a 5mm x 5mm clear box in a chrome field. By using this field, in conjunction with the provided reticle data, and the focus and exposure run mode #3, you can maximize the number of exposure offsets to determine at what exact wafer plane energy your resist clears, for any given stepper.

Follow the instructions in your UTS Users guide on how to run the Focus/Exposure matrix for your particular version of software, and use the VTGR reticle and VTGR reticle data (gamma field) to run this test.

In summary, the VTGR is designed as a tool to diagnose focus problems and generate a focus/exposure matrix, giving you a large choice of fields to examine for best wafer plane energy. Experience shows significant process improvement can result with successful implementation. Please feel free to give us a call if you should have any questions or need assistance with this valuable tool.

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