Visual Blind Step Test Reticle

Users Guide

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1) Floppy Disk Contents

Filename	Description
TRUE_3IN TRUE_4IN TRUE_5IN TRUE_6IN TRUE_8IN	The “Truestep” reticle data layout is designed to measure xy stage blindstepping accuracy without influence from reticle positioning errors. Field 1 is used to step the entire wafer. The end number designates wafer size.

Filename	Description
DROP_3IN DROP_4IN DROP_5IN DROP_6IN DROP_8IN	The “Drop in” reticle data layout is designed to measure absolute blindstepping accuracy. It includes xy stage and reticle positioning induced errors . Fields 1, 2, and 3 are used to step the entire wafer. The end number designates wafer size.

2) Introduction:

The Visual Blind Step Test Reticle (VBSTR) provides the user with the tools to measure and quantify the blind stepping performance of an Ultratech wafer stepper, models 990, 1000, 1100, 1500, and 1700. Both visual and automated metrology tool based methods are supported.

Visual methods include:

1- Coarse (5um steps, +/- 15ums range) and fine (0.5um steps, +/- 5ums range) verniers on all 4 sides of the exposed image which can be read visually using a microscope.
2- Gross Error Indicators which visually indicate blindstep errors greater than the range that the verniers support

Automated metrology based indicators include:

1- HAMS alignment keys at 13.9mm at the top and bottom of each field which support an “Automeasure” based automatic measurement scheme
2- “Box in Frame” geometry, which supports automated measurement methods, using your current metrology measurement tools.

This manual is dedicated to provide you with the information necessary to effectively measure the blind stepping accuracy of your UTS system.

3) VBSTR Reticle field layout

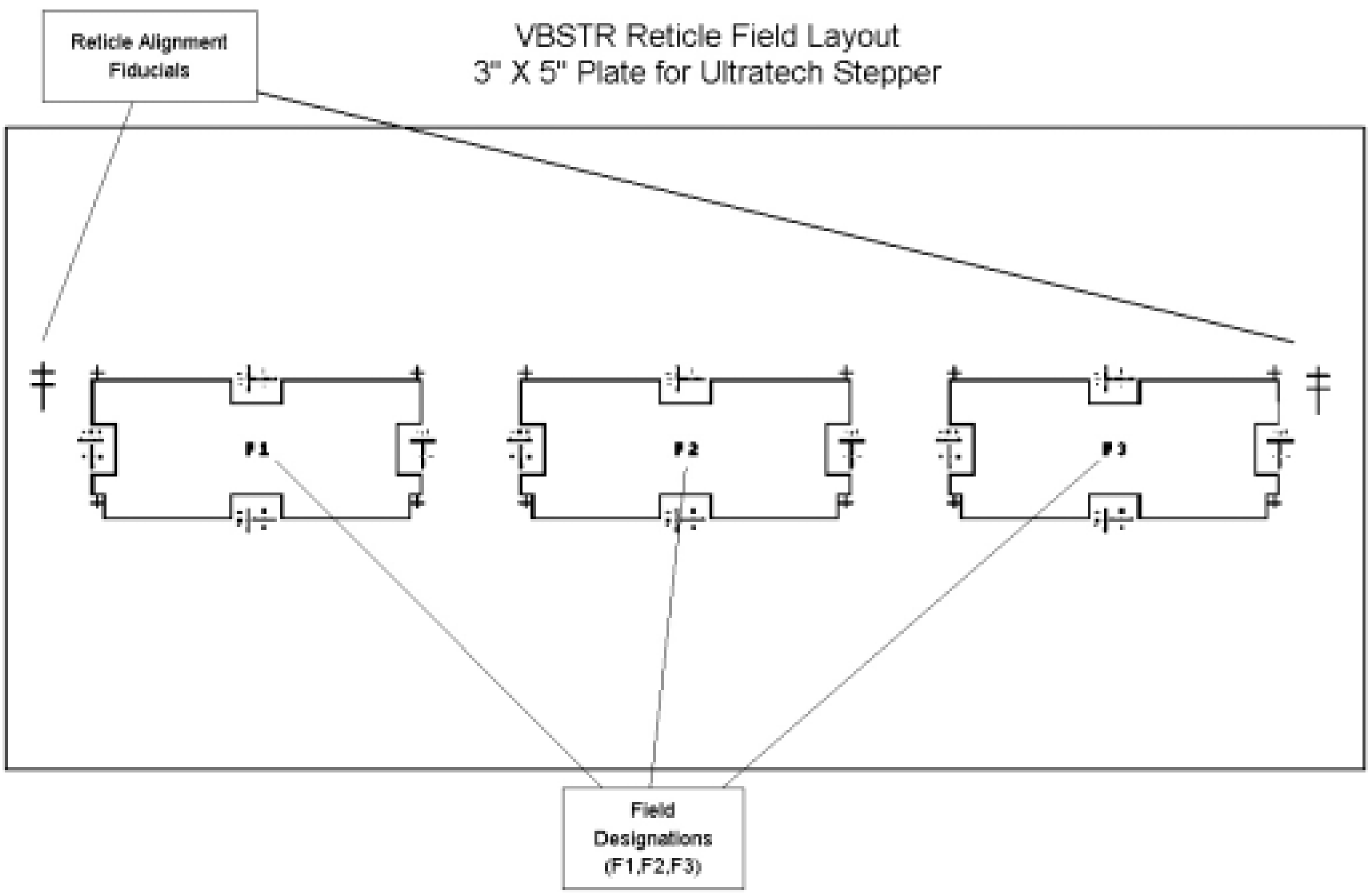


Figure 1 Reticle Layout

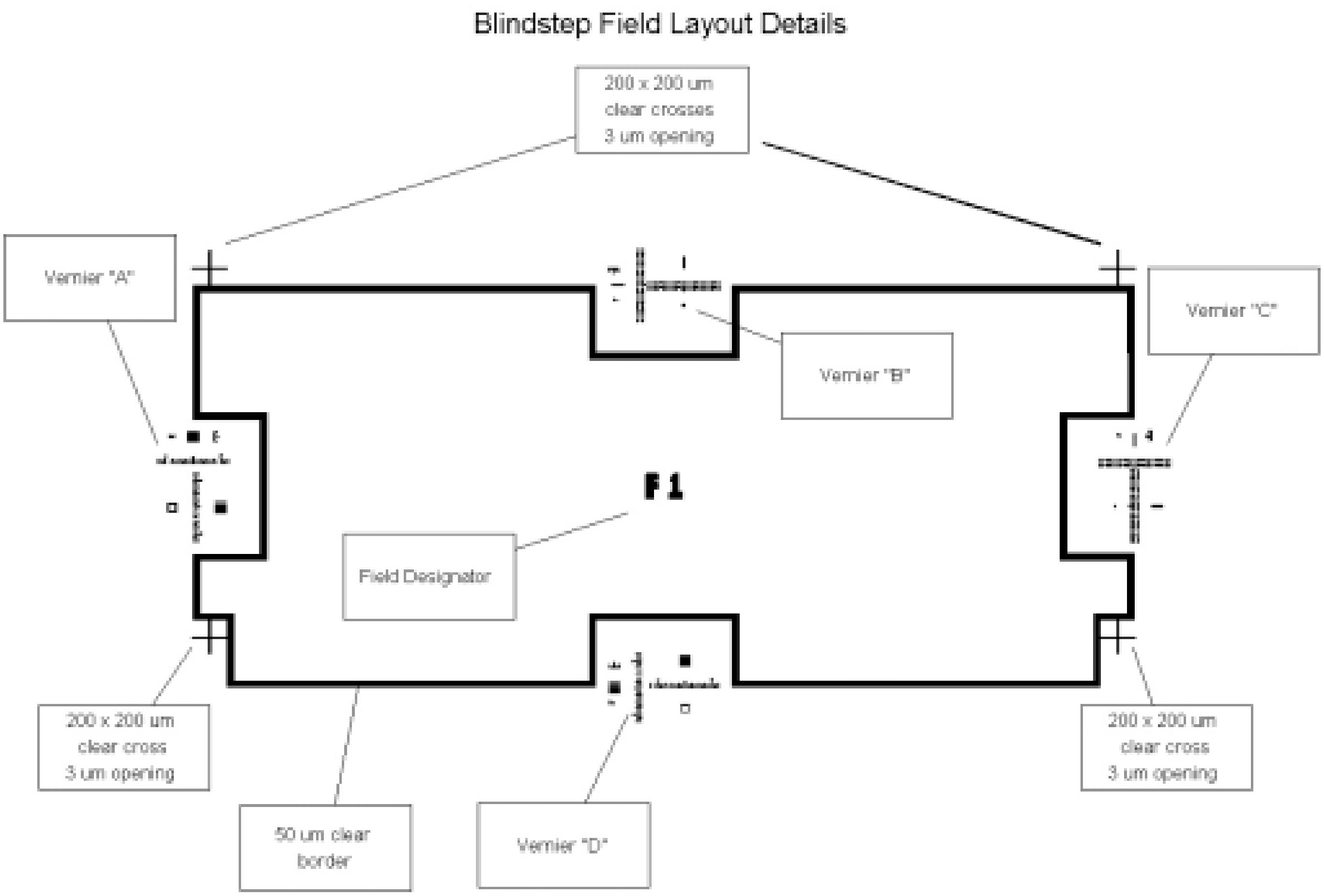


Figure 2 Field Layout

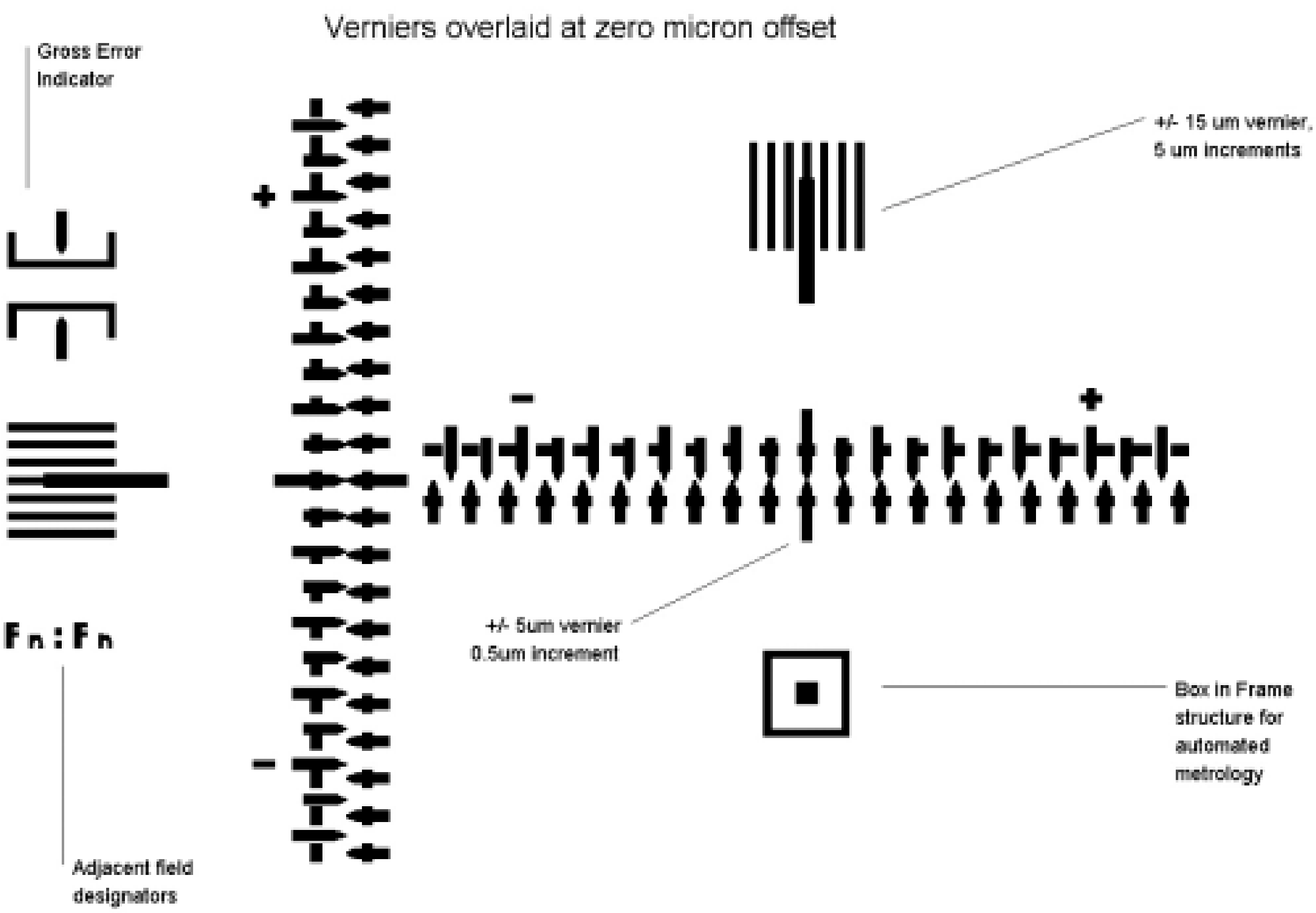


Figure 3 Verniers aligned with 0 offset

4) Creating a blind step measurement wafer

Creating a Blind Step Measurement Wafer is a simple matter of selecting the desired reticle data, seting the proper operating parameters, and exposing a run mode #1 (mechanical align only) wafer.

a) **Reticle Data:**

The VBSTR floppy diskette contains 3”, 4”, 5”, 6”, and 8” reticle data files for creating a Blind Step Measurement Wafer. You may select from two types of measurement wafers:

i) The **“Truestep”** reticle data layout is designed to measure xy stage blindstepping accuracy without influence from reticle positioning errors. Field 1 is used to step the entire wafer. The end number on the reticle data filename designates wafer size for your particular fab.

ii) The “**Drop in**” reticle data layout is designed to measure absolute blindstepping accuracy. It includes xy stage and reticle positioning induced errors . Fields 1, 2, and 3 are used to step the entire wafer. The end number designates wafer size

Refer to your particular software version / operating system for details on how to load in reticle data from external floppy diskette.

b) **Operating parameters:**

i) Exposure:

For automated metrology measurement, set the system exposure to the standard short step focus exposure value, insuring that at this setting all exposed areas of geometry are completely cleared of resist. This will insure the most accurate measurement from your metrology measurement tool.

For visual measurement, it usually is best to set the system exposure to a value that is approximately 10% less than the standard short step focus exposure value. This permits easier visual observation of the alignment verniers and determination of the correct blind step offset.

ii) Global Focus

For optimum blind step accuracy, set the Global/Local focus option to Global. This will “lock” the focus system while the wafer is stepping, eliminating blind step errors induced by the focus system. Note that some versions of operating software do not support global focus.

iii) Exposing a run mode #1:

(1) Reticle Align:

Perform a reticle alignment using the normal procedural steps for your particular revision of stepper operating software

(2) Run Mode #1

Perform a Run Mode #1 using the normal procedural steps for your particular revision of stepper operating software.

5) Measuring blindstep errors visually

Visual alignment verniers are located at the center of each side of each printed field on the Blind Step Measurement Wafer (BSMW) (figure 2). Each field on a BSMW overlaps adjacent fields on all four sides such that adjacent field verniers intersect. Visual measurement of blindstepping errors is accomplished by inspecting the coarse and fine alignment verniers at each location using a microscope. (figure 3)

a) Verniers

i) Coarse Verniers:

(1) The range for Coarse Verniers for the X and Y axis are +/- 15 microns, with each line representing 5 microns

(2) Coarse verniers should always be observed first, as it is possible to have an error of exactly 5, 10, or 15 microns, in which case the fine verniers would line up correctly.

ii) Fine Verniers

(1) The range for Fine Verniers for the X and Y axis are +/- 5 microns, with each line representing 0.5 microns.

(2) Always combine the coarse vernier offset with the fine vernier offset to determine the final blindstep error.

iii) How to interpret vernier offsets

(1) The xy stage steps in a 'serpentine' motion, stepping and exposing in the Y axis from field to field, until it reaches the edge of the wafer and shifts in the X axis to the next column. Because of this motion,

(a) the top and bottom verniers of each intersecting field typically show a greater X axis error versus Y axis. This is due to the stage holding position in the X axis and stepping in the Y axis. The Y step is very accurate over the short 10mm stepping distance. The X error that shows up is mainly due to non-perpendicularity between the two axis. (stage travel errors, A[9,*])

(b) The left and right verniers of each intersecting field typically show a greater Y axis error versus X axis. This is due to rotation of the projected reticle image versus the Xy stage travel axis, coupled with Xy stage rotation and stage travel errors (A[9,*]) while moving..

(c) There are also potential random and localized errors that will show up due to edge focus bounce and/or topology changes. Nicks and dings in the wafer chuck will also cause offset errors. X errors on the left and right sides of the field will occur near the wafer edges on chucks that are bowed.

b) Gross Error Indicator

i) The top and bottom field verniers have a "u" and "arrow" combination that can be used to detect gross blindstep errors in the X axis that are out of the range of the alignment verniers. The "u" portion of the indicator is 30 microns wide. When accurate blindstepping is achieved, the arrow will point to the center of the "u". When the arrow is outside of the "u", blindstepping error is greater than 15 microns, and can be visually approximated using the length of the "u" as a ruler.

ii) The left and right field verniers have a "c" and "arrow" combination that can be used to detect gross blindstep errors in the Y axis. Their usage is the same as the "u" gross error indicator mentioned above.

- For your conveniance, we have provided a master logsheet at the back of this manual for each wafer size.
- Please refer to the current published blindstepping specifications for your model of stepper to determine if the tool is within operating specifications.

6) Measuring blindstep error using metrology tools

Alignment geometry for automated metrology tools are located at the center of each side of each printed field on the Blind Step Measurement Wafer (BSMW) (figure 2). This geometry includes a Box in Frame structure, and HAMS alignment keys. Each field on a BSMW overlaps adjacent fields on all four sides such that adjacent field alignment geometry are positoned for automated measurement.

a) Box in Frame Structure

i) This structure is designed for use by various types of metrology based measuring equipment to automatically measure blind step accuracy. Please refer to your metrology tool operations manual on how to set up a recipe which will provide an automated solution for blindstep measurement. The following parameters can be used to develop your recipe:

	Field	Frame	Box
Length (outside dimension)	28 mm	24 um	6 um
Width (outside dimension)	10 mm	24 um	6 um
Line Width	N/a	2 um	6 um
X Location relative to center of field	N/a		
Y Location relative to center of field	N/a		

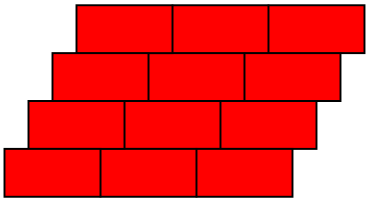
b) HAMS Alignment Keys

i) HAMS alignment keys are located at all 4 corners of each field. These keys are designed for use by various types of metrology based measuring equipment to automatically measure blind step accuracy. Please refer to your metrology tool operations manual on how to set up a recipe which will provide an automated solution for blindstep measurement. The following parameters can be used to develop your recipe:

7) Troubleshooting blindstep errors

a) Stair stepping:

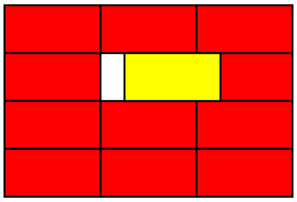
‘Stair stepping’ errors appear as the name describes, a series of exposures in a column which are offset in the X-axis by a repeating distance. This is usually caused by stepper machine variables A [9,1] (x stage movement relative to Y axis) and A [9,2] (y stage movement relative to X axis) being out of calibration. Running the diagnostic test “Stage Signature” will set these variables to the proper value.



i) When running the Stage Signature test, insure that the image rotation value is less than 0.15mr. This value indicates the amount of stage rotation as it moves about the granite surface. If this value is greater than 0.15mr, then blind stepping errors may still be present despite the variables A[9,1] and A[9,2] being updated.

b) Drop-in field errors in X axis

‘Drop-in” errors are blind stepping X-axis placement errors for the OAT fields, or “drop-in” field of a typical UTS wafer. They occur because the OAT reticle image field is not placed precisely over the top prism due to mechanical malfunctions. Possible causes for this error are:



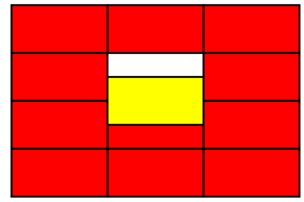
i) Reticle finger height not set up correctly. As the finger moves the reticle via the striker plate, it becomes partially ‘disengaged’ from the striker plate. This causes X-axis misplacement of the reticle over the lens. Please refer to the reticle finger setup portion of your maintenance manual for the proper method of setting up the reticle finger for your model UTS stepper.

ii) Insufficient airflow to the reticle stage. This causes the reticle to ‘drag’ while it is being moved, and misplacement in X is usually the result. Please consult your maintenance manual for proper setup of the reticle stage air flow for your model UTS stepper

iii) Reticle air slider. Over time, the reticle air slider on model 1000 and 1100 steppers develops ‘slop’ in the mechanical spacing of the air bearings on the slider. Also, the bearing ports may become ‘clogged’, resulting in positioning errors. Typically, the bearings should have about 0.0005” to 0.0008” of freeplay. Any less, and the slider will start to ‘bind’. Any more, and gross positioning errors in the X-axis will occur. SEI can refurbish and test your slider if this is found defective on your stepper.

iv) Insufficient vacuum to the reticle stage. If the reticle is not vacuumed down completely before the reticle finger dis-engages from the striker plate, a positioning error may occur. Please consult your maintenance manual for proper setup of the reticle finger for your model UTS stepper.

c) Drop-in field errors in Y axis



'Drop-in Y Axis" errors are blind stepping Y-axis placement errors for the OAT fields, or "drop-in" field of a typical UTS wafer. They occur because the OAT reticle image field is not placed precisely over the top prism due to mechanical malfunctions. Possible causes for this error are:

i) Improper airflow through the reticle stage air ports by the top prism. Too much air coming out of the ports by the top prism is usually the culprit for instances where Y placement of the drop-in field is incorrect. Please consult your maintenance manual for proper setup of the reticle stage air flow for your model UTS stepper

ii) Reticle air slider. Over time, the reticle air slider on model 1000 and 1100 steppers develops 'slop' in the mechanical spacing of the air bearings on the slider. Also, the bearing ports may become 'clogged', resulting in positioning errors. Typically, the bearings should have about 0.0005" to 0.0008" of freeplay. Any less, and the slider will start to 'bind'. Any more, and gross positioning errors in the X axis will occur. SEI can refurbish and test your slider if this is found defective on your stepper.

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