Stepper Instructions (Brief)

Introduction

The GCA 6300 DSW steppers have chucks for 3", 100 mm, and 150 mm wafers. Pieces smaller than this can also be used but there is no special chuck for this purpose. Software and hardware is available to use the steppers in the 3696 photorepeater mode to make chrome masks. See staff to change the wafer chuck to the mask chuck and vice versa. In addition to this summary for using the steppers, there are 2 manuals available for more information. The GCA DSW software manual is available in the stepper room. It is recommended you read and use it for reference.

Log into CAC

Log into the CAC system and enable the stepper you will use.

Log Into the Stepper

Log into the system by typing: L I [100,YY] where YY is your account number. Verify that the system is set properly for the chuck size you are using by running the CHUCKS command. Check the position of the Leveling Mode switch if the tool is so equipped. Set the “Transparent / Opaque” switch to the proper position.

Load and Align Reticle

THE COLUMN SHOULD ALWAYS BE COVERED! Remove the lens cover. Place the reticle on the platen vacuum chuck. Using the silver handle provided, slowly rotate the pivot table all the way to the stop so the alignment scope is over the reticle (the illumination comes on automatically). It is easiest to move the reticle by hand to coarsely align to the platen fiducials (If you can't see anything, the problem is that the marks on the mask are too far from the mask platen fiducials). When you have the reticle in position, lock the SPINDLE LOCK. The will cause the micromanipulator vacuum chuck to lower onto the reticle and hold it for alignment. Use the X and Y knobs for the right fiducial. Use the theta rotation for the left fiducial. The alignment steps may have to be repeated several times - be patient! Push in the PLATEN VACUUM button when satisfied. Check the alignment again to ensure its position. Unlock the SPINDLE LOCK. Rotate the pivot table to the lamp position. Lock the SPINDLE LOCK. Check the positions of the reticle aperture knobs.

Load Wafer

If the stage is not in the lower right corner, type LOAD. Choose the correct chuck, connect its vacuum hose to the vacuum switch box, align to the flat, and turn on the wafer vacuum switch. While being careful not to bump the chuck against the lens column above it, place the chuck on the theta stage and move it toward the back of the tool until you feel it against the stops. Turn on the theta stage vacuum switch. Close the chamber doors.
Expose Wafer

Prior to starting the job, press the following key sequence:

Press RES, wait 2 seconds.
Press MAN and the S/C button together and hold for one second.

If your job has already been defined, start the exposure sequence using the EXEC or EXPO commands. If not, then define a job using the SPEC command. Follow the prompts to enter in the exposure and focus settings. When the tool prompts you to press reset and start the AWH (automatic wafer handler, which the 6300’s don’t have), press only the MAN button instead.

At this point, the wafer stage will move under the lens to check focus and/or level the wafer. Next, the wafer moves to the alignment position where the video microscope image will appear on the screen. If the wafer does not move, try pressing the MAN button again. If this doesn’t work, start the sequence over.

***If the microscope image is on the screen and you need to abort, use CTRL-Q first then, press the REJ button to remove the image from the screen. Pressing the REJ button first will require you to reboot the system to use it again.

Align the wafer if needed and press the expose button when you are ready to continue. The tool should now expose the wafer and signal when it is complete.

Unload Wafer

Open the chamber door, turn off the theta chuck vacuum, and remove the chuck while being careful not to bump the structures above it. Turn off the wafer vacuum and remove your sample. Load another wafer for another exposure, or return the wafer chuck to the holder and close the chamber window.

Unload Reticle

Release the SPINDLE LOCK. Turn the pivot table. Pull out the Platen Vacuum switch and remove the reticle. COVER THE LENS!!

Log Out of the Stepper

Quit the job by typing CTRL - C, then A to abort. Type LOAD to return to the loading position if not there. Type L O when you are done. Turn the brightness down on the microscope screen.

Log out of CAC

Log out of the tool using the CAC system.
CHUCKS Command

Software Operation

The software can be invoked by entering ‘CHUCKS’ at the system prompt. The following screen prompt will appear and the user can then select a new chuck size and modify the loading correction offsets.

: CHUCKS
WORKING...
--- MOP Command Extension Ver 1.1 Jan 2005 (H&L Associates) ---

C - Change chuck size
L - Change loading offset correction
Q – Quit

Select command [C, L, Q] >>

To change chuck size type: C <ENTER>

After choosing to change the chuck size, the user will be prompted for a numeric value. This value must be one of the indicated valid chuck sizes; otherwise the command will be ignored.

Select command [C, L, Q] >> C

++ Chuck change V1.5 (c)H&L Associates Feb 2005 [6in]
.. Current chuck : 3 [AWL type : 6]
.. Valid sizes : 15,2,3,82,100,125,150,200

Enter chuck size >> 100

++ Chuck change V1.5 (c)H&L Associates Feb 2005 [6in]
.. Current chuck : 3 [AWL type : 6]
!! New chuck : 100

++ LCO Loading correction V1.5 (c)H&L Associates Jan 2005 X-
.. Current loading correction (mm)x:0.00000 y:-35.00000
!! New loading corrections (mm) x:0.00000 y:-20.00000

Select command [C, L, Q] >>

Loading corrections will automatically be set to the correct default values. If different values are required, continue with the next command.

To Change Loading Corrections: type L <ENTER>

After choosing to modify the current loading correction values, the user will be prompted for the X and Y offset values in millimeters. Values outside of the range ±150 mm will
be rejected. Just pressing <ENTER> at the prompt will cause the current X or Y setting to remain unchanged.

Select command [C, L, Q] >>

++ LCO Loading correction V1.5 (c)H&L Associates Jan 2005 X-
.. Current loading correction (mm) x:0.00000 y:-35.00000

Enter loading correction X(mm) >> 1.23
Enter loading correction Y(mm) >> 3.45

++ LCO Loading correction V1.5 (c)H&L Associates Jan 2005 X-
.. Current loading correction (mm) x:0.00000 y:-35.00000
!! New loading corrections (mm) x:1.23000 y: 3.45000

Select command [C, L, Q] >>

NOTE: Make sure that the Loading Correction values match the Chuck sizes listed in the table below:

<table>
<thead>
<tr>
<th>Chuck Size</th>
<th>X Offset</th>
<th>Y Offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;(or smaller)</td>
<td>0</td>
<td>-35</td>
</tr>
<tr>
<td>100mm</td>
<td>0</td>
<td>-20</td>
</tr>
<tr>
<td>125mm</td>
<td>0</td>
<td>-10</td>
</tr>
<tr>
<td>150mm</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Additional Commands

Here is a short list of other stepper commands that may prove handy: (see the command list in the back for more)

LOAD - puts the stage back into the wafer loading position
ORIG - retunes the laser and originates the stage laser metering
COPY - allows a user to copy files from another user's directory to his own
RENAME - gives an existing file a new name
? - typing '?' followed by a carriage return will back you up one line at a time in the SPEC or EDIT mode
OTHER TIPS:
If you get a FOCUS ERROR, there are 3 things to try:
- the focus knob near the monitor keyboard could be at the limit; center it.
- Check the CHUCKS command to make sure it is set correctly for the wafer chuck you are using.
- the stepper can't focus on your wafer (too thick? piece not centered?)
  - is your wafer too thick? (most chucks are nominal ± 100 um)
  - check to make sure the piece is centered on the chuck
  - check to see if there is any residue on the backside - clean it!
- make sure the chuck is set correctly on the stage, i.e. it is flat
If you get a TIME-OUT error:
    - you may be trying to focus on the edge of your substrate.

If the light appears on the monitor screen after going through the RES, MAN/SC, MAN sequence but the alignment marks don't appear, adjust the microscope illumination knob near the monitor. This may also need to be adjusted if the wafer alignment marks are out of focus.

If the micromanipulator vacuum chuck pulses on the mask when the spindle is locked, apply gentle pressure to the chuck.
Restart Procedure for GCA 6300 DSW Stepper

NOTE: Look at top of optical column for light source. Light should be seen coming from around wire entry and small round window. If lamp is on, proceed to 1.

If lamp is out: Allow 30 min. for cool-down to prevent explosion. Press start button on lamp supply at bottom of rack. Allow 10 min. warm-up before using lamp.

1. Log into stepper through the CAC system.

2. Refer to the PC screen on top of the control rack.

3. Reboot the computer by pressing Ctl-Alt-Del on PC keyboard, or reset button on PC top rack.


5. On PC keyboard: type Alt-O, then Return (Start). The start up process should appear on the stepper screen below.

6. Return to the stepper keyboard and enter the time and date as prompted.

7. Open door on left side of chamber and find small box with red lights. On Laser Compensator, press "Off" button.

To reset stepper monitor:
- Pull monitor chassis out.
- Find red button on top right.
- Turn off, then on.
- Press set-up. Press "Local/On-line".
- Press set-up.
- Push chassis back in.
Defining a Job
This is a short version of the job setup command. Section 5 and 6 of the system control manual has more details if they are needed.

SPEC
Output job name: your choice

Metric or English(*M/E): * indicates default

Comment:

Tolerance (1,2,*3, 4, 5,6): 1 is the highest value

Scale Corrections See section 5 of manual

X, PPM (-128<P<+128)

Y, PPM (-128<P<+128)

Orthogonality, PPM (-128<P<+128) See section 5

Wafer Diameter

<<Array Parameters>>

Step in X: in mm

*C -ount, S -pan or A -ll: Count - specify # of columns

How Wide? (prompt if S is chosen) Span - spans desired width

How Many Columns? (prompt for Count) All - fills all available width

Step in Y: in mm

*C -ount, S -pan, A -ll:

How High? (Span)

How Many Rows? (Column)

Translate Origin Translates the whole array in X or Y

In X

In Y:
Display? (Y/*N)  Shows array of exposures; indicates std. keys

Pass  Array 24 exposures  total exposures=24

   1  2  3  4  5  6
  1   X  X
  2   X  X  X  X
  3  X  X  X  X  X  X
  4  X  X  X  X  X  X
  5  X  X  X  X
  6  X  X

Alignment Dice are Standard

R: 4
C: 6
R: 4
C: 1

Layout? (Y/*N)  Position of exposures

For a Y answer, the output is:

Array has:  Centered:
   6 rows  3, 4
   6 columns  3, 4

1st row, col:
   X = -31.75000
   Y = -31.75000

Adjust? (Y/*N)  Invokes the 3 following questions

Re-count

Row? (M -ore/*S -ame/L -ess): More or less will increment by 1.

Columns? (M/*S/L):

<<Alignment Parameters>>
Standard Keys? (*Y/N) Yes if keys are 63.5 mm apart

Prompts for Y

Key Offset
  In X
  In Y:
EPI Shift
  In X:
  In Y:

Prompts for N

Right Alignment Die Center
  R:
  C:

Key Offset
  In X
  In Y:

Left Alignment Die Center
  R:
  C:

Left Key Offset
  In X:
  In Y:

EPI Shift Used after an epitaxial deposition
  In X
  In Y:

<<Pass>>

Name (<CR> to exit pass setup): job must have at least one pass

Comment: Will appear in the running job

Exposure (sec): Default value when job is run

Focus setting: Default value when job is run

Shift
  In X: Will translate exposure array; this is added to
  In Y: the Translate Origin values - see

A -rray, P -lug, L -abel:

A - does all exposures with the option to drop certain die
P - inserts different dice with the option to offset them
L - is not usable in the normal mode, only in photorepeater mode

Prompts for A
  Dropouts:
  R:
  C:
  will keep prompting R&C
  until no value is entered

Prompts for P
  Plugs:
  R:
  Y offset:
  C:
  X offset:

<<End pass set-up>>

Save Pass? (*Y/N)
STEPPER INSTRUCTIONS (Detailed)

1. LOAD AND ALIGN RETICLE

THE COLUMN SHOULD ALWAYS BE COVERED! Remove the lens cover. Place your reticle on the platen vacuum chuck. Rotate the alignment scope over the reticle by using the silver handle provided (the illumination comes on automatically). Move the reticle by hand to coarsely align the fiducials (if you can't see anything, that means the marks on the mask are too far from the marks on the platen). Before engaging the micromanipulator, center the knobs in their range of travel using the Alignment Travel Indicator above the knobs. Turn the spindle lock knob - DO NOT OVER TIGHTEN as it takes only light pressure to lock the spindle lock. With the spindle lock locked and the platen vacuum off, the micromanipulator vacuum chuck will lower and hold the mask for fine alignment. The right fiducial mark is for X,Y alignment. Adjustments are made using the right knob and the left most knob in the front. The left fiducial mark is the theta rotation and is the right knob in the front. The focus knob is located on top of the microscope. The alignment may take several adjustments - be patient! When the reticle is aligned to your satisfaction, push in the platen vacuum button to the left of the column. The fine alignment vacuum chuck will release. Check the alignment in the microscope again to assure it hasn't moved. Release the spindle lock. Rotate the pivot table to the lamp position. Lock the spindle lock.

2. APERTURE OPENINGS

Check the dial settings on the lamp column. These control the opening of the aperture blades on the column and are used in the event you don't want to expose the entire mask area. If the counter scale is at 100, this means they are completely open. Anything less than that will cut off some of the mask area.

3. LOAD WAFER

Choose the correct chuck, align the flat and turn on the correct vacuum switch. While being careful not to bump the chuck against the lens column above it, place the chuck on the theta stage and move it toward the back of the tool until you feel it against the stops. Turn on the theta stage vacuum switch. Close the doors.

Set the Transparent / Opaque switch to the proper position. This switch is used to tell the autofocus system which type of substrate you are using. For optically transparent substrates or very thick (>1 µm) transparent thin films, set the switch to transparent. For all others use opaque. Check the position of the Leveling Mode switch if the tool is so equipped.
1 - Microscope Focus
2 - Alignment Travel Indicator
3 - X motion
4 - Y motion
5 - Theta motion
6 - Spindle lock
7 - Alignment Microscope

1 - Platen Vacuum Switch
2 - Reticle Platen
3 - Aperture Blade Control Knob (1 of 2)
4 - Lens Cover
5 - Silver Handle
Loading Wafer on Chuck

Loading Chuck on Stage
4. JOB SET-UP STEPPER COMMANDS

Log into the system by typing: L I [100,YY] where YY is your account number.

CTRL-C, then A - to abort operation.

CHUCKS – used to program the stepper with the correct settings for the chuck size you are using. See the CHUCKS section for explanation.

SPEC - to create or specify a job. There is a more detailed sheet explaining each step in the stepper manual.

EDIT - to edit an existing job.

LISTF - to list the files in the directory

EXEC - to run a job. It will prompt you for the job name and pass. A shortcut is to type it all at once, i.e. EXEC job name\pass. For multiple passes on a wafer, enter EXEC job name\pass, pass, pass etc.

EXPO - to run an exposure or an exposure/focus test for process characterization. See the exposure section for more details.

L O - to log off the stepper.

5. EXECUTING THE JOB

Prior to starting the job using the EXEC command, press the following key sequence:

Press RES, wait 2 seconds.
Press MAN and the S/C button together and hold for one second.

The EXEC command prompts you about exposure and focus settings (the defaults are your input when the job was created), allowing for changes. When the tool prompts you to press reset and start the AWH (automatic wafer handler), press only the MAN button instead.

At this point, the alignment microscope marks should appear on the screen. If they don't, try pressing the MAN button again. If this doesn't work, start the sequence over.

***If the fiducial image is on the screen and you need to abort, use CTRL-C, then A first, then press the REJ button to remove the image from the screen. Pressing the REJ button first will require you to reboot the system to use it again.

Prior to exposing the wafer, you must align it.
For the first level, there will be no alignment (other than aligning the flat of the wafer to the flat of the chuck) since this is when you are making your alignment marks (For a piece, it is more complicated and won't be discussed here). Once you have alignment marks on the wafer and assuming they are 63.5 mm apart, you will be able to see them on the monitor. The wafer may not be in the exact position as when you exposed the
first time. Turn off the wafer chuck vacuum and rotate the wafer until you see the marks in the monitor; turn the vacuum on. This will also need to be done if you can't move the alignment marks to fit inside the marks on the monitor, i.e. you run out of theta motion with the joysticks. Using the joystick, roughly align the marks. Typing "O" will allow you to change the alignment rate - adjust this down to do the fine alignment with the joystick (the right side of the screen is X,Y adjustment; the left side is theta rotation).

When you are satisfied with the alignment, press EXP on the monitor screen keyboard. The screen disappears and tells you the wafer is being exposed. When the exposure is complete, it will indicate so. To expose another wafer with the same job, put the wafer on the chuck, and then press MAN. The monitor will display the microscope alignment marks and you proceed to align as before. To get out of the job, press CTRL–C, then A to abort. At this point, you can start another job, or if you're finished, log out.

6. CLEAN-UP

When you're finished, log out of the stepper by typing L O. Turn the screen brightness down. Open the door and unlock the spindle. Rotate the column to the side, pull the platen vacuum switch out to release the reticle, remove your reticle, and REPLACE THE LENS COVER. Close the door. LOG OUT from CAC.
**GCA Stepper Alignment Scheme**

Your alignment requirements need to be well thought out prior to CAD.

Alignment is needed on any multi-layered pattern. Alignment marks are always placed on the first level mask. There is a special GCA alignment key which matches a mark built into the GCA alignment microscope. Subsequent levels of lithography do not need alignment marks providing the original marks remain visible throughout processing.

The steppers use two microscope objectives that are 63.5 mm apart and display the alignment marks on the stepper monitor. The easiest alignment scheme has marks this distance apart. If this is the case, when the stepper prompts standard keys, the response is yes. For example, Fig. 1 has alignment marks in the center of the die (this means the key offset is at (0,0)). The stepping distance* is such that we have alignment marks 63.5mm apart, giving us standard keys of R4C1 and R4C6.

\[ * \text{stepping distance } (s) = \frac{63.5}{(n-1)} \]

where \( n \)=# of die in the row being used for alignment

Note: alignment marks must be at or below \( y=0 \). i.e. \( y=0 \) or \( y=+ \) (limited by the travel of the stage). Because the pattern on the reticle is inverted, the +y direction is toward you on the wafer. See the SHIFT KEY section in the job set-up commands at the stepper.

Fig. 2 shows an alignment scheme where the marks are not in the center of the die. They are centered at \( y=0 \) and offset in \( x \) from the center by 9.75 mm. The stepping distance now is calculated by:

\[ \frac{[63.5 - 2*(x \text{ offset})]}{(n-1)} \]

Because of the stepping distance and offset chosen, we still have standard keys (alignment marks 63.5 mm apart). When prompted for standard keys, it will also ask for a key offset in \( x \) and \( y \). This is where the 9.75 mm is entered.

For alignment marks that are not standard, for example on a piece, it becomes a little more complicated. At the standard keys prompt, the response is no. It then asks for the right alignment die center (which is the same as giving the row and column of the die you will use for alignment) and then any key offset within that die (it wants the distance in \( X \) and \( Y \) the alignment mark is from the center of the die. The recommended design has \( y=0 \) so you only need to worry about \( X \). Keep in mind the sign (+ or -) of the offset. It will then prompt you for the same information for the left alignment die center. This is how you set up the job for non-standard keys.

With standard keys alignment marks, you can view both marks at the same time on the stepper monitor. Any other scheme requires toggling between the 2 marks by typing “A”.
6 X 6 array  \( n=6 \)  \( s=12.7 \) mm
Standard Keys:  R4C1  R4C6
Key Offset:  X=0  Y=0

Fig. 1
3 X 3 array  n=3  s=22 mm
Standard Keys:  R2C1  R2C3
Key Offset:  X=9.75  Y=0

Fig. 2
Reticle Fiducials

The alignment marks, or fiducials, made on the reticle by the GCA/MANN PG3600F, are used to align the reticle. These fiducials will be placed at 103 mm apart on center and are used to align the reticle to the column. The fiducials on the mask are 25 microns wide and the marks on the column are 6.25 microns wide with equal spaces (a total of 31.25 microns).

Fiducial marks placed on all GCA stepper reticles by the PG.

Mask fiducials offset relative to the column fiducials

Mask in perfect registration with column fiducials

Reticle Alignment Splitfield Image
The fiducials on your reticle that get transferred to your wafer during the first level patterning are used in subsequent patterning levels to align the wafer to the column. On the 5x and the 10x, the alignment marks on the wafer are 2 microns wide and the marks you align to from the center are 3, 4 and 5 microns wide.

Alignment marks for the GCA steppers placed on the first level reticle.

GCA stepper alignment marks offset relative to the microscope reference marks.
GCA stepper alignment marks in perfect registration with the microscope reference marks.

POSSIBLE ERRORS

Alignment errors of the reticle to the column

Perfect alignment with a mark exactly 25 microns wide has a gap of 3.125 microns on each side. For this case, the worst error would then be 3.125 microns, which translates into 0.625 microns on the 5x and 0.3125 on the 10x.

Alignment errors of the wafer to the column

Perfect alignment with the outer 5 micron bar has a gap of 1.5 microns on each side. For this case, the worst error would then be 1.5 microns.

Stage error
Data input of 0.1 µm, the least count of X & Y coordinate stage motion is ±0.04 µm. Positional precision of each stage is ±0.05 µm

When all of the types of errors are added together, the typical alignment accuracy here at the CNF is around ± 0.25 microns. Occasionally, it can be better but it is the exception, not the rule. Keep this in mind when designing your device.
EXPOSURE

The first thing to be aware of is the thickness limits of each stepper. Each stepper has chucks for nominal thicknesses +/- 100um.

Depending on the design, thickness of the resist and wafer type, a characterization must be done to determine the best exposure time and focus value. The command EXPO is used to do this. EXPO can be used in 3 ways.

1. It can be used as an exposure/focus matrix that uses an array from an existing job. Each row is a different focus value and each column is a different exposure time.

   \[
   \begin{array}{c}
   \Delta E \\
   \Delta F \\
   \downarrow \\
   \end{array}
   \]
   
   XXXXXXXXXXX
   XXXXXXXXXXX
   XXXXXXXXXXX
   XXXXXXXXXXX
   XXXXXXXXXXX

2. EXPO can also be used as an exposure only matrix which allows you to vary exposure times only. An important difference to be aware of is the order in which the stepper exposes the die.

   \[
   \begin{array}{c}
   \Delta E \\
   \downarrow \\
   \end{array}
   \]
   
   XXXXXXXXXXX
   XXXXXXXXXXX
   XXXXXXXXXXX
   XXXXXXXXXXX

3. EXPO can also be used as an focus only matrix which allows you to vary focus only. One value for exposure dose must be specified.

   To specify the focus/exposure matrix, at the prompt for choice of test, type R. If the exposure only matrix is wanted, type E, for focus only type F. Inspection is done using the microscope looking for the die that gives you the best results.
SHIFT KEY & KEY OFFSET SECTION

In order to understand how to use these commands, it is necessary to understand the way the stepper translates the pattern from the mask to the wafer. From the mask to the wafer, the pattern gets inverted 2 times, once in X and once in Y, yielding a 180° rotation.

Reticle or Mask Pattern  Printing of same pattern on the wafer

**Key Offset:** This will be used if your alignment marks are not in the center of the die. This is explained in the stepper training manual so you should already be familiar with it. (A copy of the stepper training manual is in the back of the log book).

**Shift:** This is used when the center of the die is not at the geometric center of the mask. For example, one reason you may need this is if you do a tone reversal and the cutout frame is not symmetric about the pattern. In CAD, the conversion program uses the outermost frame as the reference for center, in this case the cutout frame. This center point becomes the center point for all the layers that it surrounds. Because it is not symmetrical about the pattern, the center for the pattern is shifted to be the same as the center for the cutout frame. Because the mask is always aligned in the same position and the stepper knows where the center of each die is in the job you've created, the shift on the mask causes the shift of the center of the die on the wafer. The stepper **always goes to the center of the die.** To determine the shift, keep in mind this point is fixed and the wafer must be moved to adjust the center.

For example:

inner frame center (1000, 1000) Pt 1
outer frame center (1050, 1050) Pt 2

To go to inner frame center to the outer frame center would require a shift in X and Y. To determine the sign of the shift, you must know the axis directions for the stage and which way the stage must move to get to the desired position.

For the above example, the shift in X would be +50 and the shift in Y would be -50. Pt 1 (1000, 1000) is fixed. We need to move the wafer so that Pt 2 (1050, 1050) is in that position.
You would also need to use the SHIFT if the pattern you made is not symmetric or has many layers. The center is calculated based on the design and the center will be skewed from the actual center of the die. Again, you would need to know the calculated center (from the CAD conversion) and the actual center of the die to determine magnitude and direction of the shifts.

**TO AVOID USING THE SHIFT OPTION:**
Always draw a symmetrical frame around the entire pattern, even if you are not doing tone reversal. For tone reversal, it uses that frame as the "cut out" for the pattern and it's center will be the geometric center of the die. For a normal conversion, the conversion program looks at the outer frame to determine the center of the die. If the outer frame is a big empty box, it will compute the center as the geometric center.
### General Stepper Information

<table>
<thead>
<tr>
<th>Reduction</th>
<th>GCA 10:1</th>
<th>GCA 5:1</th>
<th>Autostep 5:1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Size</td>
<td>10 mm</td>
<td>20 mm</td>
<td>15 mm</td>
</tr>
<tr>
<td>Wavelength</td>
<td>365 nm</td>
<td>436 nm</td>
<td>365 nm</td>
</tr>
<tr>
<td>N.A.</td>
<td>0.42</td>
<td>0.30</td>
<td>0.45</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.5 μm</td>
<td>0.9 μm</td>
<td>0.45 μm</td>
</tr>
<tr>
<td>k=0.6</td>
<td>0.7 μm</td>
<td>1.2 μm</td>
<td>0.70 μm</td>
</tr>
<tr>
<td>k=0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth of Focus</td>
<td>± 1.03 μm</td>
<td>± 2.42 μm</td>
<td>± 0.96 μm</td>
</tr>
</tbody>
</table>

#### Diagrams
- **5:1 Stepper Field** (actual size)
- **10:1 Stepper Field** (actual size)
COMMAND SET
(Note: all of these commands may not be active)

1) AEXPO Retries a previously specified DEXPO file (see below) for the purpose of generating an exposure/focus matrix on a wafer (or mask).

2) BASIC Allows access to a calculator that performs addition, subtraction, multiplication and division.

3) COMP Reads and reports the last four digits of the laser compensator.

4) COPY Allows a user to copy files from another user's area to his own area on a selected disk.

5) DELETE Deletes files from user's area on a user-selected disk.

6) DEXPO Allows a user to pre-define the parameters of an EXPO run in file form. Only AEXPO can execute this file.

7) DISP Displays graphically part or all of a job array.

8) ECHO (ON or OFF) sets up a second terminal to echo or duplicate input/output communications of first terminal.

9) EDIT Modifies a previously specified job stored either in a job file on disk or read from paper tape.

10) EXEC Runs one or more passes of a job.

11) EXPO Creates a one-time exposure/focus test array made at user-selected shutter speeds and/or focus settings.

12) HISREC Displays history files.

13) LIST Prints the job name and associated pass name(s) contained in the specified job file on disk.

14) LISTF Prints from selected user area and disk file names and time and date created.

15) LOAD Positions stages for manual wafer loading or unloading. This command is usually executed automatically.

16) LOG (IN or OUT) identifies the user to the terminal.

17) MESS Allows a user at one terminal to send a message to another terminal.

18) MODE Establishes specific hardware patterns.
19) MONITR (ON-or OFF) allows all activity at other terminal to be echoed at monitoring terminal.

20) OPER Establishes wafer alignment joystick rates.

21) ORIG Retunes laser and originates stage laser metering.

22) PFCORG Originates the Programmable Focus Control Stepper motor.

23) PRINT Prints text files stored on disk via TEDIT.

24) RENAME Gives an existing file a new name.

25) SETDSK Allows system to recognize a new disk in unit two for a Winchester system and in unit one for a dual floppy system.

26) SHUTDN Shuts down system computer after closing current history file, if any. Must be used for shutdowns when history processing is active.

27) SPEC Creates new jobs.

28) TEDIT Creates, modifies and stores text files on disk.

29) TIME Prints current time/date.

KEYBOARD CONTROLS (Note: all of these commands may not be active)

1) A Enables user to toggle between left and right non-standard alignment keys during wafer alignment process.

2) D Enables a jog mode for joystick during wafer alignment. Stages move one stepping distance in the selected direction.

3) E Cancels jog mode such as D. Normal wafer alignment modes are restored.

4) F Enables user to search for wafer alignment keys not initially in the TV field of view. Each issue of CTRL F causes stages to move a step at a time along an expanding rectangular spiral.

5) 0 Allows user to temporarily modify wafer alignment joystick rates.

6) P Initiates a progress report while a pass is being executed. The row and column of the array element being exposed as well as expected time until completion are printed, for example:

   10 EXPOSURES DELIVERED OUT OF 35 - 10:46:08 13/8/89
   ESTIMATED PASS COMPLETION IN 0 MIN 32 SEC.

7) CTRL C, A aborts the command in progress at the terminal, prints COMMAND ABORTED and returns control to the command monitor. (Also see S below).
8) **S** This function is useful for halting the scrolling of the video terminal display since it suspends operation at the terminal from which it was issued. To resume operation, type **CTRL Q** one time only. Typing **CTRL Q** twice after **CTRL S** will abort the command in progress. A safer alternative is to use the **SCROLL LOCK** key on the terminal. This toggles on and off.

9) **U** On a video keyboard terminal, **CTRL U** erases the current line of input and positions the cursor at the beginning of the deletion. On a hardcopy terminal, **CTRL U** cancels the current line of input. A carriage return/line feed is generated and the line may be retyped.

10) **Z** Suspends system activity until a second **CTRL Z** is issued.

11) **REPT** Initiates fast line feed and is equivalent to typing **RETURN** to each separate question. For this function the **REPT** key and the carriage **RETURN** key are held down simultaneously. On earlier systems where no **REPT** key is present, merely hold down **RETURN** key. Also holding down any other key longer than one second will cause a repetitious printing of that character until the key is released.

12) **RETURN** (Carriage Return) enters data and signal to the computer that the current user response is completed, the data is to be stored and the program is to advance the the next question.

13) **RUBOUT** (DELETE) Pressing RUBOUT key (DELETE on some terminals) removes the last character typed. Two RUBOUTS remove the last two characters, etc. On certain terminals RUBOUT may be a shift character. In this case the lowercase symbol (an underscore) acts like a rubout.

14) **?** In SPEC, EDIT, and MODE, pressing the ? followed by a carriage **RETURN**, backs up one line of the questioning each time it is pressed.