R·I·T	Title: GCA Stepper Operations	
Semiconductor & Microsystems		
Fabrication Laboratory	**Revision**: G	**Rev Date: 09/07/2017**

Approved by:

_____ / / _____ / /
  Process Engineer   Equipment Engineer

1   SCOPE

The purpose of this document is to detail the use of the GCA Stepper. All users are expected to have read and understood this document. It is not a substitute for in-person training on the system and is not sufficient to qualify a user on the system. Failure to follow guidelines in this document may result in banning from the tool or the RIT Semiconductor and Microsystems Fabrication Laboratory (SMFL) itself.

2   REFERENCE DOCUMENTS

- o   6000 Series DSW Wafer Stepper Operations Manual

3   DEFINITIONS

n/a

4   TOOLS AND MATERIALS

4.1   General Description

4.1.1   The GCA is a G-Line Stepper that may be set up to expose either 4-inch or 6-inch wafers. 4-inch wafers are loaded manually and 6-inch wafers may be loaded manually or with the automatic wafer handler. The resolution is approximately 1 um and the depth of focus is 3 um.

4.2   Reticle Holders

4.2.1   Reticle holders are stored in the Reticle Management System (RMS) on the left side of the stepper.

4.3   Wafer Cassettes

4.3.1   The GCA uses the dedicated black polypropylene cassettes for 6-inch wafers.

4.4   **Wafer Paddles**

4.4.1   The system uses removable wafer paddles to place wafers under the exposure column. Wafer vacuum is supplied by the plug-in tubing. Paddles are stored inside of the stepper to the left.

Paddle Storage
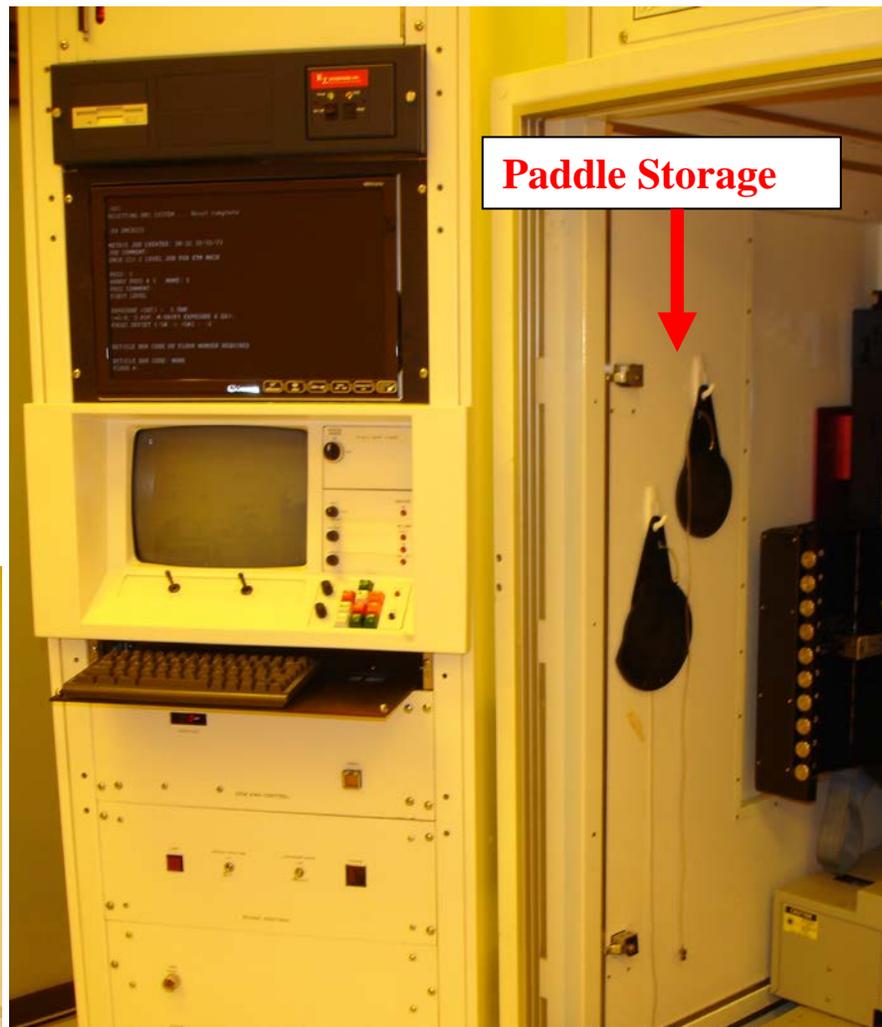
5   <u>SAFETY</u> <u>PRECAUTIONS</u>

5.1   Hazards to the Operator

5.1.1   **Laser Safety** - Lasers are used in the GCA Stepper near the stage. Use caution not to look directly into the lasers.

5.1.2   **Mechanical Hazards** - Drive assemblies have sufficient power to cause injury. Keep hands, fingers, clothing and tools clear of moving parts.

5.1.3   **Ultraviolet Radiation** - The stepper uses ultraviolet radiation. Avoid exposing eyes or skin. Always wear protective eyewear.

5.2   Hazards to the Tool

5.2.1   **Wafer Paddles** – The wafer paddles have precision machined surfaces. Be careful not to drop or damage them.

5.2.2   **Alignment Lenses** – The alignment lenses are in a position where they could easily be bumped while loading a wafer paddle. If this occurs, a baseline correction will need to be done to prevent misalignment. Please inform a staff member if this occurs.

5.2.3   **Environmental Chamber** – Please keep all doors on the environmental chamber closed after wafers and reticles are loaded.

5.2.4   **MODE file** – The MODE file contains important stepper parameters including the wafer size. When changing the wafer size, be careful not to change any of the other settings.

5.2.5   CAUTION: Under no circumstances are you to manually move the aperture blades.

Damage to the motors, gears and belts will occur.

6   INSTRUCTIONS

6.1   Initial State Check

6.1.1   Verify that there are no wafers or reticles remaining on the stepper.

6.1.2   Turn on the stepper monitor using the Monitor On/Off switch.

6.1.3   Verify that the computer is at the colon prompt (:). If it is not, log in using the command **L I [10,1]**.

R·I·T

Operations

Semiconductor & Microsystems

Fabrication Laboratory

Title: GCA Stepper

Revision: G   Rev Date: 09/07/2017

6.2   Loading a Reticle

6.2.1   Reset the Reticle Management System by typing **RES** command followed by **Enter**.

6.2.2   When loading the job parameters the alignment mark phase will be **N**egative for clear fiducials and **P**ositive for opaque fiducials. Please note that you will *not* be able to do a second level alignment if you choose **X**.

6.2.3   Reticles are loaded into the reticle holders with the chrome side down and the RIT symbol near the door of the reticle holder.

6.2.4   Reticle Holders are loaded into the Reticle Management System by pulling the knob out and placing the holder in one of the open levels.

6.2.5   If you are loading a bar coded reticle and wish to specify this when starting a job, you will need to inventory the reticle. Type **INV** at the command prompt and the system will read the bar code.

6.3   Manual Operation with 4" Paddles

6.3.1   Flip the toggle to the right of the monitor to **4"**.

6.3.2   Verify that the MODE file has been set up for 4 inch wafers. Type MODE at the command prompt, press **Enter** until down to the chuck size and set to 100mm. Change the stage alignment offsets to X=0.25 and Y=4.25. After changing, keep pressing **Enter** on the keyboard until you get to the end and save. Be careful not to change anything else in the MODE file.

6.3.3   Originate the stage using the **ORI** command followed by **Enter**.

Vacuum Port

Paddle Vacuum

Wafer Vacuum

6.3.4   Plug the paddle into the **PADDLE CONNECT** vacuum port on the **DSW/AWH SUB CONTROLLER**.

6.3.5   Place the wafer on the paddle making sure it is against all three stops.

6.3.6   While holding the wafer in place, turn on the **Wafer Vacuum**. (Note that the vacuum may not turn on until the next step) Make sure that the wafer is still against all three stops. If the wafer does not properly contact all three stops, the exposures will be misplaced and possibly rotated.

6.3.7   At the prompt, press the **RES** button on the keypad. The wafer vacuum should now be on. Wait for the Laser Sensor Lights to come on and go out.

6.3.8   Load the paddle onto the stage, using care not to hit the alignment lenses. If the alignment lenses are bumped, a Base Line test will need to be run.

Alignment Lenses
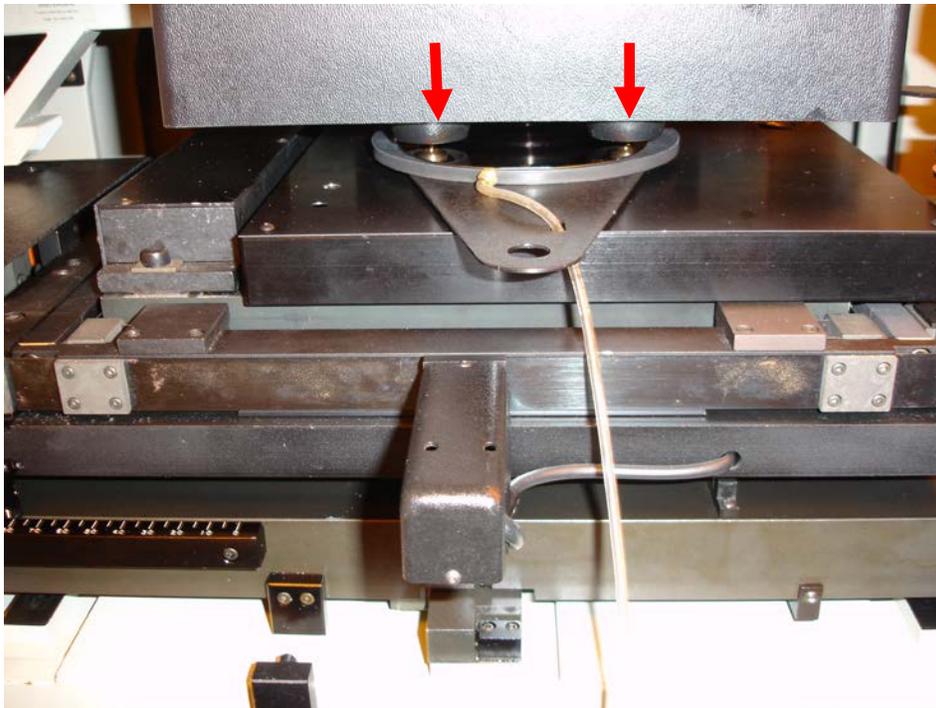
6.3.9   With the paddle in contact with both of the rear stops, turn on the **Paddle Vacuum**. Please note that it is still possible to move the paddle with the **Paddle Vacuum** on. If the paddle does not properly contact the two rear stops, the exposures will be misplaced and possibly rotated.

6.3.10   Close the doors on the environmental chamber.

6.3.11   *This is an optional step that may improve leveling for jobs where the leveling has been disabled using (-1) in the job.* At the command prompt, perform a manual level of the stage using the AWLT command followed by the jobname and level. For example AWLT EMCR221\1 will level a wafer with the first level of the EMCR221 job. Repeat until numbers are low. Repeat this step for each wafer.

6.3.12   At the command prompt, load the stepper job using the **EX** command followed by the jobname. For example **EX EMCR221** will execute the EMCR221 job.

6.3.13   When prompted enter in the appropriate job parameters. (use a **?** to back up job line by one step) You will be prompted for the following:

Pass number	(**1** for a first or single level job)
Exposure	(enter in seconds)
Focus setting	(enter focus setting)

Bar Code	(**NONE**)
Floor #	(1 through 6)
Alignment Mark Phase	(P, N or X)

6.3.14 If you get the error **RMS ERROR: $RMS BARCODE NOT IN DIRECTORY**, press **CTRL C** and **A** to abort the job. At the command prompt, type **INV** and wait for a reticle inventory to occur. At the command prompt load your stepper job again.

6.3.15 Press and hold the **MAN** button and press the **S/C** button.

6.3.16 Press the **MAN** button.

6.3.17 If needed, align the wafer using the joysticks on the stepper. The right joystick is for X and Y motion, and the left joystick is for theta adjustment.

6.3.18 Press the **EXP** button to expose the wafer.

6.3.19 At completion the wafer will return to the auto load position and the computer will display the message **Wafer # Completed**.

6.3.20 Press **MAN** to return to the load position.

6.3.21 Turn off the Paddle Vacuum and carefully remove the paddle.

6.3.22 Turn off the Wafer Vacuum and remove the wafer.

6.3.23 If more wafers need to be exposed with the same settings, load them, align and press **EXP**.

6.3.24 When the current job is complete press **CTRL C**, wait for the **::** prompt, press the letter **A** and then **Enter**. The system will return to the command prompt.

6.3.25 To return the reticle, type **RMSRET** and then **RES**. The reticle will return to the box and then the reticle changer will lower.

6.3.26 Turn **Off** the stepper monitor. The computer monitor stays on.

6.4   **Automatic Operation with the 6" Paddle**

6.4.1   Flip the toggle to the right of the monitor to **6"**.

6.4.2   Verify that the MODE file has been set up for 6 inch wafers. Type MODE at the command prompt, press **Enter** until down to the chuck size and set to **150**mm. Change the stage alignment offsets to X=4 and Y=3.5. After changing, keep pressing **Enter** on the keyboard until you get to the end and save. Be careful not to change anything else in the MODE file.

6.4.3   Turn on the **Wafer Vacuum**. Leave on when in Automatic Mode.

6.4.4   Originate the stage using the **ORI** command followed by **Enter**.

6.4.5   At the command prompt, load the stepper job using the **EX** command followed by the job name. For example **EX EMCR221** will execute the EMCR221 job.

6.4.6   When prompted enter in the appropriate job parameters. (use a **?** to back up job line by one step) You will be prompted for the following:

Pass number	(**1** for a first or single level job)
Exposure	(enter in seconds)
Focus setting	(enter focus setting)
Bar Code	(**NONE**)
Floor #	(1 through 6)
Alignment Mark Phase	(P, N or X)

6.4.7   Plug the 6" paddle into the vacuum port.

6.4.8   Load the paddle onto the stage, using care not to hit the alignment lenses. If the alignment lenses are bumped, a Base Line test will need to be run.

6.4.9   With the paddle in contact with both of the rear stops, turn on the **Paddle Vacuum**. Please note that it is still possible to move the paddle with the **Paddle Vacuum** on. If the paddle does not properly contact the two rear stops, the exposures will be misplaced and possibly rotated.

6.4.10   Place the cassette with the wafers to be exposed on the front elevator. Place an empty cassette on the back elevator.

6.4.11   Press the **RES** button on the stepper. Wait a few seconds and press **1**st **Level** and then **S/C** for a first level job or just **S/C** for a higher level. The wafers will be loaded and processed automatically.

6.4.12   If alignment is needed, align the wafer and then press **EXP** to expose the wafer. The right side of the alignment screen is for X and Y correction and the left side is

R·I·T
Operations
Semiconductor & Microsystems
Fabrication Laboratory

Title: GCA Stepper

Revision: G   Rev Date: 09/07/2017

for Theta correction. Theta correction is done by adjusting the Y motion on the left side. The X will not be aligned on the left side.

6.4.13 When all the wafers are complete an alarm will sound. Press **RES** on the stepper.

6.4.14 You will be prompted to either return the reticle or to continue.

6.5   Returning a Reticle

6.5.1   At the command prompt type **RES** to reset the reticle changer.

6.5.2   To return the reticle to the box, enter the command **RMSRET**.

6.5.3   To lower the reticle changer, enter the command **RES**.

6.6   Terminating a Job

6.6.1   To terminate a job hit **CTRL C**, wait for the **::** prompt, press the letter **A** and then **Enter**.

6.7   Errors during Run

6.7.1   **Rebooting the Stepper**

6.7.1.1 Press **Reset** button on the computer.

6.7.1.2 Enter the time and date. The time should be in the hh:mm format and the date should be in the dd:mmm:yy format. The first three letters of the month should be entered. For example 12/15/2009 would be entered as 12-DEC-09.

6.7.1.3 When the colon prompt comes up, log in by entering **L I [10,1].**

6.7.1.3 Type in the command **RES.**

6.7.1.4   Type in the command **ORI**.

6.7.2   Occasionally there will be a problem with the Reticle Management System that will force you to use the **RMS primitive commands** to transfer a reticle. Be very careful when in this mode. This mode can be entered manually by typing in the command **RMS**. CAUTION: Under no circumstances are you to manually move the aperture blades. Damage

to the motors, gears and belts will occur.   When in the primitive command mode use the following commands:

`AP`R`	opens the apertures
`AF	extends the A fork
`BF	extends the B fork
`TT	turns the turntable
`EL`X`	moves the elevator to floor # X
`AL`P`	aligns the reticle with positive alignment marks
`AL`N`	aligns the reticle with negative alignment marks
`EQ	equalizes the mask alignment sensors
`HO	home the mask alignment stage
~	used to exit the RMS prompt

6.7.3   If you are having difficulty with the reticle alignment, try using the `**EQ** and `**HO** commands while in the **RMS mode**.

7   APPROPRIATE USES OF THE TOOL

7.1   Always use a clean mask to prevent contamination of the mask handling.

7.2   Always use clean wafers to prevent contamination of the wafer chuck.

8   ATTACHMENTS

8.1   Measuring the Lamp Intensity

8.1.1   Check with a staff member to open the condenser housing.

CAUTION: Under no circumstances are you to manually move the aperture blades.

Damage to the motors, gears and belts will occur.

R·I·T
Operations
Semiconductor & Microsystems
Fabrication Laboratory

Title: GCA Stepper

Revision: G   Rev Date: 09/07/2017

8.1.2   Load a plain glass plate into the stepper.

8.1.3   Open the condenser housing, place the radiometer on the glass plate and then close the housing.

8.1.4   Open the shutter using the manual shutter switch. Do not turn it on for more than 30 seconds.

8.1.5   Since this is a 5X reduction stepper, remember to multiply the measured irradiance by 25 to get the irradiance at the wafer.

8.1.6   Exposure equals the irradiance times time.

8.1.7   If the **Shutter Select** switch is in the **Timed** position, the shutter will open for the selected time.

8.1.8   If the **shutter select** switch is in the **Integrate** position, the selected time will be adjusted by the stepper to give 25 mJ/cm^2 for each 0.1 seconds of exposure.

8.1.9   When finished with the measurements, put the radiometer away, remove the glass plate from the stepper and close the housing.

8.2   **Performing a Focus-Exposure Matrix (FEM), Energy Meander or Focus Meander –** On the GCA Stepper a matrix or a meander can be produced using the **EXPO** command. On a **Focus-Exposure Matrix** with the flat up, the focus varies by row and the exposure varies by column, while incrementing in the direction of the arrows. On an **Energy** or **Focus Meander**, the starting value is placed in the upper left with the flat up, and increments in the direction of the arrows as shown below.
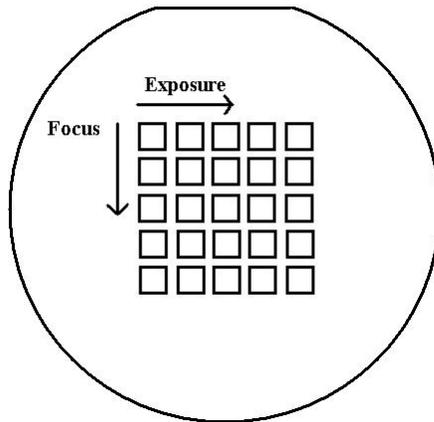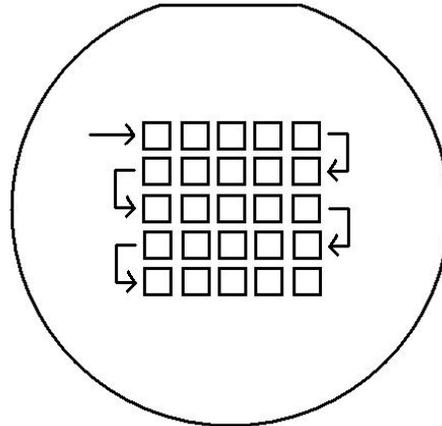
Focus-Exposure Matrix **Focus or Exposure Matrix**

8.2.1 Type in **EXPO jobname** and enter in the following parameters:

Pass: (enter a pass number)
Starting Row: (enter the starting row)
Ending Row: (enter the ending row)
Starting Col: (enter starting column)
Ending Col: (enter ending column)
Over C-ourse Focus Array, F-ine Focus Array, E-xposure Array or R-ow: (**R** for FEM)
  (**F** for focus array)
  (**E** for exposure array)
Starting Exposure (sec): (enter in seconds)
Incremental Exposure (sec): (enter in seconds)
Starting Focus Offset: (enter starting focus)
Focus Offset Increment: (enter focus increment)
Do You Want to Run an Open Frame Test (Y/*N): (choose **N**)
Bar Code: (**NONE**)
Floor #: (1 through 6)
Alignment Mark Phase (P/N/X): (P, N or X)

REVISION RECORD

Summary of Changes	Originator	Rev/Date
Original Issue	Sean O'Brien	A-03/10/2009

Added 6.4.2, 6.7.1.2, 6.3.21, 6.3.22, changed 6.1.2	Sean O'Brien	B-12/15/2009
6.2.2 added note about 2nd level alignment, added 6.3.1, 6.4.1, 6.4.14 to explain 4 to 6 inch conversion	Sean O'Brien	C-04/02/2010
Modified sections 6.3, 6.4 and 6.7	Sean O'Brien	D-03/25/2011
Clarified section 8.2 and added illustrations	Sean O'Brien	E-06/24/2011
Section 6.3 re-ordered to include optional 6.3.11 to manually level	Sean O'Brien	F-08/09/2011
Added Cautions to Never manually move the aperture blades	Bruce Tolleson	G-09/07/2017