

## **CNF Autostep Operation**

System manager: Garry Bordonaro  
Backup: Giovanni Sartorello and John Treichler

### **Overview:**

- 1) Enable the tool using NEMO
- 2) Log on to the Autostep, run CHUCK
- 3) Load your reticle(s) using RMSLOAD
- 4) Load your wafers
- 5) Run SETUP (optional)
- 6) Run your job
- 7) Unload your wafers
- 8) Unload your reticle(s) using RMSLOAD
- 9) Run CHUCK, log out of Autostep
- 10) Log out of NEMO

### **Photoresists:**

Currently there are several recommended resists for this tool:

#### OIR 620-7i

This is useful for high-resolution work. It spins between 400 and 700 nm. Sub-0.5  $\mu\text{m}$  l/s have been achieved using this resist.

#### SPR220-3.0, 4.5, & -7.0

SPR220 can be spun from 2-13  $\mu\text{m}$  in a single layer. SPR220 has excellent adhesion and plating characteristics, which make it ideal for thick film applications like MEMS.

#### SPR955-CM 0.9 & 2.0

SPR955 can be spun from 700 nm to 3  $\mu\text{m}$ . SPR955 exhibits very good adhesion and high resolution. 0.5  $\mu\text{m}$  l/s have been achieved using this resist.

#### SPR700-1.2L

Excellent resolution and superior adhesion for wet etching; very good thermal properties.

#### AZ nLOF 2020

Negative i-line resist designed for Lift-off. Very fast with excellent resolution.

Most other resists at CNF are either obsolete or do not perform optimally on this tool.

## **Logging in:**

At the command prompt type:

L\_I\_[XXX,YY] {the \_ indicates a **space**}

where XXX,YY is your account number. You will then be prompted for your password (123456). Once you are logged in type:

LISTF

This will display the files in your directory. If you have more files than can be displayed on the screen at any one time, use the <**Hold**> key located in the upper left-hand portion of the keypad to stop the screen from scrolling. Pressing <**Hold**> a second time will resume scrolling.

## **Run CHUCK:**

At the command prompt type:

CHUCK <**Enter**>, C <**Enter**>, {chuck size} <**Enter**>  
LOAD <**Enter**>

where {chuck size} is the wafer chuck you will use. See more detailed instructions in the CHUCK section.

## **Loading reticles:**

The Autostep has a fully automated reticle management system capable of storing up to 10 reticles at any one time. This system, referred to as RMS, will automatically load a reticle from a carrier cassette, place it onto the platen of the optical exposure column, and automatically align it. When your wafers are completed it will also automatically remove the reticle and return it to the appropriate cassette. To use this system properly you must have specific **Fiducial** marks on your reticle. Please refer to the photolithography web page or the GCA Reticle Handbook for details.

At the command prompt type:

RMSDIR or RMSD

This will display the cassettes and reticles that are currently loaded in the RMS. Identify a cassette from the elevator that you want to use. If there are no empty cassettes, remove a reticle from any cassette EXCEPT the SETUP-01 reticle on floor 1. Please carefully place any reticles that you remove in an appropriate container or other safe place.

### **Note:**

An empty cassette is designated by **no text** next to the corresponding position number in the displayed RMSDIR output. If the display reads NONE or BC ERROR there actually **is** a reticle in that cassette; however, it does not contain an identifying barcode.

Once you have identified a cassette floor, type the following command:

RMSLOAD or RMSL

This will send the elevator to the top position and free the RMS turntable. Pull out the chrome knob for the selected floor, remove the reticle cassette, open it carefully, and load your mask. Note the position marked for the BARCODE. Load the reticle chrome side DOWN.

Please note the following:

- 1) DO NOT REMOVE THE SETUP-01 RETICLE!!!**
- 2) DO NOT load or remove reticles without completing RMSLOAD!**
- 3) You are responsible for any reticles that you remove from the stepper. If you remove any reticles, please put them in a safe place on a table or return them to the same cassette they were found in when you are done with your exposures.
- 4) Do not leave reticles loaded in RMS if you are not using them again the same day.
- 5) If you break an RMS cassette your project will be charged.

After your reticle is loaded, press <Enter> on the keyboard. The RMS system will begin an inventory of the reticles. The names and floor locations of loaded reticles will be displayed. When this operation is complete it will return you to the command prompt.

### **Loading wafers:**

#### **Automatic Wafer Loading:**

(requires 100mm non-transparent wafers, SEMI spec standard thickness, SEMI spec primary flat, no notched wafers)

To use the AWH system, place your wafers face up (resist away from the H-bar) in the send cassette (left side or closest to the front of the chamber). The cassettes are always mounted H-BAR DOWN. Make absolutely certain that the cassette is positioned correctly and that your wafer is in the same slot on each side of the cassette. Cross-slotted wafers may break. Be certain that the backside of your wafers are absolutely CLEAN or vacuum failures will occur.

#### **Manual Loading:**

Manual loading is to be done only by trained users. Please see the Photolith staff regarding training for manual loading.

## **Running Setup:**

SETUP is a built-in procedure that automatically finds the current system focus and optimizes several other parameters for the tool. To run SETUP, type the following command:

SETUP

You will see a script run on the monitor, and then you will be prompted to perform an alignment operation. When the GCA alignment key appears on the left side of the alignment monitor, use the right-hand set of arrow keys (on the number pad) to position the mark inside the cross hairs. Do NOT adjust theta (rotation). Once the mark is properly positioned, press the <Expose> key.

At this point, no further user intervention is required. However, you should observe the data being displayed on the Metrology monitor and verify that it looks normal. Failure of the operation to complete successfully after two attempts should be reported to the staff.

**IMPORTANT:** if the FOCUS graph looks *flat* instead of *bell-shaped*, terminate the job immediately (using <Ctrl-C>, A, <Enter>) and start over. **DO NOT ALLOW IT TO FINISH!**

## **Writing job files:**

To create a new job type:

SPEC jobname

To edit an existing job type:

EDIT jobname

Jobs are organized into two parts: job-specific information (wafer template) and passes (resist layers). Wafer size and stepping distance are specified in the job-specific portion of the job. Information about the reticle, the type of alignment used, the exposure dose, focus, and the specified array are contained in each pass.

In general, there are two types of passes: those that perform some form of automated alignment, and those that perform exposure. The only type of pass that combines the two operations is a die-by-die (a.k.a DxD) alignment/exposure pass. A typical job will contain one or two alignment or MAPPING passes (no exposure information contained in these passes) and several exposure passes (no alignment or DxD alignment information contained in these passes).

You can also use the JOB command to edit your files. Instructions are in the GCA manual.

**Helpful Hints:** If using MATCH with your reticles, the template used should be ORNL4, run every 25 wafers. Leave the Leveling Batch Size set to 1. Aperture Blade settings should be 12mm when using a 15mm die size. <Shift-6> will **reset** the Array or Plug pass layout. Terminate actions using <Ctrl-C>, A, <Enter>.

## **Running Job files:**

To run a job that does not involve automated alignment, type the following:

EXEC jobname\pass

To run a job that involves automated alignment of any kind (2-point, mapping, or die-by-die), type the following:

MAP jobname\pass

If **multiple passes** within a job are required for a given exposure (i.e. a mapping pass followed by an exposure pass) type the following:

MAP jobname\pass1,pass2

where pass1 is the mapping pass and pass2 is the exposure pass.

Once this command has been entered, the comment information for the job, pass, or passes will appear on the screen followed by a series of interactive prompts. Read these prompts carefully. They will request that you verify the exposure dose, the name of the reticle, and the reticle transmission. All of these parameters can be changed at this time by entering new values at the prompt. If you have no changes, press <Enter>.

At this time the RMS system should begin locating and loading the reticle. Once reticle alignment has completed you will be prompted:

‘START AWH’

At this time you have three choices:

- 1) Press the <1<sup>st</sup> Level> key. This is the first level in your exposure process; i.e. you are doing an unaligned exposure.
- 2) Press the <S/C> key. This will load the wafer and bring it into position for wafer alignment.
- 3) Press the <Manual> key. This allows manually loading a wafer and aligning.

If option 1 is used, the automatic wafer handler (AWH) will activate, lowering the wafer cassettes until a wafer is detected. The wafer in the send cassette will be brought to the pre-aligner, aligned with respect to the flat, and then moved to the exposure chuck. After wafer levelling, the exposure will begin and the wafer will be transported to the receive cassette automatically when exposure is complete.

If option 2 is used, the same steps as above will occur with the addition of the wafer alignment process. This will move the stage to place your wafer alignment marks under the alignment

microscopes so that they will be visible on the screen. If the AWA system is disabled, press the white button on the Alignment Lamp box to illuminate the wafer marks.

### **Global alignment methodology**

Use the arrow keypad to adjust the X, Y, and rotational position of your wafer. When both alignment marks are close to being collinear and close to the cross hairs, press the <Enter> key on the number pad to switch to the fine stage travel or “Slow Mode” (Speed). Align the right mark such that the X and Y markers are positioned uniformly within the cross hair. Align the left mark such that only the Y arms (the lines running horizontally on your mark) are aligned. Do not waste time trying to align this mark in X (lines running vertically on your mark); it accomplishes nothing. The left-side mark is for rotational adjustment only!

Useful commands for manual global alignment

**O:** adjusts the speed of the X, Y, and theta (rotation) travel. 5 is a good starting value for coarse adjustments. Use up to 10 if you have a lot of ground to cover (searching for your marks).

**F:** moves the stage in an outward spiral pattern allowing you to cover every possible field of view around your alignment mark.

**A:** toggles back and forth between your alignment marks if you have non-standard keys.

**D:** moves from die to die when X or Y is pressed.

**T:** moves the current alignment die under the opposite microscope when X is pressed.

**E:** ends operation of D or T.

### **Exposing wafers:**

Once you are ready to expose, press the <Expose> key located on the upper right-hand corner of the keypad.

If your job performs additional automated alignment, the procedure will begin at this time.

For Manual exposure, please see the tool manager for procedures.

If you are performing a first level job, all the wafers will be exposed in order using the AWH. If you are performing a job with alignment, you will need to perform the manual alignment and exposure steps above for each wafer.

## **Logging out:**

After completion of a job using the AWH you will be prompted with the following two questions:

Do you wish to continue the job? (Y or N)  
Do you wish to return the reticle? (Y or N)

Answer these questions appropriately. When you are finished, your reticle has been removed from the RMS, and RMSLOAD is completed, type:

L\_O {the \_ indicates a **space**}

This will log you out.

Please log out of NEMO and email any questions or concerns to the tool manager.

## **Other useful commands and troubleshooting**

If you need to terminate an action while it is running, type:

<Ctrl-C>

The system halts. The command prompt will change to the following:

::

If you type <Enter> the system resumes.

If you type A (for ABORT) at this double prompt followed by <Enter>, the action will be stopped and the standard command prompt will appear.

To copy a file, type:

**COPY**

From? [XXX,YY]filename <Enter>

To? [XXX,YY]filename <Enter>

If an AWH serial communication error occurs while you are starting your job, type:

**RST**

This will reset the AWH system.

If there is a reticle loading or alignment error, type:

**RESET**

This will reset the RMS system.

To take an inventory of the RMS elevator without executing RMSLOAD, type:

**INV**

To reset the stage coordinate system, type:

**OR**

To return a reticle to the library box, type:

**RMSRET** or **RMSR**

To remove a wafer from the exposure chuck while using the AWH, type:

**REMF**

If you see TIMEOUT ON READ FROM ACS PORT or any other ACS error, go to the ACS chassis in the stepper chamber, turn the control knob to CLEAR, press the **RESET** button, then turn it back to ACS after it beeps. The INITIALIZING light will be on for approximately 5 minutes. When it goes out, type:

**CHUCK**, then **A** to run the ACS restore command, then **R**

If you are unhappy with the way that your substrate was pre-aligned, and you think that the pre-aligner can do better (i.e. it has done better with your wafers in the past) press the <**Retry**> key. If you decide not to expose the wafer, you can press <**Reject**> key.

If you are running a pass with uDFAS alignment and you receive an “Auto Focus Failure” error message, you may have called the job and pass with EXEC, instead of MAP.

## **TO CHANGE WAFER MODES:**

If you type **CHUCK** followed by <Enter> at the command prompt, you will see the following:

--- MOP Command Extension (c)2007,2025 H&L Associates ---

C - Change chuck size  
L - Change loading offset correction  
W - Change wafer type to NOTCH or FLAT  
A - Run ACS RESTORE command  
Q - Quit

Select command >>

Typing **C** followed by <Enter> yields:

```
++ Chuck change V1.95 (c)H&L Associates 1998,2016 [8in] [X+]
.. Current chuck : 100
.. Valid sizes   : 10,15,2,10100,15100,2100,10150,15150,2150,
                  3,82,100,125,150,200
```

Enter chuck size >>

### Example:

<b>100</b>	{use 100mm chuck center}
<b>2</b>	{use 2-inch wafer leveling with 3-inch chuck center}
<b>10100</b>	{use 10mm piece leveling with 100mm chuck center}
<b>15150</b>	{use 15mm piece leveling with 150mm chuck center}

Typing **L** followed by <Enter> yields:

```
++ LCO Loading correction V1.3 (c)H&L Associates Aug 2004 X+
.. Current loading correction(mm) x:-.500000 y:7.000000
```

Enter loading correction code (man,awh) >>

<b>MAN</b>	sets default loading correction to FRONT LEFT of stage
<b>AWH</b>	restores loading correction for automatic wafer loader

**Note:** for 5" Plate, 125mm, 150mm, and 200mm chucks the stage **MUST** be set for non-standard loading by using the **MAN** correction followed by the **LOAD** command **before** mounting the chuck. Failure to do so may result in damage to the AWH system.

### **IMPORTANT!**

**When finished you must return to default values:**

**Chuck size = 100, Loading correction = AWH, Wafer type = E. Run LOAD.**

Typing **W** followed by <**Enter**> yields:

```
++ WAFER Change Utility V1.25 (c)H&L Associates 1998, 2025
.. Current wafer type : FLAT
```

Enter N for notched or F for flat wafer >>

Select the correct type for your substrate. Return the setting to FLAT when finished.

Typing **A** followed by <**Enter**> yields:

Press the “R” key to run ACS RESTORE >>

If you see TIMEOUT ON READ FROM ACS PORT or any other ACS error, go to the ACS chassis in the stepper chamber, turn the control knob to CLEAR, press the RESET button, then turn it back to ACS after it beeps. The INITIALIZING light will be on for approximately 5 minutes. When it goes out, type:

**CHUCK**, then **A** to run the ACS restore command, then **R** <**Enter**>.

## Common Problems and some suggested Solutions:

**P:** The fork for reticle loading is not responding.

**S:** Run RESET, possibly RMSRET or RMSLOAD

**P:** Error message ACS system failure or TIMEOUT ON READ FROM ACS PORT

**S:** ACS is the Atmospheric Compensation System used to pressurize the lens. The controller is located inside the chamber at the far-right corner behind the wafer handler. See if the Initializing LED is on. If so, press the RESET button on the ACS. If the error persists after 5 minutes, go to the ACS chassis in the stepper chamber, turn the control knob to CLEAR, press the RESET button, then turn the control knob back to ACS after the unit beeps. The INITIALIZING light will be on for approximately 5 minutes. When it goes out, type:

**CHUCK**, then **A** to run the ACS restore command, then **R <ENTER>**.

**P:** Autofocus / Out of focus failure

**S:** 1. The machine may not be in the correct chuck size mode. Refer to the CHUCK instructions.  
2. The array defined in the print job is bigger than the actual wafer.  
3. The substrate thickness is not right. Make sure you use the correct chuck.

**P:** The printed array is shifted in the Y direction on the order of millimeters.

**S:** 1. Make sure you aligned to the correct row of dies.  
2. The machine may not be in the correct chuck size mode. Refer to the CHUCK instructions.

**P:** The keyboard is not responding

**S:** 1. You are not logged into NEMO. Log in.  
2. This can happen during an alignment for several reasons which can confuse the computer. (Keep in mind this is ancient software). You will need to end the Terminal session and start a new session. Using the keyboard, type **<Alt-S>**, select “Exit Session” and press **<Enter>** to end the Terminal session. In the upper right corner of the screen, **<Tab>** to the left-most icon and press **<Enter>** to open a new session. When complete, press the **<Enter>** key again to resume operation.

**P:** The brightness/contrast on the left or the right screen is poor during the alignment session.

**S:** During the alignment session, by default the **<Inc>** and **<Dec>** allow you to change the microscope focus. Brightness control can be toggled using the “.” key on the keypad.

**P:** While executing a job a message regarding a “Failure to Read IAS Port” is displayed

**S:** A number of things can cause this. The most common cause is failure when trying to run MATCH without having the proper marks on the reticle. MATCH removes rotational misalignment from the reticle using four INSITU marks patterned on the mask located at 12, 3, 6 and 9 o’clock. The DWL2000 can write these automatically. If you make your mask on the DWL2000, the FRAME data must be printed on your mask to use the MATCH function. If you

have a mask made elsewhere you should include the MASK\_BLANK data from the AS200.GDS file.

This error can also be caused by loss of stage position information. Type **OR** to originate the stage and reset the stage position. If the error persists contact the tool manager.

**REPORT ALL PROBLEMS WITH THIS SYSTEM TO  
THE TOOL MANAGER.**

## **AS200 Restart Instructions – STAFF ONLY**

### **To restart the VT340 Terminal Emulation:**

Using the keyboard, type <Alt-S>, select “Exit Session” and press <Enter> to end the Terminal session. In the upper right corner of the screen, <Tab> to the left-most icon and press <Enter> to open a new session. When complete, press the <Enter> key again to resume operation.

### **DO NOT REBOOT AS200 SYSTEM WITHOUT STAFF ASSISTANCE!**

### **To reboot the AS200 System PC:**

Toggle the KVM switch on the black Smart Set PC keyboard: press <Scroll Lock> twice rapidly, followed by the **UP** arrow. Pressing <Ctrl-Alt-Del> will reboot the PC. At the prompt window, press <Enter> twice. At the blue text screen, type <Alt-P>, then using the up/down arrow buttons highlight “Initialize Bus”, then press <Enter>. Type <Alt-O>, highlight “Start”, then press <Enter>. Once again press <Scroll Lock> twice rapidly, followed by the **UP** arrow.

Using the AS200 system keyboard, make sure <Caps Lock> is on and enter the time and date information. Please note that the time is in 24 hour format, and the date is entered as follows: DD-MMM-YY where DD is the current day of the month, MMM is the three letter abbreviation for the current month, and YY are the last two digits of the current year.

At the AS200 keyboard, log into the AS200 system. At the prompt execute the following commands in any order: **RESET**, **RST**, **ORIG**. Then type **CHUCK**, then **A** to run the ACS restore command, then **R** <Enter>.

### **To reboot the Smart Set PC:**

Using the Smart Set keyboard, pressing <Esc> brings up the Smart Set menu; 6 followed by <Enter> quits to the DOS prompt. <Ctrl-Alt-Del> will reboot the PC.

### **IMPORTANT:**

The normal operating condition is for the KVM to be switched to the Smart Set PC.

### **Theory of Operation:**

The AS200 operates using TWO computers simultaneously: the rack mounted RSX System PC in the Electronics rack, and the Smart Set PC in the Operator cabinet. Both computers share a keyboard, mouse, and monitor through a KVM switch located in the Operator cabinet. The shared monitor is the Smart Set monitor on the lower left of the cabinet, and the keyboard and mouse are located on a shelf inside the cabinet. Open the door below the system keyboard to access the shared input hardware.

The GCA system software is displayed on the top monitor screen, which shows the output of a DEC VT Lan 40 running VT340 terminal emulation software. This mimics the originally supplied VT340 terminal while eliminating the CRT failure modes and other inherent problems. The terminal software must be running before restarting the RSX system in order to operate the AS200.

The normal operating condition is for the KVM to be switched to the Smart Set PC. Pressing **<Esc>** brings up the Smart Set menu; 6 followed by **<Enter>** quits to the DOS prompt. **<Ctrl-Alt-Del>** will reboot the PC. A reboot brings the Smart Set PC to normal operating status.

To toggle the KVM switch to the system PC: press **<Scroll Lock>** twice rapidly, followed by the UP arrow. All three button presses must be executed within a very short time period.

The system PC normally shows nothing on the monitor while the AS200 is operating. To quit the RSX system: type **<Ctrl-J>** on the AS200 system keyboard. This should bring up a blue text-based screen on the monitor; this is the RSX System Emulation program interface. Commands are entered from the black KVM-attached keyboard. Rebooting the RSX PC will bring the system back to this same screen.

To restart the RSX System software: type **<Ctrl-P>**, then using the up/down arrow buttons highlight “Initialize Bus”, then press **<Enter>**. Type **<Ctrl-O>**, highlight “Start”, then press **<Enter>**. You should see the RSX System boot messages on the AS200 screen. At this point you should toggle the KVM switch to return the display to the Smart Set PC.

Using the AS200 system keyboard, make sure **<Caps Lock>** is on and enter the time and date information. Please note that the time is in 24 hour format, and the date is entered as follows: DD-MMM-YY where DD is the current day of the month, MMM is the three letter abbreviation for the current month, and YY are the last two digits of the current year.

At the AS200 keyboard, log into the AS200 system. At the prompt execute the following commands in any order: **RESET**, **RST**, **ORIG**. Then type **CHUCK**, then **A** to run the ACS restore command, then **R** **<Enter>**.

## **IMPORTANT:**

The normal operating condition is for the KVM to be switched to the Smart Set PC.