University of Minnesota Nano Fabrication Center
Standard Operating Procedure

Equipment Name: Canon 2500 i3 stepper

Coral Name:	canon	Revision Number:	4
Model:	2500 i3	Revisionist:	Tony Whipple
Location:	Bay 3	Date:	19 Jan 2011

1 Description

The Canon is a optical (I –Line) imaging lithography system. It can take 5 inch mask also called a reticle and reduce the image size 1/5 to project it on the wafer. The method of Lithography is some times called a projection form of lithography. The equipment is : Canon 2500 i3 I-line stepper April 1993

2 Safety

a   Do Not ever place yourself into the system except loading for the wafer cassette or the reticle.

b   Follow all warning and limits list in this SOP or given by NFC staff.

3 Restrictions/Requirements

a   Must be a qualified user on Canon

b   Only whole 4 inch wafers are allowed.

c   The backside of the wafer **must be clean**, inspect before loading wafers.

d   Do NOT edit, modify, or save any programming items in the system.

e   Normal resists only

4 Required Facilities

a   Compressed air 78 psi

b   House vacuum

c   Nitrogen gas
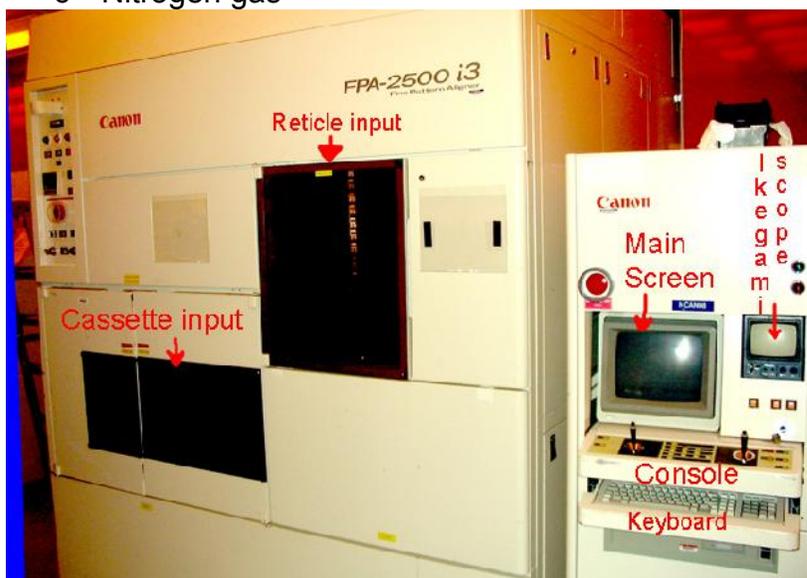
5   **Definitions**

a   HP computer - is the user interface to do all commands

b   Reticle - is the image or pattern to be transferred onto the wafer.

c   Mask - same as above.

d   Reticle tray - is the item that holds the reticle for transferring in the stepper

e   Reticle library - is where the reticle trays are kept in the stepper

f   Wafer stage - is where the wafer sits while being exposed.

g   Cassette indexer is the wafer cassette sits so wafers can be loaded and unloaded.

h   Alignment marks - are features that allow layers to align to each other.

i   First layer jobs - first layer put the first pattern on a unpatterned wafer.

j   Second layer jobs – are a process to pattern a layer and have it aligned to a layer that was patterned before.

k   Overlay accuracy – this is how well one layer is aligned to another.

l   TVPA alignment marks- These are to help to get the wafer roughly aligned

m   FRA marks - aligns the mask to the optical column.

n   AA or Multi marks - These are to do the fine aligning layer to layer.

o   Ikegami Scope - Monitor which displays live video from cameras inside the stepper.


6   **Setup**

a   The wafers to be processed should be coated, and having extra test wafers could make the imaging process faster. Wafer backside clean?

b   Make sure to have the correct reticle and have it loaded into the reticle holder correctly. Have the reticle with the chrome facing down with the arrow at the top away from you. Match this with the arrow on the reticle holder.   See Appendix on **Reticle Tray**.

7   **Operating Instructions**

a   Enable Canon Stepper on Coral system prior to starting work. Check that the monitors are working you might need to turn the power on them.

b   Check that status of the system by looking at the lower left corner and confirming that it is ready by displaying **SEQ 001E** at the bottom of display.   You must confirm this, if it is not this STOP and call staff!

c   Turn on Ikegami scope monitor. Make sure there are not any masks on the lens column by looking at the far left side of the consol. Check that the **UNLOAD** button is on and not the **LOADED** .

d   Place reticle holder in the bottom opening with the arrow going in first Load the reticle by typing **RMV** .

e   Type 1 to edit the correct direction to load you want the line to display number, to have it to run **Set**. Make sure the slot listed is **slot 14**.

f   Once the line 1 says **Set** press the F1 key **GO** on the keyboard.

g   This will load the Reticle Tray into slot 14 on the library. Typing the command **RCH** and pressing return will load the reticle onto the lens column. Make sure that slot 14 is displayed and Ikegami scope is on.

h   Press the **F1** (GO) button and this will the reticle on the optical column. After 60 to 90 seconds you should see the FRA marks displayed on the Ikegami screen, if it aligns correctly the screen will go blank. If the reticle failed to align the red error light will be blinking. See section on **Errors**

i   At the console type **ST *File_name*** and press the return key. The job will be a 1st layer or 2nd layer job. The name is based on the die size. Check the Job table to confirm the correct job needed. Example: ST N15_2 for a second layer job for a 15 mm process. Only run the size that your process was designed for - Such as Do not run N15_1 for a 5mm size design if you are planning on doing multiple layers, it will NOT work.

j   Edit the needed items to run the job correctly. This is done by reviewing the Parameter Check Screen and the values can be changed to make the process better. Such items as Exposure, focus, number of wafers and alignment shift (called AA offset). Select line number to edit option.
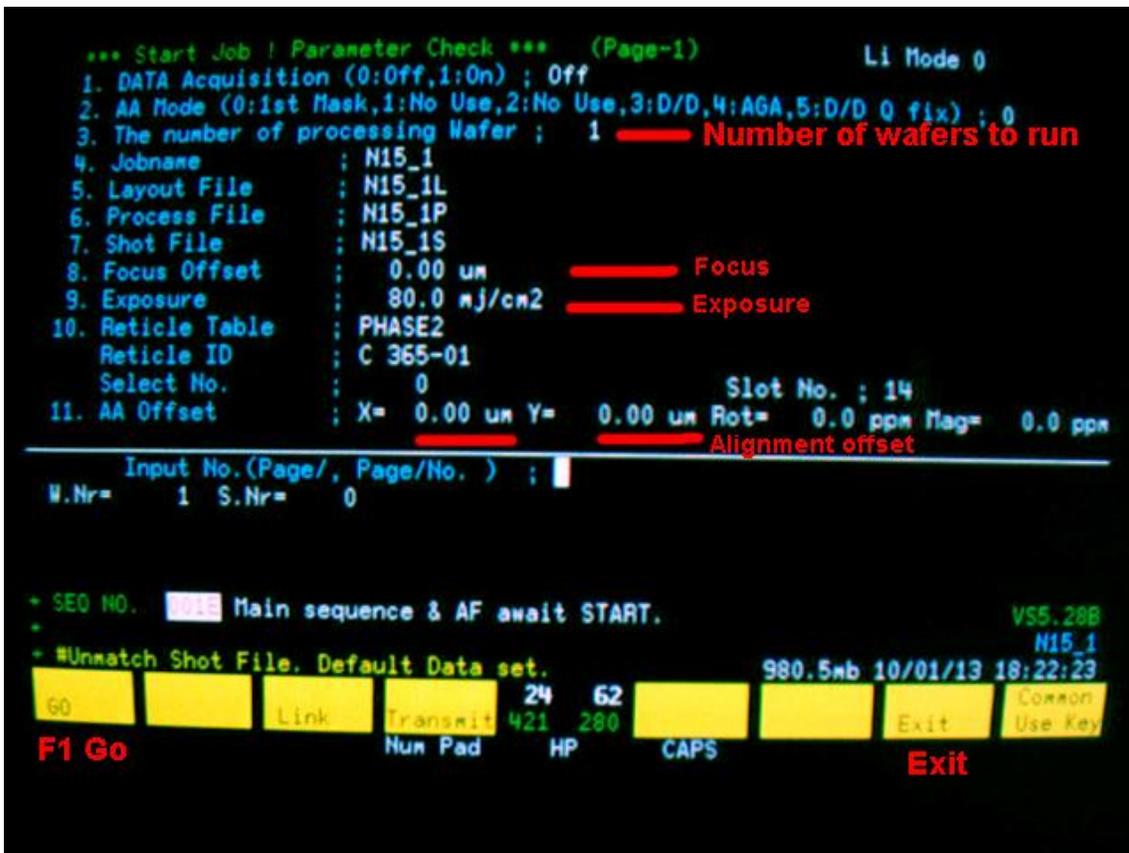
k   Load the wafers to the input indexer, make sure the wafers are NOT cross slotted, the C1 or C2 SETTING Led will light up if the cassette is placed correctly, then press the C1 or C2 CARRIER button to have it scan.

l Press the **F1** (GO) button and this will load the wafer, and check the reticle on the optical column. After 60 to 90 seconds you should see the wafer image on the screen and as it exposes each die it will change color.

m Once the wafer is exposed it will be sent to the output cassette. Press the C1 or C2 CARRIER button on the wafer indexer to bring up the cassette. After the cassette has moved to the top,. Wait until the C1 or C2 button starts blinking before removing the cassette. Press the **Alarm Clear** button on the console to clear the blinking light on the system.

n The reticle needs to be returned to the library slot. Type **RRL** and this will remove the reticle from the column and place it into the library. Then type **RMV** to remove it from the library and have it placed into the bottom slot. Select the item for line 1 to **EJECT** the reticle cassette from slot 14 to the bottom opening slot. Turn off Ikegami scope monitor.

o Check to make sure that the red light is NOT blinking on the console. If the red light is blinking, and you can not find the cause log the system down on Coral. There might be an error code at the bottom left of the screen, include the number and text to help in solving this later.

p Log out of Coral.

TVPA aligning   <u>Second layer process</u>

This is for aligning the 2nd or later layers to the first layer. The first layer must have ENOUGH contrast to be visible to the stepper imaging cameras. Keep in mind the image will change once resist is on the wafer. Selecting the correct die size for the first and following layers is important, in that the stepper will not work if this part is over looked. Your mask set is made for a given die which works with a limited number of jobs.

To pattern a second layer, load the reticle on the lens and load a wafer in a cassette as done before. At the console type **ST *File_name*** and press the return key. The only difference is the last digit must be one greater than what was ran before. Example: If N10_1 was ran for the first layer then the next layer should be N10_2 as this will align to the past patterned N10_1 design.

On the parameter screen select all the normal options, with number 11 being one that does the fine tuning between layers. Fress F1 (GO) and it will load wafer.

To align the wafer it first goes through the TVPA sequence. The TVPA alignment feature (see image) needs to be found and located. If there are several layers you must choose the correct TVPA feature. Keeping track of these from each new layer will make this step of finding the correct TVPA much easier.
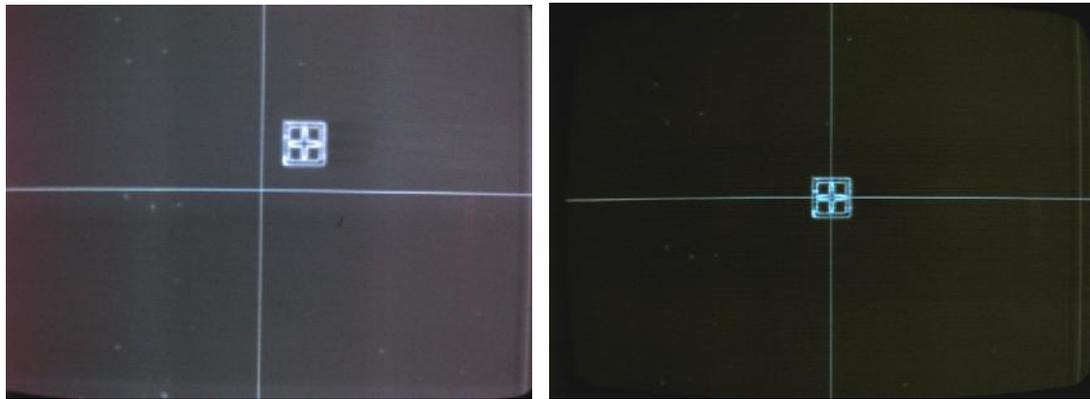
Fig 3. TVPA as loaded into system   TVPA after being aligning

When the TVPA image comes up, press the P/A button on the console, then you can center the mark in the crosshairs. Then on the keyboard type **POR** and press return key.   Then on the console press the L for the Left side, again use the joystick to center image, then again type **POR** and return. From this you can press the <u>continue</u> button on the Console or type CONT on the keyboard and press return.

The wafer will do a rough alignment and Theta rotation of the wafer. The next pattern to be measured is the Multi-marks and after this is measured the wafer will then be exposed

Check to make sure that the red light is NOT blinking on the console, and if it is find the cause and do not leave the system with it blinking. Either find the cause and fix it so you can clear the alarm or clear the alarm and log the system down on Coral.

Log out of Coral.

8   Problems/Troubleshooting

Check the list below for a possible problem, if you do not know what to do, ask first before doing anything else.

If the system has an error record what the error test is.

See the Appendix covering errors.

This is a April 1993 FPA-2500 i3 Canon Stepper model.
It is a 5X reduction I-line (365nm) system that uses 5 inch masks.

The maximum field size of field is 20mm X 20mm, substrate size is limited to 4 inch whole wafers only.

NFC can make masks for the stepper, see Mark Fisher or Tony Whipple for details on the limitations and recommendations.

Appendix:

Reticle Tray:
Make sure to have the correct reticle and have it loaded into the reticle holder correctly. The mask has the chrome down in the holder with the arrow on the mask facing up, away from you, matching the arrow on the mask loader. The holder is loaded into the input bottom slot of the system with the arrow going in first. At the console type the command RMV to start to load the reticle.
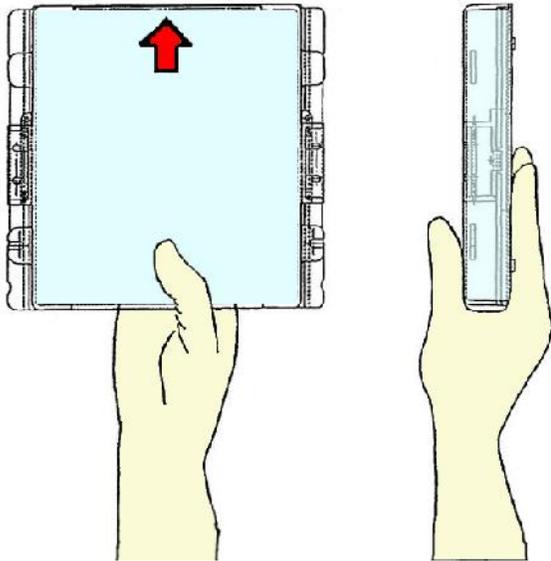
Carry the Reticle Tray from the center and avoid the slide clips, arrow first in.

Loading Reticle tray :

The steps of commands are entered by the keyboard. The commands used are :

RMV command moves tray from the input / output to **slot 14** of the library

RCH command moves the tray to the intermediate library and opens the tray and removes the reticle and loads it on top of the lens column.   The Ikegami screen will display the FRA marks, the system will move the mask around and align the reticle to lens system. If the screen goes bank and the red light does not go on the alignment to the lens was successful, if not the red light will be blinking. To solve this problem, first press the clear button on the consol and then on the consol press the RA button and with both joysticks move the reticle around and try to match them up so as to be even on the Ikegami screen. Then press the RA button again on the consol, and then type RA and enter from the keyboard. The system will again try to align the reticle.

Unloading Reticle tray :

RRL command moves the reticle from the lens to the tray and both to slot 14.
RMV command moves tray from the input / output to **slot 14** of the library

Loading wafers :
The wafers are to be transferred by using the stepper only cassettes, they have a label on them "Canon Stepper Only " Do Not use any other cassette. The wafers need to be loaded with the front resist coated facing the label. The wafers do not need to be in any orientation as the system will flat find them. The cassette has an H-bar that is used to help load it into the loading indexer.

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Loading the stepper job:

At the console type ST *File_name* and press the return key, and then press the
F1 (go)   Example is N15_1 is the first layer for a 15mm X 15mm die
This will bring up a new page on the screen. From this screen you can

Job setup: Example is N15_1 is the first layer for a 15mm X 15mm die

Mask design Limits and issues:
The die size limits for the stepper 20mmX20mm, 15mmX15mm, 10mmX10mm
and 5 mmX5mm to start with.   The naming convention is:
The letter N followed by the die size and the layer number.
   N   {die size}   _   (layer number)

Die size:

Layer 1	Layer 2	Layer 3	Layer 4	Layer 5
5mm X 5mm				
N05_1	N05_2	N05_3	N05_4	N05_5
10mm X 10mm				
N10_1	N10_2	N10_3	N10_4	N10_5
15mm X 15mm				
N15_1	N15_2	N15_3	N15_4	N15_5
20mm X 20mm				
N20_1	N20_2	N20_3	N20_4	N20_5

5mm = 157 die   10mm = 49 die   15mm = 25 die   20mm = 16 die

Errors:

Reticle not aligned following code is displayed:
Reticle not Aligned → Type "RA", "ST"

If the reticle did not align the FRA alignment feature. To recover from this you
have to help the automatic search function. From the console press the R/A
button then you can move the right joystick around Left-Right or up-down to have
the FRA marks aligned close enough to have the system to try alignment again.
If the reticle needs to be rotated you can move the left joystick up or down to
make the reticle to rotate. Once it is close type from the keyboard **RA** and press
the enter key.

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Need to remove wafer from stage, or stop job that did not align ?
To remove wafer from stage [NEVER REMOVE IT BY HAND !] Let the robot do it by typing command "RL" and return and the wafer will come out, if it does not work - put the system down on Coral and include where the wafer is at.

Cassette not loaded or not pressing the C1 elevator:

Carrier1 error → Set it, press "Cont"

The problem is that you did not load a cassette or index the elevator. To fix this just load the cassette and press the C1 button, it will continue after this.

Problems with alignment type of job and not being able to find good multi-marks.

0-200-0002   AGA measurement → Type "RPA"

The above instructions will only cause it to try again, which might be worth doing but if you want to end this and send the wafer back out type **RL** and press return. This will send the wafer back out to the cassette. After this you can try a different wafer or select another job to run, aligning to different layer might work better.

A serious error   Do not do any more actions.   STOP! put down on Coral
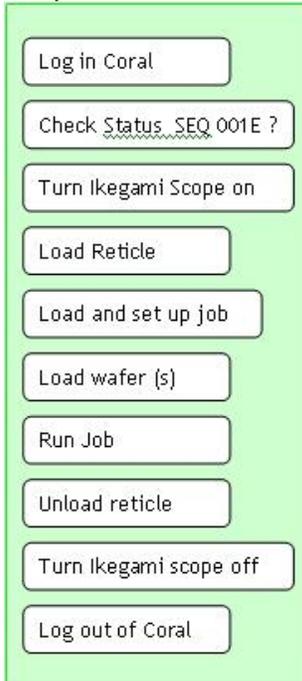
Clean air (lens) Pressure Failure

This is a serious error and if you see this, do nothing except notify NFC, including info explaining where your wafers were and if a reticle is loaded or not. The more detailed info that you can give the better it will help in getting the system back working. Doing anything with this error can cause greater damage to the stepper, so leave the system alone. But also turn on the RED light and put down in Coral listing the error that it had so other users do not try to run the system.

Reference:
Sequence of commands to run a

Log in Coral

Check Status SEQ 001E ?

Turn Ikegami Scope on

Load Reticle

Load and set up job

Load wafer (s)

Run Job

Unload reticle

Turn Ikegami scope off

Log out of Coral

Focus and Exposure testing

To find the correct exposure and focus can be found by using any reticle you want. First load by the sequence of commands RMV and RCH as explained above. Once the reticle and wafer are loaded the command AUX FEC is typed. The first line is to be edited by typing **1/** and pressing return. (That is the number 1 and then the backslash.) From here you can edit the Exposure and Focus values. The normal arrangement is to have exposure start low from the left side and increases as it moves to the right. Focus is low from the bottom row and moves positive as it moves upward. Exposure has 15 columns and the focus has 11 rows.   Normal starting values could be 70 mj with a step of 5 mj and then the pocus starting with -1.0um with steps of 0.2um. This will give you a range of -1.0um to +1.0um with the center being a zero. Only 5mm center of reticle is used during this test.