Disco Dicing Saw SOP

1. Scope

1.1 This document provides the operating procedures for the Disco Dicing Saw.

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3. Reference Documents

3.1 Referenced within this Document
   3.1.1 None

3.2 External Documents
   3.2.1 None
4. Equipment and/or Materials

4.1 Disco Dicing Saw
4.2 Wafer/Sample
4.3 Tape Applicator
4.4 Blade
4.5 N2
4.6 DI Water

5. Safety

5.1 Follow all Nanofab safety procedures.
5.2 At any point, if the alarm goes off, read the error message on the screen to know what the alarm is about, before pressing the ALRMCLR (alarm clear) key (next to the START/STOP key) to silence it.
5.3 Always read machine response in lower-screen positions of monitor to know what to do next.
5.4 The blades are very expensive. Common causes of blade breakage:

5.4.1 The wafer is not centered on the chuck, so the blade plunges vertically into the wafer as it begins its cut, instead of 10-mm before the edge of the wafer, based on the size or the wafer entered in Device Data.
5.4.2 The wafer dimension entered in Device Data is smaller than actual: blade breaks for the same reason as in the preceding case. It does not hurt to specify dimension 5% greater than actual.
5.4.3 The WORK THICKNESS is set more than 0.100-mm lower than actual.
5.4.4 The FEED SPEED is set too high for the depth of cut (= WORK THICKNESS + TAPE THICKNESS – BLADE HEIGHT) for the particular blade and material.
5.4.5 The Blade Breakage Detector is set too low for the blade and by forcing it down over blade, prior to adjustment.

6. Process Notes

6.1 Except when in the middle of a cutting operation, pressing the EXIT key enough number of times will eventually lead back to the < MAIN MENU >.
6.2 A cutting operation may be paused at any time by pressing the START/STOP key. Machine will complete its current cut, then bring the middle of the cut under the high-magnification camera screen for inspection. During this pause, the only way to modify the current operation is by pressing either the HAIRLINE ADJ or CUT POS ADJUST softkey; avoid pressing these keys when in the < STOP CORRECTION (1) > screen for inspection purposes. Cutting operation will resume from where it left off with the press, again, of the START/STOP key. To abort the cutting operation, press the STOP OPERATION softkey (F1 in < STOP CORRECTION (1) > or < STOP CORRECTION (2) >).
6.3 Cutting may be interrupted immediately by pressing the red Z EM key: spindle will be raised to 10-mm blade height, Chuck Table will be returned to x-origin position (i.e. its center position, under the microscope), alarm will sound and cutting will be halted, but cutting water will keep flowing.
6.3.1 In this case: Turn off alarm (as in Note 1), and press \textbf{CUT WATER} key to stop DI water from being wasted.

6.3.2 From this point, inspect the wafer, as in Note 5, before resuming cutting. When cutting is resumed, it will restart at the last, halted, index ($y$) position.

7. Setup Procedures

7.1 Film Framing the Wafer

7.1.1 Place wafer face down in the tape applicator, aligning the wafer with the straight line grooves while centering it using the concentric circular grooves as guides.

7.1.2 Center a film frame around the wafer.

7.1.3 Pull tape over the wafer and film frame, without touching either, and affix to front and rear edges of applicator.

\textbf{NOTE:} Make sure tape is not too wavy and it covers the film frame equally on both sides.

7.1.4 Lift up and engage roller assembly end bearings in guides.

7.1.5 Push roller \textit{slowly} over the wafer and film frame, forward and back.

7.1.6 Return roller assembly into it’s not in use position.

7.1.7 Close hinged top.

7.1.8 Verify that the Film Frame is under the Circle Cutter by sighting the blade position above the centered Film Frame: it should lie 3/8 inch outside of the inside circumference of the frame. This cutter can be re-positioned by loosening its knob handle.

7.1.9 Push down lightly on the Circle Cutter knob and go around once; if the Film Frame is old and heavily scored, you may need to go around more than once, but don't do this more than is necessary.

7.1.10 Separate tape trimmings from the roll by cutting it squarely with the other cutter in the back, by pushing down and dragging across it.

7.1.11 Open hinged top.

7.1.12 Carefully, lift up tape trimmings, pulling radially outwards to prevent lifting up tape from Film Frame, in case there are spots where it hasn't been cut through.

7.1.13 Lift out framed wafer. Use provided finger recesses in chuck to do so.
7.2 **Power Up**

7.2.1 Open city water and DI water valves.

7.2.2 Open N2 and compressed air valves.

7.2.2.1 Verify air pressure between 80 and 100 psi (about 1 turn CCW).

7.2.3 Ensure splash cover is down.

7.2.4 Turn start key switch located in the tool compartment to start, then release to the on position.

7.2.5 Mount and center your framed wafer on the chuck table (C/T).

**NOTE:** In order for the wafer to be well centered, the spaces between the clamp edges and film frame must match and be symmetric at both clamps.

7.2.6 Press **SYS INIT** key to initialize system.

**NOTE:** If framed wafer was on the chuck, it will be automatically clamped when initialization is completed. Otherwise, wait for initialization to complete, then mount framed wafer on the chuck and press **C/T VAC**.
7.3 Blade Exchange

7.3.1 Go to the <BLADE EXCHANGE> screen: from <MAIN MENU>, F5-F1.

7.3.2 If spindle was spinning, it should come to a stop: WAIT until it is fully stopped and Splash Cover locking pin is pulled back: NEVER force Splash Cover open.

7.3.3 Raise the Splash Cover all the way then let down gently: it should stay locked in up position; if not, try again.

7.3.4 Raise the wheel cover assembly out of the way to gain access to the spindle for blade replacement: use the provided J-shaped round-bar handle (NOT the wash nozzle tube!).

7.3.5 Slide keypad protector over keypad and out-of-the-way.

7.3.6 Using provided torque wrench, remove flange nut (it is left-handed: CW to loosen). The torque wrench reversible tool-end has two "pin spanners," one wider than the other. Use the wider spanner to remove and install the flange nut. Do NOT disturb the inner, smaller spindle nut!

7.3.7 Carefully, remove outer flange with thumb and middle-finger nails, grabbing it by the dovetail-turned protrusion on the outer flange: DO NOT drop outer flange, as any dent on the flange rim will weaken blade rigidity, resulting in excessive chipping and eventual broken blades.

7.3.8 Remove blade, if one is already there, handling it extremely gently
7.3.9 Place new blade on (again, very gently), seating its inner circumference on the short Neck of inner flange.

7.3.10 Carefully replace outer flange (see above on how to grab hold of it); wiggle it on until it rests flat and snug against the blade, while the blade is still resting on the Neck of inner flange.

7.3.11 Verify that the blade and flange are well seated by spinning the spindle by hand: no wobble should be detected.

7.3.12 Replace the outer flange nut using the torque wrench: nut should be started gently and effortlessly; if not, back up, adjust the alignment of the torque wrench relative to the spindle axis, and try again.

7.3.13 Once the nut is "snug" against the flange and blade, spin the spindle, again by hand, to verify that blade is properly seated.

7.3.14 Tighten nut with torque wrench (set at 360 cNm) until "click" is felt and heard.

NOTE: The nut should be turned CCW relative to the shaft which is held by the Allen-key extension of the rear part of the wrench; alternatively, the rear part of the wrench may be turned CW relative to its front part. Leave BBD/wash-nozzle assembly in the up position for now.

7.3.15 Slide keypad protector to the left, to uncover keypad.

7.3.16 In < BLADE EXCHANGE > screen (accessed above), pay particular attention to the following:

7.3.16.1 Select the appropriate UNIT, by toggling between MM and INCH with the F1 key (the SELECT softkey, generally used to scroll through a list for a field entry).
7.3.16.2 Enter Blade O.D. (outside diameter, e.g. 52 mm). This number is the first dimension number (of 3) on the blade-cassette label. Press return.

7.3.16.3 Enter BLADE THICKNESS.

7.3.16.4 Choose NEW/OLD Blade

7.3.16.5 The BLADE TYPE: 2 and FLANGE O.D. 49.4 mm should never change, but check, anyway, to make sure.

7.3.17 Press ENTER and verify that the machine responds with a beep and "Data updated" at the bottom left of the screen.

7.3.18 Press EXIT once to return to the < BLADE MAINTENANCE > screen.

7.4 Blade Breakage Detector Adjustment

7.4.1 Go to the < BLADE BREAKAGE DETECTOR > screen: \textbf{F2} from < BLADE MAINTENANCE > (the last screen in the previous section).

7.4.2 With the blade breakage detector (BBD) raised, verify that the sensitivity meter reads above 90%; if not, detector needs to be cleaned, first; ask for help.

7.4.3 Carefully lower the BBD/wash-nozzle assembly with the J-shaped handle, watching the sensitivity meter so it doesn't go past zero;

7.4.4 With knurled-head Clamp Screw (introduced above) loosened, adjust up with larger-head knob until it reads at least 10% before proceeding, once again, carefully.

7.4.5 Finally, make sure BBD ass'y is pushed down all the way.

7.4.6 Complete the adjustment of the larger-head knob screw, slowly rotate the blade and ensure the sensitivity meter reading is between 5% and 15% in all positions of the spindle. A quality blade should run concentric enough not to fluctuate the reading by more than 2%.

7.4.7 Hand-tighten Clamp Screw by turning knurled end CW until snug.

7.4.8 Lower the Splash Cover by pushing up on the handle, then gently letting it down: NEVER pull down!

7.4.9 Exit back to < MAIN MENU >.

7.5 Blade Setup

NOTE: Access < NON-CONTACT SETUP > (with \textbf{SET UP} key) at most times (even during a paused cutting operation), to check for blade wear, which also automatically corrects the actual blade height to correspond to the blade height you specify for your cuts. The blade wear info (in mm) can momentarily be read at the bottom of the screen upon completion of Setup: it is positive for a reduction in \textit{blade exposure}, the reduction in diameter being twice that. Hit enter, hit enter again.

7.5.1 Press the \textbf{SET UP} key on the key pad.

7.5.2 If DI water is on, press \textbf{F10} to go to < NCS SENSOR CLEANING >: spindle will come to a stop if it was spinning; press \textbf{F1} to stop sensor-wash water flow.

7.5.3 If the bar graph is yellow or red, first clean the non-contact setup sensor with a damp wad of tissue: this will require raising the Splash Cover.
7.5.4 If in the < NCS SENSOR CLEANING > screen, press Exit once.

7.5.5 While in the < NON-CONTACT SETUP > screen, press **ENTER**.

7.5.6 If the Splash Cover had been opened since the last initialization, machine will first take a moment to reinitialize, then prompt you to "Execute one more time"; press **ENTER** again; Setup is started.

7.5.7 Wait until Setup is completed.

7.5.8 Align hairlines, if desired.

7.5.8.1 Proceed to < HAIRLINE ALIGNMENT > (**F5** from < BLADE MAINTENANCE >) to make a test cut in an inconspicuous place on your wafer, such as near its edge.

7.5.8.2 Press **F8** to focus and **F9** to focus further, then press exit.

7.5.8.3 Use **F7** to adjust the lighting, then press exit.

7.5.8.4 Enter the correct settings.

7.5.8.5 Save them by pressing **ENTER**.

7.5.8.6 Jog to the inconspicuous y position under the camera.

**NOTE:** Press the Index button to move one index at a time or the Screen Index button to move one screen at a time.

7.5.8.7 Press **START/STOP**.

7.5.8.8 After cut is made, adjust hairlines with the cut, by y-jogging, and narrowing or widening hairlines.

7.5.8.9 Press **ENTER** to complete Hairline Alignment.

7.6 **Device Data File**

7.6.1 Select or open a device data file for editing.

7.6.1.1 From the < MAIN MENU >, press **F4**, or press the **DEVICE DATA** key from most any screen.

7.6.1.2 Select your Device Data file using Scroll keys in section of keypad to the right of numeric keys.

**NOTE:** Right Scroll key moves you from the directory-name list to the file-name list; up/down Scroll keys move you up and down through the alphanumerically sorted list.

7.6.1.3 If you haven't yet created one, select any file and copy it (**F2**) and give it an 8-character-limited name.

**NOTE:** For alphabetic characters, press **SHIFT** to toggle between the dual functions of the keys: when indicator light above the **SHIFT** key is lit, you're in character-entry mode.

7.6.1.4 Locate the file you just named in the directory and select it.

7.6.1.5 Press **ENTER** to open file for editing; or press **F10** (**REGISTRATION**) to select it for the cutting operation without editing and returning to < MAIN MENU >.

7.6.2 If editing, the fields to watch out for are:

7.6.2.1 **SPINDLE REVOLUTION 30000 RPM** is right for most uses.
7.6.2.2  **CUT MODE**: A, with no Sub-Indexing;

**NOTE:** Contact lab staff for information about other programming operations.

7.6.2.3  **WAFFER SHAPE**: ROUND or SQUARE;

7.6.2.4  **RND&nbsp;WORK&nbsp;SIZE**: enter diameter of wafer if **WORK&nbsp;SHAPE** is ROUND; ignore otherwise.

7.6.2.5  **SQR WORK SIZE CH1/CH2**: enter the maximum rectangular dimensions of wafer parallel to the CH1/CH2 cut directions, if **WORK&nbsp;SHAPE** is SQUARE; ignore otherwise.

7.6.2.6  **WORK THICKNESS**: enter the known wafer thickness, accurate within +/- 0.100-mm (0.004-in.).

7.6.2.7  **TAPE THICKNESS**: for our blue tape, it is 0.130-mm (0.005-in.).

7.6.2.8  **BLADE HEIGHT**: if singulating dies on your wafer, use a height of 0.020-mm below the tape-wafer interface, i.e. 0.055-mm (0.002-in.) with our provided 0.130-mm mounting tape.

7.6.2.9  **INDEX CH1/CH2**: enter the center-to-center spacing between dies, orthogonal to the CH1/CH2 cut direction.

7.6.2.10 **FEED SPEED**: if cutting glass with a 320-grit resin blade, divide 2 by the depth of cut in mm to obtain the feed speed in mm/s; if cutting silicon, divide 6 by the depth of cut in mm to obtain the feed speed in mm/s.

7.6.3  Press **ENTER** to save the data.

7.6.4  Press **EXIT** twice to return to the < **MAIN MENU** >.

8. Cutting Procedures

8.1  **Auto or Semi-Auto Cutting**

8.1.1  Load the framed wafer on the chuck.

8.1.1.1  Place framed wafer on chuck table with the squares ends of frame aligned with frame clamps. The wafer must be centered well to be cut correctly.

8.1.1.2  Move hands and fingers away from chuck table as you press **C/T VAC** to turn on vacuum and air-powered Frame Clamps.

8.1.2  Go to a Cutting Operation screen:

8.1.2.1  < **AUTO CUTTING** >: from < **MAIN MENU** >, **F3-F3**. This is for cutting automatically in one to four, precisely angled, directions (channels), possibly with Sub-Indexing. Without Sub-Indexing, it is designed to cut in two orthogonal directions (CH1 & CH2) in sequence, with a constant **INDEX** (specified in selected Device Data) for each channel. Without Sub-Indexing, the number of cuts are automatically figured out by the machine to cover the entire wafer, assumed centered and with dimensions specified in selected Device Data.
8.1.2.2 < SEMI-AUTOMATIC CUTTING >: from < MAIN MENU >, F3-F4. For making cuts in only one direction (one channel). Advantage over Auto Cutting: number of cuts and position of first cut may be specified and altered with a single alignment.

8.2 Manual Alignment

8.2.1 From either cutting operation screen, go to < MANUAL ALIGNMENT > (F4).

8.2.2 Wafer 9-o'clock position will come under the view of the high-magnification (1 pixel = 1 micron, approx. 420x) camera.

8.2.3 Adjust Lighting/Brightness.

8.2.4 Run Auto Focus:

8.2.4.1 Press and hold down F8 key until "Auto focus started" is displayed at bottom of screen. Alternatively, go to the < FOCUS ADJUSTMENT > screen, by briefly pressing F8, and choosing from the whole slew of softkey actions displayed along the bottom of the screen; remember to EXIT that screen when done.

8.2.5 If the wafer surface is still not visible after "Auto focus completed" is displayed, try adjusting the lighting by going to the lighting adjustment screen (F7). The F-key actions (displayed along the bottom of the screen) are self-explanatory. Remember to EXIT this screen, when done, but do not press EXIT twice or the program will exit Manual Alignment without completing it.

8.2.6 The six Jog keys, clustered together at the front-right corner of the keypad, provide operator control of the motion of the x, y and θ axes in three different modes.

8.2.6.1 Pressing INDEX key toggles "index stepping" on/off (keypad indicator lamp is on/off and " [INDEX] "/" [     ]" is displayed at top-right corner of screen). This will cause the front-rear-pointing (y) Jog keys to move the y-stage by CH1 Index value (set in selected Device Data) and the left-right-pointing (x) Jog keys to move the x-stage by the CH2 Index value; this will be reversed when aligning for CH2. This mode is best for moving from one street on the wafer to the next, for inspection purposes. Also, with index-stepping on, pressing the "CW θ" Jog key (with CW arrow drawn on it) switches to CH2 alignment; pressing the other (CCW) θ Jog key returns it to CH1.

8.2.6.2 Pressing SCR INDEX key toggles "screen-stepping" mode on/off (keypad indicator lamp on/off and screen " [SCR_1] "/" [     ]"). This mode is programmed to move the table in approximately one screen (0.400-mm) per step, in both the x and y directions. This mode is best for moving short distances. It also affects the θ Jog keys: each brief press rotates the chuck through 2-degrees.

8.2.6.3 With neither mode selected (" [     ]" on screen), each brief press of a translation Jog key moves its corresponding stage by approximately 2 microns. Pressing and holding any Jog key in this mode, moves its corresponding stage smoothly at three consecutively higher speeds: very slow for the first two seconds the key is held down; an intermediate speed for the next two seconds; very fast (10-mm/s in the y direction, 45-mm/s in the x) thereafter. This key mode is the best for both micro-adjustments and covering large distances. Its effect on the θ Jog keys is similar.
8.2.7 Align the $\theta$ orientation of the chuck so the saw $x$-axis is parallel with the singulation streets on your wafer using the Jog keys and the ALIGN $\theta$ softkey (F5).

8.2.8 Make rough $\theta$ adjustments using $\theta$ keys.

8.2.9 For precise and fast adjustment, follow the procedure below.

8.2.9.1 Find one end of a singulation street and align its centerline with the crosshairs on the screen.

8.2.9.2 Press F5: table moves to the opposite end of your wafer (based on the dimensions you specified in the selected Device Data) along the $x$-direction. Machine prompts you to "Select a target for $\theta$ adjustment then press F5 key."

8.2.9.3 Find your street (it may be off-screen) with $x$ & $y$ Jog keys, only, and align the screen crosshairs with its centerline.

8.2.9.4 Press F5: table returns to its starting position but with the table rotated so as to "level" the two points.

8.2.9.5 Re-align the crosshairs with the centerline of the street, and repeat the above steps to fine-tune the adjustment. The last prompt on the screen should read "$\theta$ adjustment done." At this point the screen also reads: "After aligning CH1, perform the street adjustment, ... then press the ENTER key."

NOTE: If you accidentally press any of the $\theta$ keys, before completing the next two steps, you will have to re-align $\theta$. When this is the case, the screen prompt will read "Adjustment $\theta$ ."

8.2.10 Align the hairlines on the screen to any one of the equally-spaced streets on the wafer. If using Sub-Indexing, align it with the position relative to which the ALIGN value in the < DEVICE DATA SUBINDEX > screen is the distance toward the FRONT or REAR of the first cut. This is what is meant by "street adjustment."

8.2.11 Press ENTER: alignment for the current channel is completed. This is all there is to alignment for < SEMI-AUTOMATIC CUTTING >.

8.2.12 If Auto Cutting, machine will rotate table to the next (higher-numbered) channel's orientation, relative to the current orientation, and prompt you to do the same for this channel, except $\theta$ alignment is no longer necessary: "After aligning CH2, perform street adjustment, ... then press the ENTER key." Find the street for this channel as for the previous one and press ENTER. Repeat, if there are more channels.

8.2.13 If Semi-Auto Cutting:

8.2.13.1 Align the position for the first cut, after exiting < MANUAL ALIGNMENT >.

8.2.13.2 Specify the number of cuts in the CUT LINE field: the default "0" means "do the entire wafer." to index the cuts toward the rear from the current $y$-position, press REAR (F5); to index toward the front from the current $y$-position, press FRONT (F10).

8.3 Starting and Monitoring Cutting Operation

8.3.1 Immediately following Manual Alignment, start cutting by pressing START/STOP key. Pause it by pressing it again: machine will stop after it finishes the current cut, and will position the cut just made under the microscope for your inspection. You may jog only the $x$ and $y$ stages without disturbing where the next programmed cut will be made when cutting is resumed with
a press of the **START/STOP** key. If cutting is noisy, suspect imminent blade breakage and press the red **Z EM** key, your best emergency response in most situations. The big EMO button should only be used as a last resort.

8.3.2 If blade breakage is detected and operation is paused, follow the on-screen choices to:

8.3.2.1 Resume the cutting operation (not recommended without making some adjustments to fix the cause of the breakage) or

8.3.2.2 Stop operation and modify device data to correct the problem before restarting operation from the beginning.

**NOTE:** Apart from adjusting the blade height by +/- 0.100 mm, changing feed speed, or changing the next cutting position, you cannot modify the operation, unless you first abort the operation.

### 9. Shutdown Procedures

**9.1 Unload Wafer**

9.1.1 When done dicing, press **C/T VAC**.

9.1.2 Wait until the table is in its pulled-out position and the workpiece is released.

9.1.3 If another wafer needs to be diced, do only steps 9.2.5 through 9.2.7, below, then return to AUTO OR SEMI-AUTO CUTTING section.

**9.2 Power Down**

9.2.1 Turn off spindle

9.2.2 Raise splash guard

9.2.3 Lift wheel cover

9.2.4 Use torque wrench to remove flange nut (turn clockwise).

9.2.5 Remove flange nut.

9.2.6 Remove blade.

9.2.7 Replace outer flange and flange nut, do not tighten.

9.2.8 Lower splash guard.

9.2.9 Open front panel.

9.2.10 Switch off power with the key switch:

**NOTE:** Machine will go through its power-down sequence:

9.2.11 Wait until it’s completely shut down.

9.2.12 Shut off City Water and DI water, leaving Air and N2 on.

9.2.13 Raise the Splash Cover and remove your blade; replace outer flange and nut, only loosely.

9.2.14 Shut off Air and lower Splash Cover.

9.2.15 Slide the keypad cover over the keypad to keep it dry during the following operation.
9.2.16 Blow dry your workpiece and upper surface of mounting film and frame with N2 gun, blowing towards the splash cover.

9.2.17 Lift workpiece up and tilt towards keypad, so as not to get C/T wet, finally holding it vertically over space between keypad and C/T. Blow dry bottom side of mounting film and frame.

10. Blade Selection Rules

10.1 The maximum depth of cut is determined by Blade Exposure, minus some allowance (0.1-mm is safe): Blade Exposure = (Blade_OD – 49.4-mm)/2.

10.2 Blade Exposure should not exceed 10 times the Blade Thickness, for resin blades. It may be 20 to 30 times the Blade thickness for Nickel-bond blades, such as Disco's NBC-Z series blades. The larger the Exposure-to-Thickness ratio, the wavier the cut is likely to get.

10.3 For dicing silicon, we typically order Disco blade NBC-Z 1070 (10 µm grit), with dimensions of 52 x 0.09 x 40 (OD x Thickness x ID, in mm).

10.4 For dicing glass, we typically order Disco blade P1A850 SDC320R10MB01 with dimensions of 58 x 0.25 x 40.

10.5 The rule of thumb on feed speed is 2-mmsq/s divided by the depth of cut with the #320-grit (60 µm) resin-bond blade for glass cutting, just mentioned. It is 6-mmsq/s divided by the depth of cut for the NBC-Z series blades (down to 5 µm grit) on silicon. Use the lower feed speed and a resin-bond blade on other hard-to-cut material.

11. Disco Contact Information

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12. Revision History

<table>
<thead>
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<th>Rev</th>
<th>Date</th>
<th>Originator</th>
<th>Description of Changes</th>
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<td>19 Apr 2010</td>
<td>Sam Bell</td>
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