Design Rules for Heidelberg DWL 66

DXF

1. Use a 100% Autocad compatible editor
2. Only use polylines
3. Always join polylines, be careful when using arcs within a polyline
4. Avoid placing structures on Layer 0
5. Do not use special characters in layer names
6. use mm as the standard unit
7. Polylines with width may not have a change in width(tapering)
8. Various scaling in x and y when inserting blocks is not supported
9. External blocks are not supported
10. Avoid using BLOCK insertions
    Try to make the design flat
11. Try to use only circle and polyline

Cif

1. Definition or reference depth can be at maximum 16
2. The number of definitions or references can at maximum be 4096

GDSII

1. The inclusion of other GDSII files or text libraries will be ignored
2. Node statements in GDSII will be ignored
3. Definition or reference depth can be at maximum 16
4. Number of structures is limited to 8192

Be sure to indicate tone and orientation of mask:
Lightfield (end result is mostly transparent mask with Cr features) or Darkfield (end result is opaque [Cr] mask with some transparent areas)
Written as Cr side up or down

Pay attention to overlapping features. Xor feature can be used to create subtractive features (concentric circles to make a donut) but all other overlapping features will be subtracted as well.

Standard Operation Procedure Laser Pattern Transfer System Heidelberg DWL66 (TRL "Heidelberg")

(A) Introduction

The Laser Pattern Transfer System Heidelberg DWL66 is designed to expose photosensitive films that react to light with a wavelength equal to 442 nm. The positive resist available at TRL (both thin and thick), as well as the photoresist used in mask plates, are sensitive to this wavelength. The system can process 4-inch wafers, 6-inch wafers, 5X5 plates and 7X7 plates. The machine uses as layout files with extension .dxf, .gds, gerber, cif, odb, gdsii, structure, and hpgl. The machine is able to transfer layouts using as reference some previously patterned features (alignment capabilities). The system can also act as a stepper, with the noticeable difference that different layouts can be transferred to each die in the same run. The maximum working area is a square of 130X130 mm.

The machine automatically finds the upper and lower bounds of your layout, and uses the geometrical center of the resulting rectangle as center of the layout, and aligns it to the center of your substrate. PLEASE MAKE SURE THAT YOUR LAYOUT IS CENTERED PROPERLY USING The MENTIONED CONVENTION.

The system has three computers. The computer closest to the room door (computer "TRANSLATOR") is used to translate your layout to something that the laser system understands; this computer also transfers the file to the laser brain. The computer nearest to the Laser Chamber is the brain of the Laser system (computer "BRAIN"). The computer between the other two is used to give orders to the Laser Chamber (computer "COMMANDER").

This machine is TRL-green compatible, and any user must abide by the TRL lab protocols, including following a process submitted to, and approved by the MTL's Process Technology Committee, ptc@mtl.mit.edu.

You must also be trained and staff approved to operate this machine, and you must have reservations on, and engage the machine in CORAL, before operations can start.

If you have any problems when operating the machine, please contact immediately Dennis Ward (ward@mtl.mit.edu), John Kymissis (johnkym@mit.edu), or Luis Fernando Velásquez–García (pegasus@mtl.mit.edu).

(B) Operating Procedures

0. Standby Configuration

When you arrive, or depart, the Heidelberg should be in the standby configuration:

a. The door of the Laser Chamber closed
b. The Laser Chamber with no patterning activity
c. The communication cable disconnected
d. The Laser Power Supply in OFF
e. The room with the yellow-colored light ON (this kind of light will not damage the photosensitive films)

1. File Transfer (computer TRANSLATOR)

a. Engage machine in Coral. Make sure you previously reserved the time for using the machine. As a guideline, the layout transfer of a typical 7X7 plate with 5 μm of M.F.S. can be completed within 5 hours, with about 3 hours of laser patterning.
b. Turn on the Laser Power Supply, located at the back of the Laser Chamber. To turn it on, turn the key to the ON position. The Laser Power Supply must be turned ON at least 30 minutes before using the laser.
c. Copy your file to the corresponding folder inside the computer TRANSLATOR. For example, .dxf files go to the folder /home/convert/dxf
d. Open the DWL66-Convert Software. A window with the options File, Conversion, Configuration, ?, and Write lens Size at its top appears.
e. Select the proper lens, based on your minimum feature size:

LENS (mm)	**2**	**4**	**10**	**20**	**40**
M.F.S(microns)	0.6	0.8	2	4	8

f. Configure the fields that appear on the **Standard Screen**:
    i. Select your file in the field “Source File”
    ii. Select the format of your file in the field “Format”. The options are cif, gerber, odb, gdsii, dxf, structure, and hpgl.
    iii. Set the magnification factor (default 1.0)
    iv. Set the layout rotation (default 0)
    v. Set the x, y offsets (default 0,0)
    vi. Set the mirroring on each axis.
        - ❖ Most of the time the mirroring around the x-axis is set as “no”.
        - ❖ If your file has a layout directly transferred to a wafer, the mirroring on the y-axis should be set as “no”.
        - ❖ If your file has a layout for a mask, as seen through the plate, then the mirroring at the y-axis should be set as “yes”.
    vii. Define the active borders of your layout, in nanometers. This task is far easier if you created your layout centered on 0,0. The layout must fit inside the coordinates +/- 65 mm on any axis. The center

of the layout should be the same geometrical center of the rectangle where the whole layout is incribed. There is the option to make the software find the limits of your layout (automatic mode).

viii. Select the exposure mode
   - ❖ Non-inverted means that the features contained in your file are the regions that are exposed by the laser.
   - ❖ Inverted means that the features contained in your file are the regions that are not exposed by the laser.

ix. Set the Frame size (default value is 0).

x. Save your options. In order to do this, click the save icon on the bottom of the screen.

g. Configure the fields that appear on the **Advanced Screen** (to gain access click the Advanced icon on the bottom of the screen):
   i. Set the stripe width (default value is 100)
   ii. Set the pixel size → THIS VALUE IS SET WHEN YOU SELECTED The PROPER WRITE HEAD
   iii. Set the Arcres (default value 3.0)
   iv. Dxf units: this pretty much depends on how you defined your dxf file. For example, if you defined the dxf drawing units as microns, the factor is 1000; if you defined the dxf drawing units as millimeters, the factor is 1000000.
   v. XOR: the system recognizes the XOR logic operation. If you want it, select ON; otherwise, select OFF
   vi. Set the exposed area field (the default value is OFF.)
   vii. Set the Automatic Centering at ON
   viii. Set the spot size correction for the x- and y- axis (the default value is 0,0)
   ix. Set the Scale Factor x at 1.0
   x. Set the Scale factor y at 1.0113780
   xi. Set the Left optic path. The default mode is OFF
   xii. Set the Scale offset. The default mode is OFF
   xiii. Set the Invert spot size correction. The default selection is OFF
   xiv. Save your selections. In order to do this, click the save icon on the bottom of the screen.
   xv. Get back to the Standard screen. To do this, click the Standard icon on the bottom of the screen.

h. Translate your file into a file with extension .cfg. The general procedure is Configuration → your file type → Create New your file type.cfg.
   For example, for a dxf file:
   Configuration → dxf → create New dxf.cfg.
   A new screen appears. Choose the layers that you want part of the layout by clicking the items on the left column. Click Save. Click Exit.

i. Save your work by clicking the Save icon on the bottom of the screen.

j. Preview your layout. In order to do this, click the Preview icon on the bottom of the screen. The preview screen gives you the option to see how the system understands your file. It also allows you to check the dimensions of your layout.

You can use the commands fill, polarity (invert), XOR, and Toggle, to diagnose the patterning capabilities of the system. You should try the configuration that you just saved in order to check that the system and you agree on what the layout represents and transfers. You should also check the Xmin, Xmax, Ymin, Ymax values. You can also use the preview screen to zoom and measure your layout.

k. If the preview looks fine, create the LIC directory for your job. The field for the LIC directory appears on the Standard screen. Please give a meaningful name to the LIC directory, so you can recognize it later. If you change your mind about the configuration of your job, before going any further, you must completely erase the LIC directory that you created and all its contents, using the commands of the operational system that the computer TRANSLATOR has. Don't try to overwrite the LIC files: you will freeze the tool and it will need to be re-initialized.
l. Convert your file. In order to do this, click the Convert icon on the bottom of the Standard Screen. Acknowledge the file conversion after is done.
m. If no errors were reported, get the communication cable (one of its ends is attached to the ceiling, the other end should be disconnected), connect it to the computer BRAIN. If everything is fine, the LEDs ACT and LNK of the connection bus should start blinking.
n. Transfer your job to the system: File → Transfer the LIC Files. While TRANSLATOR is sending your file to BRAIN, don't do anything at all with any of the computers / subsystems of the Heidelberg tool. Once the transfer is done (a goodbye appears), disconnect the communication cable and close the DWL66-Convert software.

2. Substrate Uploading

a. Wear a pair of fresh gloves.
b. Open the Laser Chamber. To do this, pull to the left the mechanic switch next to the BRAIN.
c. You need to install the proper substrate chuck and the proper writing head. The substrate chuck is based on the size of your substrate, while the writing head is chosen using the lens size that you selected. In particular,
    i. If the correct chuck and writing head are installed, go to d.
    ii. If the right writing head is installed, but the substrate chuck needs to be changed, you must disconnect the writing head BEFORE changing the substrate chuck. Then, you connect back the writing head.

HOW TO CHANGE THE WRITING HEAD

- Disconnect the serial cable and the voltage cable from the writing head. To disconnect the voltage cable, press the cable and then pull the cable out.
- Then, unscrew the three screws that support the writing head. The writing head cannot fall once it's fully unscrewed because there is a rail that supports it.

- ❖ Put the writing head away face up (cone up). Put it back to the writing head storage cabinet.
- ❖ Take the correct writing head from the cabinet.
- ❖ Attach the writing head using the three screws that you just took out. You need to push the writing head up to make the screws reach the treaded holes of the writing head.
- ❖ Connect the serial cable and the voltage cable to the writing head.

HOW TO CHANGE THE SUBSTRATE CHUCK

- ❖ This procedure must be done AFTER the writing head is disconnected from the laser system.
- ❖ Pull out the substrate chuck without sliding it. Otherwise, the o-rings will move out of their grooves.
- ❖ Put the substrate chuck back into the substrate chuck container cabinet.
- ❖ Take the right substrate chuck from the substrate chuck container cabinet.
- ❖ Slide the substrate chuck using as guideline the frame on the left of where the substrate chuck will finally rest on the laser table. During this procedure, the plate should be hovering above the o-rings.
- ❖ Once the chuck reached the end of the frame, rotate the chuck using as pivot the frame to make the chuck make contact to the o-rings. In this procedure the chuck cannot slide with respect to the o–rings.

d. You need to install the proper filter, using the following table. The filter can go anywhere on the filter rail. The filters are inside the corresponding storage cabinet.

LENS (mm)	**2**	**4**	**10**	**20**	**40**
FILTER (%)	1	1	10	50	No filter

e. Wear a pair of fresh gloves on top of the gloves that you are wearing.
f. Mount your substrate, roughly centered with respect to the chuck center. You can use pins to align your substrate.
g. Stick the substrate to the chuck by activating the vacuum. You do this with turning the proper knob perpendicular to the wafer chuck.
h. If the thickness of your substrate is smaller than the height of the pins, you must take out the pins before continuing.
i. Close the Laser Chamber door.

3. **Perform Your Laser Patterning** (computer COMMANDER)
   a. MAKE SURE THE FILE TRANSFER CABLE IS DISCONNECTED!
   b. Open the DWL66 software (Dwlmenu)
   c. Set the write head size. To do this, double click on the corresponding field at the upper right corner of the software screen. Select the proper .cfg file for the write head of your job, and the dwl file setup. Click the Load it Icon.
   d. Click the icon that shows a Vernier to gain access to the control panel. You can also push F9 to gain access.
   e. Push the Home icon (+). The laser table should position the laser head to the 0,0 that was declared before.
   f. Click the Head up icon.
   g. Click the Focus icon. Set the lamp intensity with the vertical arrows of the LAMP control.
   h. Check that there is enough space between the substrate and the writing head to see in the gap the red dots of the table control diode lasers.
   i. Find the center of your substrate using the DWL Control Panel: Stage → Find Plate Center → Start. The procedure will take a few minutes. Once the dimensions of the substrate are determined, it will allow you to set the 0,0 at the center of your substrate.
   j. Select the job folder. The default folder is Dennis01, and unless you are doing something different from patterning one field, that is the folder that you must choose: Job → Make Job → Open → select Dennis01
   k. The last action opens a new screen. There is a Design field. Click on it. Then, put your file there: File → designs → select your file → To Job. Exit.
   l. Set the defocus, Energy, and command using the following table.

HEAD	**2 mm**	**4 mm**	**10 mm**	**20 mm**	**40 mm**
Defocus	1700	1700	3500	3500	2000
Energy	40/60	40/60	80/100	100/80	30
Ramp*	1.11397	1.11397	1.13467/1.13743	1.12363	1.12363

* the full ramp command is os9:dg_ramp –f=dgr_XXXXXX.cfg, where XXXXXX is the number declared in the last table.

   m. Save your job.
   n. Run your job: Job → Run Job. The Expose Screen appears.
   o. Click the EXPOSE icon. If the IF:OK is green, go ahead and order the system to transfer your file. The system will give you an estimate of the patterning time.

4. Leaving the Machine the Way You Found It
   a. Once the job is complete, click OK, raise the Head, and click the substrate download icon (↘).
   b. Wear a pair of fresh gloves and then open the Laser Chamber. To open the chamber, pull to the left the mechanic switch next to the BRAIN.
   c. Stop the vacuum that holds the substrate by turning the proper knob parallel to the substrate chuck.
   d. Wear a second pair of fresh gloves, and then take the substrate out.

e. Close the Laser Chamber.
f. Turn off the Laser Power (on the back of the Laser Chamber).

What is left is to develop the photosensitive film, which is not part of this SOP. As a guideline,

- If the substrate is a wafer coated with resist, use the corresponding developer for the resist, until the features are fully developed.
- If the substrate is a mask, use the SOP of how to make optical masks (use blue-dot, i.e., CMOS metal contaminated labware. Develop the resist using AZ 915 for about 60 seconds, then etch the chromium film for about 1:20 with CR-7, and then use nanostrip for 10 minutes to remove the photosensitive film.)

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