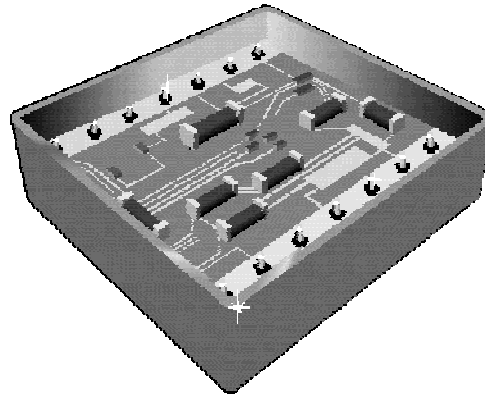


# Drawing Rules for Photomask Generation.

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## Introduction

This note gives *general* guidance on setting data up for photomask generation by JD Photo-Tools Ltd. This is only a ***suggested guide***, and is written mostly for Autocad users. Thanks to the tools written by our preferred CAM suppliers (LinkCAD) we can accept many different forms and layouts, and our expert CAD dept can cope with many types of varied data.



## Photomask - General

The smallest feature that we can image is between 1um and 2um, depending upon the feature geometry. This is the slightly more (2um+) for both Clearfield - so our smallest line must be at least 2um away from the next object, otherwise we risk the chance of these objects merging together.

Please allow 1mm tolerance for the image to be centroid to the mask edge. Because of this, we also prefer a minimum spacing of 5mm of clear data around the edge of the mask.

<i>Minimum feature:</i> 1um - 2um depending on feature geometry and substrate used
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<i>Feature Accuracy:</i> 0.8um at SUPER HIGH resolution
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<i>Mask Dimension Accuracy:</i> $0.6 + (10L/1000) \text{ um}$ <i>where L = measuring length in MM</i>
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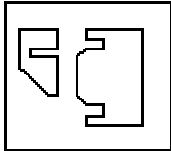
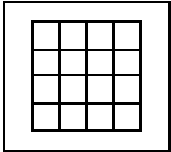
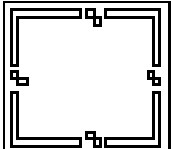
We can image either darkfield or Clearfield, with no price difference or feature difference between the two. There are no limitations (except for file size) as to the number of features on a mask, and no limitations as to the feature geometry.

We recommend CAD files use at least 5 decimal places in inches, and 4 decimal places in millimetres.

## Cad Files

LinkCAD facilitates the exchange of design data between various CAD systems and mask making machines. LinkCAD tries to preserve as much as information as possible when converting a design from one format to another. However, some CAD formats contain graphical entities that do not have an equivalent entity in another format. To avoid any surprises you should observe a few design rules, which are described below

### Typical Photomask Make-up

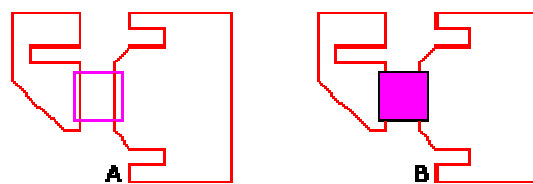
<b>CHROME</b>		Defines chrome areas to be filled on mask. Many masks have two or more layers, and there may also be layers defined for inner polygons.
<b>OUTLINE</b>		Outline of circuit. This layer is normally not plotted but is useful when setting up your array.
<b>FIDUCIAL</b>		Fiducials. This layer is optional. Generally one would like a border around the entire mask with alignment marks and text.

### Autocad Drawing entities

You can use a zero width polylines to define each area. It is also possible to use lines, solids, or polylines with width. Our Software will recognize any of the above forms and fill in the areas on the mask.

#### *Polylines*

Circuit traces are also drawn using AutoCAD's Polyline entity. The polyline can be assigned a width and can have many vertices. **Don't use AutoCAD's trace entity;** although it may sound like a good entity to use, it actually consists of separate polygons and is not efficiently converted.



The boundary can be from lines or zero width polylines [A] or from plines with width [B].

#### *Solids*

You may desire that some polylines are treated as boundaries (i.e., the square end is preserved) and others are treated as circuit traces. The simplest approach is to use AutoCAD's "SOLID" entity for all rectangular pads. Use polylines to interconnect the SOLID's. The SOLIDS will be filled so that the edges remain square. The polylines will be plotted using a single aperture.

## Drawing

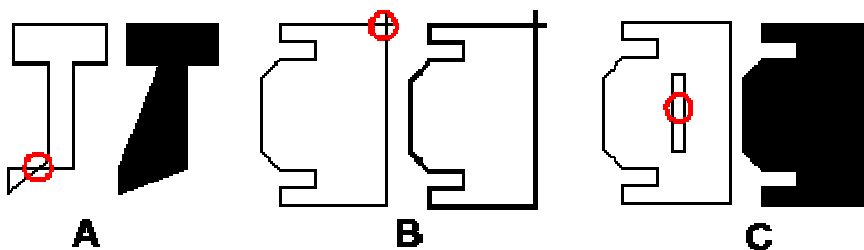
Set the required layer. Begin drawing the figures that will be chrome/emulsion areas on the mask. Define each figure using a zero width closed polyline. If you are interconnecting areas you can also use a polyline with width for the interconnects. Each boundary will be filled solid during translation. Use grid snap or object snap to insure that all the line endpoints are exactly touching.



*Properly drawn figures in AutoCAD (at left)  
will be filled in by the translator and appear on the film at right.*

## Drawing Errors to Avoid

- Extraneous lines that touch the boundaries. These are detected by the post processor and may affect your photoplot. These are extremely hard to see if they are covered by another larger line.
- Figures insides of figures: The larger outer figure will cover up the inner figure
- Boundaries that self intersect
- Hatching - this is a visual aid only, and will not appear in the DXF file
- Truetype fonts - again, this is not supported by DXF files. All fonts must be compiled into SHX fonts before using them. Enclose any SHX fonts newly compiled along with your data.
- Do not use Scale or Rotate within blocks. This is not supported
- Don't use AutoCAD's trace entity.
- If your drawing contains unused layers and blocks, erase these layers/blocks and purge the drawing file to eliminate the extraneous data.



**[A]** Figure self intersects. The filling routines will not work correctly.

**[B]** Endpoints don't meet. Figure is not filled by processor. In many cases, the overlap is not easily visible in AutoCAD.

**[C]** Designer intended the inner polygon to be empty on the film. However, the outer polygon covered it.

## Blocks

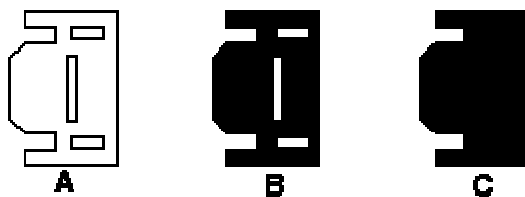
The typical mask may have hundreds of Donuts, Solid Rounds or Solid Rectangles. While you could draw each one on AutoCAD as a donut or circle, there is a more efficient way. The trick is to use a Block command for each element.

First determine the size and shape of your pads. Next assign a unique and descriptive block name for each pad. Each block will later be assigned to a Gerber D-code. The block name should be short but descriptive of the block (e.g. round10, rectangle50x30 etc)

Set the active layer. Draw the representation of your pads. What you draw is only symbolic of what will show up on the mask. Define each figure as a block. Use the center of the figure as the reference point of the block. Give each block a short name. Using the block insert command, insert the block at the appropriate position. You may wish to create a macro or an AutoLisp routine to speed things up. Repeat this for each type you use in the design.

## Drawing "Islands and "Holes"

Islands and holes are areas of clear mask surrounded by dark mask. A very common mistake is to simply draw the island area as a figure surrounded by the metallized area. This is not going to work as the outer area will cover the hole.

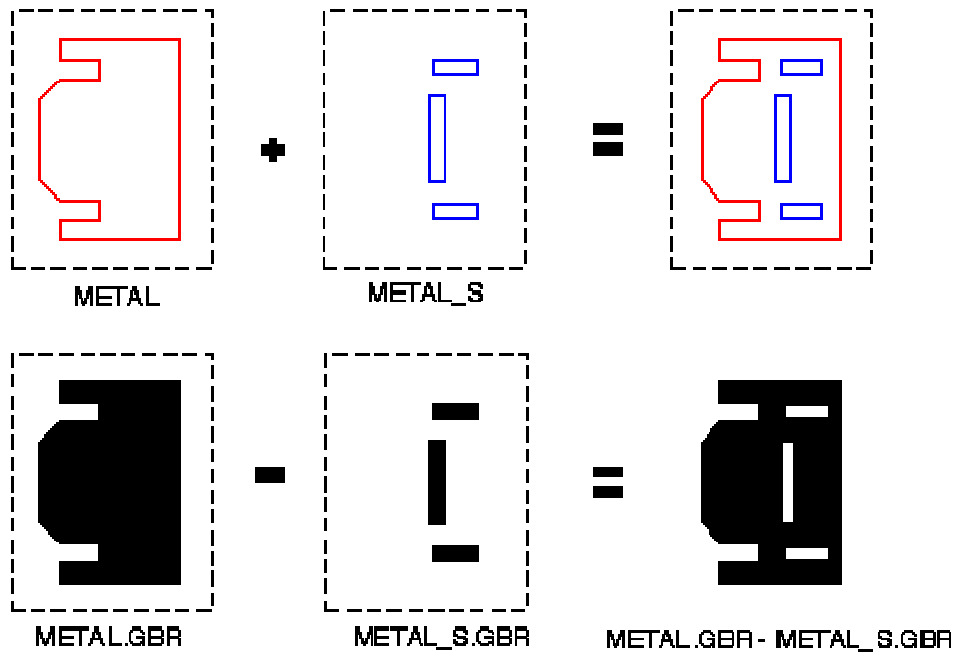


The designer drew the figure [A] expecting to get figure [B]. Instead, the mask came back as in figure [C]. The mistake was that the inner polygons were covered while filling the outer polygon. One should create a separate layer for the inner polygons and have the photoplotter do a composite mask. There are several drawing strategies that avoid covering the holes. The most powerful technique is to use the ability of laser photoplotters to do composite plotting. The data on any layer can be added or subtracted from data on another layer.

The subtractive process is used for plotting islands. The procedure is simple. Create one or more additional AutoCAD layers to hold the inner polygons. Then draw the inner polygons or "holes" on the layer assigned to this purpose. Produce two layers: one for the outer polygons and a separate one for the inner polygons. Then instruct the tell the mask operator to subtract the hole layer.

Example -- Create the basic AutoCAD layers adding one for inner polygons:

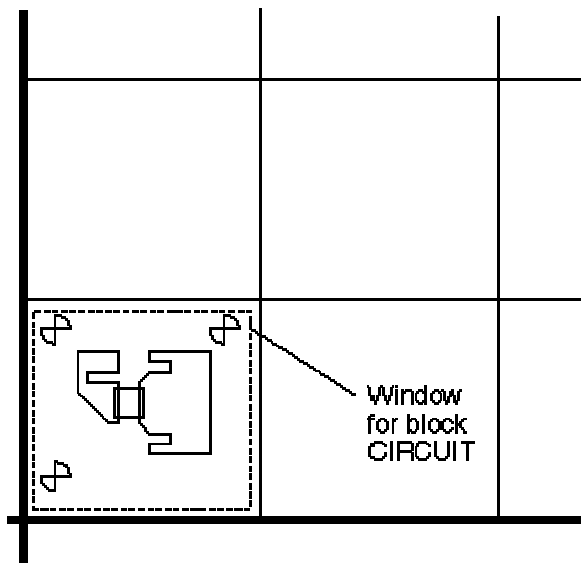
After drawing the outer metal figures on layer METAL, set the current later to METAL\_S. Now draw the inner polygons on layer METAL\_S. You will produce two layers; one from layer METAL and one from METAL\_S. When METAL and METAL\_S are plotted, be sure to indicate that they should be merged; have METAL\_S subtracted from METAL.



## Arraying the Data

Whether you should array your circuit depends on its complexity. If the circuit is simple then send the photoplotter arrayed data. Complex circuits produce files too large to transfer easily to diskettes or by modem.

To array the data on AutoCAD use the BLOCK command. Turn on the required layers. Define a block at 0,0. **Do not scale or rotate the block.** Using the AutoCAD array command, and the array data you calculated when creating the outline layer, array the block.



Once the basic circuit is complete, make it into a block. Insert and array the block. This minimizes the size of the AutoCAD file and speeds the translation to Gerber. However, it does not reduce the eventual size of the Gerber file.

Before arraying the circuit, save the drawing file under a different name. You will have a drawing file of the single circuit in case changes need to be made. It is easier to modify the file and array again, rather than edit the arrayed file.

After you've finished the array and checked it, create a DXF file. If your drawing contains unused layers and blocks, erase these layers/blocks and purge the drawing file to eliminate the extraneous data.

### **Defect rates**

The process of our manufacturing, and the specification of the plates and photo-resist, means that there may be minor defects that appear randomly across the image. Usually these defects are cosmetic only, and sometimes the defect actually causes no working problem with the design. A defect is defined as having a size greater than the quoted rate below, and can either be a "pinhole" in what should be the chrome/emulsion part of the mask, or it can be a chrome / emulsion spot in the clear part of the mask (also referred to as 'shorts' or 'breaks')

**Quoted Defects for standard materials/service: Less than 1defect per square inch**  
**Defects: greater than 5 microns in size**

For further information, please contact our technical department  
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