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Etching Design Guidelines

Photo Chemical Machining can be an inexact science, with a large number of variables that need to be controlled in order to produce accurate results. The finer the detail/tolerance, the more difficult it becomes. Mastercut have developed a range of techniques to maximise accuracy and simplify the process. If fine detail and/or high precision are required, we can assist you to modify your design to achieve the required outcome. For dimensions such as slots, corners etc, there are a few guidelines for designers which detail practical limitations as the dimensions of these features approach the thickness of the metal.

- Typical sheet sizes are 300x300 mm, 300x400 mm or 300x450 mm, other sizes are possible by request
- There must be a 15mm border around the entire perimeter of the sheet
- Minimum spacing between any two parts is 3mm (preferably 5mm)
- For surface etching, no line can be thinner than 0.15mm
- For complete etching, no line is to be thinner than 1.5 times material thickness (eg on 0.9mm material, the minimum width would be 1.35mm)
- Minimum hole diameter is at least 1.5 times the metal thickness (eg on 0.9mm material, the minimum hole diameter would be 1.35mm
- Wherever possible, nest pieces to attain maximum yield from the sheet. Depending on the designs, you may be able to rotate some parts to enable a better fit
- 'Micro-tabs' or 'mouse-bite' tabs are required to hold each part into the parent sheet. They need to be at the leading edge of the sheet so that they "pull" the pieces along as the sheet travels through the etcher. Rotated pieces may need tabs repositioned to the leading edge.

Dimensions

The etching process results in undercutting at the edges of the resist film on the surface in all directions. Undercutting is the effect of the acid on the wall of a hole as it is being created, which prevents the wall from being a straight edge. This is further explained in the references to "bevel" below.

Tolerances of Etched Dimensions

Because of the many parameters involved in determining etching tolerances, it is impossible to give a definite, absolute rule which will cover all circumstances. Some of the more common variables which affect the etching tolerances are the type of material being etched, size of the panel and the equipment being used. As a general rule of thumb, a tolerance of +/- 10% of the metal thickness is usually acceptable.

Table 1 & 2 give tolerances to be expected for varying metal thickness and flat sizes.

Table 1: Prototype & Short Runs
Thickness, T, millimetres

Approx flat size	0.025 mm	0.050 mm	0.130 mm	0.250 mm	0.400 mm	0.500 mm	1.000 mm
50mm x 50mm	Empirical	±0.025 mm	±0.025 mm	±0.025 mm	±0.040 mm	±0.050 mm	±0.100 mm
200mm x 250mm	Empirical	±0.025 mm	±0.025 mm	±0.040 mm	±0.050 mm	±0.080 mm	±0.130 mm
300mm x 400mm	Empirical	±0.025 mm	±0.040 mm	±0.050 mm	±0.080 mm	±0.100 mm	±0.160 mm

Table 2: Production Runs
Thickness, T, millimetres

Approx flat size	0.025 mm	0.050 mm	0.130 mm	0.250 mm	0.400 mm	0.500 mm	1.000 mm
50mm x 50mm	Empirical	±0.025 mm	±0.025 mm	±0.030 mm	±0.050 mm	±0.080 mm	±0.130 mm
200mm x 250mm	Empirical	±0.025 mm	±0.030 mm	±0.050 mm	±0.080 mm	±0.100 mm	±0.160 mm
300mm x 400mm	Empirical	±0.030 mm	±0.050 mm	±0.080 mm	±0.100 mm	±0.130 mm	±0.180 mm

Table 1 is for prototype or short run of parts with not more than one dimension per piece requiring the tolerance shown.
Table 2 reflects approximate tolerances on full production runs.

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Relationship of Hole Size to Metal Thickness

The diameter of a hole cannot be less than the metal thickness. This relationship however, does vary as the metal thickness changes as shown in *Table 1*.

Metal Thickness (t)	Smallest Hole Diameter (D)
Less than .025mm	Empirical
.025mm or over	At least 1.5 times metal thickness

Table 1

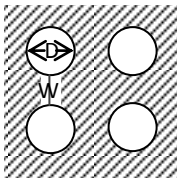

Fig. 1

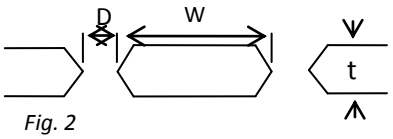

Fig. 2

Relationship of line width to metal thickness (*Fig. 1* & *Fig. 2*)

Metal Thickness (t)	Space between slots (W)
Less than .025mm	At least 1.25 times metal thickness
.127mm or over	At least 1.25 times metal thickness

Table 2

The width of metal between holes (*W*) is not usually a problem in Photo Chemical Machining. However, when this space is the remaining surface area in a large field of slots or holes, there are limitations as to how small the metal width between the holes can be (*table 2*).

Relationship of <u>Inside</u> Corner Radius (R) to Metal Thickness (*Fig. 3*)

The smallest corner radius is directly proportional to the thickness of the metal ie. for metal thickness of 0.05mm, the corner radius would be a minimum of 0.05mm.

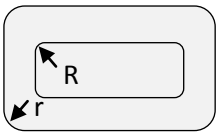

Fig. 3

Relationship of <u>Outside</u> Corner Radius (r) to Metal Thickness (*Fig. 3*)

Outside corners tend to etch more sharply than inside. Therefore, radii of less than metal thickness are obtainable. The outside radii should be at least 0.75 times metal thickness (t).

Corner Radii

The PCM process tends to round off corners. This is often advantageous because it keeps the part from causing scratches or cuts and catching on the other parts. However, if a square corner is desired, there are techniques available to obtain them. For example, *Fig. 6* shows how serifs can be added to the artwork so that when the image is transferred it will reproduce as a sharp corner on the actual part.

Fig. 6

Bevel

By nature of the etching process there will be some degree of slope to the walls of holes or to the metal edge. It is easier for Mastercut to etch equally from both sides, instead of etching from just one. However, in a two side etch the depth may be varied to produce more bevel on one side. Normally, this condition is referred to by the percentage of etch from either side (eg 90/10 would be etching 90% from one side and 10% from the other (*Fig. 5)*).

When such variation is required, it should be so specified.

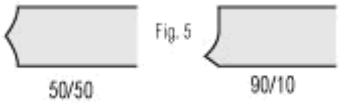

Fig. 5

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Relationship of Bevel (A) to Metal Thickness

Etching one side: An etchant attacks the material laterally as well as vertically. The result, therefore, is the condition of etch configuration for a hole which is known as the "bevel". (*Fig. 4a*)

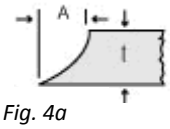


Fig. 4a

As a rule of thumb, when etching from one side, the bevel (A) is approximately 0.75 times metal thickness (*t*).

Etching two sides: Assuming that the material is being etched equally from two sides, it can be easily seen that the bevel is appreciably reduced. (*Fig. 4b*)

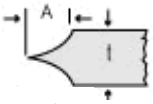


Fig. 4b

As a general rule, when etching from two sides, the bevel (A) is approximately 0.4 times metal thickness (*t*).

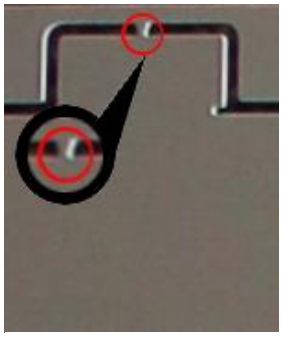
Centre-to-Centre Dimensions

For small pieces, it is usually possible to etch PCM parts which tend to duplicate the centre-to-centre dimensions which exist on production artwork. Because of the limitation in the area of artwork preparation, the following table gives practical centre-to-centre tolerances for finished parts.

Centre to Centre Dimensions	Tolerances
25 mm or less	± 0.013 mm
25 mm - 75 mm	± 0.025 mm
75 mm - 150 mm	± 0.025 mm
150 mm - 250 mm	± 0.080 mm

'Micro-Tabs' & 'Mouse-Bites'

These tabs hold each piece in place within the parent sheet and allow the etched pieces to be "twisted" out of the parent sheet with only a couple of simple bends back and forth.
There are two alternatives to the style of tabs that can be used. Micro-tabs leave a small point proud of the edge of your piece which can be easily filed back. Alternatively, the mouse-bite, which is shaped like a little 'W', breaks evenly to the edge, the part will have to small scallops out of the edge of the material.


'Micro-Tabs'


'Mouse-Bites'


'Twisting'

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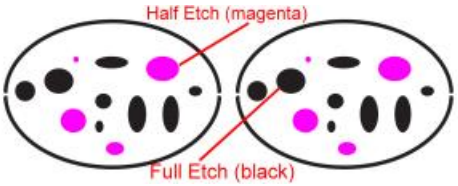
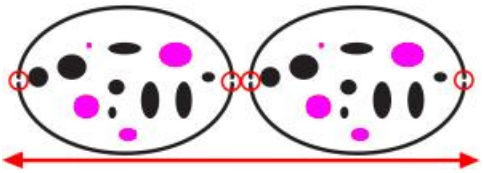
Artwork Guidelines

It is essential to follow these guidelines to ensure that your parts turn out as expected.

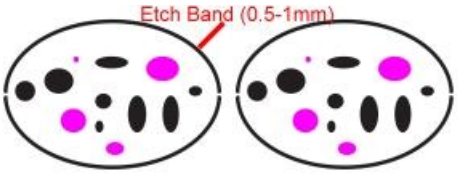
- Allow a 15mm border around the edge of the sheet (ie for a 450x300mm sheet, the artwork area would be 420x270mm)



- Make full etch and half etch sections different colours (black for full etch, magenta for half etch)
- Tabs should be 1 ½ times the material thickness



- Try to keep tabs in the same direction. They should be positioned at the head and foot of each piece so that the tabs "pull" the pieces through the etcher
- Wherever possible, we recommend that you rotate the pieces to that the tabs are in a location which would make them easy to file down, or where their existence is irrelevant
- Minimum un-etched line width is the same as tabs, 1 ½ times the material thickness
- Minimum line width for half etching is 0.15mm
- Minimum line width for full etching is the same as material thickness (providing it is over 0.15mm)



- Make etch band width between 0.5 – 1mm