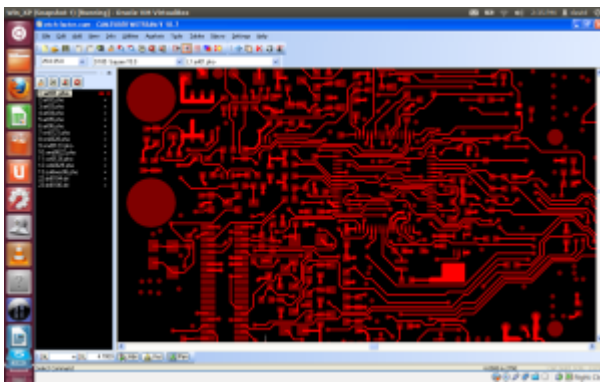


Etch Factor

An etch factor or etch compensation is a process modification made by the **Printed Circuit Board (PCB)** manufacturer to compensate for the chemical etching process. The chemical etching process is a subtractive operation that removes copper gradually when forming the circuit pattern. The size of the features at the end of the process are smaller than the size of the features at the beginning of the process. When a PCB design requires a track width of 0.005" (0.127 mm) the PCB manufacturer has to start out with a wider track. The amount the track is increased by is referred to as an etch factor or etch compensation. The etch factor is also proportional to the thickness of the copper or copper weight being removed. The more copper being etched through the larger the etch factor.



Etch factor added with CAM tool.

The fact that the PCB manufacturer has to increase the feature size to compensate for their manufacturing process is critical for a PCB designer to understand. The designer must provide enough spacing in their design for the PCB manufacturer to process the design. In other words, the minimum spacing in the design must meet the manufacturer's minimum space that they may consistently process. In PCB manufacturing there are three types of spacing that we consider. They are...

- 1) Copper feature to copper feature. This includes line to line, Line to pad and pad to pad only.
- 2) Copper feature to a second copper feature with a solder mask opening. This includes line to pad where the pad has an opening in the solder mask for the pad in copper.
- 3) Copper feature to copper feature where both features have a solder mask opening. This would include two pads in copper that both have openings in the solder mask for both pads.

It is important for the designer to know their manufacturers and understand what they can process repeatedly for minimum spacing. Exceeding the manufacturer's minimum process capability reduces yields or throughput and raises costs. The increased costs are passed on to the buyer in one way or another. Knowing your manufacturer, their process and their limitations goes a long way in staying cost competitive, delivering on time and maintaining quality. For the purpose of this post I shall keep the parameters limited to what is considered mainstream using alkaline etching chemistry. Alkaline or ammonia etch is common in the industry and works on both the inner and outer layer processing. Your



PCB manufacturer may have other chemistries available that require a lower etch or compensation factor. Hence, the reason why it is important to know your vendor.

With regards to Item 1 “Copper feature to copper feature” we need to consider the copper thickness or weight to be chemically etched through. This would be the same for inner and outer layer copper weights. The matrix below is a listing of copper weights and spacing that we typically require as an absolute minimum requirement...

Copper Wt.	Design Line Width	Etch Factor	Min Mfg. Space	Min Space in the design
½ Oz	.004"	.001"	.004"	.005"
1 Oz	.005"	.002"	.004"	.006"
2 Oz	.006"	.004"	.004"	.008"
3 Oz	.007"	.006"	.004"	.010"
4 Oz	.008"	.008"	.004"	.012"

The minimum space the factories release to the manufacturing floor in the matrix above is set to 0.004" feature to feature. Tighter spacing than that and you enter the realm of **High Density Interconnects (HDI)**. Line widths are assumed to finish at the IPC reduction tolerance of 20%.

With regards to Item 2 “Copper feature to a second copper feature with a solder mask opening.” we have to allow for tolerances for solder mask coverage and registration. The registration accuracy of the copper image and the solder mask image on the outer layers must be accounted for to ensure that two critical parameters are met.

- Solder mask is kept off of the pads being soldered to.
- The solder mask covers unlike conductors near the pad being soldered to prevent solder shorts.

The edge of the solder mask opening to the edge of the solder pad needs to be 0.003" to allow for the tolerances to register the solder mask artwork and to keep from depositing ink off of the pad edge. Likewise, we need 0.003" from the edge of the unlike conductor and the solder mask opening to ensure that the unlike conductor is covered preventing any solder from wicking over and shorting out to the copper. The spacing at this point on the outer layers would be 0.006" between the copper feature to a second copper feature with a solder mask clearance. The matrix below would also apply...

Copper Wt.	Design Line Width	Etch Factor	Min Mfg. Space	Min Space in the design
½ Oz	.004"	.001"	.005"	.006"
1 Oz	.005"	.002"	.005"	.007"
2 Oz	.006"	.004"	.005"	.009"
3 Oz	.007"	.006"	.005"	.011"
4 Oz	.008"	.008"	.005"	.013"



With regards to Item 3 “Copper feature to copper feature where both features have a solder mask opening” we not only have to account for feature registration but for solder mask placed between features. The solder mask between features is referred to as a solder mask dam. The solder mask dam deposited between two unlike copper features reduces the potential of solder wicking between the two features at assembly resulting in a solder short. The minimum width of the dam is typically 0.003” in width. This would also require two 0.003” clearances and one 0.003” dam for a total space of 0.009” between features. The matrix below would apply...

Copper Wt.	Design Line Width	Etch Factor	Min Mfg. Space	Min Space in the design
½ Oz	.004”	.001”	.008”	.009”
1 Oz	.005”	.002”	.008”	.010”
2 Oz	.006”	.004”	.008”	.012”
3 Oz	.007”	.006”	.008”	.014”
4 Oz	.008”	.008”	.008”	.016”

The values above are considered typical for conventional processing for standard technology. Spacing that drops below the values above are possible but may result in reduced manufacturability and may require special processing and equipment. This would begin to enter the realm of High Density Interconnects (HDI) leading edge technology. Your vendor may not be capable of processing HDI. BBG is capable of manufacturing HDI technology at some of our off-shore factories. HDI designs are reviewed on a case by case basis.