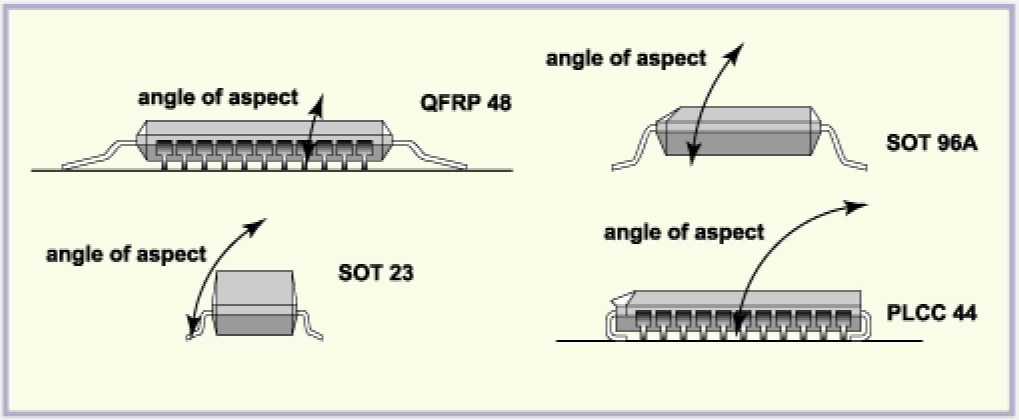
Solder Skips

When soldering bottom-side surface mount components, the requirement is to get solder in contact with the terminations and pads for *long* enough and *intimately* enough for wetting to take place. Where the solder cannot properly wet the interface and form a joint, the result is a type of defect known as a ‘solder skip’. Tackling this problem involves both design strategies and machine modifications.

Soldering problems began as soon as surface mount components started to be wave-soldered to polymer circuit boards. Whilst chip components presented few problems, active component formats were not very ‘soldering-friendly’, SOICs and PLCCs being especially difficult to wave solder. This is because the ends of the leads are too close to the relatively high body mouldings. The ‘angle of aspect’, formed between the upper edge of the component body and the end of the solderable lead, is about 60° for SOICs and can reach 90° for PLCCs (Figure 1).

The solder wave finds it difficult to access these corners, because of the high surface tension of the molten solder. Until wetting takes place, the solder surface in contact with a component is like a balloon pressing against the walls of a room – in a tight corner, at best it will only make contact at the periphery.

Figure 1: The contours of SOICs, PLCCs and QFPs



This lack of contact means that smooth 'lambda' waves, so good at soldering through-hole components, often produce unsatisfactory SM soldering results because there is not enough movement to break the surface tension of the solder at the component lead/pad interface. A similar sort of situation exists where SM parts are closely spaced, making it difficult for the solder to access the joint. This problem is both addressed during board design and tackled during manufacture by using waves with high turbulence and an appropriate angle of attack. The concept of the double wave is shown in Figure 2.

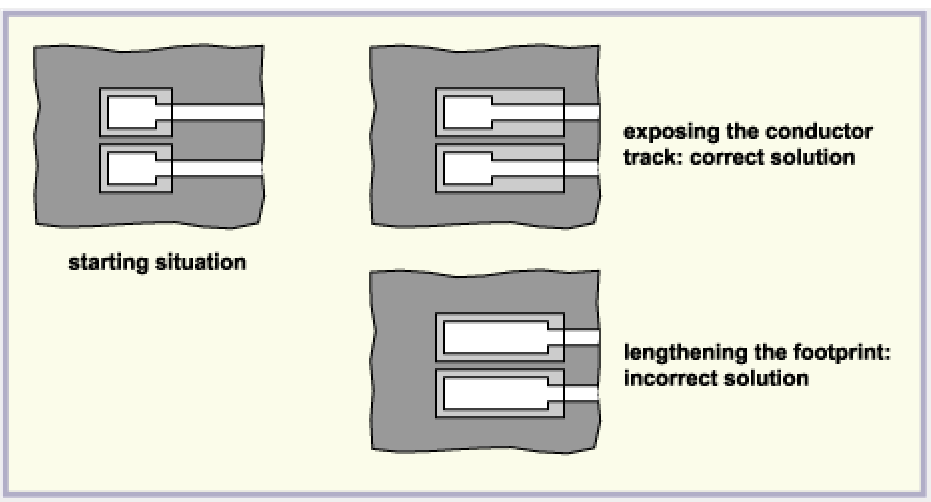
Figure 2: Double wave system: the 'chip' wave is on the left

The primary or 'chip' wave is a symmetrical wave with an intentionally turbulent wave crest (Figure 3). The high kinetic energy at the point where the solder meets the board ensures that the solder finds its way to every joint on the board. A secondary wave then allows the solder to drain away from the board without leaving behind any bridges or unwanted accumulation of solder.

Figure 3: Close-up of turbulent chip wave

From the design perspective, the potential for skipped joints can be reduced by extending the footprint, or exposing a short length of track not covered by the solder mask. These can help lead the solder to a joint close to a high component body (Figure 4).

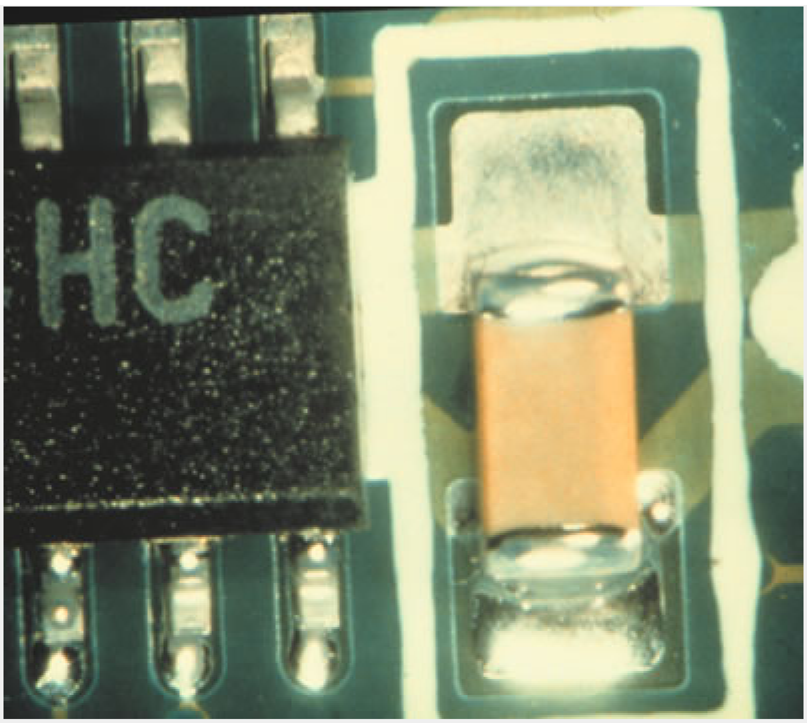
Figure 4: Letting the conductor track lead the solder to the joint



Footprints for MELFs and chips should extend far enough to provide an aspect angle of about 60°. This allows for slight misalignment of the component, so that in no circumstances does the angle get steeper than 45°.

One also has to remember that even the underside of an assembly is not flat, and that the wave comes into contact with a three-dimensional surface. It is therefore possible for areas of the board to be physically prevented from coming in contact with the solder, creating a type of solder skip referred to as ‘shadowing’ (Figure 5).

Figure 5: Shadowing caused by an adjacent component

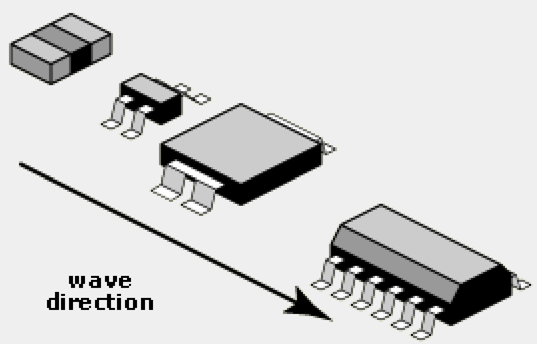


This specific problem can be overcome by altering the direction in which the board approaches the solder wave, but only if the layout engineer has forseen the potential for this kind of defect and has made sure that there is at least one direction in which shadowing will not occur.

A similar effect can happen with closely-spaced pins, as with connectors. Here the solution is to orientate the banks of pins parallel to the direction of flow, so that the pins hit the wave sequentially and the presence of the component body does not affect the joint. When laying out the board, therefore, it is recommended that all DIP and axial components should be aligned along one axis. This has the subsidiary benefits that it makes the board easier to inspect, and slightly reduces the auto-insertion machine time, saving on production costs; having even one axial component on a board oriented in a different axis, means that the axial insertion machine must rotate the board or pallet to install that component.

When surface mount components are to be wave-soldered, again there is a preferred orientation of the component relative to the wave (Figure 6) in order to reduce both shadowing and bridging.

Figure 6: Recommended orientation for SM components



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