KNOCKING DOWN THE BONE PILE

A Rework Dilemma: PCB Shields

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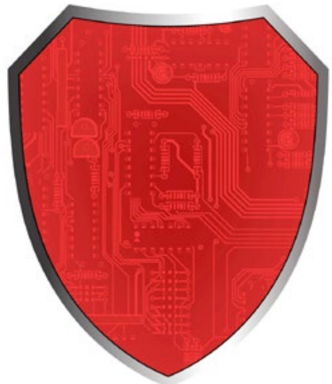

RF shields minimize radio frequency (RF) noise to prevent it from affecting the sensitive and critical electronic components beneath the shield. They also prevent such noise from interfering with neighboring devices or other systems in the vicinity. RF shields typically have a unique design and conform to the layout of the PCB. Often, the shields are not regular-shaped designs; rather, they are designed and are shaped by the PCB layout. Typically these shields can be found on handheld wireless device PCBs such as smartphones, netbooks, tablets, portable medical devices and audio/video players, to name a few.

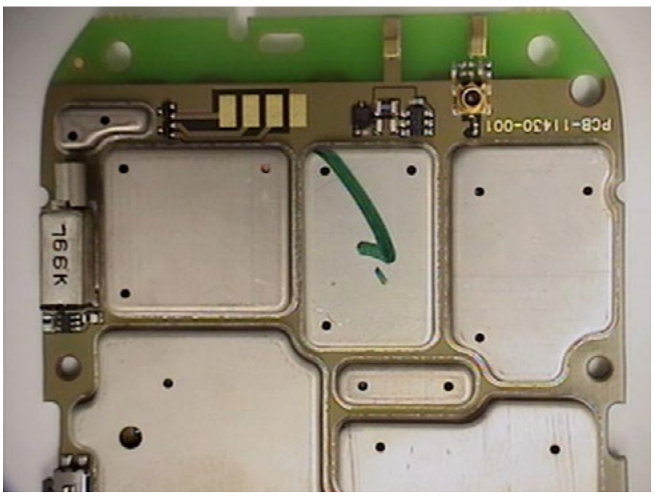

Figure 1: Example of multiple shields on handheld wireless PCB.

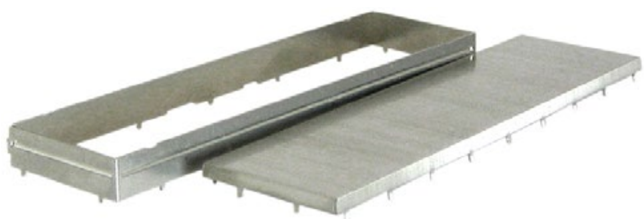

Figure 2: Example of two-piece shield.

There are two basic construction types for these shields. Some of them are a two-piece construction with a "fence" soldered to the PCB and a cover fitted over this fence.

Other shields are a one-piece construction with an open-sided can overlaying the components and soldered to the PCB. These one-piece shields are a serious challenge to rework and will be the focus of this rework discussion.

Challenges of Shield Rework

There are numerous challenges associated with reworking shields, including, but not limited to:

1. Devices are very tight and close to the shield itself—many times within a few millimeters. This means that the rework process, if not precisely controlled, can present problems in disturbing nearby devices.

2. Shield trace solder excavation and PCB board prep are challenging as well, especially for odd-shaped shields. Manual methods require extreme dexterity as the distance between the land of the shield and neighboring devices

Figure 3: Example of one-piece shield.

is very small. This means that neighboring devices can be disturbed.

Resoldering of the shields can be very challenging as the gap between the shield lip and the board needs to be closed so as to not allow for any ingress or egress (in some cases) of RF signals. This means there is little room for error.

Reflow Methods

There are a variety of reflow methods that are used for single-piece RF shields, including the use of hot air convection, conduction and laser sources.

After removal, the shields themselves need to be discarded for a variety of reasons. First, the shields are typically discolored after having gone through multiple heat cycles. While these discolored, formed pieces are not a reliability concern, the end users do not want this inside their product and have augmented their inspection criteria to make a discolored shield a defect.

Second, in these rework processes, tin shields can become highly oxidized and nearly unsolderable surfaces. Finally, from a practical basis, the shield lips soldered to the PCB can warp after reflow (the shields are typically 2–4 mils in thickness) and thereby cannot then sit on the same plane as the PCB, rendering it impossible to close the gap between the PCB and the land of the board. This will make the purpose of the shield, which is to properly attenuate RF signals, a failed one.

The most commonly used method for the reflow of these shields involves the use of a hot air system with a customized nozzle. A bottom heater is used to first heat the PCB to 100–125°C. Once this temperature is established, the hot air nozzle will come over the device. The nozzle itself is custom-designed to contour to the shape of the part, with the air baffles blowing the hot air towards the periphery of the part where the lip of the shield connects to the PCB land. The removal profile must be carefully thermocoupled as there are parts underneath the shield which should have limited heat exposure. In addition these same parts may be under filled, which can cause the solder on these components to experience "solder squirt out," an unrecoverable defect in the rework process. These undesired reflow problems along with the extended lead times of the nozzles makes the hot air removal method time consuming and expensive.

Another method for the reflow of the RF shields is the use of a conductive soldering iron. In this method a conductive tip, shaped exactly to the outline of the shield, is placed on top of the shield. It is powered by a very generously-powered power supply that can deliver enough thermal energy to the shield to remove it quickly. The downside of this method is that the tips themselves are highly customized and subjected to both a machining and plating process, resulting in an expensive, long lead time in the manufacturing process. The flip side is thatthis method is a very fast way to both de-solder and to re-solder shields.

Another method involves the use of a laser source. In this method, a material, which can absorb energy from the wavelength of the laser source being used is placed onto the shield. The laser then directs its beam to the selective area of this material on the shield surface and rapidly transfers this energy in the form of heat to the shield. This allows the shield to quickly be removed. The benefits of this approach are very rapid removal, thereby limiting potential peripheral part damage and little chance for neighboring device reflow. The downside of this approach is that the laser source is capital intensive.

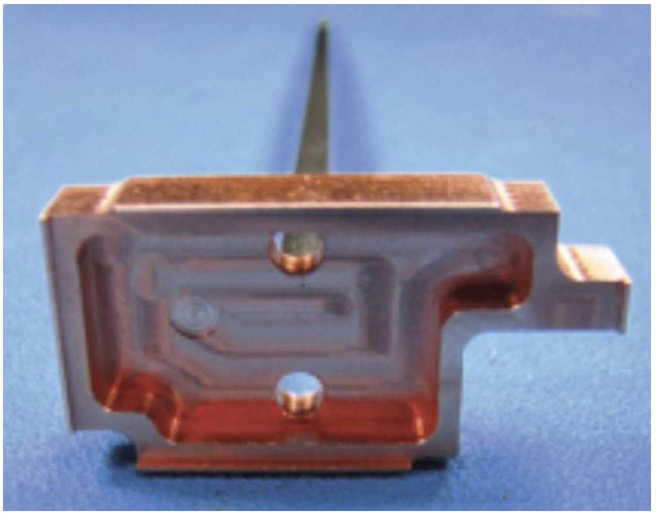

Figure 4: Customized RF shield conductive tip.

Site Preparation

Several methods can be employed in order to excavate the remnant solder on a PCB after shield removal, including the use of solder wick, non-contact hot air excavation and copper coupons.

The most common solder excavation method, especially predominant in cases where the volume of rework is low, is the use of solder braid. The keys to making sure all of the remnant solder is wicked off and flat with no neighboring device damage is to use the proper technique and materials. In terms of the materials for this method the use of the correct-sized braid, the proper flux and the correct conductive hand soldering tool is important. Using the correct size of braid is critical for correct removal as too large of a braid can damage neighboring components; too small of a braid can lead to inefficiencies in the removal process as well as potentially damaging the PCB laminate or solder mask.

The proper flux will ensure that the solder wets the braid properly. Finally, making sure the conductive power supply can deliver the power required for the application—especially if the board has a large thermal mass or the shield is connected to a ground plane, is required. In terms of technique the solder wick should be place a perpendicular to the area to be excavated and then lifted off during heating. It should not be dragged across the surface of the PCB as this may damage pads, laminate and mask.

A non-contact hot air programmable excavation system can also be used to scavenge the solder from a PCB after the RF shield has been removed. In this system, the board is brought up to temperature using a preheater. Next, a solder excavation tool with both a heated nozzle and a vacuum source emanating from the orifice of the tool will be programmed to drive around the periphery of the shield land pattern on the PCB. This is a non-contact method and has the advantage of not being subject to the skill level of the operator for consistency and for not damaging either the land or the laminate of the PCB. While this method is quite slow, it is very repeatable. Like all air driven sources in PCB assembly it is imperative to keep the air systems clean or they will not work.

The final method being used for remnant solder removal involves the use of a pre-fluxed copper coupon. It is used as a wicking vessel to pull up the solder around the land. Custom flux-coated coupons, cut to the shape of the shield, are placed in to a rework station. Once they come to temperature they are lowered to the surface of the PCB. The remnant solder is then drawn to the coupon for subsequent removal. After this operation the spent coupon is discarded. This is a fairly slow technique, but results in less damage than the completely manual solder-wicking approach previously described.

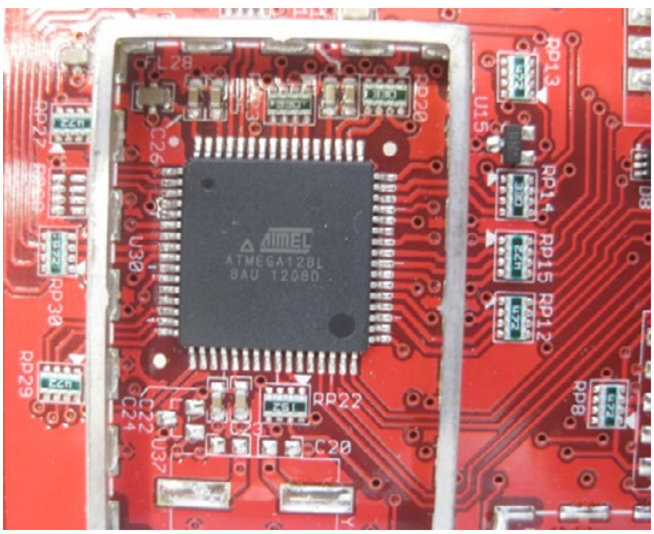

Figure 5: Example of parts being in very close proximity to shield.

Solder Deposition

Several methods are used to make sure that a consistent solder fillet is formed between the lip of the shield and land on the PCB. Manual soldering, solder dispensing and solder performs are all methods which can be used to close the gap. Manual soldering requires that the proper technique is used to ensure that the entire periphery of the shield has no gaps between shield lip and land. In many handheld consumer devices employing these shields, the spacing to neighboring shields or components is less than two millimeters, requiring a very high level of dexterity from the soldering technicians. Parts and neighboring shields can be easily damaged. Robotic solder paste dispensing is a very consistent way to get the same volume of solder

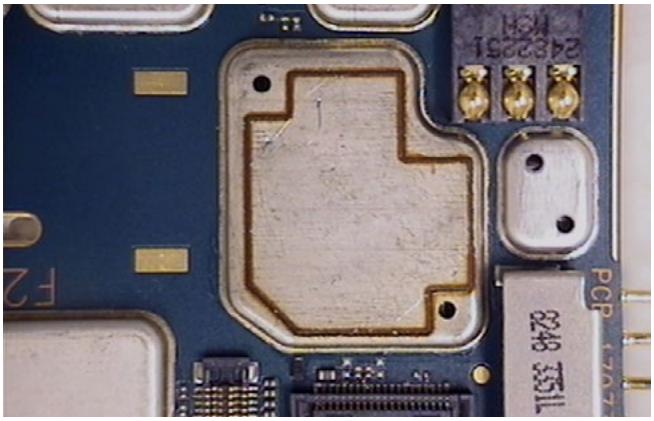

Figure 6: Shield scribed with laser.

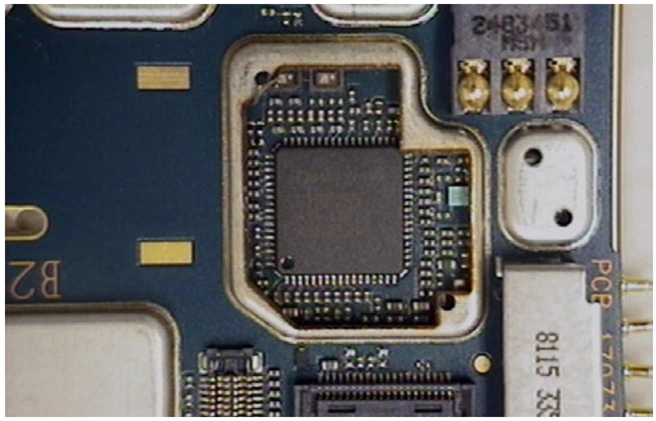

Figure 7: Hole opened in shield top.

paste down on to the land each and every time. Typically auger-driven systems ensure as repeatable of a dispensing volume as possible without indiscriminant "tails" or "gaps" in the solder deposition due to the sometimes inconsistent incoming pneumatic pressure. Finally, custom solder performs are another way to ensure consistent solder paste volume deposition along the lip of the shield. This is an expensive approach but one in which the various reflow methods previously described can be used to reflow the solder to prevent any gaps.

Open the Can Approach

Another approach in which the potential damaging side effects of the reflow process can be avoided is to selectively cut out a portion of the shield, rework the location directly under the area in which the cut-out was made and patch the shield afterwards. By using the proper laser wavelength and a very fast cutting profile, a select area can be cut out. After removal of the cut-out shield area, the hand soldering tool or rework nozzle can be used to remove and replace the device in question. This greatly reduces the likelihood of neighboring or underside components to go in to reflow or from being damaged. After replacement a special shielding tape can be affixed over the opening in order to close up the hole and maintain the efficacy of the shield.

Conclusion

With the proliferation of handheld wireless devices, the PCB assembly processes, including rework has become more challenging. A variety of methods can be employed in order to make the rework processes of reflow, site preparation and solder deposition easier given the complexity of the PCB and the volume of rework required. As devices get even more densely packed these challenges will only increase, requiring further developments in rework processes. **SMT**

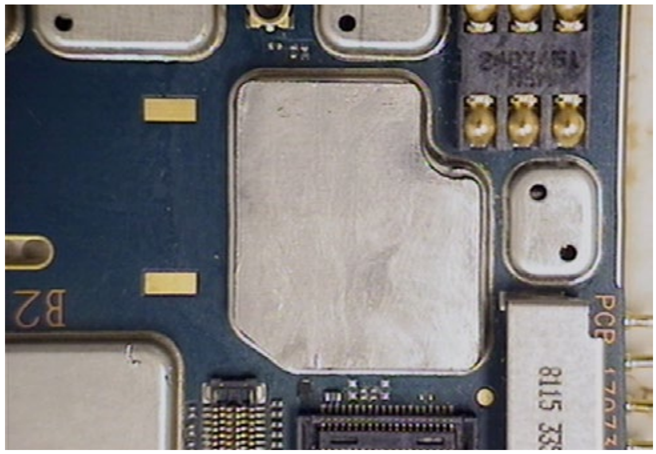

Figure 8: After removal, replacement tape "patch" eliminates need for reflow of replacement shield.

Bob Wettermann is the principal of BEST Inc., a contract rework and repair facility in Chicago. His column, *Knocking Down the Bone Pile,* will appear bi-monthly in *SMT Magazine.*