# Inductive Soldering for High Thermal Demand Applications

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## Soldering Challenges of Highly Metalized Components and PCBs

In consumer and industrial electronics, metal alloys made of tin, silver, and copper (SAC) alloys have established themselves as the industry standard for lead-free soldering. Coupled with multi-layered printed circuit boards (PCBs) and components made on metalized lead frames for heat dissipation, today's electronics require high-powered hand soldering solutions.

Highly metalized components and PCBs act like heat sinks. They create a heat distribution effect that pulls heat away from the soldering tip, making it challenging to deliver heat to create a good solder joint.

To help understand the heat dissipation effect, think of a large copper frying pan - if heat were applied to one small point on the frying pan (equivalent to the tip of a soldering iron applied to a sheet of copper) the pan would distribute that heat until the entire pan came up to a high enough temperature to cook.

Similarly, the heat spreader effect makes soldering more difficult by pulling heat away from the soldering tip, requiring a more robust solution to heat both the component and PCB, and to melt the solder.

The heat spreader effect is seen with high-power transistors like TO-220s, as well as multi-layer printed circuit boards and PCBs with large, metalized ground planes.

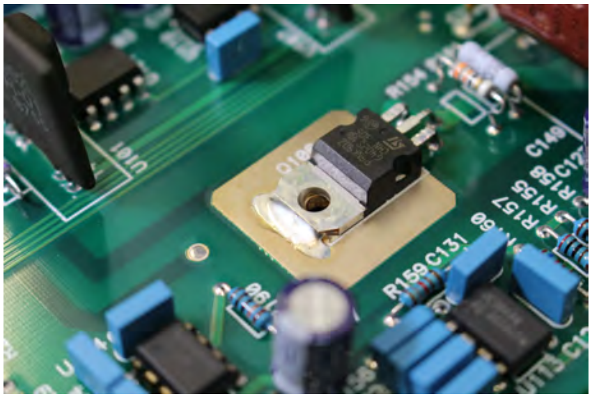

**Figure 1. TO-220 soldered to PCB.**

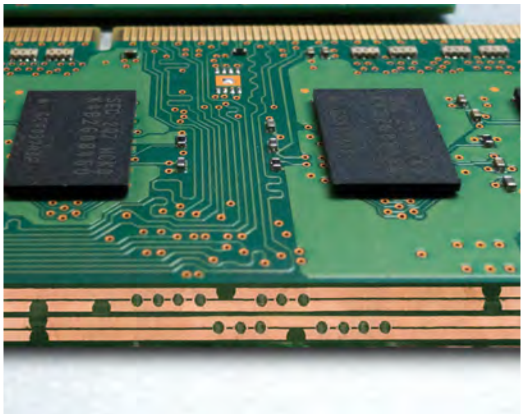

**Figure 2. Multi-layer circuit board cross section showing copper layers**

Another type of PCB that exhibits the heat spreader effect is the insulated metal substrate (IMS). IMS circuit boards are commonly used for LED lighting and other applications that generate significant heat. These are created by layering conductive and non-conductive adhesives on top of a metal plate, which allows heat to be efficiently pulled away from high heat generating components. Hand soldering these IMS circuit boards can be exceedingly difficult due to the massive metal substrate.

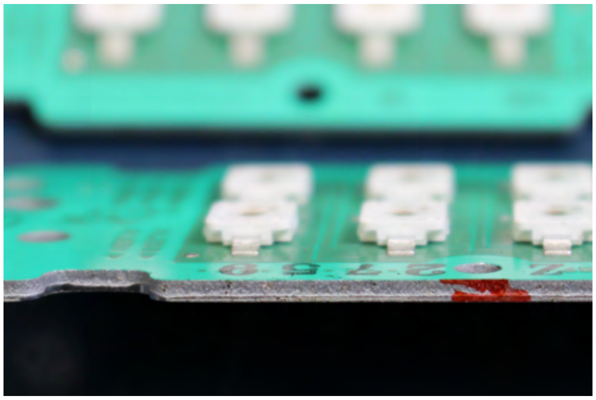

**Figure 3. Insulated Metal Substrate (IMS) circuit board**

## Other Difficult-to-Solder Components

RF shielding (sometimes called metal cans), coax cables with metalized grounding, and electronics in glass, are others in the top 10 list of most difficult-to-solder components. Glass applications (such as windshield defroster electronics), along with RF shielding and grounding applications (typically made of metals), conduct heat very efficiently, act like large heat spreaders, and are especially difficult to solder.

## Compensation Methods and Potential Risks

To overcome the soldering challenges inherent with highly metalized components and circuit boards, soldering technicians might attempt to compensate by extending dwell time — the time they hold the hot tip of the soldering iron to the solder joint to melt the solder. They might also increase the temperature at the tip of the soldering iron. These compensation methods not only decrease tip life but can also result in reliability issues or damage to both PCBs and components.

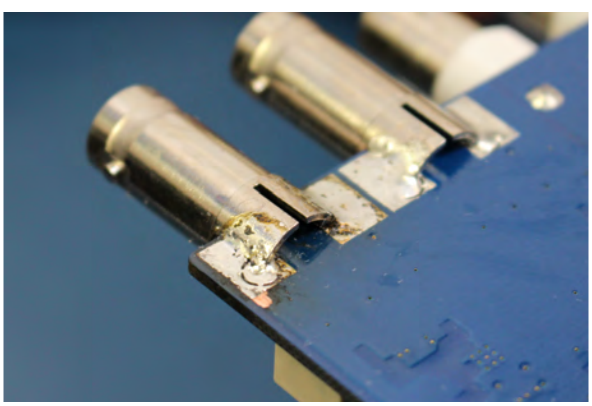

**Figure 4. Burnt solder joint due to too much heat while soldering**

Another compensation method is to preheat the circuit board and attempt to solder the assembly while the board is hot. This can result in safety issues for the soldering technician. Soldering technicians tend to hold their faces close to the PCB, and sometimes rest their hands on the boards, resulting in an uncomfortable working situation and perhaps even a painful burn.

**Figure 5. Soldering high thermal demand application**

## Industry Standards for Soldering

IPC Industry standard IPC-J-STD-001G specifies acceptable soldering temperatures and dwell times. These guidelines have been established to help protect circuit boards and components from damage caused by applying too much heat, or too little heat for too long.

However, there are numerous instances with resistive soldering where technicians have attempted to compensate for the heat spreader effect by increasing dwell time and soldering tip temperature, only to achieve adverse results — damage to the inside of components or circuit boards before the solder is melted.

## Inductive vs. Resistive Soldering

Inductive soldering provides several benefits over resistive soldering, including heat transfer/generation that is quick, efficient, repeatable, and accurate.

Inductive soldering irons utilize an induction coil wrapped around a magnetic alloy. When alternating current flows through the coil, a field is created, and this generates heat.

Inductive heating is based on physics, where the temperature of the magnetic alloy is controlled by the current flowing through the coil around it. Induction heating is more efficient and easier to control than resistive heating and allows for heat on demand.

In inductive soldering irons, the heater and temperature sensor are built right into the soldering tip, creating a closed-loop circuit for heat transfer that is quick, efficient, repeatable, and accurate.

Resistive soldering irons heat the entire tip through conduction. Using resistive heating technology, the tip acts like a heat reservoir, with higher thermal resistance and lower thermal performance than inductive heating. This means that it is slower to heat up and more difficult to maintain consistent solder tip temperature without dangerous temperature overshoot.

Resistive soldering irons with less efficient thermal transfer properties will require higher temperatures to achieve the same result while risking potential damage to components and PCBs.

## Benefits of Inductive Soldering

With today's delicate and complex electronics, temperature accuracy and control are a consistent challenge. Highly metalized components and PCBs, combined with thermally sensitive electronics and the need for lead-free soldering, result in difficult demands for process control.

To meet these challenges, manufacturers need a high-performance soldering system with inductive soldering. Inductive soldering creates heat on demand, quickly, and efficiently, overcoming the challenges of highly metalized PCBs, components, and substrates.

And since inductive soldering produces heat in a precise and controllable manner, it can handle both the smallest and most delicate of components as well as the most demanding thermal load applications.

## Summary

Electronics are getting smaller, faster, smarter, and more functional. And while size is being decreased, more heat is being generated in smaller spaces. To assist with heat removal, designers are utilizing more conductive materials like glass and metal in their electronic designs. Lead frames, multi-layer PCBs, metalized substrates, and ground planes will continue to play an important role that will require robust soldering solutions.

While the trend with resistive soldering systems is to build higher wattage systems that create and move more heat to the soldering tips faster, inductive soldering systems are taking a different approach. Utilizing a standard power supply and increasing the frequency of the power around a magnetized alloy is proving to be a much more efficient and powerful solution to generate and maintain heat at the soldering tip. The quick, efficient, and accurate heating methods of inductive soldering are providing excellent, repeatable results.

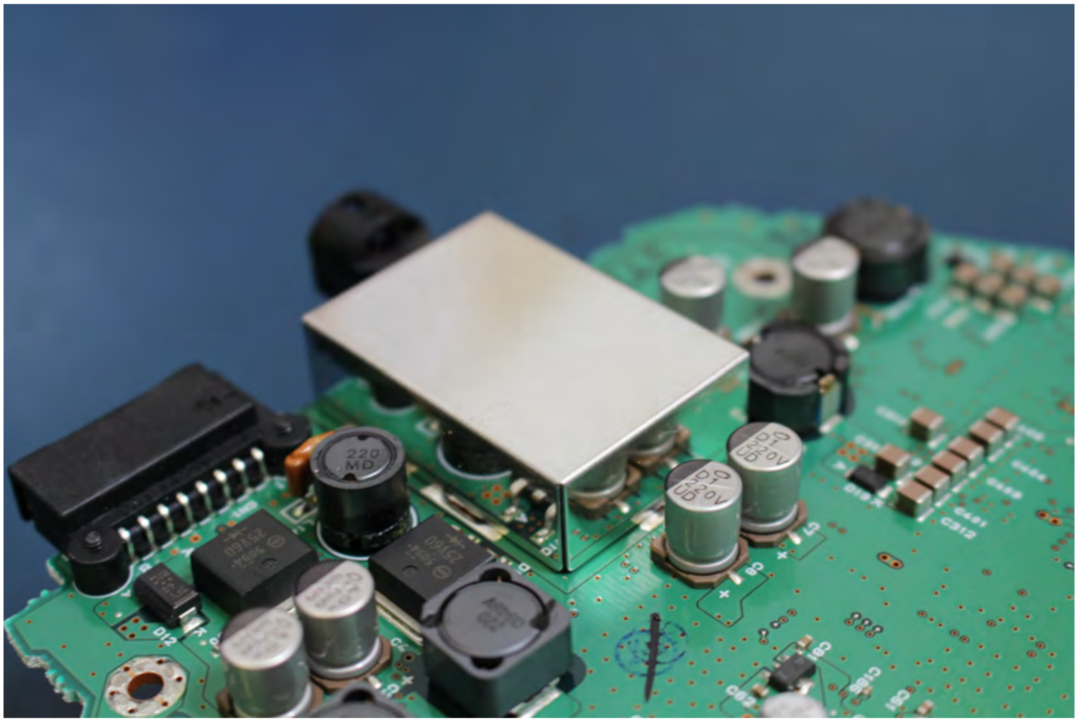

Figure 6. RF shielding soldered to PCB.

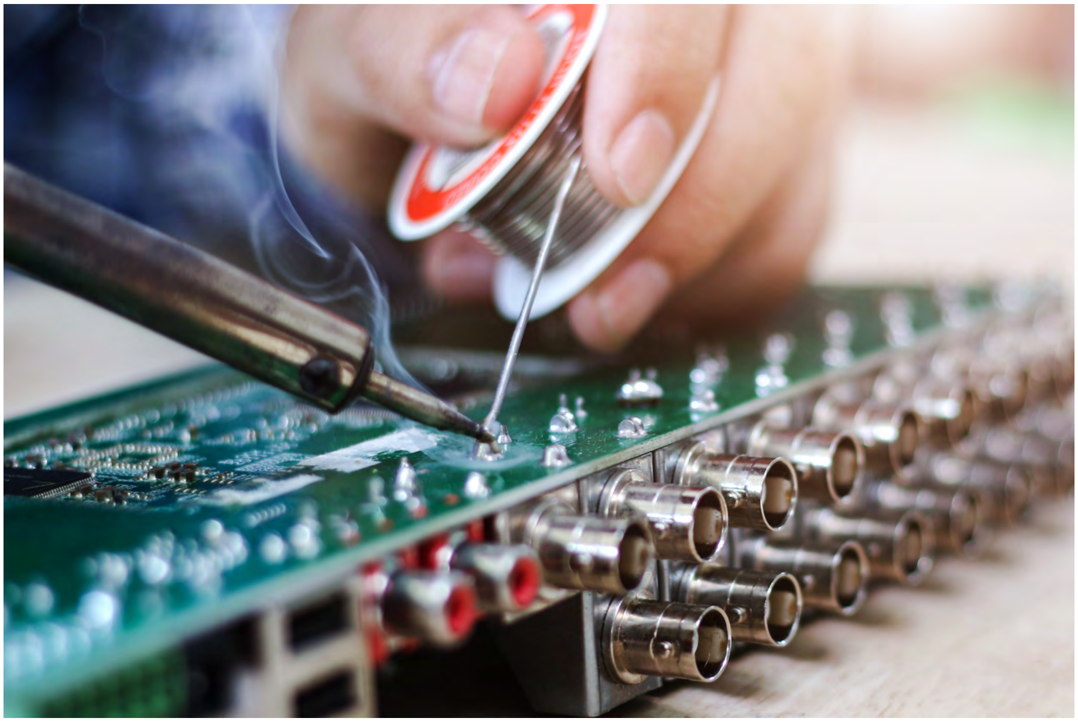

Figure 7. RG COAX directly soldered to PCB.

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