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Resistance Reflow Soldering Stranded Copper Wire

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Introduction

The key to successfully resistance reflow soldering stranded copper wire to a variety of different terminals is to prevent the stranded copper wire from spreading out during the soldering process.

This microTip describes when to use resistance reflow soldering in place of resistance welding, wire and terminal material requirements for creating a reflow bond, and the wire captivation methods used to prevent the wire from spreading out during the reflow soldering process.

Best Applications for Resistance Reflow Soldering

Resistance reflow soldering is most advantageous for the following applications:

- The terminal is sensitive to excessive heat exposure. Examples include copper pads on flex or rigid printed circuit boards (PCB) where too much heat can delaminate the delicate copper pads from their substrate material.
- Electrode access is limited to contacting the copper wire only; i.e., no opposing electrode is permissible.

The table below provides a guideline for choosing between reflow soldering and resistance welding.

	Reflow Soldering	Welding
Electrode Access	Top Side Only (Parallel Gap)	Top and Bottom (Opposed)
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Terminal Thermal Mass	Low	High
Peak Temperature	300 to 400°C	1,000 to 1,500°C
Joint Bond Type	Reflow	Diffusion Solid State
Joint Strength - Tensile	Good	Excellent
Joint Strength – Peel	Weak	Moderate to Good
Process Current	20-A to 0.8-KA	0.8 to > 2-KA
Process Time	20 to 50-ms	5 to 20-ms

For detailed information on the resistance welding process, please download the following microTip, "Resistance Welding Stranded Copper Wire".

Stranded Copper Wire Requirements

- Wire Diameter - 18-AWG (1.02-mm) to 38-AWG (0.10-mm)
- Wire Plating – Minimum of 6-microns of tin.

Terminal Requirements

The plating thickness and use of flux are absolutely critical for producing a strong reflow solder joint.

- Plating – 15 to 25-microns or more of tin, tin lead solder, or lead free tin alloy solder.
- Flux Coating – No-clean flux
- Alloys – Brass, bronze, copper, invar, kovar, or nickel.
- Part Thickness – 25-microns to 0.5-mm.

Wire Captivation Methods

There are three methods for captivating the wire strands during resistance reflow soldering: a) Electrode Tip Shape, b) Pig Tail Insulation, and c) Fixture Design. Each method has its own set of advantages and disadvantages and covers a range of wire diameters best suited to the captivation method. Note that solidifying the stranded copper wire before reflow soldering is not recommended. It is very hard to remove the oxides created by the resistance welding process using no-clean flux during subsequent reflow process.

Electrode Tip Shape

Grooving an electrode tip with a ½-diameter or V-Groove shape reduces the tendency of the stranded wire to spread out during the reflow soldering process. Fig-1 shows an opposed electrode configuration, but this process also works with the parallel gap electrode configuration. IMPORTANT - Shaped electrodes will NOT prevent all wire strands from separating from the main wire bundle.

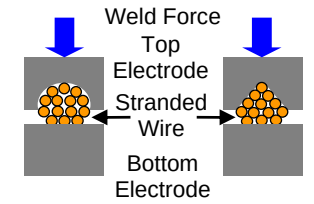

Fig-1, Electrode Tip Shapes

The electrode tip captivation method requires only one step, an advantage for this method.
Disadvantages to using shaped electrodes include: a) not all wire strands are captivated and soldered, b) tip is difficult to clean and maintain compared to a flat tip electrode, and c) the top electrode(s) may short out against the bottom electrode or fixture surface, effectively terminating the reflow soldering process.

Pig Tail Insulation

Reflow soldering stranded wire to a terminal using the Pig Tail Insulation captivation method requires two steps, a minor disadvantage for this method. Fig-2 illustrates an opposed electrode configuration, but this process also works with the parallel gap electrode configuration.

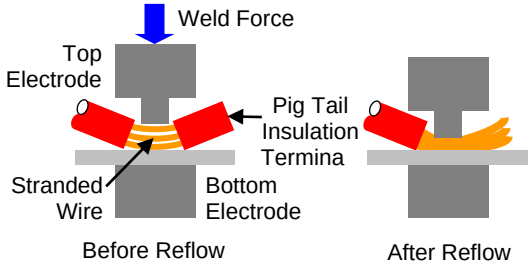

Fig-2, Pig Tail Insulation

First, separate but do not remove the wire insulation. This "Pig Tail" reduces the wiring spreading during reflow soldering. Leave sufficient space for the top electrode(s) to contact the exposed wire strands. Second, complete the reflow by contacting the stranded wire with a flat, ½ diameter, or V-Groove rectangular top electrode. Removing the Pig Tail after soldering is optional. Use a tip with a rectangular cross-section instead of a round cross-section to ensure that no wire strands escape.

Fixture Design

A fixture with guideposts or retaining pins can hold the stranded wire over the terminal and reduce the strands from spreading during reflow soldering. The fixture design can accommodate one or more terminals. A different fixture is required for the opposed and the parallel gap electrode configurations. Fig-3 shows the opposed fixture design. Fabricate the bottom electrode from molybdenum, copper-tungsten, or tungsten to produce the proper heat generation and heat balance. Use molybdenum or tungsten for the top electrode. Weld current shunting from the stranded wire to the tool steel will be minimal due to the insulation layer between the bottom electrode and the tool steel.

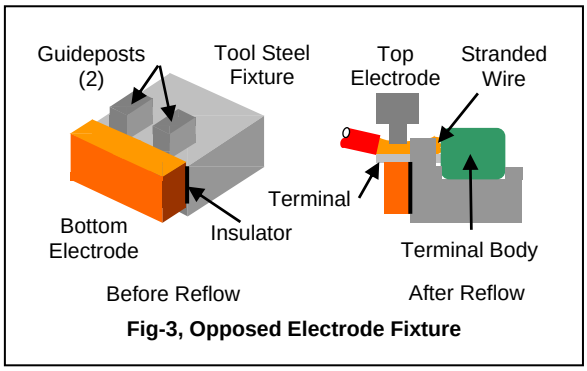

Fig-3, Opposed Electrode Fixture

Fig-4 illustrates the parallel gap fixture design. Use molybdenum or tungsten for the two top electrodes. Weld current shunting from the stranded wire to the tool steel will be minimal due to the high electrical resistance of the tool steel.

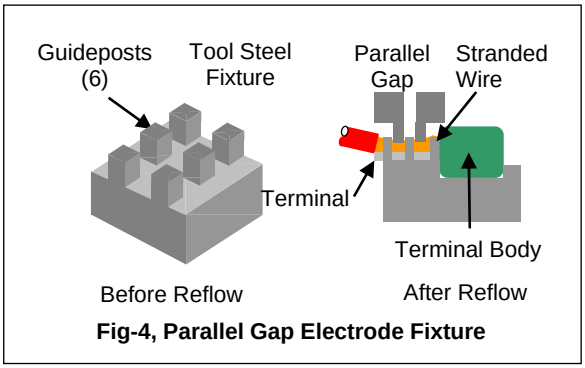

Fig-4, Parallel Gap Electrode Fixture

Place the terminal body on the Tool Steel Fixture. The terminal leads should cover and touch the bottom electrode or fixture surface with minimum contact force. Next, place the stranded wire over each terminal. The guideposts captivate the stranded wire. Complete the reflow by contacting the stranded wire with a flat rectangular electrode.

Important – the top electrode tip(s) should NOT touch the guideposts. This captivation method offers the advantage of being able to easily clean both electrode tips. Placing each stranded wire correctly requires time, a primary disadvantage for this method.

Summary

Each stranded wire captivation method offers advantages and disadvantages. The wire diameter size, number of strands, and the operating space to accommodate the top and bottom electrodes will dictate the wire captivation method.