

# HAND SOLDERING BASICS<sup>1</sup>

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## ABSTRACT

Soldering quality and performance vary depending on tip geometry, board thickness, temperature, flux type, technique, etc. Everyday knowledge of soldering is not enough. This Technical Note outlines some basic rules of thumb that apply to all hand soldering operations. With the proper tools and techniques, productivity will increase, board quality and rework consistency will improve, and board damage will be kept to a minimum. This Technical Note discusses methods to improve daily soldering practices as well as methods to maintain your soldering tool tip life.

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## PROCESS CONTROL

To rework a PCB successfully with high quality standards, stringent process controls must be developed. Putting process controls in place will ensure that your results are consistent and repeatable. Once you have your process in place, you can be assured that your product's reliability will improve, productivity will increase, and scrap rate will decrease.

### **Product reliability:**

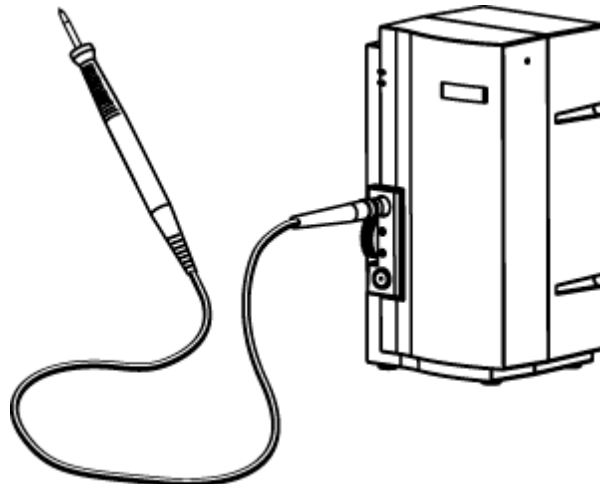
Bad process control can lead to bad solder joints, damaged traces and vias, and thermal damage of the component. If the PCB is damaged, it will not meet quality standards, and it may fail in the field.

### **Productivity:**

Good process control will increase your productivity. It makes your process more efficient, and cuts extraneous rework time from your operator's schedule.

### **Scrap Rate:**

Damaging boards wastes money and cuts back your output yield. Process Engineers can greatly increase quality by establishing standards for soldering processes. Metcal recommends the following generic process guidelines for general soldering and rework.



**Metcal systems help create consistent process control, because they eliminate temperature variables and don't require calibration.**

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<sup>1</sup> Edited by Linden McClure, Ph.D.

## TIP SELECTION

It is very important to choose the correct tip geometry for the application. The tip must fit the joint correctly. A correct fit will maximize power delivery, increase tip life, and result in higher efficiency.

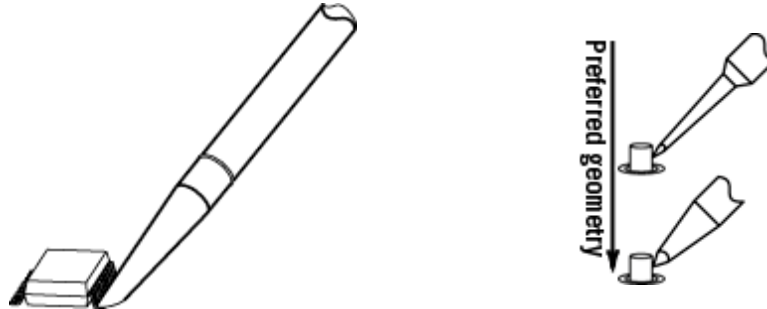
- Power Delivery: Metcal's SmartHeat technology delivers power according to the thermal demand of the joint. Good contact allows better power delivery.
- Heat transfers best through solid contact.
- Scratching, rubbing, pressing hard, etc., will not aid the transfer of heat.
- Using a tip that is too small will take longer, will abuse the tip, and will not efficiently pass power to the load. A small tip will seem to be too cold or too slow.



- A tip that is too large will damage the PCB, abuse the tip, and could cause a hole in the tip.
- Shorter, bulky tips will deliver more power.
- Short, blunt tips are for heavy loads only. They are not suited for fine pitch rework.
- Long, fine tips are best for hard to reach applications, or fine terminals (20 mil QFP).
- Long, fine tips will not deliver power as efficiently, since the solder joint is farther from the heater. Long tips slow heat transfer considerably.
- In general, larger tips will have more iron plating, making them more robust under abrasive conditions.

### Use Specialty Tips:

If you have a specific SMT application, like multi-lead soldering or pad cleaning, use the Metcal tip that is designed to accommodate the application. The tip will last much longer, and the board will be put under much less stress.



## TEMPERATURE SELECTION

Start with a 600 Series tip. If your board is simple and does not have too many backplanes, use a 500 Series tip cartridge. If you are soldering or desoldering a heavy board with copper planes, you may want to use a higher temperature series. If you are removing a large component, you may need to use a 700 Series tip cartridge to accommodate the large load.

### Choose the lowest temperature possible:

In general, Metcal systems use lower temperatures than conventional irons. Metcal can afford to use low temperatures since power delivery varies, depending on the size of the load. Direct Power<sup>1</sup> allows soldering of heavy loads at low temperatures, by maximizing power (heat) to the load.

### Take flux type into consideration:

If you are using a No-Clean flux, use lower temperatures. High temperatures will flash No-Cleans right off the board. Combining 700 Series tip cartridges and No-Clean flux will sharply reduce tip life. If you are using an RMA flux, you can afford to use a higher temperature series tip cartridge.

### Is temperature important?

Remember, good contact, a wet connection, and the correct tip geometry are the keys to effective soldering. You want to maximize the efficiency of power delivery to the load, at low temperatures. Using low temperatures will lessen danger to the board, lessening your scrap rates. Raising the temperature should only be done as a last resort.

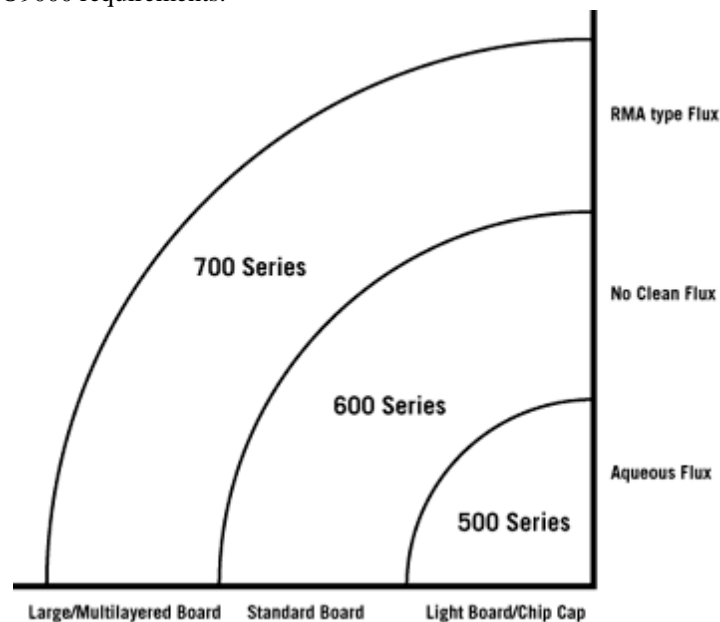
### How do I change the tip temperature?

To change the temperature, you need to change the tip cartridge. Temperature is not controlled by the power supply. Temperature is constant, while power is variable.



### How do I calibrate tip temperature?

Calibration is extremely important to maintaining good process control. Because Metcal soldering systems use a Curie point<sup>1</sup> heating technology that cannot significantly vary tip temperature, they do not have to be calibrated. Idle temperature cannot vary +/-1C. Metcal provides a No Calibration Required certification, making it easy for Metcal users to meet ISO9000 requirements.



**This diagram shows some basic relationships between flux type, board type, and tip series. Actual results will depend on many factors in the operational environment.**

## FLUX SELECTION

In the soldering process, flux is often the only variable that CANNOT be changed. Customers often specify a particular flux that must be made part of the rework process. Flux can be found in solder core wire, or added to the solder joint in liquid or paste form. Flux is very important to the process control. The process engineer must understand the function of flux, how fluxes differ and perform, how flux affects your PCB quality, and how flux affects solder tip life. Flux is an acidic material that is designed to clean oxides from the solder joint, and help transfer heat to the solder joint.

**There are many types of flux. In general, there are three categories of flux.**

- Clean (RMA): A more traditional type of flux, RMA has more acidic content.
- No-Clean: By far the most common in today's marketplace. There is less flux per volume in wire core solder. No-Clean flux has weaker acid than RMA.
- OA (Aqueous): The acid in OA flux is inorganic and more active than the acid found in RMA flux.

**Flux will affect your solder joint quality.**

- Clean (RMA) flux is more acidic. It leaves heavy residue that needs to be cleaned off the PCB.
- No-Clean flux leaves much less residue. After light touch-up with No-Clean, cleaning is not necessary. Many manufacturers choose No-Clean flux in order to omit the cleaning process after rework. If you use No-Cleans, you must lower your tip temperatures. Combining 700 Series tip cartridges and No-Cleans will sharply reduce tip life.

**Flux greatly affects your solder tip life.**

- RMA flux is much BETTER for the solder tip. It stays on the tip longer due to its gummy consistency. While soldering, RMA core solder wire will cover the tip and protect it from oxidation.
- No-Clean flux is much WORSE for your solder tip. It burns off right away, and there's less of it. Therefore, the tip will oxidize faster. It's almost like not using flux at all.

**If you are adding liquid or paste flux to the joint, it means that the flux in your wire core solder is not enough.**

For general through-hole soldering, the flux in the wire core solder is sufficient. You do not need to add more. For SMT, use it sparingly!

More flux makes soldering easier, BUT

- Too much flux will contaminate the board
- Too much flux will attack the tip faster. As flux activates, it attacks oxides on the tip. However, it also attacks the iron plating.

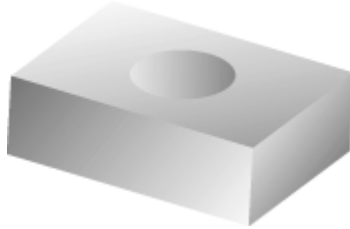


**This diagram shows why No-Clean Flux-cored solder seldom works as well as RMA-cored solder**

## TECHNIQUE: HOW TO SOLDER

Soldering is the act of heating two metals (a pad and a lead) and a solder alloy to form a solder joint. As the joint cools, a strong electrical and mechanical connection is formed.

- Select the correct tip and tip temperature (see previous section).
- Turn on the system, wait for the tip to heat up (10-30 seconds).
- Clean the tip on a damp, clean sponge.



**Sponge should be:**

- **Damp, not dry: use de-ionized water**
- **Clean, not dirty**
- **Sulfur-free (do not use household sponges)**



- Contact the terminal and the pad simultaneously and feed wire core solder into the joint.
- Do not feed solder into the tip while you solder. Feeding solder into one part of the tip may cause the flux to activate in only one spot. This feeding may cause a hole in the iron plating of the tip.
- Hold the tip steady until the joint is filled evenly with solder.
- Do not rub the tip against the lead.
- Do not apply too much pressure to the joint.
- Good contact with a wet surface is sufficient to pass heat efficiently into the solder joint.
- After soldering, clean the tip on the sponge, tin the tip with RMA solder, and turn the system off.

## SOLDERING IRON TIP PLATING FAILURES

Even under normal usage, the plating on all soldering iron tips will eventually fail. Plating life is highly dependent on the soldering application, the type of fluxes and solder used, and most importantly, operator technique. Because of this, manufacturers of soldering iron tips do not generally warrant plating life.

However, with proper care, the solder tip life of any solder tool can be greatly increased!

Tip plating failures for all solder tips can be divided into four main classes:

**Cracking:**

- Select the largest tip possible for the lead being soldered.
- Do not apply excessive pressure when soldering. To maximize heat transfer, use a tinned tip.
- Take care not to bang the solder tip against the metal workstand when inserting the tool.
- Do not use tips as a screwdriver or a prying tool.

**How cracking occurs: when a crack opens in the iron plating due to abuse or corrosion, solder comes in contact with the copper core, forming an intermetallic compound. This flaw propagates through the tip, quickly leading to failure and breakage.**



**Wear:**

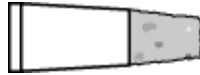
- Select the largest tip possible for the lead being soldered. Blunter tips carry more plating.
- Do not apply excessive pressure during soldering.
- Do not scrub the lead. To maximize heat transfer, tin the tip and create a solder bridge.
- Do not drag solder. If you must drag solder, use a specialty SMT tip.
- Do not use commercial tip tinner for routine tinning. Use a flux core solder wire or paste.
- Use a clean, wet sponge to clean the tip. Do not use a dry sponge, rag, or any abrasive.

**Corrosion:**

- Select lower activity fluxes where possible. RMA flux is best for maximum tip life.
- Use only sulfur free sponges for cleaning tips.
- Use only clean sponges. Discard dirty sponges.
- Use de-ionized, purified water to dampen sponges.
- Use RMA solder to tin tips during storage. If possible, avoid aqueous or high activity flux solders.

**To Minimize Corrosion:**

1. **CLEAN the tip with a damp sponge**
2. **TIN the tip with solder**
3. **TURN OFF power supply when not in use**



**Corrosion attacks the tip, leading eventually to dewetting or plating failure.**

**Dewetting:**

- Turn the system off when not in use.
- Use the lowest possible temperature when soldering. Low temperature reduces oxidation.
- Keep tips tinned when in use and during storage. This keeps air from the tip.
- Use a flux with suitable activity during soldering. Use only clean sponges. Use de-ionized, purified water to wet the sponges



**Oxides & other build-up on tip prevent wetting**

**No-Clean Solders:**

- Use the lowest possible temperature. Low temperature reduces thermal oxidation, solvent volatilization, and polymerization.
- Use an RMA wire solder or solder paste to tin the tip after use.

**Heater Care:**

- Do not use pliers to change tip cartridges. Use a Cartridge Removal Pad.
- Do not drop tip cartridges onto hard surfaces.
- For surface mount tips, do not bang the tips to dislodge components. Use a sponge.

