Better Soldering
(A COOPER Tools Reprint)

Purpose

We hope this short manual will help explain the basics of Soldering. The emphasis will be on the care and use of equipment.

Overview

Soldering is accomplished by quickly heating the metal parts to be joined, and then applying a flux and a solder to the mating surfaces. The finished solder joint metallurgically bonds the parts - forming an excellent electrical connection between wires and a strong mechanical joint between the metal parts. Heat is supplied with a soldering iron or other means. The flux is a chemical cleaner which prepares the hot surfaces for the molten solder. The solder is a low melting point alloy of non ferrous metals.

Solder and Flux

Solder is a metal or metallic alloy used, when melted, to join metallic surfaces together. The most common alloy is some combination of tin and lead. Certain tin-lead alloys have a lower melting point than the parent metals by themselves. The most common alloys used for electronics work are 60/40 and 63/37. The chart below shows the differences in melting points of some common solder alloys.

Tin/Lead	Melting Point
40/60	460 degrees F (230 degrees C)
50/50	418 degrees F (214 degrees C)
60/40	374 degrees F (190 degrees C)
63/37	364 degrees F (183 degrees C)
95/5	434 degrees F (224 degrees C)

Most soldering jobs can be done with fluxcored solder (solder wire with the flux in a "core") when the surfaces to be joined are already clean or can be cleaned of rust, dirt and grease. Flux can also be applied by other means. Flux only cleans oxides off the surfaces to be soldered. It does not remove dirt, soot, oils, silicone, etc.

Base Material

The base material in a solder connection consists of the component lead and the plated circuit traces on the printed circuit board. The mass, composition, and cleanliness of the base material all determine the ability of the solder to flow and adhere properly (wet) and provide a reliable connection.

If the base material has surface contamination, this action prevents the solder from wetting along the surface of the lead or board material. Component leads are usually protected by a surface finish. The surface finishes can vary from plated tin to a solder - dipped coating. Plating does not provide the same protection that solder coating does because of the porosity of the plated finish.

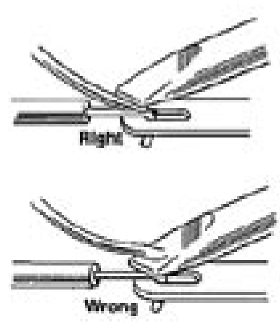

Fig. 1

The Correct Way to Solder
Some Reasons for Unwettability

The selected temperature is too high. The tin coating is burnt off rapidly and oxidation occurs.

Oxidation may occur because of wrong or imperfect cleaning of the tip. E.G.: when other material is used for tip cleaning instead of the original damp Weller sponge.

Use of impure solder or solder with flux interruptions in the flux core.

Insufficient tinning when working with high temperatures over 665 degrees F (350 degrees C) and after work interruptions of more than one hour.

A "dry" tip, i.e. If the tip is allowed to sit without a thin coating of solder oxidation occurs rapidly.

Use of fluxed that are highly corrosive and cause rapid oxidation of the tip (e.g. water soluble flux).

Use of mild flux that does not remove normal oxides off the tip (e.g. no-clean flux).

The Soldering Iron Tip

The soldering iron tip transfers thermal energy from the heater to the solder connection. In most soldering iron tips, the base metal is copper or some copper alloy because of its excellent thermal conductivity. A tip's conductivity determines how fast thermal energy can be sent from the heater to the connection.

Both geometric shape and size (mass) of the soldering iron tip affect the tip's performance. The tip's characteristics and the heating capability of the heater determines the efficiency of the soldering system. The length and size of the tip determines heat flow capability while the actual shape establishes how well heat is transferred from the tip to the connection.

There are various plating processes used in making soldering iron tips. These plating operations increase the life of the tip. The figure below illustrates the two types of plating techniques used for soldering iron tips. One technique uses a nickel plate over the copper. Then an iron electroplate goes over the nickel. The iron and the nickel create a barrier between the copper base material and tin used in the solder alloy. The barrier material prevents the copper and tin from mixing together. Nickel-chrome plating on the rear of the tip prevents solder from adhering to the back portion of the tip (which could cause difficulty in tip removal) and provides a controlled wetted area on the iron tip. Another plating technique is similar but omits the nickel electroless plating, leaving the iron to act as the barrier metal.

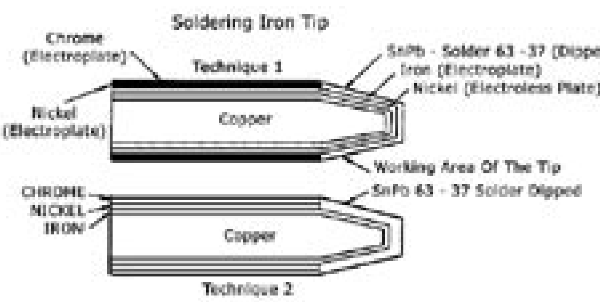

Fig 2

What is a Weller® Tip - How Does It Work?

A Weller tip is made of a copper corewhich is electro-plated with iron to extend the life of the tip. The non-working end of the tip is plated with nickel for protection against corrosion and then chrome plated to prevent the solder from adhering except where desired. The wettable part is tin covered.

The task of the tip is to store the heat which is produced by the heating element and to conduct a maximum amount of this heat to the working surface of the tip.

For fast and optimal heat transfer to the solder joint the tip mass should be as large as possible. When choosing a soldering tip always select the largest possible diameter and shortest reach. Use fine-point long reach tips only where access to the work piece is difficult.

How to Care For Your Tip
Because of the electro-plating Weller tips should never be filed or ground. Weller offers a large range of tips and there should be no need for individual shaping by the operator. If there is a need for a specific tip shape which is not in our standard range we can usually provide this on a special order basis.

Although Weller tips have a standard pretinnng (solder coating) and are ready for use, we recommend you pretin the tip with fresh solder when heating it up the first time. Any oxide covering will then disappear. Tip life is prolonged when mildly activated rosin fluxes are selected rather than water soluble or no-clean chemistries.

When soldering with temperatures over 665 degrees F (350 degrees C) and after long work pauses (more than 1 hour) the tip should be cleaned and tinned often, otherwise the solder on the tip could oxidize causing Unwettability of the tip. To clean the tip use the original synthetic wet sponges from Weller (no rags or cloths).

When doing rework, special care should be taken for good pretinnng. Usually there are only small amounts of solder used and the tip has to be cleaned often. The tin coating on the tip could disappear rapidly and the tip may become unwettable. To avoid this the tip should be retinned frequently.

Additional Tip and Tiplet Care Techniques
Listed below are suggestions and preventative maintenance techniques to extend life and wettability of tips and desoldering tiplets.

Keep working surfaces tinned, wipe only before using, and retin immediately. Care should be taken when using small diameter solder to assure that there is enough tin coverage on the tip working surface.

If using highly activated rosin fluxes or acid type fluxes, tip life will be reduced. Using iron plated tips will increase service life.

If tips become unwettable, alternate applying flux and wiping to clean the surface. Smaller diameter solders may not contain enough flux to adequately clean the tips. In this case, larger diameter solder or liquid fluxes may be needed for cleaning. Periodically remove the tip from your tool and clean with a suitable cleaner for the flux being used. The frequency of cleaning will depend on the frequency and type of usage.

Filing tips will remove the protective plating and reduce tip life. If heavy cleaning is required, use a Weller WPB1 Polishing Bar available from your distributor.

Do not remove excess solder from a heated tip before turning off the iron. The excess solder will prevent oxidation of the wettable surface when the tip is reheated.

Anti-seize compounds should be avoided (except when using threaded tips) since they may affect the function of the iron. If seizing occurs, try removing the tip while the tool is heated. If this fails, it may be necessary to return the tool to Weller for service. Removing the tip from the tool on a regular basis will also help in preventing the tip from seizing.

We recommend using distilled water when wetting the cleaning sponge. The mineral content in most tap water may contaminate your soldering tips.

Storing tips after production use:

_____-- Clean hot tip thoroughly with damp sponge.
_____-- Apply coating of solder to tip.
_____-- Turn unit off to allow tip to cool.
_____-- Put tip away in proper storage or in iron holder

How to "Renew" Your Tip
Emery cloth may be carefully used to wipe away oxidation when the tip is hot. The tip should then be immediately retinned to prevent further oxidation. In extreme cases of tip oxidation or "tip burnout" they may be cleaned using a soft steel brush along with an active flux. Once again, retinning the tip immediately is important.

Soldering Iron Temperature Settings
In order to raise the temperature of solder above it's melting point, soldering tip temperatures are usually set between

700 degrees F and 800 degrees F. Why such a high temperature when the most commonly used solders have a melting point under 400 degrees F? Using a higher temperature stores heat in the tip which speeds up the melting process. The operator can then complete the solder connection without applying too much pressure on the joint. This practice also allows a proper formation of an intermetallic layer of the parts and solder. This is critical for reliable electrical and mechanical solder joints.

How Precise is the Indicated Tip Temperature?
Very fine long soldering tips have less heat conductivity than large short tips and therefore will run slightly cooler. Electronic control soldering stations have a tip temperature control accuracy of at least plus or minus 10 degrees F (6 degrees C) which is the current Mil Spec. Weller tips for electronic soldering tools are carefully designed to give accurate temperatures measured at the center of the solder wetted area. The specifications of the individual soldering stations are assured only if Weller tips are used. The sensor hole in these tips is very critical to their proper operation. Use of other than Weller tips may cause damage by overheating or tip freezing on the sensor or in the tool barrel.

Tip Temperature Measuring
Weller offers two methods for measuring tip temperature. One is a contact method which may yield low readings but is useful in verifying tip temperature stability and showing that the tip is within the desired range for soldering. The second method employs a welded thermocouple tip. This approach is based on using a standard calibration tip and results in much more accurate tip temperature measurements. Both methods require the use of the WA2000 Soldering Iron Analyzer. Please consult with your Cooper Tools representative or your local distributor for more information.

The Operator's Effect on The Process
The operator has a definite effect on the manual soldering process. The operator controls the factors during soldering that determine how much of the soldering iron's heat finally goes to the connection.

Besides the soldering iron configuration and the shape of the iron's tip, the operator also affects the flow of heat from the tip to the connection. The operator can vary the iron's position and the time on the connection, and pressure of the tool against the pad and lead of the connection.

When the tip of the iron contacts the solder connection, the tip temperature decreases as thermal energy transfers from the tip to the connection. The ability of the soldering iron to maintain a consistent soldering temperature from connection to connection depends on the iron's overall ability to transfer heat as well as the operator's ability to repeat proper technique.

The Reliable Solder Connection
Two connection elements must properly function for a solder joint to be reliable. The solder within the connection must mechanically bond the component to the PCB. The connection must also provide electrical continuity between the device and board. The proper intermetallic layer assures both.

Mechanical
In surface mount and nonclinched through-hole technology, the solder provides the mechanical strength within the connection. Important factors for mechanical strength include the wetting action of the solder with the component and board materials, physical shape and composition of the connection, and the materials' temperature within the connection during the process. The connection temperature should not be too high, causing embrittlement, or too low, resulting in poor wetting action.

Electrical
If a solder connection is mechanically intact, it is considered to be electrically continuous. Electrical continuity is easily measured and quantified.

Recognizing the Reliable Solder Connection
Two easily measured indicators in the soldering process that can determine the reliability of the solder connection are

the soldering iron's tip temperature and the solder's wetting characteristics. The tip's temperature during the soldering process is an indicator of the amount of heat being transferred from the tip to the connection. The optimum rate of heat transfer occurs if the soldering iron tip temperature remains constant during the soldering process.

Another indicator for determining reliability is the solder's wetting action with the lead and board materials. As operators transfer heat to the connection, this wetting characteristic can be seen visually. If the molten solder quickly wicks up the sides of the component on contact, the wetting characteristic is considered good. If the operator sees the solder is flowing or spreading quickly through or along the surface of the printed circuit assembly, the wetting is also characterized as good.

Right Amount of Solder
_____a) Minimum amount of solder
_____b) Optimal
_____c) Excessive solder

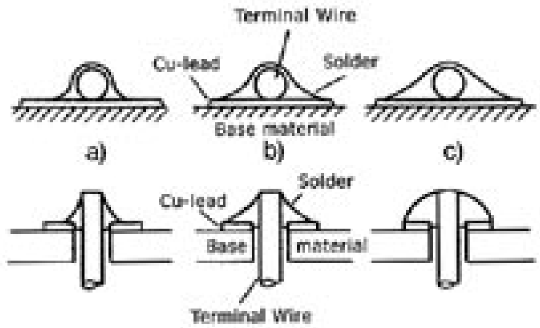

Fig. 3

Solderability
_____a) Bad solderability of terminal wire
_____b) Bad soldering of PCB
_____c) Bad soldering of terminal wire and PCB

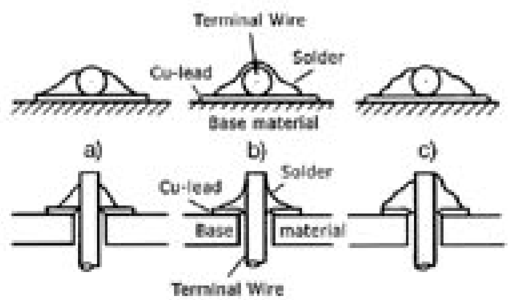

Fig 4

Key Points to Remember

Always keep the tip coated with a thin layer of solder.
Use fluxes that are as mild as possible but still provide a strong solder joint.
Keep temperature as low as possible while maintaining enough temperature to quickly solder a joint (2 to 3 seconds maximum for electronic soldering).
Match the tips size to the work.
Use a tip with the shortest reach possible for maximum efficiency.

Summary
Operator training and experience will, over time, provide the consistency needed for excellent hand soldering results. Part of the training includes a proper understanding of solder characteristics, how a soldering iron works, how to maintain tips, correct techniques, recognizing good solder joints, and potential problems.