Soldering Techniques (Part 1)

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Though soldering is one of the oldest metallurgical techniques, its importance has only increased with the passage of time and advent of new technologies. Even today all electrical and electronic components and assemblies required to be joined electrically are soldered, as soldering has remained a comparatively cheap and simple technique.

Fig. 1 (a): Solder on to non-metallic or unclean surface
(b): Solder on to clean metallic surface

Wetting

A drop of molten solder dropped on a non-metallic or an unclean surface forms a round ball, like a water drop on a non-porous surface. This is illustrated in Fig. 1(a) while Fig. 1 (b) shows molten solder on a clean solderable base metal. In the latter case the solder has been able to 'wet' the base metal, and the secret of good soldering is the ability to properly wet the base metal with the solder.

Under the normal conditions, however, both the base metal and the fusible solder alloy have a thin film (of tarnish) on their surfaces which does not permit a proper wetting of the surfaces. This film is produced by environmental attack on the metal and consists mainly of oxides, sulphides and carbonates and other corrosion products.

The removal of this film is a basic function of fluxes. Since the films are insoluble in any of the conventional solvents, and cannot be removed easily, like grease, they are reacted upon chemically with materials which produce compounds soluble in the liquid flux.

A good quality flux must have the following properties:

1. It should be capable of withstanding soldering temperatures without evaporating or breaking down.
2. It should be capable of properly wetting the base metal.
3. (a) It should have low corrosivity at room temperature, if any; (b) it should emit low corrosivity fumes during soldering; and (c) it should leave a low corrosivity residue, if any.
4. It should act as a heat transfer medium from the heat source to the solder and the workpiece.
5. It should provide reducing cover or at least prevent the access of atmospheric oxygen to the newly cleaned surface.
6. It should be made of non-irritating materials and give off harmless fumes only during soldering.
7. It should have a high flash point to prevent explosion in the case of overheating.

The fluxes used in soldering can be divided mainly into two general categories: (i) organic fluxes, and (ii) inorganic fluxes. Those required for electrical and electronic work are mainly organic fluxes. And they are generally resin-activated by addition of specially selected amino-hydrochlorides so that cleaning of electrical connections after soldering is not necessary.

By far, most of the soldering work is carried out by hand with a soldering iron or a soldering gun. Flux is also available in the form of paste besides being included in resin-cored solder wire, as shown in Fig. 2. For wave soldering and dip soldering, usually a liquid flux, the solvent being isopropyl alcohol, is used.

Solders

Though there are various alloys used as solder, it is out of the scope of this article to discuss all of them in detail. We may, therefore, restrict ourselves to the 'soft solders' only which are popular for electrical and electronic connections. Soft solder is essentially an alloy of tin and lead in different proportions:

It is worth noting the following facts about these two metals and their alloys:

1. Tin is not attacked by air or water and thus has a high corrosion resistance.
2. Lead is soft and dense, but highly prone to corrosion. Thus, in normal environmental conditions, it tarnishes rapidly. However once a tenacious layer of corrosion has

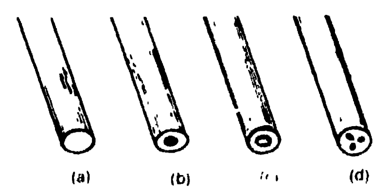

Fig. 2: Types of solder wire with flux: (a) solid wire, (b) cored solder, (c) cen-tri-core, and (d) tri-core

formed, the environmental attack on the metallic lead ceases as the corrosion layer protects the metal from further corrosion. As long as the corrosion layer is tenacious and non-soluble in the media, the metal surface underneath remains protected. As the tarnished surface of lead is not affected by water, the metal (lead) can be used satisfactorily in most environments.

3. Tin alloys with a metal very easily, but requires a high melting temperature to make solder. And it is costly.
4. Lead when alloyed with tin, reduces its melting temperature and adds to the overall strength of the alloy. It also moderates the action of alloying to the base metal.
5. Tin is good in wetting while lead is poor. Their com-

bination in different proportions provides varying degrees of wetting, economy of product, melting temperatures and hardness.

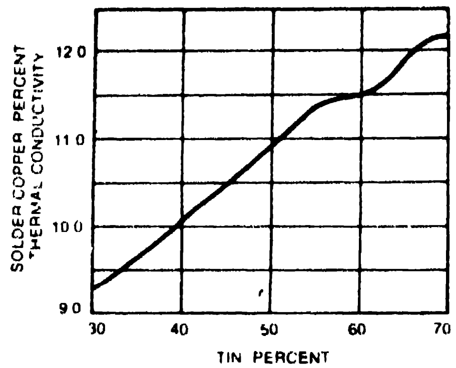

Fig. 3: Thermal conductivity as a function of tin content

The proportions of tin and lead in solder are expressed in a ratio. A 60:40 solder has 60 per cent tin and 40 per cent lead.

A solder sometimes contains traces of metals such as bismuth, copper, zinc, magnesium and antimony for giving it some special characteristic. Since percentage of these metals is generally very low, they are not generally accounted for in the ratio. Following are some common tin/lead ratios for the solder and their uses.

Ratio (Tin:Lead)	***Uses of the Solder***
70:30	**Good for pre-tinning, costly.**
63:37	**Eutectic solder, the best solder as it has no pasty state.**
60:40	**Good general-purpose solder.**
50:50	**Low-cost general-purpose solder.**
45:55	**Used for hermetic sealing.**
40:60	**Common solder.**

Ideally, a solder should have the following qualities:

Wetting : The solder should have a good capillary action so that it may fill in the space between the two metallic surfaces properly and join them together properly.

Melting temperature: The solder should be able to melt and wet the base metal at as low a temperature as possible, consistent with its other properties. This will ensure that the delicate electronic components to be soldered will not get damaged in the process. Melting temperature is dependent on the amount of tin in the solder. The curve in Fig. 3 shows thermal conductivity of solder as a function of tin content.

Strength : The tensile strength and the shear strength of a solder are sufficiently high if it contains a composition of tin/ lead in-between 40:60 and 90:10. It should, however, be remembered that the primary purpose of soldering is not to secure good tensile and shear strengths in connection, but to form a permanent electrical connection with the optimum environmental characteristics.

Electrolysis: When two dissimilar metals are dipped in an electrolyte (which may be moisture of any kind), a galvanic corrosion starts. This is also known as electrochemical corrosion. As a matter of fact, a galvanic couple is formed which is short circuited on itself through the electrolyte. The metal of higher potential becomes the anode and tends to corrode. With specific regard to solder, this can result in decreased electrical conductivity and weakened physical condition.

Creep : Creep may be defined as a time-dependent deformation which accompanies the application of a stress or combination of stresses to a solid.

Good soldering technique

The following few steps must be observed in order to ensure soldered joints of low electrical resistance and high mechanical strength.

1. Utmost cleanliness
2. Good mechanical connections before soldering
3. Use of proper flux for the job
4. Use of proper solder alloy for the job
5. Proper temperature
6. Proper timings
7. Good inspection and cleaning

One must also keep in mind that rosin is the only flux that gives long life, and freedom from corrosion and noise. Hence, only rosin fluxes are recommended for electronic assemblies.

To be continued next month.