

# LEAD-FREE IN ELECTRONICS

## AN OVERVIEW

Without going into the political or environmental reasons and ramifications of the subject, we must acknowledge that whether we like it or not we will be faced with the need to solder with leadless alloys henceforth. The simplest explanation for the interest in lead-free solders is *temerity*: fear of bureaucracies, fear of lawyers in this litigious age, fear of trade barriers set up by bureaucrats and lawyers, and fear of being one-upped by the competition. Let us see if there might be a new way to express what is really meant by 'lead-free' soldering.

Solder since time immemorial has consisted of lead and tin in the approximate proportions of 40% lead and 60% tin. This alloy works well, is eutectic or very nearly so depending upon how much of each metal is involved, and is cheap, primarily because lead itself is cheap. Lead is found in great abundance in the crust of this terrestrial ball, and because it has a low melting point is easy to extract from its ores. Unfortunately lead is also a toxic metal and in the interest of human health and well-being, lead-bearing solders are being removed from industry and the market place by executive fiat (in the EU), which in turn puts pressure upon manufacturers to cooperate or conform - despite the fact that 80% of lead used throughout the world goes into battery manufacture; 8% into the automobile industry, 3% into the manufacture of ammunition; and less than 1% in the manufacture of electronic goods.

Solder is not glue and soldering is not gluing. Soldering is the formation of alloys and chemical combinations, under heat, for the purpose of joining two or more (usually) metallic bits together. These joints may also be formed by passing an electrical current through the metals (resistance soldering) or by heating the metals themselves with a tightly focused heat source (e. g. a laser) to fuse them together, but that is not within the scope of this sheet. Soldering as we intend to treat it here is a series of (more or less) controlled chemical reactions. Solder, flux, and the base metal(s) all react with either other to form a solder joint. The acid in the flux reacts with the solder metals, helped along by heat, to reduce the molecular adhesion of the solder alloy (and also to form salts, though not, we trust, too many of them). The acid also reacts with any oxides on the base metals to form chemical compounds that are carried off by the solvent in the flux; it also reacts with the base metals, forming more salts, but again not too many of them. Finally, the metal in the solder - almost exclusively the tin; the other metals are there to lower the melting point of the solder alloy and act as a vehicle for the tin - reacts with the base metal, helped of course by heat, to form intermetallic alloys that fuse the base metals together, so what we end up with is an alloy sandwich. This sandwich is coated with 'pure' solder to help stabilize the joint mechanically and keep it from cracking, because the intermetallics are brittle: thus, the thinner they are the less chance they will have to break apart. It must be recognized that the physical as well as the electrical integrity of the joint is important.