



# Solder Alloy for Electronics

★ U.S. Patent 5,527,628 and worldwide patents pending

- **The best all-round lead-free alternative**
- **Proven in production use for electronics manufacturing**
- **Lowest melting high-tin, lead-free alloy, without undesirable additions**
- **Eutectic alloy (no melting range)**
- **Enhanced wetting characteristics**
- **Compatible with existing processes and process equipment**

## APPLICATIONS

Multicore Ecosol TSC alloy is designed to be substituted for tin/lead alloys in all electronics assembly soldering operations. Some adjustment to reflow equipment settings will be required but the resulting soldered joints will perform as well as tin/lead solder joints in all respects.

Multicore Ecosol TSC alloy eliminates the handling and waste management hazards due to lead for operators using conventional lead-containing alloys. Where lead has also been eliminated from other coating and soldering processes in PCB and component manufacture, the use of Multicore Ecosol TSC will ensure that completely lead-free assemblies are produced.

## PRODUCT RANGE

Multicore Ecosol TSC is a lead-free substitute for eutectic and near-eutectic tin/lead solders. This alloy is supplied as solder powder in pre-mixed solder creams for screen printing and stenciling applications. It may also be supplied in other forms such as wire or bar for hand soldering or wave soldering, to meet customers' specific needs.

## RECOMMENDED OPERATING CONDITIONS

Multicore Ecosol TSC is a proprietary alloy of composition 95.5% tin / 3.8% silver / 0.7% copper. It may be regarded as a refinement of the established Sn96.5 / Ag3.5 (Sn96, 96S) binary eutectic alloy.

Although many solutions have been proposed to meet the requirements for a lead-free alloy to replace standard tin-lead solders, Multicore Ecosol TSC offers significant benefits to users over the main alternatives, as indicated in the following comparison table:

Alternative alloy	Potential problems in implementation
Tin-zinc	Oxidation, corrosion and manufacturability of alloy.
Tin-indium	With 20% indium, expense and availability make this non-viable; also oxidation considerations.
Tin-bismuth	Poor compatibility with no-clean fluxes, high defect rates, poor mechanical performance at elevated temperatures.
Tin-copper eutectic	Viable option but poorer wetting characteristics, and solderability on some surfaces not ideal; inferior mechanical properties.
Tin-silver eutectic	Viable option but higher melting temperature than Ecosol TSC and no inhibition to copper dissolution.
Tin-antimony	Suitable for engineering soldering but melting temperature too high for electronics assembly.
Tin-silver-bismuth	Low melting phase (not eutectic alloy).
Tin-silver-copper-antimony	Antimony addition has no proven value and raises melting point.

The main challenge to be met in introducing lead-free soldering processes is to achieve good solder joints while keeping soldering temperature low enough to avoid damage to temperature-sensitive components and boards. In this respect it is vital that the solder melting point is as low as possible. Ecosol TSC has a melting point of 217°C (423°F), the ternary eutectic of the Sn-Ag-Cu system, giving it the advantage of being the lowest melting lead-free alternative and hence offers significant advantages over the higher melting point binary tin-copper and tin-silver alloys, without the undesirable additions of bismuth, zinc or indium. These elements are commonly used either singly or in combination during the manufacture of some lead-free alloys to reduce melting points, but they may also give increased defect rates due to poorer wetting characteristics, reduced hot mechanical strength and bridging.

Reflow temperature profiles designed for tin/lead alloys will need to be revised accordingly to cater for the melting point of Multicore Ecosol TSC being 34°C (54°F) higher than that of tin/lead eutectic or near eutectic alloys, though the superheat needed has been found to be less than that required for tin-lead.

It is possible to solder all common finishes used on the solderable surfaces of electronic components and PCBs, including tin/lead finishes. However, if tin/lead coatings are soldered, the resulting joint will be contaminated with lead and the melting temperature (solidus) of the fillet will be reduced to that of eutectic tin/lead alloy.



## TECHNICAL SPECIFICATION

Test data indicate that the physical and mechanical properties and wetting behavior of Multicore Ecosol TSC alloy are comparable to those of tin/lead eutectic or near-eutectic alloys, and in most cases considerably improved over other lead-free alloys.

Alloy Composition:

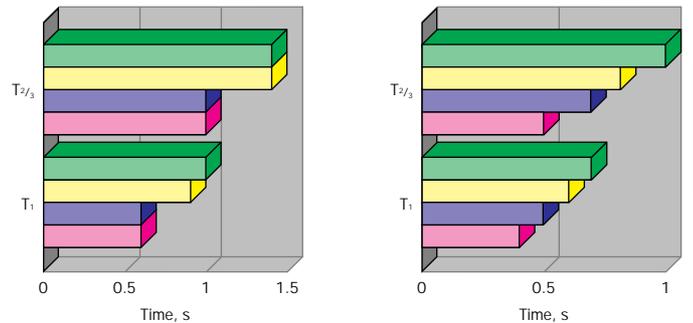
Element	Content %
Zn	< 0.001
Al	< 0.001
Cd	< 0.002
Au	< 0.005
Ni	< 0.007
Fe	< 0.02
As	< 0.03
In	< 0.03
Pb	< 0.1
Sb	< 0.1
Bi	< 0.1
Others	< 0.2
Cu	0.7 ± 0.1
Ag	3.8 ± 0.2
Sn	Remainder

Physical and mechanical properties of Ecosol TSC alloy compared with other lead-free alloys and Sn63Pb37:

Property	Ecosol TSC	Sn63 Pb37	Sn96.5 Ag3.5	Sn99.3 Cu0.7
Melting point, °C	217	183	221	227
	423	361	430	441
Electrical conductivity, % IACS	13	11.9	14	-
Electrical resistivity, $\mu\Omega\text{cm}$	13	14.5	12.3	-
Brinell hardness, HB	15	17	15	-
Density, $\text{g mm}^3$	7.5	8.4	7.5	7.3
Tensile strength, 20°C				
N $\text{mm}^{-2}$ at 0.004 $\text{s}^{-1}$ strain rate	48	40	58	-
Joint shear strength				
N $\text{mm}^{-2}$ at 0.1 $\text{mm min}^{-1}$ , 20°C	27	23	27	23
N $\text{mm}^{-2}$ at 0.1 $\text{mm min}^{-1}$ , 100°C	17	14	17	16
Creep strength*				
N $\text{mm}^{-2}$ 20°C	13.0	3.3	13.7	8.6
N $\text{mm}^{-2}$ 100°C	5.0	1.0	5.0	2.1

\* Shear stress for  $10^3$  hours to failure

### Comparison of wetting times at 250°C for Ecosol TSC alloy vs. other lead-free alloys and Sn60Pb40:



On clean copper with pure rosin flux

On clean copper with 0.5% halide-activated rosin flux

<span style="color: green;">■</span>	Sn99.3Cu0.7
<span style="color: yellow;">■</span>	Sn96.5Ag3.5
<span style="color: purple;">■</span>	Ecosol TSC
<span style="color: pink;">■</span>	Sn60Pb40

T<sub>1</sub> = time to commencement of wetting

T<sub>2/3</sub> = time to reach 2/3 maximum wetting force

## HEALTH AND SAFETY

**WARNING:** Users must refer to the Material Safety Data Sheet relevant to specific Multicore Ecosol TSC products before use.

This data is based on information believed to be reliable and is offered in good faith, but MULTICORE MAKES NO WARRANTIES EITHER EXPRESS OR IMPLIED AS TO ITS ACCURACY AND ASSUMES NO LIABILITIES ARISING OUT OF ITS USE BY OTHERS as conditions and methods of use of the products are beyond MULTICORE'S control. The prospective user should determine the suitability of the product before using it on a commercial scale. MULTICORE warrants only that the product will conform to its physical descriptions. MULTICORE MAKES NO OTHER WARRANTIES EXPRESS OR IMPLIED AND EXPRESSLY DISCLAIMS ANY IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL MULTICORE BE RESPONSIBLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER THE CLAIM IS IN CONTRACT, NEGLIGENCE OR OTHERWISE.