# Part 4: Lead-free Implementation — Critical Production Considerations

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*This is a four-part series. Part 1 outlined the two primary options in implementing lead-free electronics, while Part 2 provided the viable solder alloys for either of two approaches. Part 3 explained successful lead-free implementation without higher temperature, and Part 4 summarizes critical production parameters.*

As highlighted in my January column, reflow temperature below 238°C is a proven SMT manufacturing condition.[1] Therefore, the solder joint alloys that can be reliably soldered below 238°C can serve as a replacement for 63Sn37Pb without requiring any changes in process, boards and components. The relationship between the process and alloy melting temperatures (or add-on temperature) used for 63Sn37Pb still is essentially applicable to lead-free. Benefited by recent advancements in reflow oven capabilities, the solder alloy with melting temperature below 213°C is expected to readily perform its purpose under existing process conditions without requiring changes. This is the premise of designing solder alloys at the outset.

For more than two years, high-volume production using the quaternary SnAgCuIn alloys have been carried out successfully under existing reflow profile parameters without increasing the process temperature; thus, no changes in components and boards materials are necessary. Peak temperature ranges from 220° to 235°C. Reliability tests also have been designed and conducted as extensively and exhaustively as practical to verify expected solder joint performance. Globally, lead-free production under existing SMT settings already is a proven process.

For effective lead-free implementation, the ability to distinguish the truly lead-free-induced issues from inherent SMT manufacturing (bugging and debugging) maneuvers, regardless of lead-free or Sn/Pb is a must. Furthermore, a solid knowledge of SMT production parameters and what constitutes best practices are critically important to the success of lead-free implementation.

Bear in mind that a higher temperature is always more potentially degrading to electronics, during production or during service life. For example, a higher process temperature downgrades the plastic package moisture sensitive level (MSL) as the industry has specified; in other words, the practical useful floor time after the original sealed packages are open.

Six scenarios are contemplated below to illustrate the various lead-free production setups in relation to production results.

## Scenario 1:

- Unchanged printed circuit board (PCB) bare board material
- Unchanged component temperature tolerance level
- Solder paste melts at 218°C; reflow peak temperature set at 245°C.

## Scenario 2:

- Unchanged PCB bare board material
- Unchanged component temperature tolerance level
- Solder paste melts at 218°C; reflow peak temperature is set at 230° to 235°C.

### Scenario 3:

- Unchanged PCB bare board material
- Unchanged component temperature tolerance level
- Solder paste melts at 218°C; reflow peak temperature is set at 230° to 235°C with specific reflow profile parameters and operation flow.

### Scenario 4:

- Change PCB bare board material to a higher temperature tolerance
- Change component to a higher temperature tolerance level
- Solder paste melts at 218°C; reflow is set at 245°C.

### Scenario 5:

- Unchanged bare board of PCB material
- Unchanged component temperature tolerance level
- Solder paste melts at <210°C; reflow is set at 230° to 235°C.

### Scenario 6:

- Unchanged bare board of PCB material
- Unchanged component temperature tolerance level
- Solder paste melts at <210°C; reflow is set at 220° to 235°C.

In essence, the properties and characteristics of the solder material, soldering process, and the board and components must be synchronized to achieve best practices. Among the above-mentioned six scenarios, only three of the six fall in the category of best practices of SMT manufacturing. That is, having a robust production operation in a practical sense; thus high yield, low defects and high integrity. If you have the right answers (choices) and are crystal clear about the reasons behind the choices, you are in control of implementation of lead-free manufacturing at your facility.

### Reference

[1] Jennie S. Hwang, "Environment Friendly Electronics: Lead-free Technology," Electrochemical Publications, Great Britain, 900 pages (ISBN: 0 901 150 401).

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