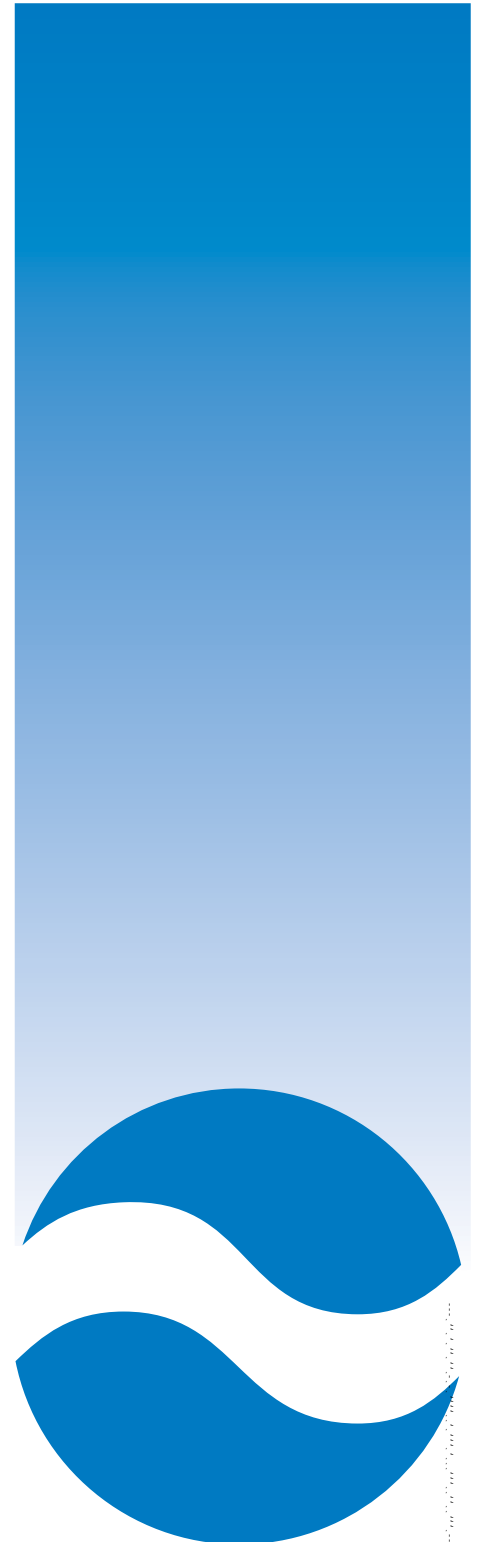


IPC J-STD-001ES
December 2010

JOINT INDUSTRY STANDARD

Space Applications
Electronic Hardware
Addendum to
IPC J-STD-001E
Requirements for
Soldered Electrical
and Electronic
Assemblies



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Space Applications Electronic Hardware Addendum to IPC J-STD-001E Requirements for Soldered Electrical and Electronic Assemblies

Developed by the Space Electronic Assemblies J-STD-001 Addendum Task Group (5-22as) of the Assembly & Joining Processes Committee (5-20) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

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Space Applications Electronic Hardware Addendum to IPC J-STD-001E Requirements for Soldered Electrical and Electronic Assemblies

0.1 Scope This Addendum provides requirements to be used in addition to, and in some cases, in place of, those published in IPC J-STD-001E to ensure the reliability of soldered electrical and electronic assemblies that must survive the vibration and thermal cyclic environments getting to and operating in space.

0.1.1 Purpose When required by procurement documentation/drawings, this Addendum supplements or replaces specifically identified requirements of IPC J-STD-001, Revision E of April 2010.

0.1.2 Precedence The contract takes precedence over this Addendum, referenced standards and User-approved drawings (see IPC J-STD-001E 1.7.1). In the event of a conflict between this Addendum and the applicable documents cited herein, this Addendum takes precedence. Where referenced criteria of this Addendum differ from the published IPC J-STD-001E, this Addendum takes precedence. See Table 1 of this addendum, clauses 1.7 Order of Precedence and 1.7.1 Conflict.

0.1.3 Existing or Previously Approved Designs This Addendum **shall not** constitute the sole cause for the redesign of previously approved designs. When drawings for existing or previously approved designs undergo revision, they should be reviewed and changes made that allow for compliance with the requirements of this Addendum.

0.1.4 Use This Addendum is not to be used as a stand-alone document.

Where criteria are not supplemented, the Class 3 requirements of IPC J-STD-001E **shall** apply. Where IPC J-STD-001E criteria are supplemented or new criteria are added by this Addendum, the clause is listed in J-STD-001ES, Table 1, Space Applications Requirements, and the entire IPC J-STD-001E clause is replaced by this Addendum except as specifically noted.

The clauses modified by this Addendum do not include subordinate clauses unless specifically stated (e.g., 1.4 does not include 1.4.1). Clauses, Tables, Figures, etc. in IPC J-STD-001E that are not listed in this Addendum are to be used as-published.

0.1.5 Lead-Free Tin For the purpose of this document, lead-free tin is defined as tin containing less than 3 percent

lead by weight as an alloying constituent. Solder alloy Sn96.3Ag3.7 is exempt from this requirement. See Table 1 of this addendum, clause 3.2.

0.1.6 Use of Lead-Free Tin The use of components, assemblies, packaging technology, mechanical hardware, and materials meeting any of the following conditions **shall** be prohibited unless documented and controlled through a User approved Lead Free Control Plan (LFCP) incorporating either a replating or hot solder dip (HSD) process that completely replaces the lead-free tin finish, or a minimum of two mitigation measures.

- Lead-free Tin platings, metallization, etc., on external surfaces of parts, mechanical parts, etc., or in internal cavity surfaces (i.e.: hybrid, relay crystal cans, MEMS etc)
- Any components, printed circuit assemblies (PCAs), etc. assembled with lead-free tin solder alloys except Sn96.3Ag3.7 (see paragraph 3.2).

0.1.6.1 Lead Free Control Plan The Lead Free Control Plan (LFCP) **shall** document controls and processes that assures that assemblies containing lead-free tin solder alloys and/or component finishes will perform as intended within the expected parameters of the mission, e.g., environment, duration, etc. At a minimum, the LFCP **shall**:

- a. Document every incidence of lead-free tin technology and prevent its use without review and approval by the User prior to implementation.
- b. Incorporate a minimum of two mitigation measures when the lead-free tin finish is not completely replaced through a replating or HSD process.
- c. Include any special design requirements, mitigation measures, test and qualification requirements, quality inspection and screening, marking and identification, maintenance, and repair processes.
- d. Require review and approval by the User prior to implementation.

The following documents may be helpful when developing the LFCP:

- GEIA-STD-0005-1, Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder



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- GEIA-STD-0005–2, Standard for Mitigating the Effects of Tin Whiskers in Aerospace and High Performance Electronic Systems
- GEIA-HB-0005–1, Program Management / Systems Engineering Guidelines For Managing The Transition To Lead-Free Electronics
- GEIA-HB-0005–2, Technical Guidelines for Aerospace and High Performance Electronic Systems Containing Lead-free Solder and Finishes
- GEIA-STD-0006, Requirements for Using Solder Dip to Replace the Finish on Electronic Piece Parts

0.1.6.2 Mitigation Components, sub-assemblies, assemblies, and mechanical hardware identified as having lead-free tin surfaces, platings, metallization, etc., but which by package design or engineering decision are not protected by SnPb replating or HSD, **shall** be protected by at least two process or design mitigation techniques to reduce or eliminate the risks created by metallic whisker formation in the expected end-use application/environment. Use of mitigation methods **shall** require technical review and approval by the User prior to implementation. Mitigation measures that may be used are:

- a. Design – Components, sub-assemblies, assemblies, and mechanical hardware identified as having external surfaces, platings, metallization, etc. with a lead-free tin finish **shall** be physically positioned or mechanically isolated to ensure the growth of conductive whiskers does not adversely affect performance or reliability. Direct line-of-sight spacing between electrically uncommon conductive surfaces **shall** be sufficient to ensure whisker growth rates (1mm/yr. nominal) over the life of the mission do not violate minimum electrical clearance requirements.
- b. External surfaces, platings, metallization, etc., with a lead-free tin finish **shall** be fully coated with conformal coating with a total cured finish of not less than 100 µm [0.004 in].
- c. Embedment/Encapsulation – Embedment or encapsulant material **shall** fully wet and cover all surfaces of parts and areas specified by the approved engineering documentation. Cured material **shall** be compatible with the hardware and mission environment, and **shall not** adversely affect hardware performance or reliability.
- d. Other mitigation techniques approved by the User prior to use.

0.1.7 Red Plague (Cuprous/Cupric Oxide Corrosion) Red Plague (cuprous/cupric oxide corrosion) can develop in silver-coated soft or annealed copper conductors (component leads, single and multistranded wires and PCB conductors) when a galvanic cell forms between the copper base metal and the silver coating in the presence of moisture (H₂O) and

oxygen (O₂). Once initiated, the sacrificial corrosion of the copper base conductor can continue indefinitely in the presence of oxygen. The color of the corrosion by-product (cuprous oxide crystals) may vary depending on the different levels of oxygen available, but is commonly noted as a red/reddish-brown discoloration on the silver coating surface.

Definitions For the purpose of this document:

Desiccant is defined as a chemically-inert media used to absorb moisture from the air within a sealed container or package to induce or sustain a level of dryness (desiccation).

Dew Point is defined as the temperature at which a volume of air at a given atmospheric pressure reaches saturation and the entrained water vapor precipitates and condenses.

Red Plague (Cu₂O) is defined as the sacrificial corrosion of copper in a galvanic interface comprised of silver and copper, resulting in the formation of red cuprous oxide (Cu₂O). Continued exposure to an oxygen rich environment can then lead to black cupric oxide (CuO). Galvanic corrosion is promoted by the presence of moisture and oxygen at an exposed copper-silver interface (i.e.: conductor end, pin-hole, scratch, nick, etc.).

Unit Pack is defined as the standardized unit of desiccant material, which at thermal equilibrium with air at +77°F (+25°C), will adsorb at least 3 gm (~0.1 oz) of water vapor at 20% relative humidity (RH) and at least 6 gm (~0.2 oz) of water vapor at 40%RH.

0.1.7.1 Red Plague Control Plan – Minimum Requirements

The use of silver-coated copper conductors shall require the implementation of a User-approved Red Plague Control Plan (RPCP) to reduce and control exposure to environmental conditions and contamination that promote the development of cuprous/cupric oxide corrosion (Red Plague) and latent damage. The minimum requirements are as outlined below:

0.1.7.1.1 Shipping and Storage Wire and cable shall be shipped and stored in sealed water-vapor-proof packaging (i.e.: Moisture Barrier Bag, dry pack, etc.), with capped ends, activated desiccant, and humidity indicator card. Silver-coated copper wire and cable shall be segregated and dispositioned if the humidity indicator card registers 70% or more RH.

- a. Water-vapor-proof protection packaging **shall** meet MIL-STD-2073–1E Method 51. Moisture Barrier Bags (MBB) **shall** meet MIL-PRF-81705, TYPE 1.
- b. Capping. Wire and cable ends **shall** be capped with heat shrinkable end-caps conforming to SAE-AMS-DTL-23053/4, or sealed with a material such as an insulating electrical varnish for a length of approximately 25 mm (1 in.).

