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# TECHNICAL SPECIFICATION

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## Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 23: Rework and repair guidance to address the implications of lead-free electronics and mixed assemblies

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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# PROCESS MANAGEMENT FOR AVIONICS – AEROSPACE AND DEFENCE ELECTRONIC SYSTEMS CONTAINING LEAD-FREE SOLDER –

## Part 23: Rework and repair guidance to address the implications of lead-free electronics and mixed assemblies

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62647-23, which is a technical specification, has been prepared by IEC technical committee 107: Process management for avionics.

The text of this technical specification is based on the following document: IEC/PAS 62647-23[1].

This technical specification cancels and replaces IEC/PAS 62647-23, published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Coherence with IEC/TS 62647-1, IEC/TS 62647-2 and IEC/TS 62647-21 definitions.

b) Reference to IEC 62647 documents when already published.

The text of this technical specification is based on the following documents:

| Enquiry draft | Report on voting |
|---|---|
| 107/206/DTS | 107/219/RVC |

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62647 series, published under the general title *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International Standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

[1] IEC/PAS 62647-23, which served as a basis for the present document, is also known as GEIA-HB-0005-3.

# INTRODUCTION

## 0.1 General

The global transition to lead-free (Pb-free) electronics impacts the aerospace, defence and high performance (ADHP) industry and other industries having high reliability applications in various ways.

This document is intended to facilitate the development of procedures and processes for use when undertaking the rework/repair of aerospace, defence, and high performance (ADHP) electronics systems. It is intended to contain sufficient information to support the processing of equipment that incorporates either tin-lead (Sn-Pb) or lead-free (Pb-free) solder alloy, Sn-Pb or lead-free (Pb-free) piece parts and printed circuit board (PCB)/printed wiring board (PWB) finishes, or a combination thereof.

This document may be used by original equipment manufacturers (OEMs), contract manufacturers (CMs) and commercial depots. This document may also be used by personnel performing rework/repair at the organizational (O) level, intermediate (I) back shop level, and depot (D) overhaul level.

## 0.2 Pb-free and legislation

Recent directives and legislation by nations around the world mandated elimination of lead and other hazardous material usage in sectors of the electronics industry by 2006. In electronics, lead (Pb) has been a primary component of tin-lead (Sn-Pb) solder used in piece part attachment and PCB/PWB finishes for over 50 years, and more recently in the solder spheres for attachment of ball grid array (BGA) packages. Since there is no “drop-in” replacement for Sn-Pb solder alloys, multiple Pb-free alloys have emerged in the manufacturing industry as replacements. These multiple replacement alloys are being used in printed circuit boards (PCBs)/printed wiring boards (PWBs) finish, piece part termination finish and as solder alloys, leaving the rework/repair technician with literally hundreds of possible combinations of metallurgy in the finished repair.

The majority of the Pb-free alloys being considered have melting temperatures 34 °C to 44 °C (61 °F to 79 °F) higher than that of tin-lead (Sn-Pb) eutectic solder. These higher Pb-free processing temperatures require significant changes to convective rework/repair procedures and minor adjustments in conductive hand soldering procedures to ensure that quality products will be produced.

Another major concern is the potential re-emergence of tin whiskers as an additional equipment failure mechanism. Tin whiskers are electrically conductive, crystalline structures of tin (Sn) that grow under compressive force from surfaces where tin (Sn) (especially electroplated tin (Sn)) is used as a final finish. Tin whiskers have been observed to grow to lengths of several millimeters (mm). Numerous electronic system failures have been attributed to short circuits caused by tin whiskers that bridge closely-spaced circuit elements. Tin whiskers have been successfully suppressed for decades by the addition of lead (Pb) to tin (Sn) plating used in high reliability applications. With the global shift to Pb-free solders, tin whiskers have re-emerged as a major concern to reliability. IEC/TS 62647-2:2012 further discusses tin whisker issues and mitigation techniques.

Procedurally, conductive Pb-free rework/repair is similar to that of Sn-Pb. However, adjustments should be made to accommodate the generally poorer wetting ability of Pb-free solders as well as differences in appearance and inspection criteria. Convective rework/repair will require redevelopment of profiles to accommodate the higher melting temperature of Pb-free alloys. Also, Pb-free rework/repair has a tighter process window leaving a smaller margin

for error in comparison to Sn-Pb. With the proper materials, preparation, skill, and the use of fundamentally sound procedures, Pb-free rework/repair can be successfully and reliably accomplished [28][2].

2 Numbers in square brackets refer to the Bibliography.

# PROCESS MANAGEMENT FOR AVIONICS – AEROSPACE AND DEFENCE ELECTRONIC SYSTEMS CONTAINING LEAD-FREE SOLDER –

## Part 23: Rework and repair guidance to address the implications of lead-free electronics and mixed assemblies

## 1 Scope

This part of IEC 62647 provides technical background, procurement guidance, engineering procedures, and guidelines to assist organizations reworking/repairing aerospace and high performance electronic systems, whether they were assembled or previously reworked/repaired using traditional alloys such as Sn-Pb or Pb-free alloys, or a combination of both solders and surface finishes. This document contains a review of known impacts and issues, processes for rework/repair, focused to provide the technical structure to allow the repair technician to execute the task.

This document focuses on the removal and replacement of piece parts. For the purposes of this document, the term “rework/repair” is used as defined in 3.1.29 and 3.1.30.

The information contained within this document is based on the current knowledge of the industry at the time of publication. Due to the rapid changing knowledge base, this document should be used for guidance only.

NOTE 1 For the purposes of this document, if the element “lead” is implied, it will be stated either as Pb, as lead (Pb), or as tin-lead. If a piece part terminal or termination “lead” is referred to, such as in a flat pack or a dual-inline package, the nomenclature lead/terminal or lead-terminal will be used.

NOTE 2 Processes identified in the document apply to either rework or repair.

This document may be used by other high-performance and high-reliability industries, at their discretion.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC/TS 62647-1:2012, *Process management for avionics – Aerospace and defence electronics systems containing lead free solder – Part 1: Preparation for a lead-free control plan*

IEC/TS 62647-2:2012, *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 2: Mitigation of deleterious effects of tin*

IEC/TS 62647-22:2013, *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 22: Technical guidelines*