IEC/PAS 62647-23

Edition 1.0 2011-07

PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

colour inside

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

PRICE CODE X

ICS 03.100.50; 31.020; 49.060

ISBN 978-2-88912-568-5

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 8
2 Normative references 8
3 Terms and definitions 9
4 Symbols and abbreviated terms 14
5 Pb-Free Concerns 15
5.1 Reliability 15
5.1.1 Mixed metallurgy reliability 15
5.2 Configuration management 16
5.3 Risk management 17
5.4 Tin whiskers 17
5.5 Copper dissolution (erosion) 17
6 Materials 17
6.1 Solder 17
6.1.1 Solder alloys 17
6.1.2 Solder forms 18
6.2 Fluxes 18
6.3 Piece parts 19
6.3.1 Termination finishes 19
6.3.2 Area arrays (BGA, CSP, etc.) 19
6.4 Printed circuit boards 19
6.4.1 Laminate material 19
6.4.2 Surface finish 20
6.5 Conformal coatings 20
7 Soldering equipment 20
7.1 Hand soldering equipment 21
7.1.1 General hand soldering equipment considerations 21
7.1.2 Tip selection 21
7.1.3 Soldering iron tip life 21
7.2 Fountain soldering 22
7.3 Convective soldering equipment 24
7.3.1 Thermal profile issues 24
8 General rework/repair considerations 24
8.1 Rework/repair procedure order of precedence 25
8.2 Technician training 25
8.3 Pb-Free rework/repair considerations 25
8.3.1 General process considerations 26
8.3.2 Solder processing considerations 26
8.3.3 Flux considerations 26
9 Pre-rework/repair processes 27
9.1 Alloy identification 27
9.1.1 IPC/JEDEC J-STD-609 27
9.1.2 X-Ray fluorescence (XRF) 29
9.1.3 Pb swabs 29

9.2 Piece part and CCA preparation 29
9.2.1 Piece part preparation 29
9.2.2 CCA preparation 30
10 Rework/repair processes 30
10.1 Conductive Hand Soldering 30
10.2 Convective soldering process 32
10.2.1 Solder paste handling 32
10.2.2 Paste printing 32
10.2.3 Reflow process 32
11 Post-Rework/Repair Processes 34
11.1 Cleaning 34
11.2 Inspection 34
11.3 Reapplication of Conformal Coating 34
Annex A (informative) Termination Finishes 35
Annex B (informative) Tin whiskers 37
Bibliography 42

Figure 1 – Soldering iron tip construction 22
Figure 2 – Worn soldering iron tip 22
Figure 3 – Copper dissolution 23

Table 1 – Assembly and piece part marking methods 28
Table A.1 – Piece-part terminal and BGA ball metallization solder process compatibility risk (see IEC/PAS 62647-22 (GEIA-HB-0005-2)) 35
Table B.1 – Tin whisker information (see IEC/PAS 62647-22 (GEIA-HB-0005-2)) 38
Table B.2 – Piece part termination tin whisker risk (see IEC/PAS 62647-22 (GEIA-HB-0005-2)) 40

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC-PAS 62647-23 has been processed by IEC technical committee 107: Process management for avionics.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
107/132/PAS	107/140A/RVD

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single 3-year period, following which it shall be revised to become another type of normative document, or shall be withdrawn.

This PAS is based on GEIA-HB-0005-3 and is published as a double logo PAS. GEIA, Government Electronics and Information Technology Association, has been transformed into TechAmerica Association.

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.

INTRODUCTION

0.1 General

This PAS is intended to facilitate the development of procedures and processes for use when undertaking the rework/repair of Aerospace and High Performance (AHP) electronics systems. It is intended to contain sufficient information to support the processing of equipment that incorporates either Tin-Lead (SnPb) or Lead-Free (Pb Free) solder alloy, SnPb or Pb-Free piece parts and printed wiring board finishes, or a combination thereof.

This PAS 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.

The purpose of this Working Group is to generate a series of industry standards and documents intended to facilitate the maintenance of suitable equipment quality and reliability standards within the AHP industries during the general industry migration to Pb-Free.

This PAS is intended to work in concert with IEC/PAS 62647-1 (GEIA-STD-0005-1), IEC/PAS 62647-2 (GEIA-STD-0005-2), and IEC/PAS 62647-21 (GEIA-HB-0005-1).

This PAS may be referenced in proposals, requests for proposals, work statements, contracts, and other aerospace and high performance industry documents.

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 (SnPb) solder used in piece part attachment and 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 SnPb solder alloys, multiple Pb-Free alloys have emerged in the manufacturing industry as replacements. These multiple replacement alloys are being used in Printed Wiring Boards (PWB) / Printed Circuit Boards (PCB) 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 61 °F to 79°F (34 °C to 44 °C) higher than that of SnPb 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 Sn that grow under compressive force from surfaces where Sn [especially electroplated 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 Pb to 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/PAS 62647-2 (GEIA-STD-0005-02) further discusses Tin Whisker issues and mitigation techniques.

This document will provide guidance to the organization performing rework/repair on various combinations of SnPb, Pb-Free and mixed technology assemblies likely to be seen as the global transition to Pb-Free solder continues. The organization typically consists of program

management, procurement, process engineering, bench technician, and quality assurance personnel.

Procedurally, conductive Pb-Free rework/repair is similar to that of SnPb. However, adjustments must 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 SnPb. With the proper materials, preparation, skill, and the use of fundamentally sound procedures, Pb-Free rework/repair can be successfully and reliably accomplished[1].

1 http://www.solder.net/leadfreerepair.asp

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 PAS 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 SnPb or Pb-Free alloys, or a combination of both solders and surface finishes. This PAS 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 PAS focuses on the removal and replacement of piece parts. For the purposes of this PAS, the term “Rework/Repair” is used as applicable.

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

2 Normative references

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

IEC/PAS 62647-1, *Process management for avionics – Aerospace and defence electronics systems containing lead free solder – Part 1: Lead-free management*

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

IEC/PAS 62647-21, *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 21: Program management – System engineering guidelines for managing the transition to lead-free electronics*

IEC/PAS 62647-22, *Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 21: Technical guidelines*

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

GEIA-STD-0005-2, *Standard for mitigating the effects of tin 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*