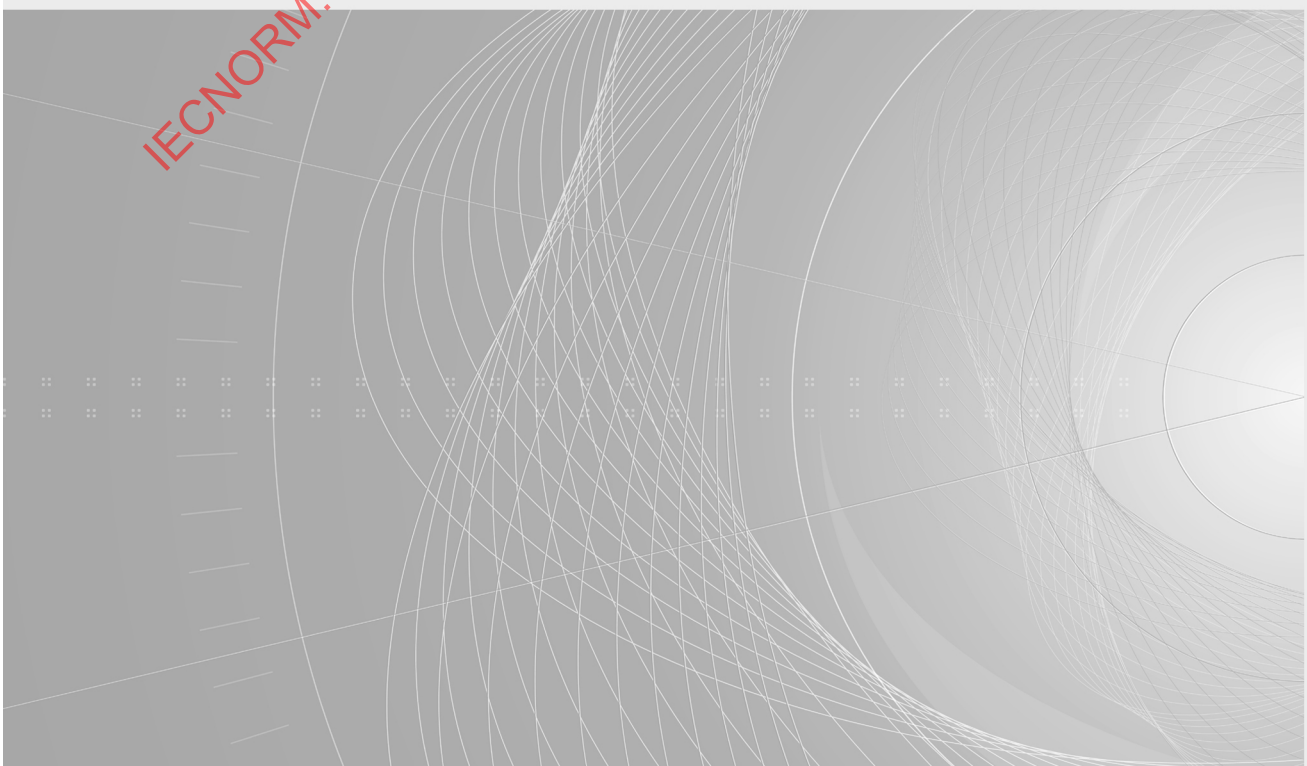
IEC TS 62647-4

Edition 1.0 2018-04

TECHNICAL SPECIFICATION

Process management for avionics – Aerospace and defence electronic systems containing lead-free solder –
Part 4: Ball grid array (BGA) re-balling



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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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Process management for avionics – Aerospace and defence electronic systems containing lead-free solder – Part 4: Ball grid array (BGA) re-balling

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 4: Ball grid array (BGA) re-balling

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

IEC TS 62647-4, 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 documents:

Enquiry draft	Report on voting
107/314/DTS	107/331/RVDTS

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

A list of all the 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 website 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- withdrawn,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.

INTRODUCTION

As the result of RoHS directives, soldering assembly processes have migrated predominantly from tin-lead to Pb-free, and a majority of BGA components manufacturers have converted from tin-lead solder balls to Pb-free solder balls. This has introduced well documented reliability concerns. In the case of a leaded soldering process, a solution can be to replace the Pb-free solder balls on the BGA components with tin-lead solder balls. This will prevent mixing solder alloys.

This document was prepared to standardize the requirements and guidelines for replacing the solder balls on applicable BGA components. The requirements within this document are derived from existing industry standards and a collaboration of service providers and customers, typically avionics original equipment manufacturers (OEMs).

This document is intended to be used by de-balling/re-balling providers and customers to incorporate these requirements into their operations to provide a consistent and well-controlled process, or to create a de-balling/re-balling plan that augments their existing processes.

There are two major reasons to de-ball/re-ball BGA components: alloy compatibility and replacement of damaged balls.

The customer should understand the potential risks of the BGA de-balling/re-balling process for a specific package.

To avoid reliability problems, the BGA de-balling/re-balling process should be qualified and carefully controlled to prevent the possibility of BGA failure after re-balling. Generally, automated processes contribute positively to this objective and are encouraged in the electronic industry.

This document does not guarantee a particular yield or reliability of BGA components going through the de-balling/re-balling process. BGA component construction and materials used should be evaluated for compatibility with the solder re-balling process to ensure that BGA component reliability and integrity are maintained.

Because of the dynamic nature of the transition to lead-free (Pb-free) electronics, this and other similar documents are based on the best information and expertise available; its update will be considered as future knowledge and data are obtained.

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

Part 4: Ball grid array (BGA) re-balling

1 Scope

This part of IEC 62647, which is a Technical Specification, defines the requirements for replacing solder balls on ball grid array (BGA) component packages in the context of an electronic components management plan (ECMP) for aerospace, defence and high reliability products.

NOTE 1 IEC TS 62239-1 and EIA-STD-4899 describe the electronic components management program (ECMP).

It does not apply to column grid array (CGA) components or chip scale components.

This re-balling document addresses two types of configurations. For other configuration types, see Annex A for tailoring.

- Configuration 1: A BGA package that will be de-balled and then re-balled with tin-lead balls compatible with a tin-lead soldering assembly process.
- Configuration 2: A BGA package that will be de-balled and then re-balled with Pb-free balls compatible with a Pb-free soldering assembly process.

The intent of this document is to provide re-balling companies (hereinafter referred to as the re-balling provider) with the administrative and technical requirements to be incorporated within existing processes or for establishing, implementing and maintaining a new set of processes or the creation of a stand-alone re-balling process.

This document is intended to be used by de-balling/re-balling providers and customers, typically avionics original equipment manufacturers (OEM); it defines the requirements for re-balling providers who are providing services to the aerospace, defence, high performance and high reliability electronics industry.

Requirements for new BGA component part number qualification are also included. This document identifies the need for the creation of new part numbers for re-balled BGA components, covers process and testing requirements for the de-balling/re-balling process and encourages the automated processes due to the ability to control the process.

Companies engaged in re-balling are supposed to have the necessary knowledge, experience and tools, and to customize if needed their own methods for defining a de-balling/re-balling process that meets the requirements in this document.

Each customer determines the applicability of this document and the need for full replacement of the existing solder balls. Some applications can have unique requirements that exceed the scope of this document and are therefore specified separately.

This document is not intended to address all procedures and processes associated with a de-balling/re-balling facility; it is assumed there are management, quality, manufacturing, safety, calibration and training processes/procedures in place as well as all the necessary tools and equipment to accomplish the work.

NOTE 2 For the purposes of this document, if the term “BGA” is used alone, it is stated as “BGA component".

NOTE 3 The replacement, for example, of damaged tin-lead balls by new tin-lead balls or damaged Pb-free balls by new Pb-free balls is not specifically addressed in this document but some parts of the document and the table for tailoring the requirements (see Annex A) can be used for supporting the operations.

Although developed for the avionics industry, this process can be applied by other industrial sectors at their discretion.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 61340-5-1, *Electrostatics – Part 5-1: Protection of electronic devices from electrostatic phenomena – General requirements*

IEC TR 61340-5-2, *Electrostatics – Part 5-2: Protection of electronic devices from electrostatic phenomena – User guide*

IEC 62090, *Product package labels for electronic components using bar code and two-dimensional symbologies*

IEC 62668 (all parts), *Process management for avionics – Counterfeit prevention*

AEC-Q100-010, *Solder ball shear test*

ANSI/ESD S20.20, *Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)*

ECA/IPC/JEDEC J-STD-075, *Classification of Non-IC Electronic Components for Assembly Processes*

IPC J-STD-001, *Requirements for Soldered Electrical and Electronic Assemblies*

IPC J-STD-001xS[1], *Space Applications Electronic Hardware Addendum to IPC J-STD-001x Requirements for Soldered Electrical and Electronic Assemblies*

IPC J-STD-002, *Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires*

IPC J-STD-004, *Requirements for Soldering Fluxes*

IPC J-STD-005, *Requirements for Soldering Pastes*

IPC/JEDEC J-STD-020, *Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State Surface Mount Devices*

IPC/JEDEC J-STD-033, *Handling, Packing Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices*

IPC/JEDEC J-STD-035, *Acoustic Microscopy for Non-Hermetic. Encapsulated. Electronic. Components*

[1] In « IPC J-STD-001xS » the « x » refers to the issue of the IPC J-STD-001 document ; for exemple « IPC J-STD-001FS » refers to « IPC JST-001F » (issue F).

IPC-TM-650 number 2.3.25, *Test Methods Manual – Detection and Measurement of Ionizable Surface Contaminants by Resistivity of Solvent Extract (ROSE)*

JEDEC J-STD-046, *Customer Notification of Product/Process Changes by Electronic Product Suppliers*

JEDEC JESD625, *Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices*

JEDEC JESD22-A101, *Steady State Temperature Humidity Bias Life Test*

JEDEC JESD22-B101, *External visual*

JEDEC JESD22-B107, *Mark Permanency*

JEDEC JESD22-B117, *Solder Ball Shear*

JEDEC JESD213, *Standard Test Method Utilizing X-ray Fluorescence (XRF) for Analyzing Component Finishes and Solder Alloys to Determine Tin (Sn) – Lead (Pb) Content*

MIL-STD-883, *Test Method Standard: Microcircuits*

SAE AS5553, *Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
AM
acoustic microscopy
microscopy that employs very high or ultra-high frequency ultrasound

Note 1 to entry: Acoustic microscopy is a technical field where the acoustic microscope operates non-destructively and penetrates most solid materials to make visible images of internal features, including defects such as cracks, delaminations and voids; the acoustic microscope is generally called “scanning acoustic microscope (SAM)”.

3.2
approved supplier
organization selling or supplying materiel, parts, products or provision of a service, which has been determined capable by a procuring organization to deliver throughout the lifetime of a contract

3.3
BGA
ball grid array
surface mount package wherein the balls for terminations are formed in a grid on the bottom of a package

Note 1 to entry: There are different varieties of BGA packages and solder ball technologies such as CBGA, PBGA, TBGA packages.

3.4
CBGA
ceramic ball grid array
BGA package with a ceramic body

3.5
declaration of conformance
document certified by a competent authority that the supplied good or service meets the required specifications

Note 1 to entry: Declaration of conformance can also be called certificate of conformance; the competent authority can be the original manufacturer of the supplied good or service.

3.6
CTE
coefficient of thermal expansion
degree of expansion of a material divided by the change in temperature

Note 1 to entry: PCB/PWB CTE (x-y) is measured in the direction in the plane of the piece part mounting surface and is used to quantify the stresses in the solder joint arising from the differences in CTE between the piece parts and the PCB/PWB during thermal cycling. CTE (z axis) is measured in the "thickness" direction and is typically used to quantify plated through hole stress

Note 2 to entry: The term "piece part" can be used in lieu of "component".

[SOURCE: IEC TS 62647-22:2013, 3.1.8, modified – Note 2 has been added.]

3.7
customer
one who pays for the service or the services provided by another

3.8
de-balling
process operation that consists in removing the solder balls from a BGA

3.9
HIC
humidity indicator card
card on which a moisture-sensitive chemical is applied such that it will make a significant, perceptible change in color (hue), typically from blue (dry) to pink (wet) when the indicated relative humidity is exceeded

3.10
Pb-free
lead-free
less than 0,1 % by weight of lead (Pb) in accordance with reduction of hazardous substances (RoHS) guidelines

[SOURCE: IEC TS 62647-1:2012, 3.8, modified – "lead-free" has been added as a second term.]

3.11
MSL
moisture sensitivity level
alphanumeric rating indicating a plastic electronic device's susceptibility to damage due to absorbed moisture when subjected to reflow soldering as determined by IPC/JEDEC J-STD-020

3.12
OCM
original component manufacturer
company specifying and manufacturing the electronic component

[SOURCE: IEC TS 62668-1:2016, 3.1.13]

3.13
part number
unambiguous identifier

Note 1 to entry: A part number unambiguously identifies for example an electronic component, a design, or an equipment.

3.14
PCB
printed circuit board
PWB
printed wiring board
substrate using conductive pathways, tracks or signal traces etched from copper sheets laminated, and allowing to connect electrically a set of electronic components to realize a circuit card

[SOURCE: IEC TS 62647-21:2013, 3.1.10]

3.15
PBGA
plastic ball grid array
BGA with a plastic body

3.16
qualification by similarity
act of qualifying a product part number based on already available testing results which have been used to deliver the qualification to another product part number whose technical characteristics are considered similar or practically similar

Note 1 to entry: Qualification by similarity may apply to a component part number when the component has package and die sizes, construction and materials which are considered to be insignificantly different from an already "qualified" component part number.

3.17
re-balling
process operation that consists in putting back a solder ball in replacement of the previous one on a ball grid array (BGA) package

3.18
re-balling provider
company offering de-balling and re-balling service

3.19
RoHS
European directive dealing with the restriction of the use of certain hazardous substances

Note 1 to entry: The RoHS directive is a European Union directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

3.20
solder ball technology
technology employing solder balls or bumps at the component package level to make mechanical and electrical connections between the component package and the PCB/PWB

EXAMPLE 1 Ball grid arrays (BGAs), flip chips and chip scale interconnections.

3.21
tin-lead
solder bearing the elements tin and lead, and corresponding to 63 % by weight of tin and 37 % by weight of lead unless otherwise specified

[SOURCE: IEC TS 62647-3:2014, 3.1.6]

3.22
TBGA
taped ball grid array
BGA on a tape substrate

Note 1 to entry: The tape is generally a polyimide film.

3.23
qualification
process for confirming and approving that a product or service meets the needs or requirements of its user

Note 1 to entry: For the purposes of this document, the qualification process applies to manufacturing and production operations and processes. It is generally based on objective evidence (for example tests results, process parameters) demonstrating that the product requirements and the quality demands are met.

3.24
XRF
X-ray fluorescence
method for material composition analysis

[SOURCE: IEC TS 62647-2:2012, 3.1.28]

4 Process approach

4.1 Typical process

Figure 1 provides a typical flowchart for BGA de-balling/re-balling processes and operations in accordance with the configurations 1 and 2 mentioned in Clause 1.

The process step 12a of Figure 1 addresses a new BGA component part number qualification which is performed using the de-balling/re-balling process before launching production lots of this new BGA component part number in a “production lot” mode; the process steps 4 to 11 of Figure 1 apply and the customer’s approval of the qualification is based on results provided by the re-balling provider (see 6.7).

The process step 12b addresses the inspection and control of re-balled BGA components in a “production lot” mode.

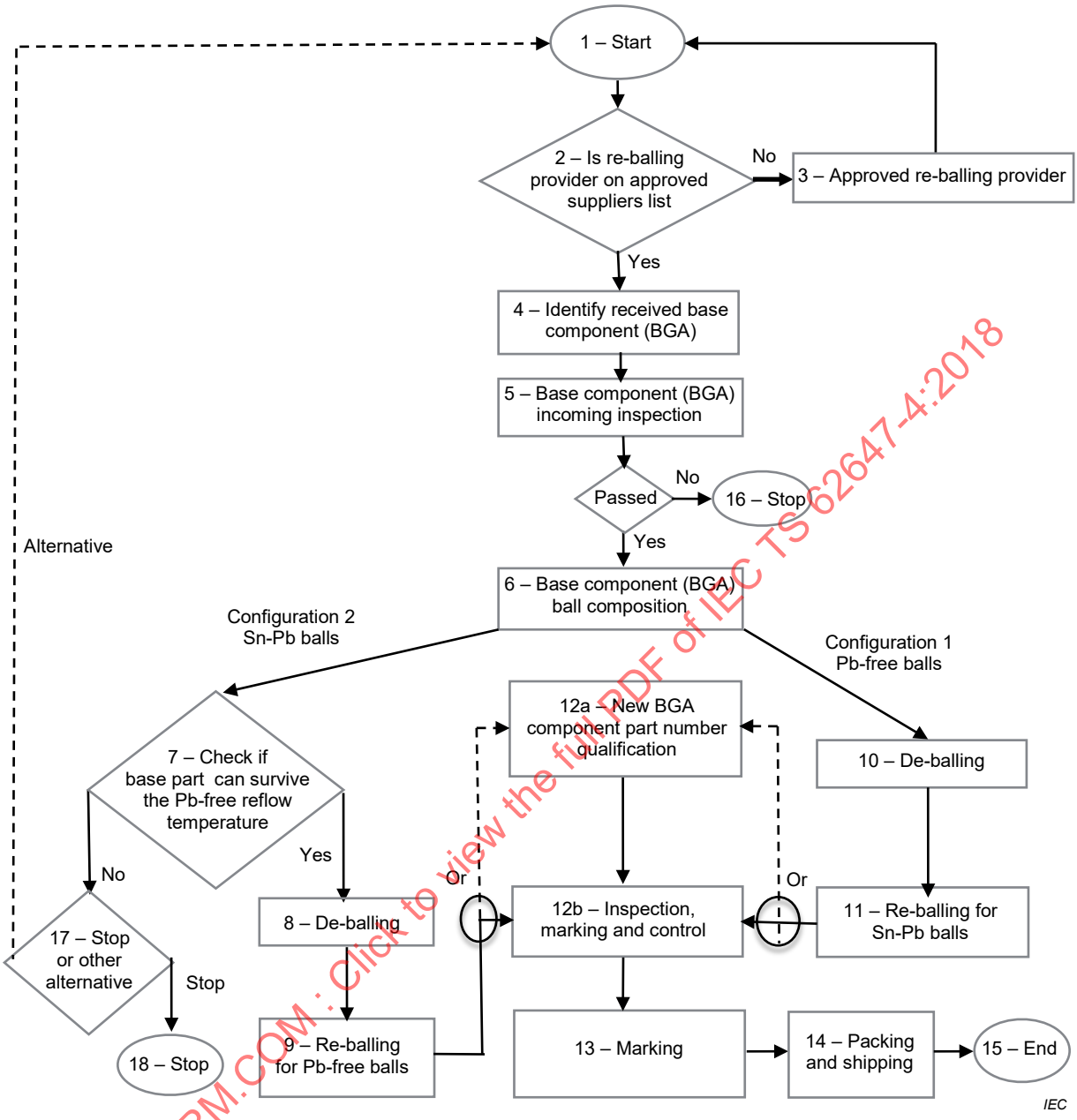

Figure 1 – Typical flowchart of de-balling/re-balling operations

Table B.1 provides a requirements matrix that may be used to document the accomplishments of the requirements for IEC TS 62647-4.

The requirements of this document may be tailored to address the customer's unique/specific program needs. If tailoring is performed, the re-balling provider shall obtain the documented customer's approval. The customer is cautioned that tailoring the test plan by reducing the sample sizes, eliminating the tests, or relaxing the acceptance criteria can result in compromised reliability of the processed components. Annex A provides a tailoring template that may be used.

4.2 Awareness

As a reminder, BGA de-balling/re-balling process and operations can degrade the performance and reliability of the electronic components as determined in the original component manufacturer's (OCM) datasheet and/or technical data and lead to the loss of any regular or extended warranty which is normally provided by the original component manufacturer (OCM) regarding the electronic component use and storage. Consulting with the OCM is recommended to determine if there are potential limitations concerning additional reflow and re-processing of the BGA terminations.

5 General requirements

5.1 Process control at the customer level

5.1.1 Customer's responsibilities

The re-balling provider shall be on the approved suppliers' list with an approved de-balling/re-balling process.

If the re-balling provider is not on the approved suppliers' list the re-balling provider can assist in gaining approval by demonstrating how its de-balling/re-balling process complies with the requirements contained herein by mapping its demonstration data to the compliance verification matrix contained in Annex B which can depend on the class assigned to the BGA components (see 5.2.2) and any tailoring.

NOTE 1 Some customers might require for approval additional information that can include:

- process capability definition and description (including process flow chart);
- process monitoring definition and description;
- acceptance criteria definition for re-balled BGA component (for example co-planarity, ball size and shape, ball shear strength and cleaning contamination level).

NOTE 2 Subclause 5.1 addresses the process steps 2 and 3 identified in Figure 1.

5.1.2 Electronic components classes

Electronic components are divided into four classes which define the levels of requirements. Descriptions are provided in Table 1.

Table 1 – Electronic component class

Class	Class description	Class definition
1 [a]	General electronic products	Products suitable for applications where the major requirement is function of the complete assembly.
2 [a]	Dedicated service electronic products	Products where continued performance and extended life are required, and for which uninterrupted service is desired but not critical. Typically the end-use environment would not cause failures.
3 [a]	High performance/harsh environment electronic products	Products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment can be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.
Space [b]	High performance/extremely severe environment electronic products	Products where performance is required for surviving the vibration and thermal cyclic environments getting to and operating in space.
[a] See IPC J-STD-001.		
[b] See IPC J-STD-001xS (Space Applications Electronic Hardware Addendum)		

5.2 Process control at re-balling provider level

5.2.1 Re-balling provider's responsibilities

The re-balling provider is responsible for the development and implementation of requirements and procedures necessary to prevent damage and to control conditions for passing the production tests (see 6.5) and to satisfy customer requirements (see 5.3).

If the re-balling provider plans to subcontract activities, it shall:

- inform the customer, consider subcontractor(s) which is(are) in its own approved suppliers list, or in the customer-approved suppliers list if any, and request customer's approval with regard to the intended subcontracted activities;
- if approved by the customer, cascade all the requirements with regard to the potential subcontractor(s) and subcontracted activities, and verify the implementation of requirements.

5.2.2 Electronic component classes

Prior to processing, the re-balling provider shall obtain the component class from the customer (see 5.1.2).

5.2.3 Counterfeit prevention and traceability management

5.2.3.1 Electronic component counterfeit prevention

If the re-balling provider is engaged in the procurement of BGA components

- the re-balling provider shall only purchase BGA components:
  - direct from the original component manufacturers; or
  - from franchised or authorized distributors with full traceability through the supply chain to the original component manufacturer;
- if this is not possible, the re-balling provider shall:
  - advise the customer;
  - ask the customer where it purchases the BGA components in accordance with its anti-counterfeit management plan or any other decision with regard to BGA components procurement source;
- the re-balling provider shall, in any case, have a counterfeit electronic components management plan/process which satisfies the requirements of IEC 62668 (all parts) and/or SAE AS5553 or equivalent.

5.2.3.2 Materials, chemicals, components, and process tools and equipment traceability

5.2.3.2.1 Materials and chemicals

All process materials and chemicals (balls, solder alloys, cleaning fluids, de-ionized water, fluxes, etc.) shall be traceable to their original manufacturers.

5.2.3.2.2 BGA components

Changing solder ball metallurgy composition is considered a major change according to JEDEC J-STD-046. New part numbers shall be created. Process lot traceability shall be maintained and documented on all relevant paperwork and the smallest unit container. The re-balling provider shall label the containers and shipping documentation of processed piece parts in accordance with marking standard IEC 62090 or equivalent.

5.2.3.2.3 Process tools and equipment

All tools and equipment used in the de-balling/re-balling process shall be identified and traceable.

5.2.4 Quality

5.2.4.1 Quality standards

The re-balling provider shall have a documented quality system registered to an internationally recognized quality management system. In addition, the de-balling and re-balling process shall satisfy the applicable requirements of IPC J-STD-001.

NOTE 1 An internationally recognized quality management system can be the relevant parts of AS/EN/JISQ 9100 or equivalent.

NOTE 2 Usually the documented quality system includes technical operation procedures, non-conformance and corrective actions aspects and configuration management, for example of materials, chemicals, tools and equipment or processes.

5.2.4.2 Declaration of conformity

The re-balling provider shall have a process to provide at products deliveries a declaration of conformity stating that the specified requirements (see 5.2.12) are met.

NOTE ISO/IEC 17050-1 can be a relevant document to assist the declaration of conformity process.

5.2.5 Records

Quality records, technical records (for example component qualification test results, control results, process monitoring), lot travellers, change notices and all other documentation generated during the de-balling/re-balling process shall be retained for a minimum period of ten years unless otherwise required by the customer, and made available to the customer upon request within five business days.

5.2.6 Facility requirements

In addition to having the tools and equipment necessary and maintained (for example calibration) for de-balling and re-balling, the re-balling provider's facility's cleanliness, lighting, temperature, humidity and environmental control shall be in accordance with IPC J-STD-001 or IPC J-STD-001FS (Space Addendum) for the class defined by the customer (see 5.2.2 and Table 1).

5.2.7 Electrostatic discharge (ESD)

BGA components are electrostatic discharge (ESD) sensitive and ESD discharge can result in functional damages. Their handling, storage and transportation, shall satisfy the requirements of at least one of the following documents:

IEC 61340-5-1, IEC TR 61340-5-2, JEDEC JESD625, ANSI/ESD S20.20 or equivalent.

5.2.8 Physical handling of BGA components

The re-balling provider shall be responsible for the development and implementation of requirements and procedures necessary to prevent physical damage to BGA components while at the re-balling provider's facility.

5.2.9 Moisture/reflow sensitivity

The moisture sensitivity level (MSL) shall be identified and maintained in accordance with IPC/JEDEC J-STD-033 or equivalent. The cumulative bake time shall not apply.

5.2.10 Configuration management

The re-balling provider shall have an identification system used for tracking and control purposes within the re-balling provider's facility.

5.2.11 Personnel proficiency

The tasks for BGA de-balling/re-balling, as specified in this document, require instructors, operators, and inspectors. Objective evidence of their proficiency shall be maintained and be available to customers upon request. Objective evidence should include records of training to the applicable job functions being performed, work experience, evaluation to the requirements of this document, and/or results of periodic reviews of proficiency. If BGA components are procured by the re-balling provider, or if required by the customer (for example in the purchase order) that the BGA components be supplied by the re-balling provider, it is necessary that the re-balling provider personnel have anti-counterfeit awareness training including the ability to inspect to IDEA-STD-1010 requirements and be able to inspect the traceability requirements back to the customer or the original component manufacturer.

Supervised on-the-job training is acceptable until proficiency is demonstrated.

5.2.12 Order of precedence

The product shall meet the requirements specified in: (1) the contract or purchase order, (2) this document, and (3) the references cited herein. In the event of a conflict, the order of precedence shall be as listed above. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained. Annex A provides a tailoring matrix that can be used.

5.3 Customer and re-balling provider relationship

There shall be a clear understanding in the contract, statement of work (SOW) or other method of negotiation between the customer and the re-balling provider as to what is being requested, and the plan/process tailored as necessary to satisfy the customer's requirements.

Tailoring of the plan/process is accomplished by evaluating each requirement for the specific application. Upon completion of the evaluation, requirements may be added, modified or deleted. Tailoring decisions, including rationale and technical justification, shall be by agreement from the customer and documented. Annex A provides a tailoring matrix that can be used for that purpose.

6 Technical requirements

6.1 Receipt of BGA components and separate balls

6.1.1 General

The re-balling provider shall have a process to perform an initial incoming inspection, taking into account the requirements contained in 5.2.7 through 5.2.9 and considering the traceability requirements expressed in 5.2.3.

NOTE Subclause 6.1 addresses the process steps 4 and 5 identified in Figure 1.

6.1.2 Incoming inspection of BGA components

6.1.2.1 General

An incoming inspection of the BGA components and packaging shall be accomplished in accordance with the requirements specified in IPC/JEDEC J-STD-033.

The incoming personnel can refer to IDEA-STD-1010 for checking that the BGA components are not recycled or counterfeit.

NOTE Table 2 provides the sample size for inspection.

6.1.2.2 Component identification

The re-balling provider shall verify the BGA component part number or reference and the BGA component manufacturer against the purchase order.

6.1.2.3 Visual inspection

6.1.2.3.1 Damage at BGA package and balls level

The re-balling provider shall have a process in place to:

- check to ensure the BGA package is not severely warped and thereby unsuitable for the de-balling/re-balling operation;
- verify damaged or missing solder balls, and compare missing spheres to the original component manufacturer's datasheet.

6.1.2.3.2 Dimensions

The re-balling provider shall verify the BGA package dimensions (for example height, length, width), and the balls size, against the original component manufacturer's datasheet package drawing as a verification process to determine if the correct tooling is available.

6.1.2.4 Non-destructive analysis

This method applies to non-hermetic component packages.

If BGA components are procured by the re-balling provider or if required by the customer (for example in the purchase order) with regard to BGA components supplied by the customer, a sample size shall be inspected in accordance with test method TM 300 identified in Table 2.

The images can be matched with the ones of a "golden sample" BGA component if provided by the customer or if possessed by the re-balling provider (same orientation for comparison and potential detection of internal defects).

In case of defects, the re-balling provider shall contact the customer for further instructions.

Non-destructive analysis may not be required if incoming BGA components are provided from a customer's validated trusted source.

NOTE The non-destructive analysis can be based on the acoustic microscopy method or equivalent; the non-destructive analysis specified in IPC/JEDEC J-STD-035 can be used.

6.1.2.5 Inspection test methods and records

Table 2 provides test methods for inspection performed in 6.1.2.3 to 6.1.2.5.

The test methods listed in Table 2 are described in Table C.1.

The re-balling provider shall record all the test data issued in 6.1.2.

Table 2 – Typical control and inspection test methods

Test method		Sample size for production lot	Sample size for new BGA component part number qualification
Pre de-balling	Test method 100 (visual inspection)	45 or 100 % if lot size less than 45	50
	Test method 300 (acoustic microscopy (AM)) (plastic-encapsulated microcircuits PEMs only)	3	50
	Test method 1200 (X-ray fluorescence (XRF))	3	3

6.1.2.6 Bake out

According to 5.2.9, BGAs of MSL 2 or higher, received in unsealed/open packaging or sealed packaging without a humidity indicator card (HIC) or an HIC that shows evidence of moisture or any other reason to suspect moisture contamination, shall be dried following the bake out requirements defined in IPC/JEDEC J-STD-033 or equivalent.

NOTE See 5.2.9 concerning cumulative bake time with regard to MSL sensitivity.

6.1.2.7 Report to the customer

The re-balling provider shall report any rejects to the customer for disposition.

6.1.3 Incoming inspection of separate solder balls

6.1.3.1 Dimensions

The re-balling provider shall verify the balls size according to the purchase order and the original component manufacturer's datasheet and their compliance with the requirements related to the BGA components which are candidates for re-balling.

6.1.3.2 Composition

The re-balling provider shall verify the composition of the solder alloy of the replacement balls against the purchase order and the manufacturer's declaration of conformance or the balls manufacturer's datasheet.

When the solder composition is unknown, not clearly indicated within the datasheet or suspect, the re-balling provider shall contact the balls manufacturer first and perform a material analysis to determine the ball composition if not obtained from the original ball manufacturer.

NOTE The material analysis can be based on an X-ray fluorescence method or an equivalent method.

6.2 Specific analysis based on component balls alloy

The re-balling provider shall review the customer's requirements and determine what the re-balled solder balls alloy will be after re-balling and identify which configuration applies:

- configuration 1: A BGA package which will be re-balled with tin-lead balls compatible with tin-lead soldering assembly process;
- configuration 2: A BGA package which will be re-balled with Pb-free balls compatible with Pb-free soldering assembly process.

With regard to configuration 2, the higher temperature of the lead-free reflow operation can damage the component (for example reliability impact).

Before engaging in the de-balling/re-balling operations the re-balling provider shall consult the original component manufacturer's datasheet for any processing temperature limits.

The re-balling provider shall select processing parameters and profiles to ensure the parts are not exposed to peak temperatures or ramp rates beyond the limits provided by the original component manufacturer's datasheet.

Otherwise the re-balling provider shall stop and advise the customer for direction and decision.

NOTE Subclause 6.2 addresses the process steps 6 and 7 and the decision possibility identified at the process step 17 in Figure 1.

6.3 BGA component de-balling

6.3.1 General

Subclauses 6.3.2 to 6.3.8 consider the steps for the de-balling operation.

NOTE 1 Subclause 6.3 addresses the process steps 8 and 10 identified in Figure 1.

NOTE 2 IPC-7711/7721 is a relevant document addressing rework, modification and repair of electronic assemblies that can help to meet the objectives of this document.

6.3.2 Temperature excursions

Regardless of the method being used the re-balling provider shall have a temperature profile (see 6.2) for the specific BGA package and ensure control of temperature excursions and durations according to IPC J-STD-001.

NOTE Minimizing time at peak temperature contributes to the reduction of thermal stress at package level.

The temperature excursion shall be unique in its ability for not inducing additional stresses, otherwise the re-balling provider shall request customer's approval.

6.3.3 Flux

Unless specified by the customer on its design, assembly drawings, specification, or purchase order, the flux shall be selected in accordance with IPC J-STD-004 or equivalent.

Flux shall conform to flux activity level L0 of flux materials rosin (RO), resin (RE) or organic (OR). When other activity levels or flux materials are used, data demonstrating compatibility shall be available for the customer's review and approval.

If low solid flux is used, flux specific gravity or titration shall be monitored and controlled a minimum of once per shift. Controls shall include flux replacement schedule.

Flux shall be applied to the BGA components before preheat, in a consistent and repeatable manner. The flux apparatus shall be compatible with the flux used.

6.3.4 Preheat

According to its BGA re-balling process type, the re-balling provider shall determine if the BGA components need to be preheated prior to ball removal. If preheat is needed, ramp-up rates and the highest temperature shall not exceed the original component manufacturer's specification. If the original component manufacturer's specification is not available then use the reflow profile provided IPC/JEDEC J-STD-020.

6.3.5 Solder balls removal (de-balling)

The de-balling process shall not scratch the pads or damage the solder mask.

The previous solder alloy shall be removed and pads left protected with the replacement solder alloy.

NOTE The braided solder wick de-balling process can result in BGA component defects such as solder mask damage or pad surface scratches.

6.3.6 Cool down

After ball removal, the BGA components shall be cooled down to minimize thermal shock before cleaning. Cooling rates shall not exceed the original component manufacturer's specification. If the original component manufacturer's specification is not available then use the reflow profile provided in IPC/JEDEC J-STD-020.

6.3.7 Cleaning (post de-balling)

The BGA components and the BGA pads shall be thoroughly cleaned to remove all flux residues and other contaminants.

The cleaning method shall be compatible with the flux and with the electronic component class (see 5.2.2).

Cleaning shall be performed as soon as possible following de-balling in accordance with the flux manufacturer's recommendations.

BGAs shall be cleaned in a manner that prevents thermal shock and/or detrimental intrusion of cleaning solutions into BGA components that are not totally sealed and in accordance with IPC J-STD-001 or IPC J-STD-001xS for the class defined by the customer (see 5.2.2 and Table 1).

6.3.8 Complete removal and cleanliness verification

The re-balling provider shall verify that the removal of the solder balls and pad finish is complete and, in particular, that there are no:

- particulate matter;
- pad defect (for example scratches);
- solder-mask damage;
- residue of the previous alloy;
- flux residues; or
- other ionic or organic contaminants on the BGA pads or package body.

NOTE Test method 500 (see Annex C) can be used for this purpose.

6.4 BGA component re-balling

6.4.1 General

Subclauses 6.4.2 to 6.4.9 consider the steps for the re-balling operation.

NOTE 1 IEC 62647 (all parts) provides guidance for dealing with lead-free components and lead-free implementation.

NOTE 2 Subclause 6.4 addresses the process steps 9 and 11 identified in Figure 1.

6.4.2 Capability

The re-balling provider shall select:

- the correct solder sphere (ball diameter) in accordance with BGA package (including pitch, BGA configuration);

- the correct tools and fixtures (for example stencil capability, sphere placement tool, etc., taking into account potential special equipment limitations).

6.4.3 Solder paste

Unless otherwise specified on the design, assembly drawings, or instructed by the customer, the re-balling provider's process shall comply with the requirements contained in IPC J-STD-005 or equivalent when selecting solder paste.

The method of deposition shall be in accordance with the selected solder paste and the process.

6.4.4 Flux

Unless otherwise specified on its design, assembly drawings, specification, or purchase order, the flux shall be in accordance with IPC J-STD-004 or equivalent.

Flux shall conform to flux activity level L0 of flux materials rosin (RO), resin (RE) or organic (OR). When other activity levels or flux materials are used, data demonstrating compatibility shall be available for the customer's review and approval.

If low solids fluxes are used, flux-specific gravity or titration shall be controlled and monitored a minimum of once per shift. Controls shall include flux change/replacement schedule.

Flux shall be applied to the BGA components before preheat, in a consistent and repeatable manner. The flux apparatus shall be compatible with the flux used.

6.4.5 Ball placement (alignment and co-planarity)

The ball placement method shall ensure the selection of the appropriate tooling and the BGA component manufacturer's requirements for maintaining balls location and BGA co-planarity.

NOTE This includes balls alignment, pad centering, missing balls, excess balls.

6.4.6 Preheating

According to its BGA re-balling process type, the re-balling provider shall determine if the BGA components need to be preheated prior to reflow soldering. If preheat is needed, ramp-up rates and the highest temperature shall not exceed the original component manufacturer's specification. If the original component manufacturer's specification is not available then use the reflow profile provided in IPC/JEDEC J-STD-020.

6.4.7 Reflow temperature profile

Regardless of the method being used, the re-balling provider shall have an appropriate atmosphere, a temperature profile (see 6.2) for the specific package and the solder ball alloy, and ensure control over temperature excursions and durations according to IPC J-STD-001.

NOTE 1 Localized inert atmosphere is a best practice for minimizing surface oxidation when soldering.

NOTE 2 Minimizing time at peak temperature contributes to reduction of thermal stress at package level.

6.4.8 Cooling down

After soldering, the BGA components shall be cooled down slowly to minimize thermal shock before cleaning.

Cooling rates shall not exceed the original component manufacturer's specifications. If the original component manufacturer's specification is not available, then use the reflow profile provided in IPC/JEDEC-J-STD-020.

6.4.9 Cleaning (post re-balling)

The re-balled BGA components shall be thoroughly cleaned to remove all flux residues and other contaminants.

The cleaning method shall be compatible with the flux and with the electronic component class (see 5.2.2).

Cleaning shall be performed within a time limit following the re-balling in accordance with the flux manufacturer's recommendations.

BGA components shall be cleaned in a manner that prevents thermal shock and/or detrimental intrusion of cleaning solutions into BGA components that are not totally sealed and in accordance with IPC J-STD-001 or IPC J-STD-001 Space Applications Electronic Hardware Addendum to IPC J-STD-001 for the class defined by the customer (see 5.2.2 and Table 1).

6.5 Post-process inspection of re-balled BGA components

6.5.1 General

Subclauses 6.5.2 to 6.5.5 consider for the post-process inspection and control of re-balled BGA components in a "production lot" mode.

NOTE Subclause 6.5 addresses the process step 12b identified in Figure 1.

6.5.2 Production lot tests

The test methods for BGA components within a production lot are defined in Table 3 which constitutes a typical test plan. Follow the test plan in Table 3.

NOTE According to their applications, some customers can require additional test(s), such as for example a co-planarity test. JESD22-B108 is a relevant document for co-planarity test at room temperature.

Small lot sizes can require quantity adjustments that shall be agreed upon with the customer. Test methods listed in Table 3 are described in Table C.1.

Table 3 – Typical production lot test methods

Test method		Sample size (pieces number)
Post re-balling	Test method 100 (visual inspection)	100 %
	Test method 300 (acoustic microscopy (AM)) (PEMS only)	10
	Test method 500 (ionic cleanliness)	3
	Test method 600 (solderability)	3
	Test method 1000 (DPA)	3
	Test method 1100 (X-ray inspection)	3
	Test method 1200 (X-ray fluorescence (XRF))	3
	Test method 1300 (ball shear)	3

6.5.3 Process monitoring and control

This approach may be discussed between the re-balling provider and the customer when processing large volumes of the same BGA component.

The production lot test methods of Table 3 (see 6.5.2) may be replaced by the process monitoring and control methods defined in Table 4, which constitutes a typical test plan.

NOTE See also the NOTE in 6.5.2.

If considered, this approach shall be approved by the customer.

Test methods listed in Table 4 are described in Table C.1.

Table 4 – Typical test methods for process monitoring and control

Test method	Frequency	Sample size (pieces number)
Test method 100 (visual inspection)		100 %
Test method 300 (AM) (PEMS only)	Once per month	10
Test method 500 (ionic cleanliness)	Once per shift	10
Test method 600 (solderability)	Once a week	3
Test method 1000 (DPA)	Once a month	2
Test method 1100 (X-ray inspection)	Once a month	10
Test method 1200 (X-Ray fluorescence)	Once a week	3
Test method 1300 (ball shear)	Once a week	3

6.5.4 Case of failures

If there are any failures during production lot tests or process monitoring and control, the failed BGA components shall be segregated, marked as non-conforming, and the customer shall be notified prior to shipment.

6.5.5 Records

The re-balling provider shall record the test results and process parameters defined in 6.5.1 to 6.5.3.

6.6 Rework

6.6.1 General

Unless authorized by the customer, rework on re-balled BGA components shall be avoided.

6.6.2 Rework if authorized by the customer

6.6.2.1 General considerations

BGA components within the production lot shall not be reworked more than twice. Any damaged BGA components (for example cracked, dropped into the solder, etc.) shall be segregated, marked as non-conforming, and returned to the customer.

6.6.2.2 Selective rework

Selective rework is allowed, but shall meet the process qualification requirements of 6.7.

6.7 New BGA component part number qualification

6.7.1 General

A new BGA component part number shall be qualified before launching the production lots of this new BGA component part number in a “production lot” mode.

NOTE 1 The test methods used for inspection of the re-balled BGA component are in this case re-enforced with regard to the ones in the production phase.

NOTE 2 Subclause 6.7 addresses the process step 12a identified in Figure 1.

6.7.2 New BGA component part number qualification by similarity

See 3.16 for a definition of “qualification by similarity” before considering this approach.

NOTE 1 Sometimes, a BGA package can be considered similar when it differs by no more than 10 % in each dimension of length, width, and height of the package body and by no more than 15 % of the termination count of a qualified BGA component part number, but the customer would first consider the risk with regards to these criteria (vs. potential later impact on reliability for example).

If qualification by similarity is proposed by the re-balling provider, the re-balling provider should provide the customer with the characteristics data demonstrating the relevance of the approach with regards to the component subject to the de-balling/re-balling operations and request its approval.

NOTE 2 Based on the technical data provided by the re-balling provider, the customer can assess the potential risks and challenges with regard to a qualification by similarity and take a decision.

6.7.3 New BGA component part number qualification

6.7.3.1 New BGA component part number qualification – Test plan

The re-balling provider shall have a test plan for a new BGA component part number qualification (see 6.1.2 for control and inspection of incoming BGA components before de-balling and 6.7.3.2 to 6.7.3.4 for control and inspection of re-balled BGA components).

The qualification tests (see 6.7.3.2 to 6.7.3.4) may be discussed with the customer, and the tests potentially tailored accordingly taking into account class definition (see 5.2.2), volume, lots size, costs, etc.

Annex D provides a tailoring matrix that can be used.

The customer shall approve the test plan and any potential deviation to the test plan that could occur later.

6.7.3.2 New BGA component part number qualification – Test methods for inspection of re-balled BGA components

The test methods for BGA components qualification are defined in Table 5, which constitutes a typical test plan.

Test methods listed in Table 5 are described in Table C.1.

Table 5 – Typical test methods used for inspection of re-balled BGA components within the framework of new BGA component part number qualification

	Test method	Sample size (pieces number)
Post re-balling	Test method 100 (visual inspection)	100 %
	Test method 300 (acoustic microscopy (AM))	100 %
	Test method 500 (ionic cleanliness)	10
	Test method 600 (solderability)	3
	Test method 1000 (DPA)	3
	Test method 1100 (X-ray inspection) (for detecting voids)	3
	Test method 1200 (X-ray fluorescence (XRF))	3
	Test method 1300 (ball shear)	3

6.7.3.3 New BGA components part number qualification – Optional additional tests

Table 6 defines optional additional tests that can be included into the BGA components part number qualification plan if approved by the customer (see 6.7.3.1 and 6.7.3.2, and the tailoring template in Annex D).

NOTE The objective of these optional additional tests is to give the customer a statistic view of the behaviour of the re-balled BGA component under temperature and humidity stress.

Test methods listed in Table 6 are described in Table C.1.

Table 6 – Typical optional additional tests for new BGA component part number qualification

Test method		Sample size (pieces number)
Post re-balling	Test method 900 (temperature humidity bias (THB))	22

6.7.3.4 New BGA components part number qualification – Sample size

Unless otherwise determined by the customer or discussed and agreed with the customer, the BGA components qualification sample size shall be fifty pieces.

The customer shall be notified by the re-balling provider if additional BGA components are required for process setup and profiling.

According to the future volume of BGA components subject to de-balling/re-balling operations, the sample size can require quantity adjustments that shall be discussed and agreed upon with the customer.

6.7.4 Records

The re-balling provider shall record all the documents and technical data (for example tests results) issued in 6.7.1 to 6.7.4.

6.7.5 Customer's approval

The re-balling provider shall provide the customer with the whole BGA component part number qualification results coming from 6.1.2 and from 6.7.

The customer shall approve the BGA component part number qualification before proceeding to the "production lot" mode.

6.7.6 Cases of BGA component re-qualification

BGA component re-qualification is required when:

- the re-balling provider makes significant changes to its process and/or equipment and/or moves location;
- the BGA component manufacturer issues a product change notice (PCN) (which is monitored either by the customer or BGA re-baller as defined in the contract) which describes a change to:
  - the BGA component package;
  - the type of solder spheres used in the BGA package.

In this case, the re-balling provider shall reconsider the steps defined in 6.7.3 to 6.7.5.

6.8 Physical marking

Where space permits the re-balling provider shall physically mark the re-balled BGA component after passing all tests with an orange dot (or other methods approved by the customer), which is resistant to solvents and cleaning materials as specified in JEDEC JESD22-B107, in addition to the requirements identified in the customer's purchase order (which may also include use of a new customer altered item component part number or a different colour marking). The ink dot shall not obscure the indicator of the termination number one if present on the BGA package. Where there is insufficient space on the BGA component, the re-balling provider shall mark the coloured dot on the packaging.

NOTE 1 The customer would consider a new part number in its electronic components management system and procedure for each re-balled BGA component.

NOTE 2 Subclause 6.8 addresses the process step 13 identified in Figure 1.

6.9 Packaging and shipping

This operation can be optional if, for example, the de-balling/re-balling operation is performed in line within the circuit card assembly process.

Otherwise the re-balling provider shall:

- use bag and tag meeting MSL and ESD levels as defined in IPC/JEDEC J-STD-033, ECA/IPC/JEDEC J-STD-075, IPC/JEDEC J-STD-020, IEC 61340-5-1, IEC TR 61340-5-2, JEDEC JESD625, ANSI/ESD S20.20 or equivalents; the cumulative bake time of IPC/JEDEC J-STD-033 will be reset to "zero" upon final packaging;
- package the BGA component into trays or tape and reel as defined within the purchase order;
- re-identify the exterior packaging which may have been supplied by the customer, specifying re-balled BGA components with customer part number requirements identified on the purchase order and taking care to remove the original customer part number; or
- identify the exterior of the new packaging which may have been supplied by either the customer or the re-balling provider, specifying the re-balled BGA components with customer part number requirements identified on the purchase order;
- include the declaration of conformity and other documents as specified.

NOTE Subclause 6.9 addresses the process step 14 identified in Figure 1.

6.10 Re-balled BGA components segregation

The re-balled BGA components, not yet marked or marked (see 6.8), shall be segregated from the incoming BGA components to avoid any mismatching, knowing that re-balled BGA components identified as failed or damaged during production are segregated separately as defined in 6.5.4 and 6.6.2.1.

Annex A
(informative)

Template for tailoring the requirements of IEC TS 62647-4

Table A.1 provides a template for tailoring the requirements of IEC TS 62647-4.

Table A.1 – Template for tailoring of requirements

Requirement no.	Clause / subclause	Requirement description	Tailored requirement	Re-balling provider representative sign-off	Customer representative sign-off
Add additional lines as needed.					

Annex B
(informative)

Requirement matrix for IEC TS 62647-4

Table B.1 provides the requirements matrix for this document.

Table B.1 – Requirement matrix

`	Clause/ subclause in IEC TS 62647-4	Requirement	Re-baller's process cross reference clause
1	**4.1**	If tailoring is performed, the re-balling provider shall obtain the documented customer's concurrence.	
2	**5.1.1**	The re-balling provider shall be on the approved suppliers list with an approved de-balling/re-balling process.	
3	**5.2.1**	If the re-balling provider plans to subcontract activities, it shall: • inform the customer, consider subcontractor(s) which is(are) in its own approved suppliers list, or in the customer-approved suppliers list if any, and request customer's approval with regard to the intended subcontracted activities; • if approved by the customer, cascade all the requirements with regard to the potential subcontractor(s) and subcontracted activities, and verify the implementation of requirements.	
4	**5.2.2**	Prior to processing, the re-balling provider shall obtain the component class from the customer (see 5.1.2).	
5	**5.2.3.1**	If the re-balling provider is engaged in the procurement of BGA components • the re-balling provider shall only purchase BGA components – direct from the original component manufacturers; or – from franchised or authorized distributors with full traceability through the supply chain to the original component manufacturer.	
6	**5.2.3.1 Second bullet**	• (See 5.2.3.1 above) if this is not possible, the re-balling provider shall: – advise the customer; – ask the customer where it purchases the BGA components in accordance with its anti-counterfeit management plan or any other decision with regard to BGA components procurement source.	
7	**5.2.3.1 Third bullet**	• (See 5.2.3.1 above) The re-balling provider shall, in any case, have a counterfeit electronic components management plan/process which satisfies the requirements of IEC 62668 (all parts) and/or SAE AS5553 or equivalent.	
8	**5.2.3.2.1**	All process materials and chemicals (balls, solder alloys, cleaning fluids, de-ionized water, fluxes, etc.) shall be traceable to their original manufacturers.	
9	**5.2.3.2.2**	Changing solder ball metallurgy composition is considered a major change according to JEDEC J-STD-046. New part numbers shall be created.	
	5.2.3.2.2	Process lot traceability shall be maintained and documented on all relevant paperwork and the smallest unit container.	
10	**5.2.3.2.2**	The re-balling provider shall label containers and shipping documentation of processed piece parts in accordance with marking standard IEC 62090 or equivalent.	
11	**5.2.3.2.3**	All tools and equipment used in the de-balling/re-balling process shall be identified and traced.	

`	Clause/ subclause in IEC TS 62647-4	Requirement	Re-baller's process cross reference clause
12	5.2.4.1	The re-balling provider shall have a documented quality system registered to an internationally recognized quality management system.	
13	5.2.4.1	In addition, the de-balling and re-balling process shall satisfy the applicable requirements of IPC J-STD-001.	
14	5.2.4.2	The re-balling provider shall have a process to provide at products deliveries a declaration of conformity stating that the specified requirement (see 5.2.12) are met.	
15	5.2.5	Quality records, technical records (for example component qualification test results, control results, process monitoring), lot travellers, change notices and all other documentation generated during the de-balling / re-balling process shall be retained for a minimum period of ten years unless otherwise required by the customer, and made available to the customer upon request within five business days.	
16	5.2.6	In addition to having the tools and equipment necessary and maintained (for example calibration) for de-balling and re-balling the re-balling provider's facility's cleanliness, lighting, temperature, humidity and environmental control shall be in accordance with IPC J-STD-001 or IPC J-STD-001FS (Space Addendum) for the class defined by the customer (see 5.2.2 and Table 1).	
17	5.2.7	BGA components are electrostatic discharge (ESD) sensitive and ESD discharge can result in functional damages. Their handling, storage, transportation, shall satisfy the requirements of at least one of the following documents: IEC 61340-5-1, IEC TR 61340-5-2, JEDEC JESD625, ANSI/ESD S20.20 or equivalent.	
18	5.2.8	The re-balling provider shall be responsible for the development and implementation of requirements and procedures necessary to prevent physical damage to BGA components while at the re-balling provider's facility.	
19	5.2.9	The moisture sensitivity level (MSL) shall be identified and maintained in accordance with IPC/JEDEC J-STD-033 or equivalent.	
20	5.2.9	(See 5.2.9 above) The cumulative bake time shall not apply.	
21	5.2.10	The re-balling provider shall have an identification system used for tracking and control purposes within the re-balling provider's facility.	
22	5.2.11	The tasks for BGA de-balling/re-balling, as specified in this document, require instructors, operators, and inspectors. Objective evidence of their proficiency shall be maintained and be available to customers upon request. Objective evidence should include records of training to the applicable job functions being performed, work experience, evaluation to the requirements of this document, and/or results of periodic reviews of proficiency. If BGA components are procured by the re-balling provider, or if required by the customer (for example, in the purchase order) that the BGA components be supplied by the re-balling provider, it is necessary that the re-balling provider personnel have anti-counterfeit awareness training including the ability to inspect to IDEA-STD-1010 requirements and be able to inspect the traceability requirements back to the customer or the original component manufacturer. Supervised on-the-job training is acceptable until proficiency is demonstrated.	
23	5.2.12	The product shall meet the requirements specified in: (1) the contract or purchase order, (2) this document, and (3) the references cited herein.	

`	Clause/ subclause in IEC TS 62647-4	Requirement	Re-baller's process cross reference clause
24	5.2.12	In the event of a conflict, the order of precedence shall be as listed above. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained. Annex A provides a tailoring matrix that can be used.	
25	5.3	There shall be a clear understanding in the contract, statement of work (SOW) or other method of negotiation between the customer and the re-balling provider as to what is being requested and the plan/process tailored as necessary to satisfy the customer's requirements. Tailoring of the plan/process is accomplished by evaluating each requirement for the specific application. Upon completion of the evaluation, requirements may be added, modified or deleted.	
26	5.3	(See 5.3 above) Tailoring decisions, including rationale and technical justification, shall be by agreement from the customer and documented. Annex A provides a tailoring matrix that can be used for that purpose.	
27	6.1.1	The re-balling provider shall have a process to perform an initial incoming inspection, taking into account the requirements contained in 5.2.7 through 5.2.9 and considering the traceability requirements expressed in 5.2.3.	
28	6.1.2.1	An incoming inspection of the BGA components and packaging shall be accomplished in accordance with the requirements specified in IPC/JEDEC J-STD-033.	
29	6.1.2.2	The re-balling provider shall verify the BGA component part number or reference and the BGA component manufacturer against the purchase order.	
30	6.1.2.3.1	The re-balling provider shall have a process in place to: • check to ensure the BGA package is not severely warped and thereby unsuitable for the de-balling /re-balling operation; • verify damaged or missing solder balls, and compare missing spheres to the original component manufacturer's datasheet.	
31	6.1.2.3.2	The re-balling provider shall verify the BGA package dimensions (for example height, length, width), and the balls size, against the original component manufacturer's datasheet package drawing as a verification process to determine if the correct tooling is available.	
32	6.1.2.4	This method applies to non-hermetic component packages. If BGA components are procured by the re-balling provider or if required by the customer (for example in the purchase order) with regard to BGA components supplied by the customer, a sample size shall be inspected in accordance with test method TM 300 identified in Table 2.	
33	6.1.2.4	(See 6.1.2.4 above "This method applies to non-hermetic component packages."): In case of defects, the re-balling provider shall contact the customer for further instructions.	
34	6.1.2.5	Table 2 provides test methods for inspection performed in 6.1.2.3 to 6.1.2.5. Test methods listed in Table 2 are described in Table C.1. The re-balling provider shall record all the test data issued in 6.1.2.	
35	6.1.2.6	According to 5.2.9, BGAs of MSL 2 or higher, received in unsealed/open packaging or sealed packaging without a humidity indicator card (HIC) or an HIC that shows evidence of moisture or any other reason to suspect moisture contamination, shall be dried following the bake out requirements defined in IPC/JEDEC J-STD-033 or equivalent.	

`	Clause/ subclause in IEC TS 62647-4	Requirement	Re-baller's process cross reference clause
36	**6.1.2.7**	The re-balling provider shall report any rejects to the customer for disposition.	
37	**6.1.3.1**	The re-balling provider shall verify the balls size according to the purchase order and the original component manufacturer's datasheet and their compliance with the requirements related to the BGA components which are candidates for re-balling.	
38	**6.1.3.2**	The re-balling provider shall verify the composition of the solder alloy of the replacement balls against the purchase order and the manufacturer's declaration of conformance or the balls manufacturer's datasheet.	
39	**6.1.3.2**	When the solder composition is unknown, not clearly indicated within the datasheet or suspect, the re-balling provider shall contact the balls manufacturer first and perform a material analysis to determine the ball composition if not obtained from the original ball manufacturer.	
40	**6.2**	The re-balling provider shall review the customer's requirements and determine what the re-balled solder balls alloy will be after re-balling and identify which configuration applies.	
41	**6.2**	With regard to configuration 2, the higher temperature of the lead-free reflow operation can damage the component (for example reliability impact). Before engaging in the de-balling/re-balling operations the re-balling provider shall consult the original component manufacturer's datasheet for any processing temperature limits.	
42	**6.2**	The re-balling provider shall select processing parameters and profiles to ensure the parts are not exposed to peak temperatures or ramp rates beyond the limits provided by the original component manufacturer's datasheet.	
43	**6.2 (see 42 above)**	Otherwise the re-balling provider shall stop and advise the customer for direction and decision.	
44	**6.3.2**	Regardless of the method being used the re-balling provider shall have a temperature profile (see 6.2) for the specific BGA package and ensure control of temperature excursions and durations according to IPC J-STD-001.	
45	**6.3.2**	The temperature excursion shall be unique in its ability for not inducing additional stresses, otherwise the re-balling provider shall request customer's approval.	
46	**6.3.3**	Unless specified by the customer on its design, assembly drawings, specification, or purchase order, the flux shall be selected in accordance with IPC J-STD-004 or equivalent.	
47	**6.3.3**	Flux shall conform to flux activity level L0 of flux materials rosin (RO), resin (RE) or organic (OR). When other activity levels or flux materials are used, data demonstrating compatibility shall be available for the customer's review and approval.	
48	**6.3.3**	If low solid flux is used, flux specific gravity or titration shall be monitored and controlled a minimum of once per shift. Controls shall include flux replacement schedule.	
49	**6.3.3**	Flux shall be applied to the BGA components before preheat, in a consistent and repeatable manner.	
50	**6.3.3**	The flux apparatus shall be compatible with the flux used.	
51	**6.3.4**	According to its BGA re-balling process type, the re-balling provider shall determine if the BGA components need to be preheated prior to ball removal.	
52	**6.3.4**	If preheat is needed, ramp-up rates and the highest temperature shall not exceed the original component manufacturer's specification.	
53	**6.3.5**	The de-balling process shall not scratch or damage the solder mask.	

`	Clause/ subclause in IEC TS 62647-4	Requirement	Re-baller's process cross reference clause
54	**6.3.5**	The previous solder alloy shall be completely removed and pads left protected with the replacement solder alloy.	
55	**6.3.6**	After ball removal, the BGA components shall be cooled down to minimize thermal shock before cleaning. Cooling rates shall not exceed the original component manufacturer's specification. If the original component manufacturer's specification is not available then use the reflow profile provided in IPC/JEDEC J-STD-020.	
56	**6.3.7**	The BGA components and the BGA pads shall be thoroughly cleaned to remove all flux residues and other contaminants.	
57	**6.3.7**	The cleaning method shall be compatible with the flux and with the electronic component class (see 5.2.2).	
58	**6.3.7**	Cleaning shall be performed as soon as possible following de-balling in accordance with the flux manufacturer's recommendations.	
59	**6.3.7**	BGAs shall be cleaned in a manner that prevents thermal shock and/or detrimental intrusion of cleaning solutions into BGA components that are not totally sealed and in accordance with IPC J-STD-001 or IPC J-STD-001xS for the class defined by the customer (see 5.2.2 and Table 1).	
60	**6.3.8**	The re-balling provider shall verify that the removal of the solder balls and pad finish is complete and, in particular, that there are no: • particulate matter; • pad defect (for example scratches); • solder-mask damage; • residue of the previous alloy; • flux residues; or • other ionic or organic contaminants on the BGA pads or package body.	
61	**6.4.2**	The re-balling provider shall select: • the correct solder sphere (ball diameter) in accordance with BGA package (including pitch, BGA configuration); • the correct tools and fixtures (for example stencil capability, sphere placement tool, etc., taking into account potential special equipment limitations).	
62	**6.4.3**	Unless otherwise specified on the design, assembly drawings, or instructed by the customer the re-balling provider's process shall comply with the requirements contained in IPC J-STD-005 or equivalent when selecting solder paste.	
63	**6.4.3**	The method of deposition shall be in accordance with the selected solder paste and the process.	
64	**6.4.4**	Unless otherwise specified on its design, assembly drawings, specification, or purchase order, the flux shall be in accordance with IPC J-STD-004 or equivalent.	
65	**6.4.4**	Flux shall conform to flux activity level L0 of flux materials rosin (RO), resin (RE) or organic (OR).	
66	**6.4.4**	When other activity levels or flux materials are used, data demonstrating compatibility shall be available for the customer's review and approval.	
67	**6.4.4**	If low solids fluxes are used, flux-specific gravity or titration shall be controlled and monitored a minimum of once per shift. Controls shall include flux change/replacement schedule.	
68	**6.4.4**	Flux shall be applied to the BGA components before preheat, in a consistent and repeatable manner.	
69	**6.4.4**	The flux apparatus shall be compatible with the flux used.	

`	Clause/ subclause in IEC TS 62647-4	Requirement	Re-baller's process cross reference clause
70	**6.4.5**	The ball placement method shall ensure the selection of the appropriate tooling and the BGA component manufacturer's requirements for maintaining balls location and BGA co-planarity.	
71	**6.4.6**	According to its BGA re-balling process type, the re-balling provider shall determine if the BGA components need to be preheated prior to reflow soldering.	
72	**6.4.6**	If preheat is needed, ramp-up rates and the highest temperature shall not exceed the original component manufacturer's specification. If the original component manufacturer's specification is not available then use the reflow profile provided in IPC/JEDEC J-STD-020.	
73	**6.4.7**	Regardless of the method being used, the re-balling provider shall have an appropriate atmosphere, a temperature profile (see 6.2) for the specific package and the solder ball alloy and ensure control over temperature excursions and durations according to IPC J-STD-001.	
74	**6.4.8**	After soldering, the BGA components shall be cooled down slowly to minimize thermal shock before cleaning.	
75	**6.4.8**	Cooling rates shall not exceed the original component manufacturer's specifications. If the original component manufacturer's specification is not available, then use the reflow profile provided in IPC/JEDEC-J-STD-020.	
76	**6.4.9**	The re-balled BGA components shall be thoroughly cleaned to remove all flux residues and other contaminants.	
77	**6.4.9**	The cleaning method shall be compatible with the flux and with the electronic component class (see 5.2.2).	
78	**6.4.9**	Cleaning shall be performed within a time limit following the re-balling in accordance with the flux manufacturer's recommendations.	
79	**6.4.9**	BGA components shall be cleaned in a manner that prevents thermal shock and/or detrimental intrusion of cleaning solutions into BGA components that are not totally sealed and in accordance with IPC J-STD-001 or IPC J-STD-001FS for the class defined by the customer (see 5.2.2 and Table 1).	
80	**6.5.2**	The test methods for BGA components within a production lot are defined in Table 3 which constitutes a typical test plan. Follow the test plan in Table 3. NOTE According to their applications, some customers can require other tests such as for example a co-planarity test. JESD22-B108 is a relevant document for co-planarity test at room temperature. Small lot sizes can require quantity adjustments that shall be agreed upon with the customer. Test methods listed in Table 3 are described in Table C.1.	
81	**6.5.3**	This approach may be discussed between the re-balling provider and the customer when processing large volumes of the same BGA component. The production lot test methods of Table 3 (see 6.5.2) may be replaced by the process monitoring and control methods defined in Table 4 which constitutes a typical test plan. NOTE See also the NOTE in 6.5.2. If considered, this approach shall be approved by the customer. Test methods listed in Table 4 are described in Table C.1.	
82	**6.5.4**	If there are any failures during production lot tests or process monitoring and control, the failed BGA components shall be segregated, marked as non-conforming, and the customer shall be notified prior to shipment.	