



AEROSPACE STANDARD

AS6171™/2

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Superseding AS6171/2

(R) Techniques for Suspect/Counterfeit EEE Parts Detection by
External Visual Inspection, Remarking and Resurfacing, and
Surface Texture Analysis Using SEM Test Methods

RATIONALE

Counterfeit electronic components frequently have external characteristics that may be used to identify them as suspect. Visual inspection by means of optical and scanning electron microscope (SEM) techniques requires well-defined processes in order to discern and document characteristics that are consistent with counterfeit parts.

The published version of AS6171/2 was found to be different from the version that was balloted and approved by the G-19A committee. This revision is needed to address that discrepancy.

INTRODUCTION

This document provides guidance and requirements on visual and SEM procedures to be employed by the test laboratory for inspection of electrical, electronic and electromechanical (EEE) parts for suspect counterfeit part detection.

The External Visual Inspection (EVI) consists of a general inspection of the entire lot and a detailed inspection (including tests for relabeling and remarking) of a selected sample of the lot. In the general EVI inspection, the complete lot of devices that are supplied to the test laboratory is inspected for possible signs of counterfeiting, including alterations of part marking, or alterations of paperwork supplied with the devices. The detailed EVI procedure of this standard describes sampling requirements and the detailed inspection of those sampled devices under high magnification.

A small number of samples will be used for remarking and resurfacing tests, which are destructive under EVI.

DISCLAIMER

The images contained herein are provided to illustrate the application of detection methods identified in the document, and are by no means intended to imply that a manufacturer identified in an image and text is involved with the suspect product.

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1. SCOPE

This document describes the requirements of the following test methods for counterfeit detection of electronic components:

- a. Method A: General EVI, Sample Selection, and Handling
- b. Method B: Detailed EVI, including Part Weight measurement
- c. Method C: Testing for Remarking
- d. Method D: Testing for Resurfacing
- e. Method E: Part Dimensions measurement
- f. Method F: Surface Texture Analysis using SEM

The scope of this document is focused on leaded electronic components, microcircuits, multi-chip modules (MCMs), and hybrids. Other EEE components may require evaluations not specified in this procedure. Where applicable this document can be used as a guide. Additional inspections or criteria would need to be developed and documented to thoroughly evaluate these additional part types. If AS6171/2 is invoked in the contract, the base document, AS6171 General Requirements shall also apply.

1.1 Purpose

This standard establishes requirements for the inspection process, documentation of results, personnel qualification, and the inspection equipment to be used. It also outlines techniques to detect suspect counterfeit parts by a trained inspector.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AS5553 Fraudulent/Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition

2.1.2 Other Publications

ANSI/ESD S20.20	Protection of Electrical and Electronic Parts, Assemblies and Equipment
JEDEC JESD625	Requirements for Handling Electrostatic Discharge Sensitive (ESDS) Devices
IDEA-STD-1010	Acceptability of Electronic Components Distributed in the Open Market
J-STD-020	Joint IPC/JEDEC Standard for Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices
J-STD-033	Joint IPC/JEDEC Standard for Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices

2.2 Terms and Definitions

See 2.2.5 of AS6171 General Requirements.

3. DESCRIPTION OF METHODOLOGY AND PROCEDURE

3.1 General Statements

The methodology employed in external visual inspection (EVI) is for the trained inspector to physically examine the lot of devices and the corresponding documentation. The inspection consists of the following six distinct procedures:

- a. Method A - General EVI, in which all devices in the lot and associated documentation are examined.
- b. Method B - Detailed EVI, in which a specified sample of devices is given very close scrutiny under higher magnification as specified herein, and Part Weight measurement.
- c. Method C - Remarking inspection of a small sample of devices; this is destructive testing.
- d. Method D - Resurfacing inspection of a small sample of devices; this is destructive testing.
- e. Method E - Part dimension measurement on a small sample of devices using non-destructive measurement techniques.
- f. Method F - Surface texture analysis using SEM, in which a specified sample of devices is used to detect surface anomalies and modifications; this is destructive testing.

With customer approval, testing may be terminated at any time after enough evidence has been found to designate a part as suspect or counterfeit.

NOTE: For a Standard Lot, the sample size is as defined in 3.5 of AS6171 General Requirements. Sample size for Small Lots is as defined in 3.5.2 of AS6171 General Requirements.

3.2 Material Control and ESD Handling

- 3.2.1 ESD-sensitive items shall be handled from receipt to delivery in accordance with the local ESD control plan that is compliant with ANSI/ESD S20.20 or JEDEC JESD625.
- 3.2.2 Moisture-sensitive items shall be handled from receipt through delivery in accordance with the requirements of IPC/JEDEC J-STD-20 and J-STD-033.
- 3.2.3 Refer to the requirements in 3.9.5 of AS6171 General Requirements.

NOTE: IDEA-STD-1010 sections 7.1 and 7.3 provide workstation guidelines.

4. TEST EQUIPMENT AND CALIBRATION

Test equipment shall be as specified in Section 5. All equipment shall be calibrated per manufacturer's requirements. In addition, a NIST-traceable weight standard shall be used to verify calibration of the weight balance on each day of use. The accuracy of the balance shall be within 0.01% of the Actual Reading (%AR).

5. REQUIREMENTS

5.1 Sampling

- 5.1.1 The applicable Statement of Work (SOW) or purchase order shall define the appropriate documents required for the identification and traceability documentation. This documentation shall accompany the samples at all times.

- 5.1.2 Section 3.5 of AS6171 General Requirements shall apply for the type of testing and sampling required.
- 5.1.3 From each lot, a minimum of one part shall be segregated for potential use in surface analysis in such a way as not to contaminate or alter the surface chemistry of the part as received in its original condition. All such segregated parts shall either be segregated without removal from their original packaging or be handled using clean handling techniques (e.g., powder-free, static dissipative: gloves or finger cots; or laboratory handling equipment), in order to avoid contamination of parts (e.g., ionic or organic) that may be used for surface analysis. This requirement does not preclude the use of such segregated parts for non-destructive testing, but they shall not be used for destructive testing or any test that could contaminate the surface (e.g., Acoustic Microscopy, Delid/Decapsulation Physical Analysis (DDPA), Remarking and Resurfacing, or Seal Testing).
- 5.1.4 Except as stated in 3.1, all samples must be randomly selected from the lot. Sample selection shall be made from multiple trays, sticks, and reels.
- 5.1.5 Upon removal of the samples, a label shall be attached to the original container which states the following or similar wording: "[Laboratory Name (with trademark)] has sampled this container for inspection/test purposes; ____ samples were removed from their original packaging. These samples are packaged separately with this shipment and are clearly marked. Initial ____ Date ____."
- 5.1.6 Parts which have been removed from their original packaging and undergone visual inspection shall be repackaged and a label attached to the exterior packaging with the following or similar wording: "[Laboratory Name (with trademark)] has sampled this container for inspection/test purposes. These samples were removed from their original packaging and visually inspected for counterfeit detection inspection."
- 5.1.7 Moisture Sensitivity Identification

If product needs to meet the requirements of J-STD-033, the requirements of 3.9.5 of AS6171 General Requirements shall apply.

5.2 Categories of Testing and Risk Levels

Refer to 3.2 of AS6171 General Requirements.

5.3 Testing Requirements

5.3.1 Method A: General EVI, Sample Selection, and Handling

The general EVI criteria apply to 100% of the lot under test. The purpose of this general inspection is to perform a cursory inspection of the visible side(s) with the part marking (if part has a part marking) of all the components in the lot. The intent of the general inspection is to ensure that all devices are inspected in the packaging to determine if there are any gross visual anomalies.

Visual examination of the samples shall be conducted at appropriate magnification based upon the part type, size, and configuration. If the parts can be visually inspected while still in the packaging (trays, clear tubes or clear tape), they do not need to be removed from the packaging. Parts that are in packaging that does not allow visual inspection must be removed from the packaging for inspection. When these parts are repackaged, the exterior packaging shall be labeled per 5.1.6.

Images shall be taken of the external shipping package and traceability documentation. Images shall be clear and contain as a minimum the OCM's part number, date code, lot code, ESD sensitivity labels, MSL label (if applicable), Box Maker Certificate (if available), and associated bar code information.

NOTE: IDEA specification IDEA-STD-1010 is a reference document for EVI for suspect counterfeit electronic components. It contains numerous examples that illustrate many potential anomalies regarding counterfeit electronics.

5.3.2 Method B: Detailed EVI

Detailed EVI shall follow the sample criteria in 3.5 of AS6171 General Requirements except for part weight measurement as noted herein.

5.3.2.1 Equipment

The following equipment shall be available for detailed EVI:

- a. ESD protection materials
- b. Microscopes
- c. Suitable lighting (guidance note: suitable lighting may be demonstrated by the ability to produce representative images)
- d. Digital camera with sufficient resolution to discern the feature or potential defect of interest. The storage format shall be lossless.
- e. Non-contact dimensional measurement tool (such as a microscope with a calibrated, indexed stage)
- f. Handling tools, barcode scanners, magnifiers, and moisture-sensitive parts handling and packaging equipment as necessary

5.3.2.2 Overview of Part Inspection

Detailed EVI of the samples shall be conducted at 10X to 40X magnification. If a sample's acceptability cannot be determined progressive magnification up to 100x should be utilized, with the possibility that visual inspection will be inconclusive.

With the device specification or manufacturer's datasheet as a reference, the following shall be verified, as applicable:

- a. Number of leads per part
- b. Package type
- c. Pin 1 placement in tape and reel (if applicable)
- d. Correctly marked part number for the package (if applicable)

In addition, measurement shall be performed of part weight using the following procedure: For a Standard Lot, randomly select 22 samples and for Small Lots of 22 parts or less, select all parts, for the part weight measurement. When selecting the weight measurement balance, the heaviest part to be weighed should be within the balance's maximum capacity limit.

The weight of each part shall be recorded, and the mean value of the readings calculated. Any part whose weight deviates from the mean value by greater than 20% would be considered a good candidate for further evaluation as a suspect/counterfeit part.

5.3.2.3 Leads shall be inspected and should have none of the following conditions, as applicable:

- a. Nonuniform color (Figure 1A)
- b. Lack of tooling marks (for formed leads) (Figure 1B)
- c. Lack of exposed copper or other base material on the ends of the leads (typically, the base material will be visible on the ends of the leads for a new, unused component) (Figure 1C)

NOTE: Leads are sometimes hot-solder dipped for legitimate reasons; therefore, lack of exposed copper may not be conclusive evidence that the part is counterfeit.

- d. Repaired leads (Figure 1D)
- e. Bent or noncoplanar leads (Figure 1E)
- f. Excessive or uneven plating (Figure 1G)
- g. Missing leads (Figure 1F)
- h. Discoloration, dirt, or residues on the leads (Figure 1H)
- i. Scratches (or insertion marks) on the inside and/or outside faces of the leads (Figure 1I)
- j. Gross oxidation (Figure 1J)
- k. Corrosion (Figure 1K)

5.3.2.4 Hermetic devices shall be inspected for the following:

- a. Lid seal damage
- b. Glass/metal or ceramic/metal feed-through seal (cracks or chip-outs)

Figures 1A through 1K are examples of suspect conditions. Suspect conditions shall be documented with clear images highlighting the evidence. Images shall be taken per the requirements of the Test Report in 5.6.

NOTE: Visual inspection may require positioning components at multiple angles to highlight potential conditions, e.g., beyond the standard top, bottom, side, corner, and 45° angled views to obtain images highlighting the suspect condition. Images should be taken per the requirements of the Test Report in 5.6.

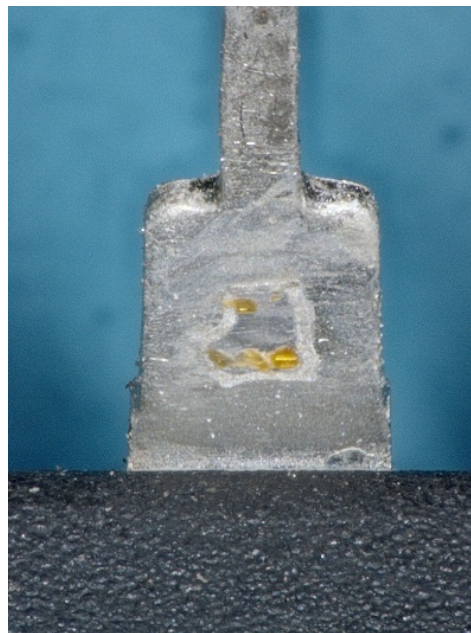
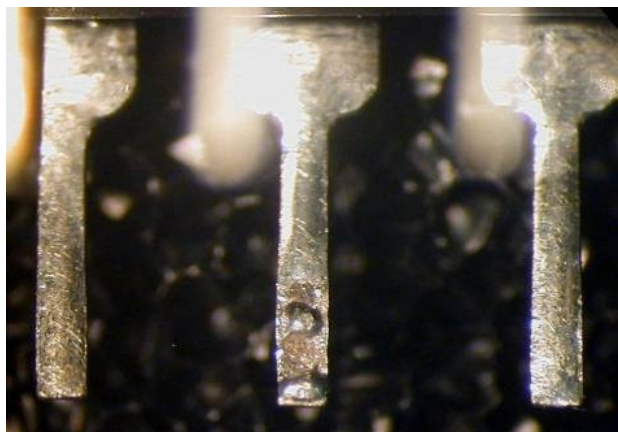


Figure 1A - Nonuniform color (Images courtesy of Honeywell)

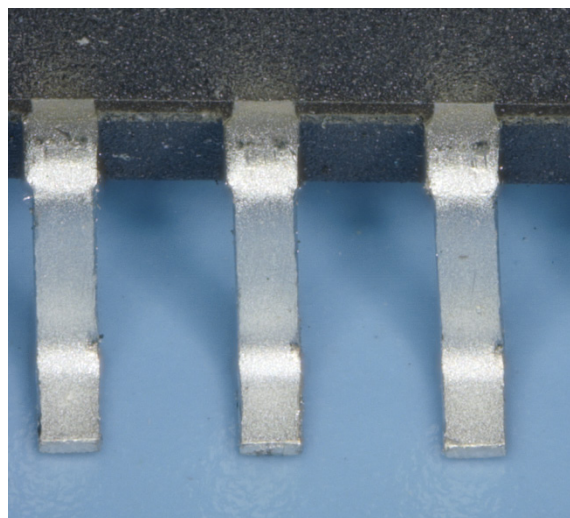
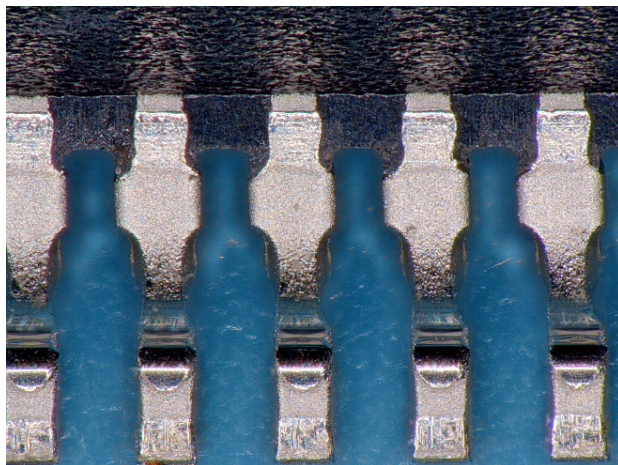


Figure 1B - Lack of tooling marks for formed leads (Images courtesy of Honeywell)
(left image shows typical tooling marks, right image shows lack of normal tooling marks)

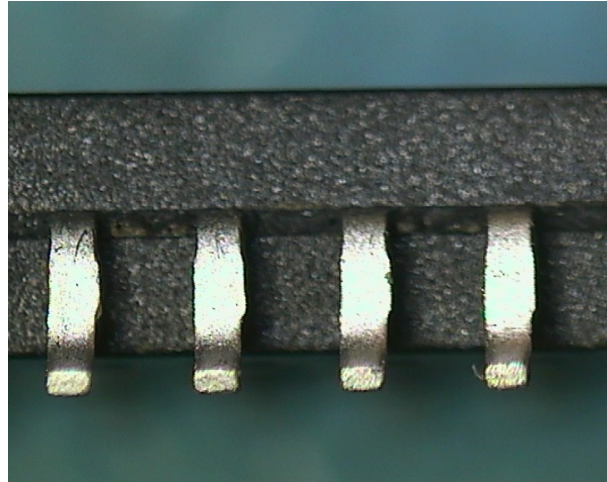
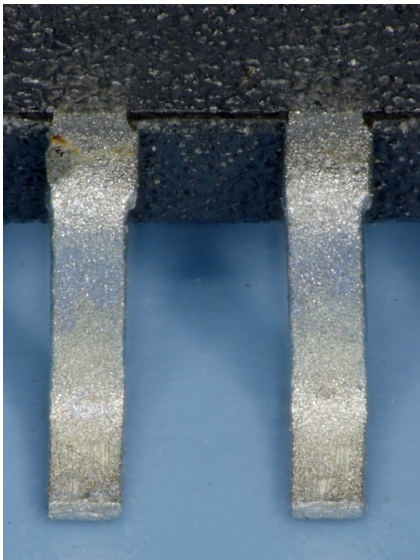


Figure 1C - Lack of exposed copper on the ends of the leads (Images courtesy of Honeywell)



Figure 1D - Repaired leads (Image courtesy of Honeywell)



Figure 1E1 - Bent or noncoplanar leads (Images courtesy of Honeywell)

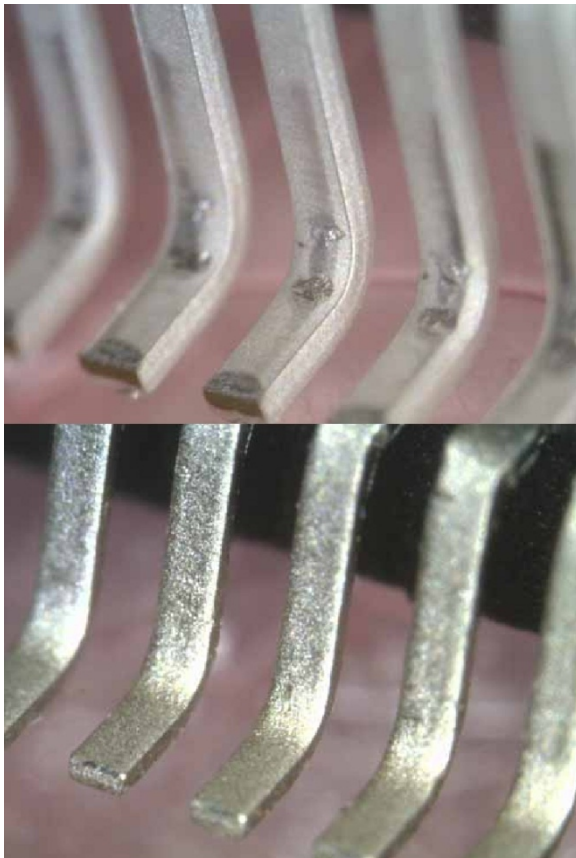


Figure 1E2 - Visibly different lead angles
(Image courtesy of Honeywell)

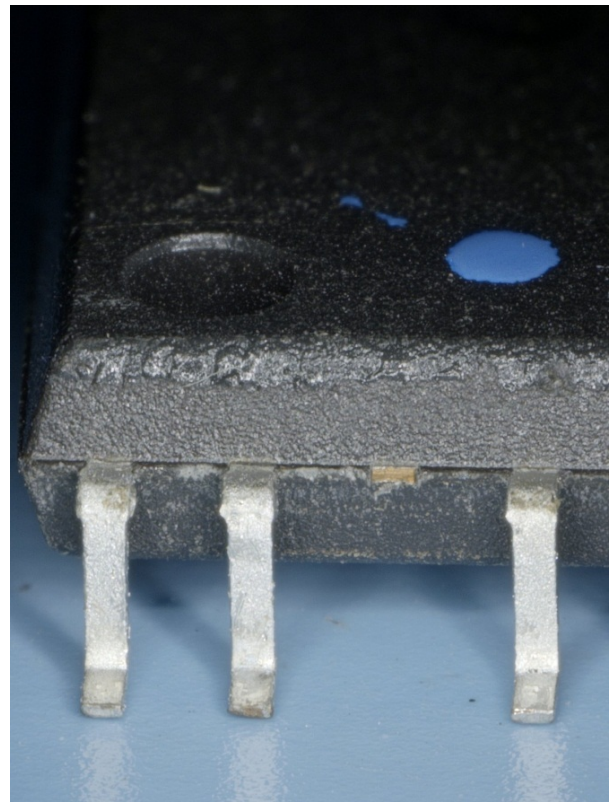


Figure 1F - Missing leads
(Image courtesy of Honeywell)

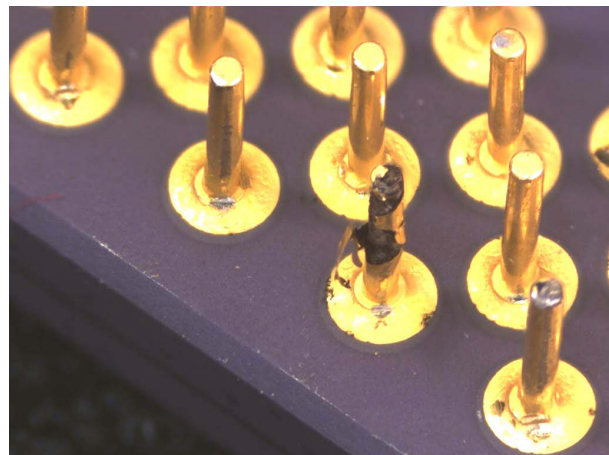


Figure 1G - Excessive, uneven, or poor plating
(left image courtesy of Silicon Cert Laboratories, LLC; right image courtesy of Honeywell)