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IPC-TM-650
TEST METHODS MANUAL

Number	
2.6.20	
Subject	
Assessment of Plastic Encapsulated Electronic Components for Susceptibility to Moisture/Reflow Induced Damage	
Date	Revision
1/95	**A**
Originating Task Group	
Plastic Chip Carrier Cracking Task Group (B-10a)	

1.0 Scope This test method is for characterizing the susceptibility of potentially moisture sensitive components to damage during exposure to solder reflow processes. These include plastic surface mount components and other plastic encapsulated electronic components [hereafter called ''packages'' in this document].

1.1 Purpose: Provide a standard flow and evaluation method to assess performance of packages to reflow conditions after moisture exposure. Moisture exposure is performed to simulate package history prior to board reflow.

2.0 Applicable Documents

ASTM B478 Method for encapsulating PSMC for cross sectioning; and method for cross sectioning and polishing without causing delamination/cracking

ASTM El04 Method for creating 85% Relative Humidity

ASTM E898 Method for weighing with high precision

EIA-583 Packaging Material Standards for Moisture Sensitive Items

EIA-JEDEC 14.1 A113 Preconditioning of Plastic Surface Mount Devices Prior to Reliability Testing

IPC-TM-650 Test Method 2.1.1, Microsectioning

IPC-TM-650 Test Method 2.1.1.2, Semi-Automatic Equipment for Microsection

IPC-TM-650 Test Method 2.6.22, Acoustic Microscopy for Plastic Encapsulated Electronic Components

IPC-SM-786 Procedures for Characterizing and Handling Moisture/Reflow Sensitive ICs

IPC-MS-810 Guidelines for High Volume Microsection

MIL-D-3464 Type II Military Specification, Desiccant, Activated, Bagged, Packaging Use and Static Dehumidification

MIL-1-8835 Military Specification, Indicator, Humidity, Card, Chemically Impregnated

MIL-B-81705 Type I Military Specification, Barrier Materials, Flexible, Electrostatic-free, Heat Sealable

MIL-STD-883 Method 2030, Military Specification, Ultrasonic Inspection of Die Attach

Nondestructive Testing Handbook ''Method For Using Liquid Penetrants: 'Liquid Penetrant Tests,''' Vol. 2, 2nd Ed., publ. American Society for Nondestructive Testing/ASM, ISBN 087 1 70-1 26-X, 1982

Proceedings of the 37th Electronic Components Conference, ''Immersion Cooling for High Density Packaging,'' Yokouchi, et. al., (1987)

''Acoustic Microscopy,'' **Metals Handbook,** Volume 17, Methods of Nondestructive Evaluation, 9th Edition, ASM International, ISBN 0-87170-007-7, 1989.

3.0 Test Specimen

3.1 The recommended minimum sample size per cell is 10 and recommended sample consists of more than 1 lot or date code. Control samples should be used to validate the data gathering process. A cell represents one temperature/relative humidity/reflow condition. Avoid contamination and mechanical damage to the packages during handling. Ensure traceability of the packages to supplier lot/date code.

3.2 Unit Marking Mark the units with a fine-tipped diamond scribe. Make the mark as far away as possible from the die and die mount pad (die attach pad) - a corner area is suggested. Do not use graphite pencil ''lead'' marking because it will leave residue or abrasion that may interfere with acoustic imaging. Do not apply excessive force when scribing components because mechanical stress on the package leads may cause or propagate small cracks at the lead/plastic interface into the package. Clean the packages with a short deionized water/and isopropyl alcohol (DI/IPA) rinse followed by a blow dry prior to any drying or weight determining processes. Random addition or removal of materials such as fingerprints, dust, residues or water soluble substances will affect the accuracy of weight gain determinations.

4.0 Apparatus and Materials

4.1 Heating and humidifying apparatus (temperature/humidity chamber) capable of achieving and maintaining the required humidity and temperature. See ASTM E104 for standard methods for creating specific levels of moisture at given ambient temperatures.

4.1.1 Equipment capable of attaining and maintaining a temperature of +125C +3/-0C.

4.2 Reflow Equipment Vapor phase soldering apparatus capable of heating the packages and basket without ''collapsing'' the vapor blanket. If the vapor blanket collapses, the test is invalid.

Notes:
1. The VPS process is based on the heat of condensation of the vapor onto the surface of the components being evaluated, therefore, the temperature variation of the process is very small. Other reflow methods have wider variations in package temperature. This test method requires the use of VPS method in order to correlate between sites. If another reflow method is used, the user must show equivalence of the thermal profile of the package body as specified in this document.
2. Because certain solder reflow processes (such as the infrared solder reflow process or the hot-air solder rework process) may result in peak internal component temperatures greater than 220°C, the user should characterize each specific process for package body temperature and consider package characterization data beyond the reference level. Specific reflow process conditions may result in packages which fail by package cracking even though samples pass this test method at the reference levels. It is up to the board assembly site to correlate its reflow process with the VPS standard process described here. For processing of components with temperatures greater than 220°C the component manufacturer and user should work as partners to identify the appropriate floor life level for that peak temperature.
3. ''IR'' reflow soldering systems are dependent upon the wavelength of the IR source and the degree of use of forced convection and interact with the non-uniform thermal mass on the printed wiring assembly as well as the dissimilar surface areas and emmissivity of the components populating the printed board. For temperature/time profiles of the PWAs in reflow systems the ideal thermometric system avoids contact with the evaluation surface; IR or fiber/fluoroptic thermometry is indicated. Thermocouple thermometry implemented with very fine (0.001-0.005'' diameter) thermocouple wire is successfully used. Phase change material in paint or crayon form may be used if only a peak temperature indication is desired.
4. ''IR'' reflow soldering systems have been successfully used to provide the ''reflow simulation'' indicated in this specification. Because ''IR'' reflow systems are a variable source of heat to the device under test, this specification uses vapor phase reflow as the reference or referee method to be employed where laboratories differ in their assessment of the robustness of a component to moisture induced damage during reflow.

4.2.1.1 Basket with low thermal mass for package retention in VPS.

4.2.1.2 Thermocouple or other thermometry to verify vapor temperature and temperature uniformity. Microfoil thermocouples, or equivalent, are recommended.

4.2.1.3 Where mixtures of fluorocarbon fluids are used, a separate controller and ancillary equipment to maintain the fluid mixture is required. See proceedings, 37th (1987) ECC, ''Immersion Cooling for High Density Packaging,'' Yokouchi et.al. or application notes from the manufacturers of perfluorinated fluids for adjustment of boiling point by mixing fluids.

4.2.1.4 Vapor phase soldering fluid specified to vaporize at +215C, -0C, +4C. Fluid with a narrow boiling temperature range and the use of a non-collapsing vapor blanket should adequately control the peak temperature and the thermal transient experienced by the packages.

4.3 Stereo low power microscope, 30X-70X with intense, collimated, oblique lighting source.

4.4 Encapsulation equipment, cross sectioning saw and polishing equipment. See ASTM B478; IPC-TM-650, Test Method 2.1.1; or IPC-MS-810 for general process details.

4.5 Apparatus capable of weighing the package with an accuracy of ± 0.001% to a resolution of ± 0.0003%. See ASTM E898 for process details.

4.6 Vacuum pencil or antistatic tweezers to avoid ESD and mechanical damage to the packages during handling and transfer.

4.7 Acoustic Microscope: See IPC-TM-650 Test Method 2.6.22, Acoustic Microscopy for Plastic Encapsulated Electronic Components, for details of AM applicable to this analysis.

4.8 Fluorescent or opaque penetrant liquid. For process information, see Volume 2 of Nondestructive Testing Handbook, 2nd Edition.

4.9 Package ''cracker,'' opener, or vise.

4.10 Camera and color film.

4.11 Metallurgical microscope with up to 400x capability.

4.13 Electrical/Electronic testing equipment.

4.14 Dry air or dry nitrogen storage cabinet or sealable moisture barrier bag with desiccant. See MIL-B-81705, Type 1; MIL-I-8835; and MIL-D-3464, Type 11.

5.0 Procedure The same evaluation method(s) and criteria should be applied before and after each stress. See Figure 1: Evaluation Flow of Acceptance Criteria.

5.1 Prepare and mark units for evaluation per section 3.

5.2 Electrically test the components. Record the results.

5.3 Inspect package visually for external cracks using a magnification of 10 - 40X. Record observations. The vulnerable surfaces of the package must be visually accessible; the required inspection method is generally not effective for a package mounted onto a substrate. Use oblique (glancing angle) directed lighting for detection and identification of bulges\and cracks. Light pipes are recommended.

5.4 Acoustic Microscopy Use AM to detect initial internal delamination and cracking. See IPC-TM-650 Test Method 2.6.22. Record images and analyst's observations. If these parts do not meet the acceptability criteria found in IPC-SM-786 these parts are not usable for this test procedure. Contact the supplier of the components.

5.5 Moisture Bake-Out Bake units 6 hours at 125°C for packages less than 2mm package body thickness and 24 hours at 125C for thicker packages.

5.6 Dry Weight (W1) Weigh units to determine the dry weight. Units in a cell may be weighed together. Avoid touching the units. Record the weight.

5.7 Moisture Introduction (soak)

5.7.1 Ensure that the T/H chamber is stable at the required temperature and humidity setpoints per IPC-SM-786.

5.7.2 Place the packages in a clean holder which allows free circulation of air and prevents mechanical damage.

5.7.3 Place the holder in the chamber. See IPC-SM-786 for the appropriate duration.

5.7.4 Remove the packages from the chamber. Blow off any surface droplets with clean dry air or dry nitrogen. Avoid touching the package.

5.7.5 The units must be weighed no sooner than 15 minutes after removal from the T/H chamber. Units must be exposed to VPS reflow within one hour for thin packages (4 hours for packages 2mm or greater) from the time the packages were removed from the T/H chamber.

5.8 Post Moisture Soak Weight (W2) Weigh Units Units in a cell may be weighed together. Avoid touching the units. Record the weight. Report weight changes where weight losses and gains are defined below.

Weight Gain = W2-W1

Percent Weight Gain = 100 * (W2-W1)/W1

5.9 Vapor Phase Reflow exposure

5.9.1 Ensure that the vapor is at the correct temperature, per the thermal profile, the condensing system is functioning properly, and that the amount of VPS fluid is adequate.

5.9.2 Place the packages in the holder.

5.9.3 Lower the holder into the vapor such that the packages are blanketed at all times by the vapor. The transition rate shall be 2-10°C/second. The dwell time of the packages in the vapor must match the attached thermal profile (immersion time: 60 ±5 sec.).

5.9.4 Raise the holder out of the vapor. **Warning, the tray and components will be very hot!**

5.9.5 Cool at room temperature for five minutes and repeat sections 5.9.3 and 5.9.4 for 3 cycles, total.

5.10 Post-reflow Electrical Test. Electrically test the components. Record the results.

5.11 Post-reflow Visual Inspection Inspect packages visually for external cracks using a magnification of 10 - 30X. See 5.3 for correct procedure. Record observations.

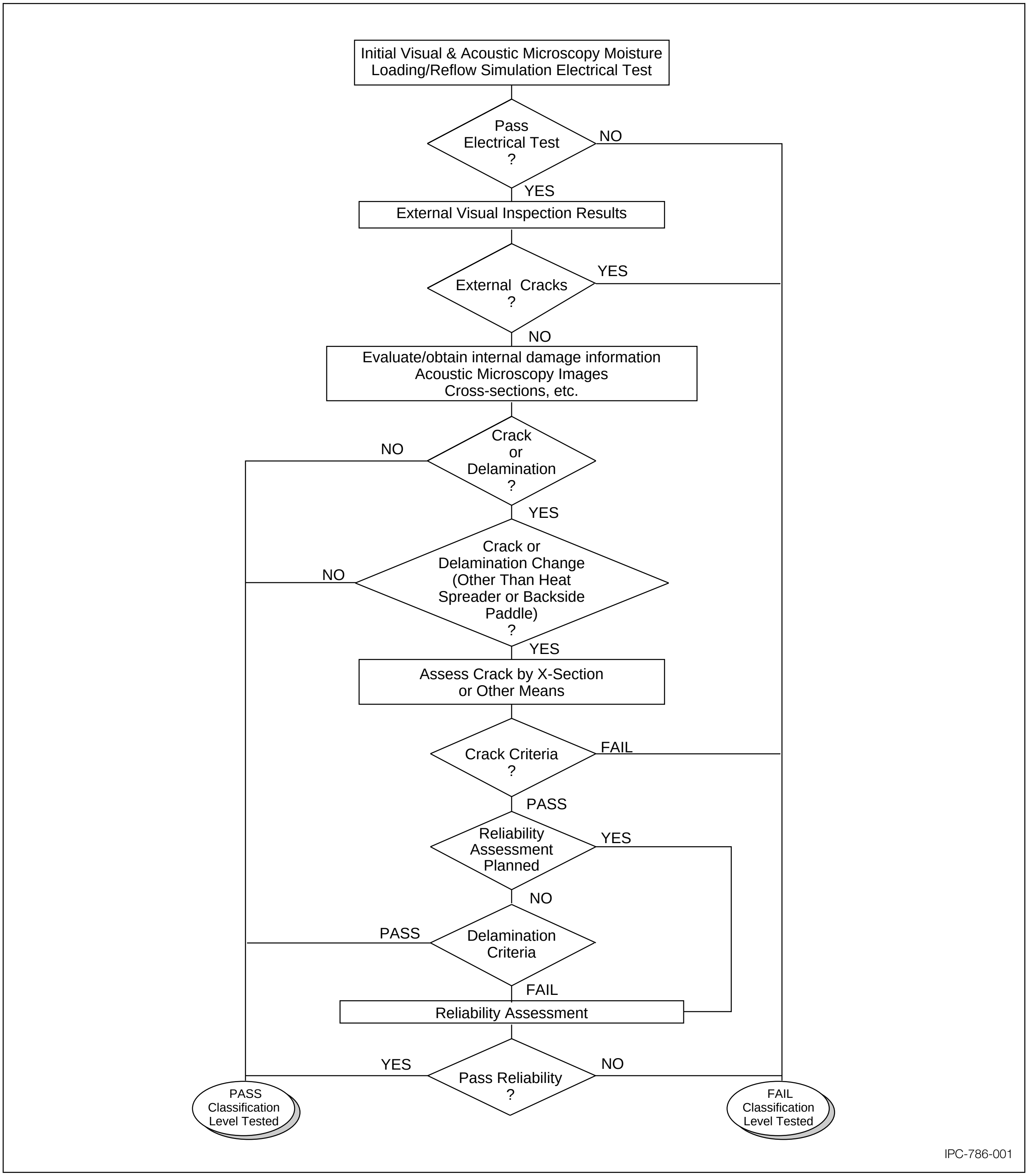

Figure 1 Flow of Accepting Criteria: Table 4–2 of IPC-SM-786A

5.12 Post-reflow Acoustic Microscopy Use AM to detect post-reflow internal delamination and cracking. See IPC-TM-650 Test Method 2.6.22. Record images and analyst's observations. If these parts do not meet the acceptability criteria found in IPC-SM-786 these parts fail the tested level.

5.13 Destructive Physical Analysis (DPA) / Cross Sections Cross-sectioning is the common method of verifying the existence of internal cracks and delamination. Cross-section through the area of interest found by acoustic microscopy. Caution: The literature indicates that the act of cross sectioning may induce delamination where no delamination existed prior to DPA. DPA is recommended to verify failures detected by AM.

Opaque or fluorescent liquids can be used to highlight cracks or delaminations which extend to the surface of the package. The package must be cross-sectioned to quantify the extent of cracking and associated delamination. Color photomicrographs can be used to document the internal cracking/delamination.

6.0 Reporting the Results

6.1 Report the supplier, part number (device type), package type, geometry and material details, lot/date code or base.

6.2 Report time/temperature/humidity soak conditions and VPS profile used.

6.3 Report package performance, PASS or FAIL. The acceptance criteria for moisture/reflow sensitivity classification levels are listed in IPC-SM-786, Paragraph 4.1.2.

6.3.1 Visual inspection observations: number of units with cracks which exceed the acceptance criteria, sample size, and magnification used. For each unit record the location and size of all cracks and delaminations.

6.3.2 Electrical test results: number of units, number of failures, failure mode, and test temperature(s) at failure.

6.3.3 Acoustic microscopy results as defined in IPC-TM-650 Test Method 2.6.22.

6.3.4 Cross-section observations: number of units with cracks which exceed the acceptance criteria, sample size, and magnification used. For each unit record the location and size of all cracks and delaminations.