

JEDEC STANDARD

Solder Ball Pull

JESD22-B115A.01

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JEDEC SOLID STATE TECHNOLOGY ASSOCIATION



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TEST METHOD B115A.01

SOLDER BALL PULL

(From JEDEC Board Ballot JCB-10-14 and JCB-16-17, formulated under the cognizance of the JC-14.1 Subcommittee on Reliability Test Methods for Packaged Devices.)

1 Scope

This document describes a test method only; acceptance criteria and qualification requirements are not defined. This test method applies to solder ball pull force/energy testing prior to end-use attachment. Solder balls are pulled individually using mechanical jaws; force, fracture energy and failure mode data are collected and analyzed. Other specialized solder ball pull methods using a heated thermode, gang pulling of multiple solder joints, etc., are outside the scope of this document. Both low- and high-speed testing are covered by this document.

Depending on test sample configuration, application and purpose of the test (characterization, qualification, production, etc.), other solder joint integrity assessment methods such as JEDEC Solder Ball Shear Test Method JESD22-B117, may be more appropriate. Generally, solder ball pull is most appropriate for devices that experience tensile loading during either the manufacturing/shipment process or end use, and have non-oblate (spherical, non-flattened) solder balls.

This test method is used to assess the ability of solder balls to withstand mechanical pull forces that may be applied during device manufacturing, handling, test, shipment and end-use conditions. To provide a tensile load, this solder joint integrity assessment technique employs mechanical jaws to clamp an individual solder ball of a free (unmounted) test sample. Solder ball pull is a destructive test.

2 Terms and definitions

ball extrusion: Extreme deformation of a solder ball that may occur during an actual pull test due to factors such as insufficient jaw clamping pressure, incorrect jaw selection, etc.

clamping fixture: A fixture that holds the test sample rigidly during solder ball pull testing (see Figure 2).

elapsed time after reflow: The elapsed time between solder ball pull and last reflow of solder ball.

failure mode: The type or location of failure observed after the solder ball is pulled.

2 Terms and definitions (cont'd)

fracture energy: The total energy required to fracture the solder ball; typically calculated by integrating the force versus displacement during the solder ball pull process.

jaw clamping pressure: The applied pressure exerted upon the solder ball by the pull tool.

high-speed pull: Pull speed that is typically 50 – 1,000 mm/s, but can extend beyond this range.

low-speed pull: Pull speed that is typically 0.1 – 15 mm/s.

null drift calibration: The procedure whereby the load transducer output is periodically reset to a value of zero, separate from a transducer calibration.

post-stress test: Solder ball pull evaluation performed after reliability stress testing such as temperature cycling or high temperature storage.

pull force: The tensile loading action applied to a solder ball in a direction perpendicular to the test sample planar surface.

pull jaw: The tool that physically clamps the solder ball during the pull test (see Figure 2).

pull speed: The nominal rate at which the pull tool moves in a direction perpendicular to the planar device surface as it pulls the solder ball.

solder pad opening diameter: The dimension defined by the base of a solder ball where the ball is bonded to a metallic surface.

test instrument: An apparatus used to pull the solder ball from the test sample and measure the load applied to the solder ball (see Figure 1).

3 General Ball Pull Apparatus

A general solder ball pull apparatus is depicted in Figure 1. The test apparatus can be specifically designed for solder ball pull testing, or it may be possible to utilize a general mechanical load-deflection test instrument. The apparatus must be capable of pulling solder balls at a known constant rate of displacement (test speed) and must be capable of recording generated tensile loads as a function of time through the use of a calibrated load cell or sensing element. Depending upon specific test sample construction and application, critical parameters associated with the test apparatus may vary from one test to another; Section 4 describes the various test parameters and the recommended reporting of these variables.

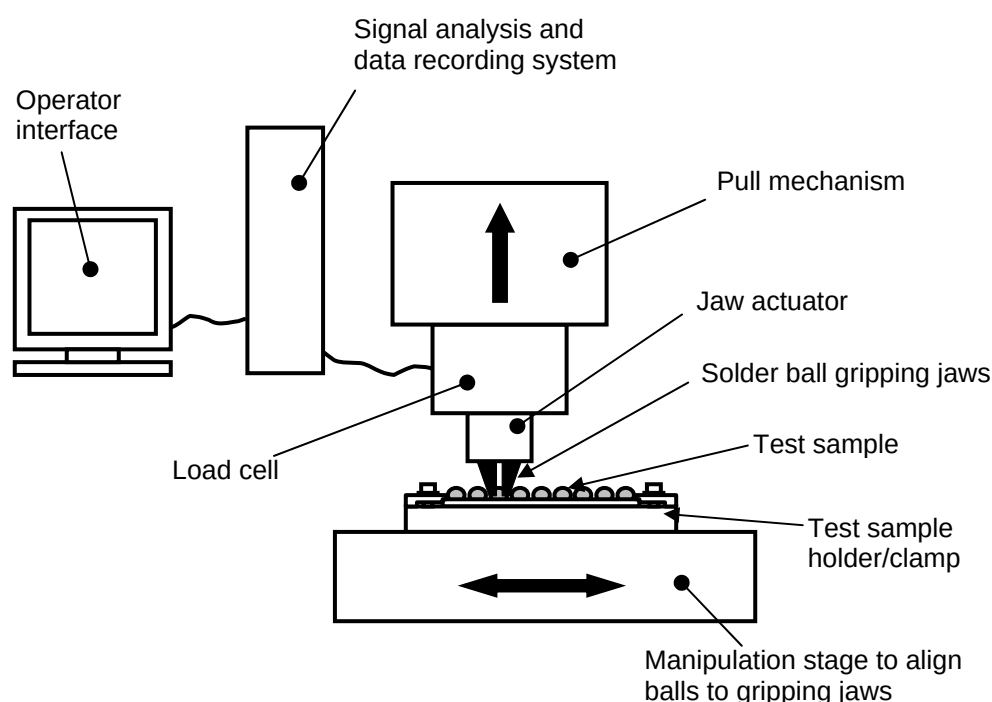


Figure 1 — General solder ball pull apparatus

4 Procedure

4.1 Solder Ball Composition

This test method applies to any solder ball composition (SnPb, SnAgCu, etc.) or construction type (homogeneous solder alloy, solder-coated organic or metallic core, etc). Alternative failure mode assessment categories may be required for some solder ball configurations. Some solder ball materials may not be suitable for testing due to excess deformation or damage during the clamping and pulling operations, e.g., elastomer-core solder balls, etc..

4 Procedure (cont'd)

4.2 Base Material

The test sample base material may be of organic or inorganic composition, and of any surface mount configuration (BGA, CSP, etc.). Base material solder ball land pads may have a plated, deposited or coated surface finish. Silicon-based test samples may be more suitably evaluated using JEDEC Flip Chip Tensile Pull Test Method JESD22-B109, depending upon solder ball geometry, solder composition, etc. Some base materials may exhibit a predominant pad cratering failure mode, e.g., PTFE, polyimide-tape, etc.; for these cases IPC-9708, Pad Crater Test Method, may be a more appropriate test method.

4.3 Preconditioning

The reflow temperature profiles associated with direct surface mount and rework processes can affect solder ball pull strength, failure mode and correlation to mechanical shock performance. Consequently, the reflow profile and total number of solder ball reflows should be recorded and kept consistent among comparative test samples. Test sample moisture loading prior to reflow is not required. Test sample bake-out prior to reflow may be required if catastrophic damage at the solder ball attach region would otherwise occur due to the presence of moisture. Preconditioning may include the addition of materials into already formed solder balls, such as Cu, to better replicate final solder ball composition of a device attached to a circuit board.

4.4 Clamping Fixture

The clamping fixture must be designed to prevent the movement of the test sample and ensure that the test sample planar surface is held perpendicular to the tool travel direction. Inadequate clamping may alter solder joint failure mode as well as fracture strength. The clamping fixture should hold the sample securely without deforming the test sample or imparting any bow or twist. It is particularly critical for high-speed pull testing that the clamping fixture is rigidly attached to the machine, and that any displacement or deformation is minimized to avoid resonant excitation of the test sample at the test speed.

Regardless of pull speed, solder balls should not be tested over unsupported sections, e.g., exposed substrate region for typical overmolded BGA; custom fixturing may be required to provide support across the entire test sample. In some cases, even custom fixturing may not be feasible to counter internal construction variations that may alter test results, such as a cavity in a lidded sample.

To minimize eccentric loading on the force transducer assembly during high-speed testing, the clamping fixture should allow lateral movement of the sample, relative to the fixture, to position the tested solder ball over the lift table central axis. In addition, perpendicularity of the fixture and the tool travel direction is particularly critical for high-speed testing to reduce the potential for lateral loading along the tool travel distance.