JEDEC STANDARD

Wire Bond Shear Test Method

JESD22-B116B

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JEDEC SOLID STATE TECHNOLOGY ASSOCIATION

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TEST METHOD B116B
WIRE BOND SHEAR TEST

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

1 Scope

This test provides a means for determining the strength of a ball bond to a die or package bonding surface, and may be performed on pre-encapsulation or post-encapsulation devices. This measure of bond strength is extremely important in determining two features:

1) the integrity of the metallurgical bond which has been formed, and

2) the quality of ball bonds to die or package bonding surfaces.

This test method covers thermosonic (ball) bonds made with small diameter wire from 15 µm to 76 µm (0.6 mil to 3.0 mil).

This test method can only be used when the bonds are large enough to allow for proper contact with the shear test chisel and when there are no adjacent interfering structures that would hinder the movement of the chisel. For consistent shear results the ball height must be at least 4.0 µm (0.16 mils) for ball bonds, which is the current state of the art for bond shear test equipment at the time of this revision.

This test method can also be used on ball bonds that have had their wire removed and on to which a 2nd bond wire (typically a stitch bond) is placed. This may be known as “stitch on ball” and “reverse bonding”. See Annex A for additional information.

The wire bond shear test is destructive. It is appropriate for use in process development, process control, and/or quality assurance.

This test method may be used on ultrasonic (wedge) bonds, however its use has not been shown to be a consistent indicator of bond integrity. See Annex B for information on performing shear testing on wedge bonds.

2 Terms and definitions

For the purposes of this standard, the following terms and definitions apply:

2.1 ball bond: The adhesion or welding of a small diameter wire, typically gold or copper, to a bonding surface metallization, usually an aluminum alloy, using a thermosonic wire bond process.

NOTE 1 The ball bond includes the enlarged spherical, or nail-head, portion of the wire (provided by the flame-off and first bonding operation), the underlying bonding surface and the ball bond-bonding surface metallurgical weld interface.

NOTE 2 Gold wire implies a gold alloy in which the gold content is likely 99% or greater. Copper wire implies a copper alloy of similarly high copper content and also includes copper wire with a very thin coating of palladium.

NOTE 3 At the time of this revision, other wire materials and wire coatings are being evaluated, but there is not enough information collected to confirm that the fail modes listed in this test method are valid for any of the new wire types.

2.2 bonding surface: Either 1) the die pad metallization or 2) the package surface metallization to which the wire is ball bonded.

2. bond shear: A process in which an instrument uses a chisel-shaped tool to shear or push a ball bond off the bonding surface (see Figure 1).

NOTE The force required to cause this separation is recorded and is referred to as the bond shear force. The bond shear force of a ball bond, when correlated to the diameter of the ball bond, is an indicator of the quality of the metallurgical bond between the ball bond and the bonding surface metallization.

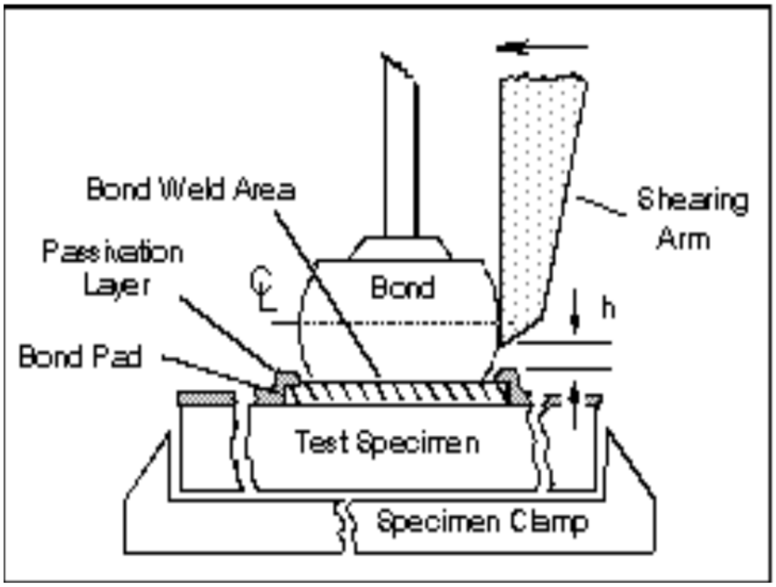


Figure 1 — Bond shear set-up for bond on die bonding pad
(Similar setup for bonds on other bonding surfaces, such as package substrate/leadframe)

2 Terms and definitions (cont’d)

2.4 shear tool; shear arm: A chisel (made of tungsten carbide or an equivalent material with similar mechanical properties) with specific angles on the bottom and back of the tool to ensure a shearing action.

2.5 stitch bond: The second bond during the ball (thermosonic) bonding process, in which the wire is typically bonded to the package bonding surface.

NOTE 1 A stitch bond may also be referred to as a crescent bond.

NOTE 2 For some unique constructions (e.g., “stitch on ball”), the second bond may be formed on top of another ball bond, from which the wire has been removed.

2.6 wedge bond: The adhesion or weld of a thin wire, typically aluminum, copper, or gold to a die pad metallization or the package bonding surface, usually a plated leadframe post or finger, using an ultrasonic wire bonding process.

NOTE See Annex B for information on performing shear testing on wedge bonds.

3 Apparatus and material

The apparatus and materials required for bond shear shall be as follows:

3.1 Inspection equipment

An optical microscope system or scanning electron microscope providing a minimum of 70X magnification. A higher magnification may be necessary for 15 µm (0.6 mil) diameter wire.

3.2 Measurement equipment

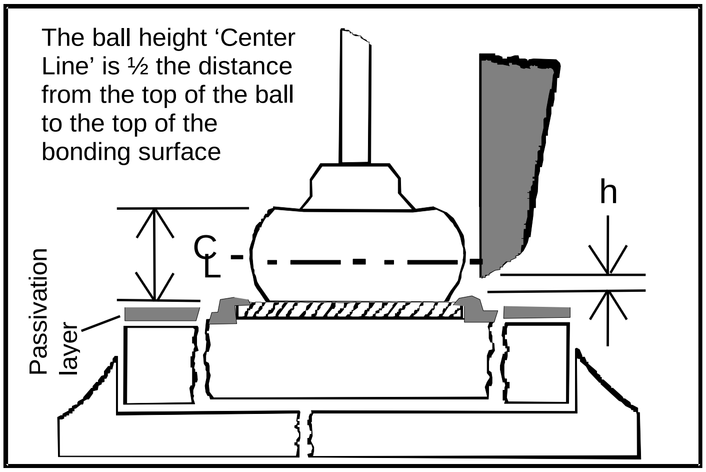
An optical microscope/measurement system capable of measuring the bond diameter to within ± 2.54 µm (0.10 mil).

3.3 Workholder

Fixture used to hold the part being tested parallel to the shearing plane and perpendicular to the shear tool. The fixture shall also eliminate part movement during bond shear testing. If using a caliper controlled workholder, place the holder so that the shear motion is against the positive stop of the caliper. This is to ensure that the recoil movement of the caliper controlled workholder does not influence the bond shear test.

3.4 Bond shear equipment

The bond shear equipment must be capable of repeatable, precision placement of the shearing tool with respect to the ball height and the bonding surface. The specified distance (h) above the topmost part of the bonding surface (e.g., passivation layer on IC, solder mask on organic substrate) shall ensure the shear tool does not contact the bonding surface (e.g., top passivation or polyimide layer, soldermask) and shall be less than the distance from the topmost part of the bonding surface to the center line (C_L) of the ball bond (see Figure 2). See Annex C for guidance when the passivation, or other structures on the die surface and excessive Al splash prevent the shear tool from contacting the ball below the center line.



The ball height 'Center Line' is ½ the distance from the top of the ball to the top of the bonding surface

Figure 2 — Proper height placement of shear tool with respect to ball center line

3.5 Bond shear chisel tool setup

When choosing the proper chisel for the bond being sheared items to consider include but are not limited to: flat shear face, sharp shearing edge, shearing width of a minimum of 1.2X the bond diameter, and bond length. The sample and chisel face should be clean and free of chips or other defects that will interfere with the shearing test.

Bonds should also be examined to determine if adjacent interfering structures are far enough away to allow suitable placement and clearance (above the bonding surface and between adjacent bonds) for the shear test tool.