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Part 22-2: Bond strength - Wire bond shear test methods

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



47/2889/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: IEC 60749-22-2 ED1	
DATE OF CIRCULATION: 2024-12-13	CLOSING DATE FOR VOTING: 2025-03-07
SUPERSEDES DOCUMENTS: 47/2884/RR	

IEC TC 47 : SEMICONDUCTOR DEVICES	
SECRETARIAT: Korea, Republic of	SECRETARY: Mr Cheolung Cha
OF INTEREST TO THE FOLLOWING COMMITTEES:	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED:	
☐ SUBMITTED FOR CENELEC PARALLEL VOTING	☒ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any relevant "In Some Countries" clauses to be included should this proposal proceed. Recipients are reminded that the CDV stage is the final stage for submitting ISC clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE: Semiconductor devices - Mechanical and climatic test methods - Part 22-2: Bond strength - Wire bond shear test methods

PROPOSED STABILITY DATE: 2031

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SEMICONDUCTOR DEVICES –
MECHANICAL AND CLIMATIC TEST METHODS –****Part 22-2: Bond strength - wire bond shear test methods**

FOREWORD

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IEC 60749-22-2 has been prepared by IEC technical committee 47: Semiconductor devices. It is an International Standard.

This first edition together with the first edition of IEC 60749-22-1, cancels and replaces IEC 60749-22 published in 2002 and is based on JEDEC document JESD22-B116B. It is used with permission of the copyright holder, JEDEC Solid State Technology Association.

This edition includes the following significant technical changes with respect to the previous edition:

Major update, including new techniques and use of new materials (e.g. copper wire) involving a complete rewrite as two separate subparts (this document and IEC 60749-22-1)

141 The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

142
143 Full information on the voting for its approval can be found in the report on voting indicated in
144 the above table.

145 The language used for the development of this International Standard is English

146 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
147 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available
148 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are
149 described in greater detail at www.iec.ch/publications.

150 The committee has decided that the contents of this document will remain unchanged until the
151 stability date indicated on the IEC website under webstore.iec.ch in the data related to the
152 specific document. At this date, the document will be

- 153 • reconfirmed,
- 154 • withdrawn,
- 155 • replaced by a revised edition, or
- 156 • amended.
- 157

SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

PART 22-2: BOND STRENGTH - WIRE BOND SHEAR TEST METHODS

1 Scope

This test method establishes 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:

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

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 (0,000 6 “to 0,003”).

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 (0,000 6 “) 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.

This test method does not include bond strength testing using wire bond pull testing. Wire bond pull testing is described in IEC 60749-22-1, Bond strength testing – Wire bond pull test methods.

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.

IEC 60749-22-1, *Semiconductor devices – Mechanical and climatic test methods – Part 22-1: Bond strength testing – Wire bond pull test methods.*

For undated references, the latest edition of the referenced document (including any amendments) applies.

Also see Bibliography (informative) references.

3 Terms and definitions

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

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

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

3.1

ball bond

adhesion or welding of a small diameter wire, typically gold or copper, to a bonding surface metallization, usually an aluminium alloy, using a thermosonic wire bond process

Note 1 to entry: 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 to entry: 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 to entry: 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.

3.2

bonding surface

either 1) die pad metallization or 2) package surface metallization to which the wire is ball bonded

3.3

bond shear

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.

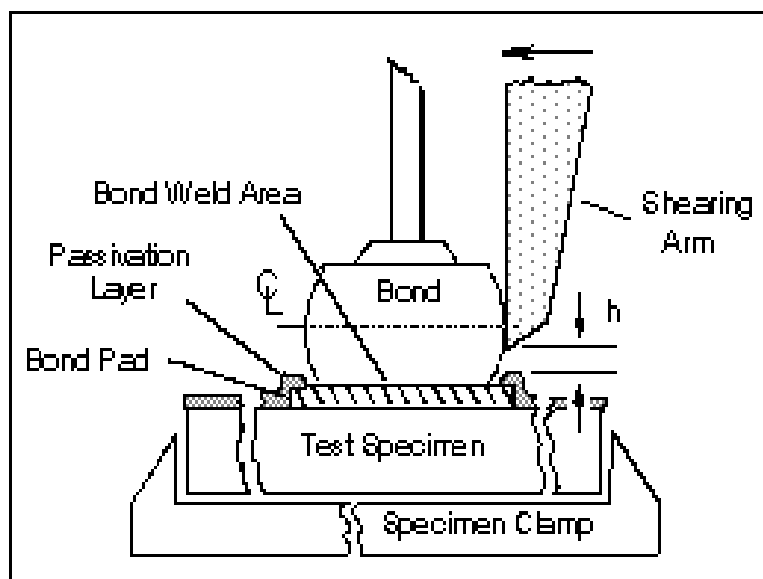


Figure 1 — Bond shear set-up for bond on die bonding pad
(Similar setup for bonds on other bonding surfaces, such as package substrate/leadframe)

3.4

shear tool; shear arm

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

3.5

stitch bond

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

Note 1 to entry: A stitch bond may also be referred to as a crescent bond.

Note 2 to entry: 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.

3.6

wedge bond

adhesion or weld of a thin wire, typically aluminium, 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 to entry: See Annex B for information on performing shear testing on wedge bonds.

4 Apparatus and material required

4.1 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 (0,000 6") diameter wire.

4.2 Measurement equipment

An optical microscope/measurement system capable of measuring the bond diameter to within $\pm 2,54 \mu\text{m}$ (0,000 1").

4.3 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 calliper controlled workholder, place the holder so that the shear motion is against the positive stop of the calliper. This is to ensure that the recoil movement of the calliper controlled workholder does not influence the bond shear test.

4.4 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, solder mask) and shall be less than the distance from the topmost part of the bonding surface to the centre line (CL) 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 centre line.

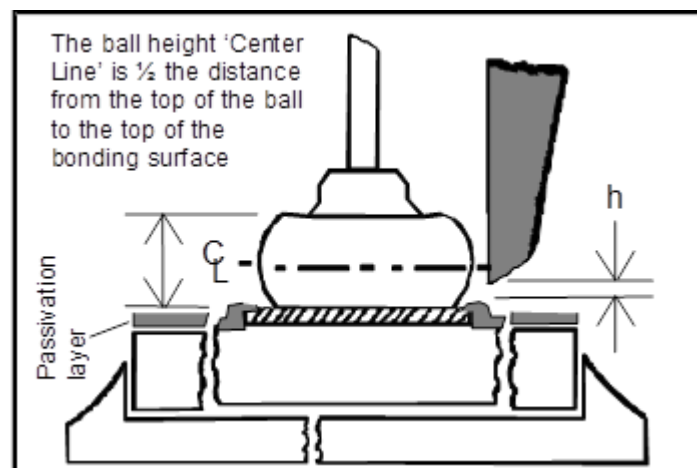


Figure 2 — Proper height placement of shear tool with respect to ball centre line

4.5 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.

5 Procedure

5.1 Calibration

Before performing the bond shear test, it must be determined that the equipment has been calibrated in accordance with manufacturer's specifications and is presently in calibration. Recalibration is required if the equipment is moved to another location.