SLOVENSKI STANDARD
oSIST prEN IEC 60749-22-2:2025

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Polprevodniški elementi - Metode za mehansko in klimatsko preskušanje - 22-2. del: Moč vezi - Preskusne metode za strižno vezavo žice

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

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ICS:

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COMMITTEE DRAFT FOR VOTE (CDV)

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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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TITLE:

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

PROPOSED STABILITY DATE: 2031

NOTE FROM TC/SC OFFICERS:

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SEMICONDUCTOR DEVICES – MECHANICAL AND CLIMATIC TEST METHODS –

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

FOREWORD

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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

158

159 # SEMICONDUCTOR DEVICES –
160 # MECHANICAL AND CLIMATIC TEST METHODS –
161
162 # PART 22-2: BOND STRENGTH - WIRE BOND SHEAR TEST METHODS
163
164

165 ## 1 Scope

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

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

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

171 This test method covers thermosonic (ball) bonds made with small diameter wire from 15 µm to
172 76 µm (0,000 6“to 0,003”).

173 This test method can only be used when the bonds are large enough to allow for proper contact
174 with the shear test chisel and when there are no adjacent interfering structures that would hinder
175 the movement of the chisel. For consistent shear results the ball height must be at least 4 ,0 µm
176 (0,000 6 “) for ball bonds, which is the current state of the art for bond shear test equipment at
177 the time of this revision.

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

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

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

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

188

189 ## 2 Normative references

190 The following documents are referred to in the text in such a way that some or all of their content
191 constitutes requirements of this document. For dated references, only the edition cited applies.

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

194 For undated references, the latest edition of the referenced document (including any
195 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.

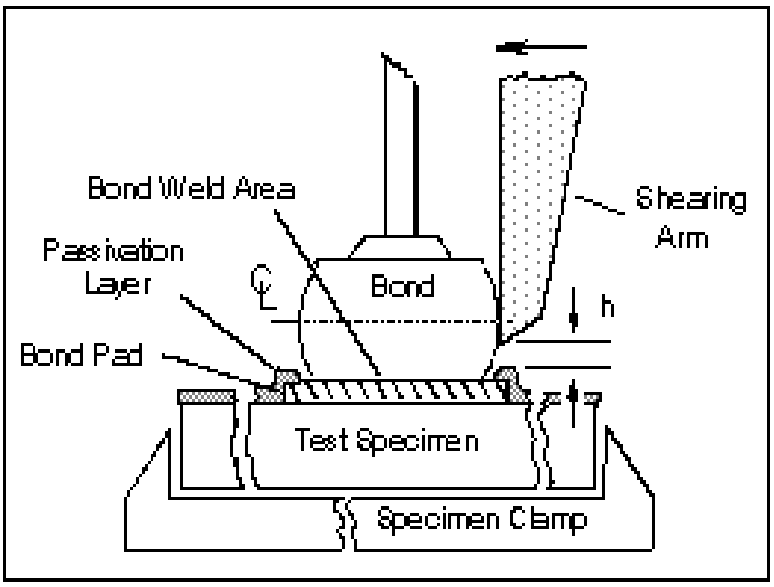

Figure 1 — Bond shear set-up for bond on die bonding pad (Similar setup for bonds on other bonding surfaces, such as package substrate/leadframe)

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 ± 2,54 µm (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.

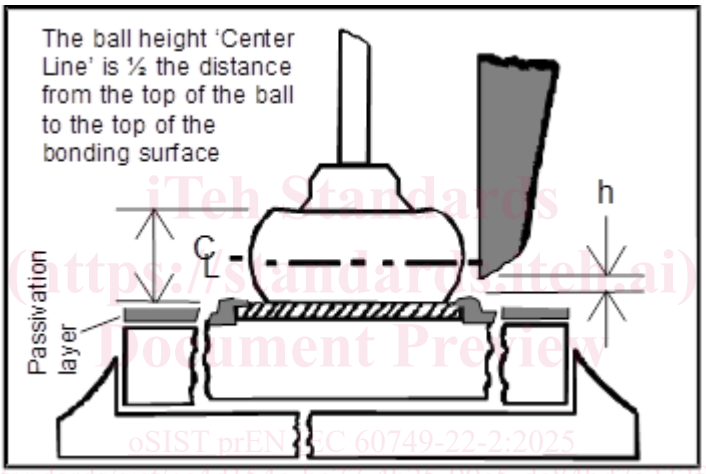

Figure 2 — Proper height placement of shear tool with respect to ball centre line

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.