Proposed Reliability Tests

Tests on fully loaded hybrids

* Visual Inspection

* Bond Strength & Lifetime

* Solder pad adhesion

Tests on modules

* Intermittent life

* Thermal cycling

Visual Inspection (I)

* Purpose: The purpose of this test is to inspect the visible top metal layer(s) of the hybrid and passive components mounted on the hybrid. It shall be performed on a 100 percent inspection basis to detect and eliminate hybrids with visual defects that could lead to failure in normal operation.

* Apparatus: Stereo Microscope capable of the needed magnification, ESD protected work place, appropriate fixture/protection for hybrid or module, dust-free environment

* Procedure: A check list shall be used

* Note: For hybrids with thin film/printed resistors or capacitors refer to the full original standard

* Points to be inspected: See next page

Ref: MIL-STD-883E, Method 2032.1

Visual Inspection (II)

Points to be inspected:

o Bonding pads -- MIL-STD-883E Method 2032.1, page 40
o Metal traces: Scratches -- MIL-STD-883E Method 2032.1, page 39

Voids -- See MIL-STD-883E Method 2032.1, page 41

o Corrosion, Adherence, Protrusion -- MIL-STD-883E Method 2032.1, p. 43
o Overlap -- MIL-STD-883E Method 2032.1, page 43
o Substrate defects -- MIL-STD-883E Method 2032.1, page 45-46
o Nonplanar element inspection -- MIL-STD-883E Method 2032.1, pp. 54-62

Bond Strength (I)

* Purpose: The purpose of this test is to measure the strength of the wedge wire bonds at the die, the hybrid, the fanout and the detector.

* Apparatus: Suitable equipment for applying the specified stress to the bond. A calibrated measurement of the applied force in grams with an accuracy of 5 percent shall be provided by the equipment.

* Procedure: The wire shall be cut so as to provide two ends accessible for pull tests. The wire shall be gripped in a suitable device and simple pulling action applied to the wire (or the device) in such a manner that the force is applied approximately normal to the surface of the die or substrate. When a failure occurs, the force causing the failure and the failure category shall be recorded.

Ref: MIL-STD-883E Method 2011.7

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Bond Strength (II)

* Sample: At least 4 hybrids for each manufacturing lot available shall be randomly chosen. On each device, 10 bonds

o From the die to the hybrid
o From the die to the fanout
o From the fanout to the detector shall be taken at random.

* Required strength:

Wire composition and diameter	Minimum strength (g)
Al 0.0007 in	1.5
Au 0.0007 in	2.0
Al 0.0010 in	2.5
Au 0.0010 in	3.0
Al 0.00125/0.0013	3.0
Au 0.00125/0.0013	4.0
Al 0.0015 in	4.0
Au 0.0015 in	5.0

Bond Strength (III)

* Failure Categories:

1) Wire break at neckdown point
2) Wire break at point other than neckdown point
3) Failure in bond (interface between wire and metallization) at die
4) Failure in bond at hybrid
5) Failure in bond at fanout
6) Failure in bond at detector
7) Lifted metallization from die
8) Lifted metallization from hybrid
9) Lifted metallization from fanout
10) Lifted metallization from detector
11) Other fatal failures (broken die etc). Describe.

Bond Strength (IV)

* Accept:

o Zero failures
o Proper operation of the equipment is indicated when $s(X) < 0.25 X$, where X is the average bond pull strength.

Bond Lifetime: Temperature Aging (I)

* Purpose: The purpose of this test is to test the reliability of the wire bonds for the qualification of a specific hybrid and bonding technology.

* Sample: At least 4 hybrids from each production lot available.

* Procedure: The sample shall be exposed to elevated temperature of 150 deg.C during 1000 hours. Destructive bond pull test shall be performed before, several times during and after the 1000 hours. Humidity shall be small.

* Accept: All samples fulfill the requirements of the destructive bond pull test

Ref: Wire Bonding in Microelectronics, George Harman, McGraw Hill 1997

Bond Lifetime: Temperature Aging (II)

* Time-Temperature Regression: In case above temperature is higher than the maximum operating temperature specified for a given hybrid technology, or the available time is too short, the following time-temperature regression shall be applied (scaled from MIL-STD-883E, Method 1005.8)

Temp (deg.C)	Time (h)
125	5434
135	2695
150	1000
175	217
190	163

Bond Lifetime: Humidity Aging

* Purpose: The purpose of this test is to test the reliability of the wire bonds for the qualification of a specific hybrid and bonding technology.

* Sample: At least 4 hybrids from each production lot available.

* Procedure: The sample shall be exposed to 85 deg.C/85% R.H. during at least 24 hours. Destructive bond pull test shall be performed before, after 12 h and after 24 h.

* Accept: All samples fulfill the requirements of the destructive bond pull test.

Ref: Wire Bonding in Microelectronics, George Harman, McGraw Hill 1997

Solder Pad Adhesion

* Purpose: The purpose of this test is to check the capabilities of the hybrid solder pads to withstand a delamination (peel) stress of specified tension and time.

* Sample: 4 pads of 4 hybrids (16 pads in total) for each production lot.

* Note: This test is a modification of the original method 2004.5.

* Procedure: A copper wire with gauge as close to the pad width as possible, shall be soldered to the pad to be tested. A tension of x g (suggested value: 227 g) shall be applied to the wire, without shock, in a direction orthogonal to the hybrid. Test time is 30 seconds.

* Figure: See MIL-STD-883E, Method 2004.5, page 7

* Failure: Any evidence of loosening or breakage.

Ref: MIL-STD-883E, Method 2004.5

Modules: Intermittent Life

* Purpose: The purpose of this test is to determine a representative failure rate for modules and/or demonstrate the reliability of the devices.

* Sample: As large as affordable.

* Procedure: DUT's shall be exposed to 125 deg.C for 1000 hours minimum. Before, several times during and after the test, the devices shall be electrically tested. The hybrids shall be operated at nominal conditions during 50% of the time. The on and off periods shall be initiated by sudden, not gradual, application or removal of input signals and bias voltages. Current limiting resistors may be necessary. Testing at higher/lower temperature shall be performed if necessary according to the time-temperature regression table.

Ref: MIL-STD883E, Method 1006 and MIL-STD883E, Method 1005.8

Modules: Temperature and Power Cycling

* Purpose: The temperature & power cycling test is performed to determine the ability of the modules to withstand alternate exposures at high and low temperatures with operating bias periodically applied and removed.

* Temperature Cycles: -40 deg.C lower temperature, +125 deg.C higher temp.

Transition time 30 minutes max

Dwell time at each temp extreme: 10 minutes min

1000 Cycles

* Power Cycles: switch on/off every 5 minutes

* Failure Criteria: Any exceeding of parametric limits of the electrical or mechanical specifications. Measurements shall be done 5 times in total.

Ref: EIA/JEDEC Standard, Test Method A105-B

References

* Military standards and test methods

o MIL-STD-883E
o Their home page

* JEDEC Standards and test methods

o Their home page

* Proposed set of electrical measurements