How to test bonds » Stud pull
MIL-STD-883 method 2031.1 Flip-chip pull-off test

1. PURPOSE

The purpose of this test is to measure the strength of internal bonds between a semiconductor die and a substrate to which it is attached in a face-bond configuration.

2. APPARATUS

The apparatus for this test shall consist of suitable equipment for applying the specified stress to the bonds. A calibrated measurement and indication of the applied stress in grams force (gf) shall be provided by equipment capable of measuring stresses up to twice the specified minimum limit value, with an accuracy of ±5 percent or ±0.25 gf, whichever is the greater tolerance.

3. PROCEDURE

The test shall be conducted using the following procedure. All die pulls shall be counted and the specified sampling, acceptance, and added sample provisions shall be observed, as applicable. The sample size number and accept number specified shall determine the number of die to be tested (not bonds). For hybrid or multichip devices, a minimum of 4 die or all die if four are not available on a minimum of 2 completed devices shall be used. All pull tests shall be performed prior to the application of encapsulants, adhesive, or any material which may increase the apparent bond strength.

When flip chips are bonded to substrates other than those in completed devices, the following conditions shall apply:

   a. The sample of chips for this test shall be taken at random from the same chip population as that used in the completed devices that they are intended to represent.

   b. The chips for this test shall be bonded on the same bonding apparatus as the completed devices, during the time period within which the completed devices are bonded.

   c. The test chip substrates shall be processed, metallized, and handled identically with the completed device substrates, during the same time period within which the completed device substrates are processed.

1. Testing

The calibrated pull-off apparatus (see 2) shall include a pull-off rod (for instance, a current loop of nichrome or Kovar wire) having a cross-sectional area of 75
percent, +3 percent, -5 percent of the chip surface area. The rod shall make connection with a hard setting adhesive material (for instance, a cyanoacrylate or other adhesive possessing high tensile strength) on the back of the flip chip. The substrate shall be rigidly installed in the pull-off fixture and the pull-off rod shall make firm mechanical connection to the adhesive material. The die shall be pulled without shock, within 5° of the normal at a rate of 500 grams ±100 grams per second, until the die separates from the substrate. When a failure occurs, the force at the time of failure, the calculated force limit, and the failure category shall be recorded.

2. Failure criteria

Any flip-chip pull which results in separation under an applied stress less than 500 kg/in² x average solder bump area (in²) x number of solder bumps shall constitute a failure.

1. Failure category

Failure categories are as follows: When specified, the stress required to achieve separation and the predominant category of separation or failure shall be recorded.

- Silicon broken
- Lifted metallization from chip
- Separation at bond-chip interface
- Failure within bond
- Separation at bond-substrate interface
- Lifted metallization from substrate
- Substrate broken

4. SUMMARY

The following details shall be specified in the applicable acquisition document.

- Minimum bond strength if other than specified in 3.2 or details of required strength distributions if applicable.
- Sample size number and accept number and selection and the number of die to be tested, if other than 4
- Requirement for reporting of separation forces and failure categories, when applicable (see 3.2.1).
End of 2031.1

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