

Notice of Change

This document and process conversion measures necessary to comply with this revision shall be completed by May 31, 2001

INCH-POUND

MIL-STD-883E
NOTICE 4
18 December 2000

DEPARTMENT OF DEFENSE
TEST METHOD STANDARD
MICROCIRCUITS

TO ALL HOLDERS OF MIL-STD-883E:

1. THE FOLLOWING TEST METHODS OF MIL-STD-883E HAVE BEEN REVISED AND SUPERSEDE THE TEST METHODS LISTED:

NEW METHOD	DATE	SUPERSEDED METHOD	DATE
1018.3	18 December 2000	1018.3	4 November 1980
2015.13	18 December 2000	2015.12	24 August 1998
2019.6	18 December 2000	2019.5	29 May 1987
5008.9	18 December 2000	5008.8	1 June 1993

2. THE FOLLOWING PAGES OF MIL-STD-883E HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

METHOD	NEW PAGE	DATE	SUPERSEDED PAGE	DATE
---	iii	31 December 1996	iii	REPRINTED WITHOUT CHANGE
---	iv	18 December 2000	iv	5 November 1999
---	v	5 November 1999	v	REPRINTED WITHOUT CHANGE
---	vi	31 December 1996	vi	REPRINTED WITHOUT CHANGE
2003.7	7	15 November 1991	7	REPRINTED WITHOUT CHANGE
	8	18 December 2000	8	15 November 1991
2010.10	39	27 July 1990	39	REPRINTED WITHOUT CHANGE
	40	18 December 2000	40	27 July 1990
2011.7	1	18 December 2000	1	22 March 1989
	2	22 March 1989	2	REPRINTED WITHOUT CHANGE
2032.1	59	1 June 1993	59	REPRINTED WITHOUT CHANGE
	60	18 December 2000	60	1 June 1993
5004.10	5	19 August 1994	5	REPRINTED WITHOUT CHANGE
	6	18 December 2000	6	19 August 1994

AMSC N/A
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FSC 5962

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3. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

4. Holders of MIL-STD-883E will verify that page changes, additions, and corrections indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the military standard is completely revised or canceled.

NOTE: The margins of this notice are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous notice were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous notice.

CONCLUDING MATERIAL

Custodians:

Army - CR
Navy - EC
Air Force - 11
NASA-NA
DLA - CC

Preparing activity:
DLA - CC

Review activities

Army - AR, MI, SM
Navy - OS, SH, TD, AS, CG, MC
Air Force - 19, 99

(Project 5962-1883)

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METHOD 1018.3

INTERNAL WATER-VAPOR CONTENT

1. PURPOSE. The purpose of this test is to measure the water-vapor content of the atmosphere inside a metal or ceramic hermetically-sealed device. It can be destructive (procedures 1 and 2) or nondestructive (procedure 3).

2. APPARATUS. The apparatus for the internal water-vapor content test shall be as follows for the chosen procedure:

2.1 Procedure 1. (Procedure 1 measures the water-vapor content of the device atmosphere by mass spectrometry.) The apparatus for procedure 1 shall consist of:

a. A mass spectrometer meeting the following requirements:

- * (1) Spectra range. The mass spectrometer shall be capable of reading a minimum spectra range of 1 to 100 atomic mass units (AMUs).
- * (2) Detection limit. The mass spectrometer shall be capable of reproducibly detecting the specified moisture content for a given volume package with signal to noise ratio of 20 to 1 (i.e., for a specified limit of 5,000 ppmv, .01 cc, the mass spectrometer shall demonstrate a 250ppmv minimum detection limit to moisture for a package volume of .01 cc). The smallest volume shall be considered the worst case.
- * (3) Calibration. The calibration of the mass spectrometer shall be accomplished at the specified moisture limit (± 20 percent) using a package simulator which has the capability of generating at least three known volumes of gas ± 10 percent on a repetitive basis by means of a continuous sample volume purge of known moisture content ± 10 percent. Moisture content shall be established by the standard generation techniques (i.e., 2 pressure, divided flow, or cryogenic method). The dew point analyzer shall be recalibrated a minimum of once per year using equipment traceable to NIST or by a suitable commercial calibration services laboratory using equipment traceable to NIST standards. Calibration records shall be kept on a daily basis. Gas analysis results obtained by this method shall be considered valid only in the moisture range or limit bracketed by at least two (volume or concentration) calibration points (i.e., 5,000 ppmv between .01 - .1 cc or 1,000 - 5,000 ppmv between .01 - .1 cc). A best fit curve shall be used between volume calibration points. Systems not capable of bracketing may use an equivalent procedure as approved by the qualifying activity. Corrections of sensitivity factors deviating greater than 10 percent from the mean between calibration points shall be required.

Note: It is recommended that the percentage of water vapor contained in a gas flowing through the gas humidifier be compared to the dewpoint sensor reading for accuracy of the sensor. The following equation may be used to calculate the percent of water vapor contained in a gas flowing through the gas humidifier.

$$\% H_2O = \frac{100(P_v m b)}{68.95 \text{ mb/psi } P_g + 1.33 \text{ mb/mmPa}}, \text{ where}$$

P_v = vapor pressure of water in the GPH based on water temperature in degrees centigrade,

P_g = gauge pressure in psi, and

P_a = atmospheric pressure in mm Hg.

- * (4) Calibration for other gases. Calibration shall be required for all gases found in concentrations greater than .01 percent by volume. As a minimum, this shall include all gases listed in 3.1c. The applicable gases shall be calibrated at approximately 1 percent concentrations as part of the yearly calibration requirements, with the exception of fluorocarbons, which may use a concentration of 200 ppmv, and nitrogen, which may use a concentration of greater than 80 percent.

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- * (5) Calibration check. The system calibration shall be checked on the day of test prior to any testing. This shall include checking the calibration by in-letting a 5000ppmv $\pm 20\%$ moisture calibration sample of the required volumes and comparing the result with the calibration sample. The resulting moisture reading shall be within 250 ppmv of the moisture level in the calibration sample. Calibration performed on the day of test prior to any testing may be substituted for this calibration check.
- * b. A vacuum opening chamber which can contain the device and a vacuum transfer passage connecting the device to the mass spectrometer of 2.1a. The system shall be maintained at a stable temperature equal to or above the device temperature. The fixturing in the vacuum opening chamber shall position the specimen as required by the piercing arrangement of 2.1c, and maintain the device at $100^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for a minimum of 10 minutes prior to piercing.

Note: A maximum 5 minute transfer time from prebake to hot insertion into apparatus shall be allowed. If 5 minutes is exceeded, device shall be returned to the prebake oven and prebake continued until device reaches $100^{\circ}\text{C} \pm 5^{\circ}\text{C}$.

For initial certification of systems or extension of suitability, device temperature on systems using an external fixture shall be characterized by placing a thermocouple into the cavity of a blank device of similar mass, internal volume, construction and size. This shall be a means for proving the device temperature has been maintained at $100^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for the minimum ten minutes. This also applies to devices prebaked in an external oven but tested with the external fixture to adjust for any temperature drop during the transfer. These records shall be maintained by the test laboratory.

- c. A piercing arrangement functioning within the opening chamber or transfer passage of 2.1b, which can pierce the specimen housing (without breaking the mass spectrometer chamber vacuum and without disturbing the package sealing medium), thus allowing the specimen's internal gases to escape into the chamber and mass spectrometer.

NOTE: A sharp-pointed piercing tool, actuated from outside the chamber wall via a bellows to permit movement, should be used to pierce both metal and ceramic packages. For ceramic packages, the package lid or cover should be locally thinned by abrasion to facilitate localized piercing.

2.2 Procedure 2. (Procedure 2 measures the water-vapor content of the device atmosphere by integrating moisture picked up by a dry carrier gas at 50°C .) The apparatus for procedure 2 shall consist of:

- a. An integrating electronic detector and moisture sensor capable of reproducibly detecting a water-vapor content of 300 ± 50 ppmv moisture for the package volume being tested. This shall be determined by dividing the absolute sensitivity in micrograms H_2O by the computed weight of the gas in the device under test, and then correcting to ppmv.
- b. A piercing chamber or enclosure, connected to the integrating detector of 2.2a, which will contain the device specimen and maintain its temperature at $100^{\circ}\text{C} \pm 5^{\circ}\text{C}$ during measurements. The chamber shall position the specimen as required by the piercing arrangement. The piercing mechanism shall open the package in a manner which will allow the contained gas to be purged out by the carrier gas or removed by evacuation. The sensor and connection to the piercing chamber will be maintained at a temperature of $50^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

2.3 Procedure 3. (Procedure 3 measures the water-vapor content of the device atmosphere by measuring the response of a calibrated moisture sensor or an IC chip which is sealed within the device housing, with its electrical terminals available at the package exterior.) The apparatus for procedure 3 shall consist of one of the following:

- a. A moisture sensor element and readout instrument capable of detecting a water-vapor content of 300 ± 50 ppmv while sensor is mounted inside a sealed device.

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- b. Metallization runs on the device being tested isolated by back-biased diodes which when connected as part of a bridge network can detect 2,000 ppmv within the cavity. The chip shall be cooled in a manner such that the chip surface is the coolest surface in the cavity. The device shall be cooled below dew point and then heated to room temperature as one complete test cycle.

NOTE: Suitable types of sensors may include (among others) parallel or interdigitated metal stripes on an oxidized silicon chip, and porous anodized-aluminum structures with gold-surface electrodes.

Surface conductivity sensors may not be used in metal packages without external package wall insulation. When used, the sensor shall be the coolest surface in the cavity. It should be noted that some surface conductivity sensors require a higher ionic content than available in ultraclean CERDIP packages. In any case, correlation with mass spectrometer procedure 1 shall be established by clearly showing that the sensor reading can determine whether the cavity atmosphere has more or less than the specified moisture limit at 100°C.

- * 3. PROCEDURE. The internal water-vapor content test shall be conducted in accordance with the requirement of procedure 1, procedure 2, or procedure 3. All devices shall be prebaked for 16-24 hours at 100°C ±5°C prior to hot insertion into apparatus. External ovens shall have a means to indicate if a power interruption occurs during the prebaking period and for how long the temperature drops below 100± 5°C. Devices baked in an external oven which loses power and whose temperature drops below 100± 5°C for more than 1 hour shall undergo another prebake to begin a minimum of 12 hours later.

Note: It is recommended that samples submitted to the labs shall include information about the manufacturing process including sealing temperature, sealing pressure, sealing gas, free internal cavity volume, lid thickness at puncture site, lid material, and the location of the puncture site.

3.1 Procedure 1. The device shall be hermetic in accordance with test method 1014, and free from any surface contaminants which may interfere with accurate water-vapor content measurement.

After device insertion, the device and chamber shall be pumped down and baked out at a temperature of 100°C ±5°C until the background pressure level will not prevent achieving the specified measurement accuracy and sensitivity. After pumpdown, the device case or lid shall be punctured and the following properties of the released gases shall be measured, using the mass spectrometer:

- a. The increase in chamber pressure as the gases are released by piercing the device package. A pressure rise of less than 50 percent of normal for that package volume and pressurization may indicate that (1) the puncture was not fully accomplished, (2) the device package was not sealed hermetically, or (3) does not contain the normal internal pressure.
- * b. The water-vapor content of the released gases, as a percent by unit volume or parts per million volume (ppmv) of the total gas content.
- * c. The proportions (by volume) of the other following gases: N₂, He, Mass 69 (fluorocarbons), O₂, Ar, H₂, CO₂, CH₄, NH₃, and other solvents, if available. Calculations shall be made and reported on all gases present greater than .01 percent by volume. Data reduction shall be performed in a manner which will preclude the cracking pattern interference from other gas specie in the calculations of moisture content. Data shall be corrected for any system dependent matrix effects such as the presence of hydrogen in the internal ambient.

3.1.1 Failure criteria.

- a. A device which has a water-vapor content greater than the specified maximum value shall constitute a failure.
- b. A device which exhibits an abnormally low total gas content, as defined in 3.1a, shall constitute a failure, if it is not replaced. Such a device may be replaced by another device from the same population; if the replacement device exhibits normal total gas content for its type, neither it nor the original device shall constitute a failure for this cause.

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3.2 Procedure 2. The device shall be hermetic in accordance with test method 1014, and free from any surface contaminants which may interfere with accurate water-vapor content measurement.

After device insertion into the piercing chamber, gas shall be flowed through the system until a stable base-line value of the detector output is attained. With the gas flow continuing, the device package shall then be pierced so that a portion of the purge gas flows through the package under test and the evolved moisture integrated until the base-line detector reading is again reached. An alternative allows the package gas to be transferred to a holding chamber which contains a moisture sensor and a pressure indicator. System is calibrated by injecting a known quantity of moisture or opening a package of known moisture content.

3.2.1 Failure criteria.

- a. A device which has a water-vapor content (by volume) greater than the specified maximum value shall constitute a failure.
- b. After removal from the piercing chamber, the device shall be inspected to ascertain that the package has been fully opened. A device package which was not pierced shall constitute a failure, if the test is not performed on another device from the same population; if this retest sample or replacement is demonstrated to be pierced and meets the specified water-vapor content criteria, the specimen shall be considered to have passed the test.
- c. A package which is a leaker in the purge case will be wet and counted as a failure. In the case of evacuation, a normal pressure rise shall be measured as in 3.1a.

3.3 Procedure 3. The moisture sensor shall be calibrated in an atmosphere of known water-vapor content, such as that established by a saturated solution of an appropriate salt or dilution flow stream. It shall be demonstrated that the sensor calibration can be verified after package seal or that post seal calibration of the sensor by lid removal is an acceptable procedure.

The moisture sensor shall be sealed in the device package or, when specified, in a dummy package of the same type. This sealing shall be done under the same processes, with the same die attach materials and in the same facilities during the same time period as the device population being tested.

The water-vapor content measurement shall be made, at 100°C or below, by measuring the moisture sensor response. Correlation with procedure 1 shall be accomplished before suitability of the sensor for procedure 3 is granted. It shall be shown the package ambient and sensor surface are free from any contaminating materials such as organic solvents which might result in a lower than usual moisture reading.

3.3.1 Failure criteria. A specimen which has a water-vapor content greater than the specified maximum value shall constitute a failure.

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- * 4. **IMPLEMENTATION.** Suitability for performing method 1018 analysis is granted by the qualifying activity for specific limits and volumes. Method 1018 calibration procedures and the suitability survey are designed to guarantee ± 20 percent lab-to-lab correlation in making a determination whether the sample passes or fails the specified limit. Water vapor contents reported either above or below the (water vapor content - volume) range of suitability are not certified as correlatable values. This out of specification data has meaning only in a relative sense and only when one laboratory's results are being compared. The specification limit of 5,000 ppmv shall apply to all package volumes, with the following correction factors permitted, to be used provided they are documented and shown to be applicable:

For package volumes less than .01 cc internal free volume which are sealed while heated in a furnace:

$$C_T = \frac{T_r + 273}{T_s + 273}, \text{ where } C_T = \text{correction factor (temperature), } T_r = \text{room temperature (}^\circ\text{C), } T_s = \text{sealing temperature (}^\circ\text{C).}$$

For package volumes of any size sealed under vacuum conditions:

$$C_P = \frac{P_s}{P_a}, \text{ } C_P = \text{correction factor (pressure), } P_s = \text{sealing pressure, } P_a = \text{atmospheric pressure (pressures may be in Torr or mm Hg).}$$

The correction factor, if used, shall be applied as follows:

Water Vapor (Corrected) = Water Vapor (Measured) $\times C_x$, where C_x is the applicable correction factor.

The range of suitability for each laboratory will be extended by the qualifying activity when the analytical laboratories demonstrate an expanded capability. Information on current analytical laboratory suitability status can be obtained by contacting DSCC-VQ.

5. **SUMMARY.** The following details shall be specified in the applicable acquisition document:

- a. The procedure (1, 2, or 3) when a specific procedure is to be used (see 3).
- * b. The maximum allowable water-vapor content falling within the range of suitability as specified in test method 5005, 5008, 5010, or general specifications MIL-PRF-38534 or MIL-PRF-38535.

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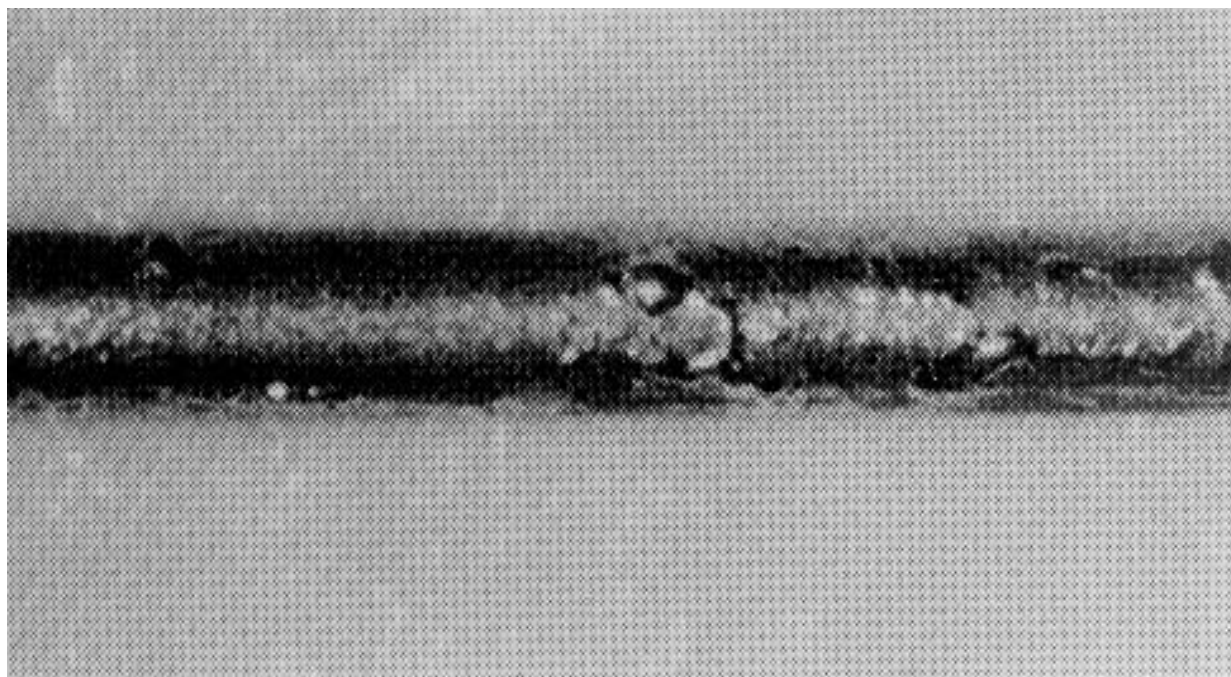


FIGURE 2003-2. Nonwetting.

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How to use this chart:

1. The chart is set-up for .5 inch long leads.
2. View the entire circumference of the lead.
3. Locate the lead diameter on the left side of the chart.
4. Locate the diameter of the void on the top of the chart.

	0.001	0.003	0.005	0.010	0.015	0.020	0.030	0.040
0.010	1000	111	40	10	4.4	2.5	1.10	0.62
0.015	1500	167	60	15	6.6	3.75	1.60	0.937
0.020	2000	222	80	20	8.8	5	2.22	1.25
0.030	3000	333	120	30	13.0	7.5	3.33	1.87
0.040	4000	444	160	40	17.7	10	4.44	2.50
0.050	5000	555	200	50	22.0	12.5	5.55	3.12
0.060	6000	666	240	60	26.6	15	6.66	3.75

Examples for less than .5 inch leads:

- A. Lead length = 0.350.
- B. $0.350/0.500 = 0.700$.
- C. To determine the number of acceptable voids, multiply the number of voids on the chart by 0.700.
- * D. For a .001 inch void on a 0.010 inch diameter lead = 700 voids.
- E. For leads greater than 1.0 inch in length, see 4.5.

FIGURE 2003-3. Solderability evaluation guidelines.

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METHOD 2003.7
15 November 1991

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Class level SCondition B
Class level B

- h. Bonds where more than 25 percent of the bond is located on die mounting material.
- i. Any evidence of repair of conductors by bridging with additional material.
- j. Bonds on foreign material.
- k. Intermetallic formation extending radially more than 0.1 mil completely around the periphery of that portion of the gold bond located on metal.

3.2.1.5 Rebonding of monolithic devices. Rebonding of monolithic microcircuits, may be done with the following limitations. No device shall be acceptable that exhibits:

- a. Rebond over exposed passivation or over metal which shows evidence of peeling. More than one rebond attempt at any design bond location. Rebonds that touch an area of exposed oxide caused by lifted metal.
- b. A bond on top of, or partially on top of, another bond, bond wire tail, or residual segment of wire.
- b. Bond along side or partially on top of another bond, bond wire tail or residual segment of wire, when the overlap width is greater than 25 percent.
- c. Rebond attempts that exceed 10 percent of the total number of bonds in the microcircuit. (e.g., for a 28 lead wire bonded package there are 56 bonds. A bond of one end of a wire shall count as a single attempt. A replacement of a wire bonded at both ends, counts as two rebond attempts.)

NOTE: For class level B only. Bond-offs required to clear the bonder after an unsuccessful first bond attempt are not considered as rebonds provided they can be identified as bond-offs.

- d. Missing or extra wires.

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METHOD 2010.10
27 July 1990

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Condition A
Class level S

Condition B
Class level B

* 3.2.2 Internal wires. During inspection for the requirements of 3.2.2, each device shall be viewed at any angle necessary to determine full compliance to this specification, without damaging the device. No device shall be acceptable that exhibits:

- a. Any wire with a separation of less than two wire diameters to unglassivated operating metal, other bonds, another wire (common wires excluded), other package post, unglassivated die area (except for wires or pads which are at the die or substrate potential), or any portion of the package including the plane of the lid to be attached.

NOTE: For condition A only. Within a 5.0 mil radial distance from the perimeter of the bond on the die the separation shall be 1.0 mil minimum.

- a. Any wire with a separation of less than one wire diameter to unglassivated operating metal, other bonds, another wire (common wires excluded), other package post, unglassivated die area (except for wires or pads which are at the die or substrate potential), or any conductive portion of the package or the plane of the lid to be attached.

NOTE: For condition B only. Within a 10.0 mil radial distance from the perimeter of the bond on the die a line of separation must be visible.

NOTE: For SOS devices, exclude the unglassivated insulator areas.

- b. Nicks, bends, cuts, crimps, scoring, or neckdown in any wire that reduces the wire diameter by more than 25 percent.
- c. Tearing at the junction of the wire and bond.
- d. Any wire making a straight line run from a die bonding pad to a package post that has no arc.

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METHOD 2011.7

BOND STRENGTH (DESTRUCTIVE BOND PULL TEST)

1. PURPOSE. The purpose of this test is to measure bond strengths, evaluate bond strength distributions, or determine compliance with specified bond strength requirements of the applicable acquisition document. This test may be applied to the wire-to-die bond, wire-to-substrate bond, or the wire-to-package lead bond inside the package of wire-connected microelectronic devices bonded by soldering, thermocompression, ultrasonic, or related techniques. It may also be applied to bonds external to the device such as those from device terminals-to-substrate or wiring board or to internal bonds between die and substrate in non-wire-bonded device configurations such as beam lead or flip chip devices.

* 2. APPARATUS. The apparatus for this test shall consist of suitable equipment for applying the specified stress to the bond, lead wire or terminal as required in the specified test condition. 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 ± 0.3 gf, whichever is the greater tolerance.

3. PROCEDURE. The test shall be conducted using the test condition specified in the applicable acquisition document consistent with the particular device construction. All bond pulls shall be counted and the specified sampling, acceptance, and added sample provisions shall be observed, as applicable. Unless otherwise specified, for conditions A, C, and D, the sample size number specified for the bond strength test shall determine the minimum sample size in terms of the minimum number of bond pulls to be accomplished rather than the number of complete devices in the sample, except that the required number of bond pulls shall be randomly selected from a minimum of 4 devices. Bond pulls in accordance with test conditions D, F, G, and H, while involving two or more bonds shall count as a single pull for bond strength and sample size number purposes. Unless otherwise specified, for conditions F, G, and H the sample size number specified shall determine the number of die to be tested (not bonds). For hybrid or multichip devices (all conditions), a minimum of 4 die or use all die if four are not available on a minimum of 2 completed devices shall be used. Where there is any adhesive, encapsulant or other material under, on or surrounding the die such as to increase the apparent bond strength, the bond strength test shall be performed prior to application.

When flip chip or beam-lead 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.

3.1 Test conditions:

3.1.1 Test condition A - Bond peel. This test is normally employed for bonds external to the device package. The lead or terminal and the device package shall be gripped or clamped in such a manner that a peeling stress is exerted with the specified angle between the lead or terminal and the board or substrate. Unless otherwise specified, an angle of 90 degrees shall be used. When a failure occurs, the force causing the failure and the failure category shall be recorded.

3.1.2 Test condition C - Wire pull (single bond). This test is normally employed for internal bonds at the die or substrate and the lead frame of microelectronic devices. The wire connecting the die or substrate shall be cut so as to provide two ends accessible for pull test. In the case of short wire runs, it may be necessary to cut the wire close to one termination in order to allow pull test at the opposite termination. The wire shall be gripped in a suitable device and simple pulling action applied to the wire or to the device (with the wire clamped) 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.

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3.1.3 Test condition D - Wire pull (double bond). This procedure is identical to that of test condition C, except that the pull is applied by inserting a hook under the lead wire (attached to die, substrate or header or both ends) with the device clamped and the pulling force applied approximately in the center of the wire in a direction approximately normal to the die or substrate surface or approximately normal to a straight line between the bonds. When a failure occurs, the force causing the failure and the failure category shall be recorded. The minimum bond strength shall be taken from table I. Figure 2011-1 may be used for wire diameters not specified in table I. For wire diameter or equivalent cross section >0.005 inch, where a hook will not fit under the wire, a suitable clamp can be used in lieu of a hook.

3.1.4 Test condition F - Bond shear (flip chip). This test is normally employed for internal bonds between a semiconductor die and a substrate to which it is attached in a face-bonded configuration. It may also be used to test the bonds between a substrate and an intermediate carrier or secondary substrate to which the die is mounted. A suitable tool or wedge shall be brought in contact with the die (or carrier) at a point just above the primary substrate and a force applied perpendicular to one edge of the die (or carrier) and parallel to the primary substrate, to cause bond failure by shear. When a failure occurs, the force at the time of failure, and the failure category shall be recorded.

3.1.5 Test condition G - Push-off test (beam lead). This test is normally employed for process control and is used on a sample of semiconductor die bonded to a specially prepared substrate. Therefore, it cannot be used for random sampling of production or inspection lots. A metallized substrate containing a hole shall be employed. The hole appropriately centered, shall be sufficiently large to provide clearance for a push tool, but not large enough to interfere with the bonding areas. The push tool shall be sufficiently large to minimize device cracking during testing, but not large enough to contact the beam leads in the anchor bond area. Proceed with push-off tests as follows: The substrate shall be rigidly held and the push tool inserted through the hole. The contact of the push tool to the silicon device shall be made without appreciable impact (less than 0.01 inch/minute (0.254 mm/minute)) and forced against the underside of the bonded device at a constant rate. When failure occurs, the force at the time of failure, and the failure category shall be recorded.

3.1.6 Test condition H - Pull-off test (beam lead). This test is normally employed on a sample basis on beam lead devices which have been bonded down on a ceramic or other suitable substrate. The calibrated pull-off apparatus (see 2) shall include a pull-off rod (for instance, a current loop of nichrome or Kovar wire) to make connection with a hard setting adhesive material (for instance, heat sensitive polyvinyl acetate resin glue) on the back (top side) of the beam lead die. 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 device shall be pulled within 5 degrees of the normal to at least the calculated force (see 3.2), or until the die is at 2.54 mm (0.10 inch) above the substrate. When a failure occurs, the force at the time of failure, the calculated force limit, and the failure category shall be recorded.

3.2 Failure criteria. Any bond pull which results in separation under an applied stress less than that indicated in table I as the required minimum bond strength for the indicated test condition, composition, and construction shall constitute a failure.

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

a. For internal wire bonds:

- (a-1) Wire break at neckdown point (reduction of cross section due to bonding process).
- (a-2) Wire break at point other than neckdown.
- (a-3) Failure in bond (interface between wire and metallization) at die.
- (a-4) Failure in bond (interface between wire and metallization) at substrate, package post, or other than die.
- (a-5) Lifted metallization from die.
- (a-6) Lifted metallization from substrate or package post.
- (a-7) Fracture of die.
- (a-8) Fracture of substrate.

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METHOD 2015.13

RESISTANCE TO SOLVENTS

1. PURPOSE. The purpose of this test is to verify that the markings will not become illegible on the component parts when subjected to solvents. The solvents will not cause deleterious, mechanical or electrical damage, or deterioration of the materials or finishes.

1.1 Formulation of solvents. The formulation of solvents herein is considered typical and representative of the desired stringency as far as the usual coatings and markings are concerned. Many available solvents which could be used are either not sufficiently active, too stringent, or even dangerous to humans when in direct contact or when the fumes are inhaled.

1.2 Check for conflicts. When this test is referenced, care should be exercised to assure that conflicting requirements, as far as the properties of the specified finishes and markings are concerned, are not invoked.

2. MATERIALS.

2.1 Solvent solutions. The solvent solutions used in this test shall consist of the following: 1/

a. At 20-30°C a mixture consisting of the following:

(1) One part by volume of an aliphatic alcohol and/or aliphatic ester, USP grade or better.

* (2) Three parts by volume of mineral spirits in accordance with A-A-2904, type II, previously designated as TT-T-291, type II, grade A, or three parts by volume of a mixture of 80 percent by volume of kerosene and 20 percent by volume of ethylbenzene.

b. A semiaqueous or nonaqueous based organic solvent e.g., a terpene or heterocyclic compound. 2/

c. This solvent has been deleted. When a suitable replacement for this solvent has been found, it will be added as solution c.

d. At 63°C to 70°C, a mixture consisting of the following: 1/

(1) 42 parts by volume of deionized water.

(2) 1 part by volume of propylene glycol monomethyl ether.

(3) 1 part by volume of monoethanolamine or equivalent inorganic base to achieve the same pH.

2.1.1 Solvent solutions, safety aspects. Solvent solutions listed in a through d above exhibit some potential for health and safety hazards. The following safety precautions should be observed:

a. Avoid contact with eyes.

b. Avoid prolonged contact with skin.

c. Provide adequate ventilation.

d. Avoid open flame.

e. Avoid contact with very hot surfaces.

1/ Normal safety precautions for handling these solutions (e.g., same as those for diluted ammonium hydroxide) based on O.S.H.A rules for Monoethanolamine or other precautionary measures with regard to flash point, toxicity, etc.

2/ Or any EPA demonstrated equivalent. When using EPA approved alternative solutions for test, the device manufacturer should consider the recommended temperature for cleaning specified by the solvent supplier.

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2.2 Vessel. The vessel shall be a container made of inert material, and of sufficient size to permit complete immersion of the specimens in the solvent solutions specified in 2.1.

2.3 Brush. The brush shall be a toothbrush with a handle made of a nonreactive material. The brush shall have three long rows of hard bristles, the free ends of which shall lie substantially in the same plane. The toothbrush shall be used exclusively with a single solvent and when there is any evidence of softening, bending, wear, or loss of bristles, it shall be discarded.

3. PROCEDURE. The specimens subjected to this test shall be divided into three equal groups. Each group shall be individually subjected to one of the following procedures:

NOTE: Metal lidded leadless chip carrier (LCC) packages shall be preconditioned by immersing the specimens in room temperature flux type symbols "A" or "B" (flux types "L0" or "L1") in accordance with ANSI/J-STD-004 previously designated as RMA flux in accordance with MIL-F-14256, for 5 to 10 seconds. The specimens shall then be subjected to an ambient temperature of $215^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 60 seconds +5, -0 seconds. After the preconditioning, each device lid shall be cleaned with isopropyl alcohol.

- a. The first group shall be subjected to the solvent solution as specified in 2.1a maintained at a temperature of $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$.
- b. The second group shall be subjected to the solvent solution as specified in 2.1b maintained at a suitable temperature.
- c. This solution has been deleted, (see 2.1c).
- d. The fourth group shall be subjected to the solvent solution as specified in 2.1d maintained at a temperature of 63°C to 70°C .

The specimens and the bristle portion of the brush shall be completely immersed for 1 minute minimum in the specified solution contained in the vessel specified in 2.2. Immediately following emersion, the specimen shall be brushed with normal hand pressure (approximately 2 to 3 ounces) for 10 strokes on the portion of the specimen where marking has been applied, with the brush specified in 2.3. Immediately after brushing, the above procedure shall be repeated two additional times, for a total of three immersions followed by brushings. The brush stroke shall be directed in a forward direction, across the surface of the specimen being tested. After completion of the third immersion and brushing, devices shall be rinsed and all surfaces air blown dry. After 5 minutes, the specimens shall be examined to determine the extent, if any, of deterioration that was incurred.

3.1 Optional procedure for the fourth group. The test specimens shall be located on a test surface of known area which is located 15 ± 2.5 centimeters (6 ± 1 inches) below a spray nozzle(s) which discharges 0.6 ± 0.02 liters/minute (0.139 gpm) of solution (2.1d) per 6.5 square centimeters (1 in^2) surface area at a pressure of 140 ± 30 kilopascal (20 ± 5 psi). The specimens shall be subjected to this spray for a period of 10 minutes minimum. After removal and within 5 minutes the specimens shall be examined in accordance with 3.1.1. The specimens may be rinsed with clear water and air blow dried prior to examination.

3.1.1 Failure criteria. After subjection to the test, evidence of damage to the device and any specified markings which are missing in whole or in part, faded, smeared, blurred, or shifted (dislodged) to the extent that they cannot be readily identified from a distance of at least 15.0 cm (6 inches) with normal room lighting and without the aid of magnification or with a viewer having a magnification no greater than 3X shall constitute a failure.

4. SUMMARY. The following detail shall be specified in the individual specification: The number of specimens to be tested (see 3).

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METHOD 2019.6

DIE SHEAR STRENGTH

1. **PURPOSE.** The purpose of this test is to determine the integrity of materials and procedures used to attach semiconductor die or surface mounted passive elements to package headers or other substrates. This determination is based on a measure of force applied to the die, the type of failure resulting from this application of force (if failure occurs) and the visual appearance of the residual die attach media and substrate/header metallization.

2. **APPARATUS.** The test equipment shall consist of a load-applying instrument with an accuracy of ± 5 percent of full scale or 50 grams, whichever is the greater tolerance. A circular dynamometer with a lever arm or a linear motion force-applying instrument may be used to apply the force required for testing. The test equipment shall have the following capabilities:

- a. A die contact tool which applies a uniform distribution of the force to an edge of the die (see figure 2019-1).
- b. Provisions to assure that the die contact tool is perpendicular to the die mounting plane of the header or substrate.
- c. A rotational capability, relative to the header/substrate holding fixture and the die contact tool, to facilitate line contact on the edge of the die; i.e., the tool applying the force to the die shall contact the die edge from end-to-end (see figure 2019-2).
- d. A binocular microscope with magnification capabilities of 10X minimum and lighting which facilitates visual observation of the die and die contact tool interface during testing.

3. **PROCEDURE.** The test shall be conducted, as defined herein, or to the test conditions specified in the applicable specific acquisition document consistent with the particular part construction. All die strength tests shall be counted and the specific sampling, acceptance, and added sample provisions shall be observed, as applicable.

3.1 **Shear strength.** A force sufficient to shear the die from its mounting or equal to twice the minimum specified shear strength (figure 2019-4), whichever occurs first, shall be applied to the die using the apparatus of 2 above.

* **NOTE:** For passive elements only attached at the end terminations, the area used to determine the force applied shall be the total area of the mounting surface of the end terminations. An area between end terminations filled with non-adhering filler shall not be used to determine the force applied.

- a. When a linear motion force-applying instrument is used, the direction of the applied force shall be parallel with the plane of the header or substrate and perpendicular to the die being tested.
- b. When a circular dynamometer with a lever arm is employed to apply the force required for testing, it shall be pivoted about the lever arm axis and the motion shall be parallel with the plane of the header or substrate and perpendicular to the edge of the die being tested. The contact tooling attached to the lever arm shall be at a proper distance to assure an accurate value of applied force.
- * c. The die contact tool shall apply a force gradually from zero to a specified value against an edge of the die which most closely approximates a 90° angle with the base of the header or substrate to which it is bonded (see figure 2019-3). For rectangular die, the force shall be applied perpendicular to the longer side of the die. When constrained by package configurations, any available side of the die may be tested if the above options are not available.
- d. After initial contact with the die edge and during the application of force, the relative position of the contact tool shall not move vertically such that contact is made with the header/substrate or die attach media. If the tool rides over the die, a new die may be substituted or the die may be repositioned, provided that the requirements of 3.1.c are met.

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3.2 Failure criteria. A device which fails any of the following criteria shall constitute a failure.

- a. Fails die strength requirements (1.0X) of figure 2019-4.
- b. Separation with less than 1.25 times the minimum strength (1.0X) specified in figure 2019-4 and evidence of less than 50 percent adhesion of the die attach medium.
- c. Separation with less than 2.0 times the minimum strength (1.0X) specified in figure 2019-4 and evidence of less than 10 percent of adhesion of the die attach medium.

NOTE: For eutectic die attach, residual silicon attached in discrete areas of the die attach medium shall be considered as evidence of such adhesion. For metal glass die attach, die attach material on the die and on the package base shall be considered as evidence of acceptable adhesion.

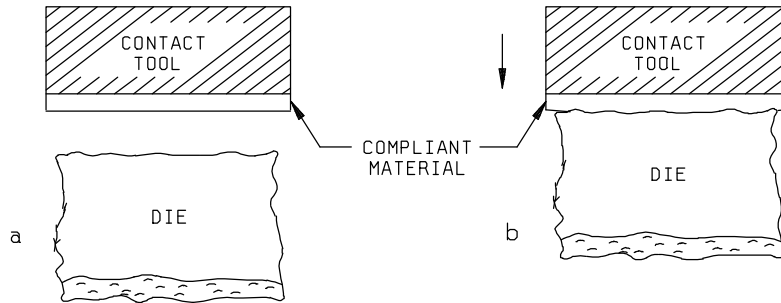
3.2.1 Separation categories. When specified, the force required to achieve separation and the category of the separation shall be recorded.

- a. Shearing of die with residual silicon remaining.
- b. Separation of die from die attach medium.
- c. Separation of die and die attach medium from package.

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

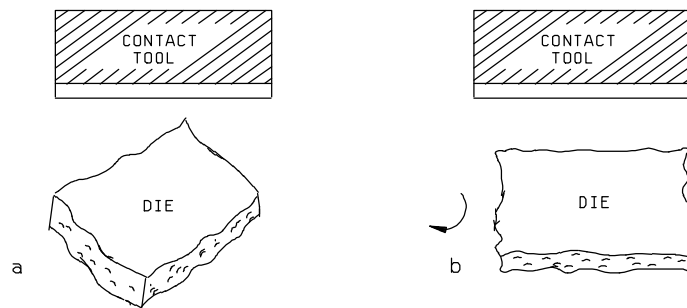
- a. Minimum die attach strength if other than shown on figure 2019-4.
- b. Number of devices to be tested and the acceptance criteria.
- c. Requirement for data recording, when applicable (see 3.2.1).

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FIGURE 2019-1. Compliant interface on contact tool distributes load to the irregular edge of the die.



*

FIGURE 2019-2. Rotate the die contact tool or the device for parallel alignment.

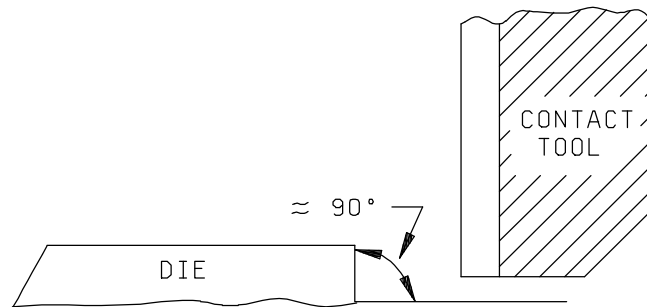
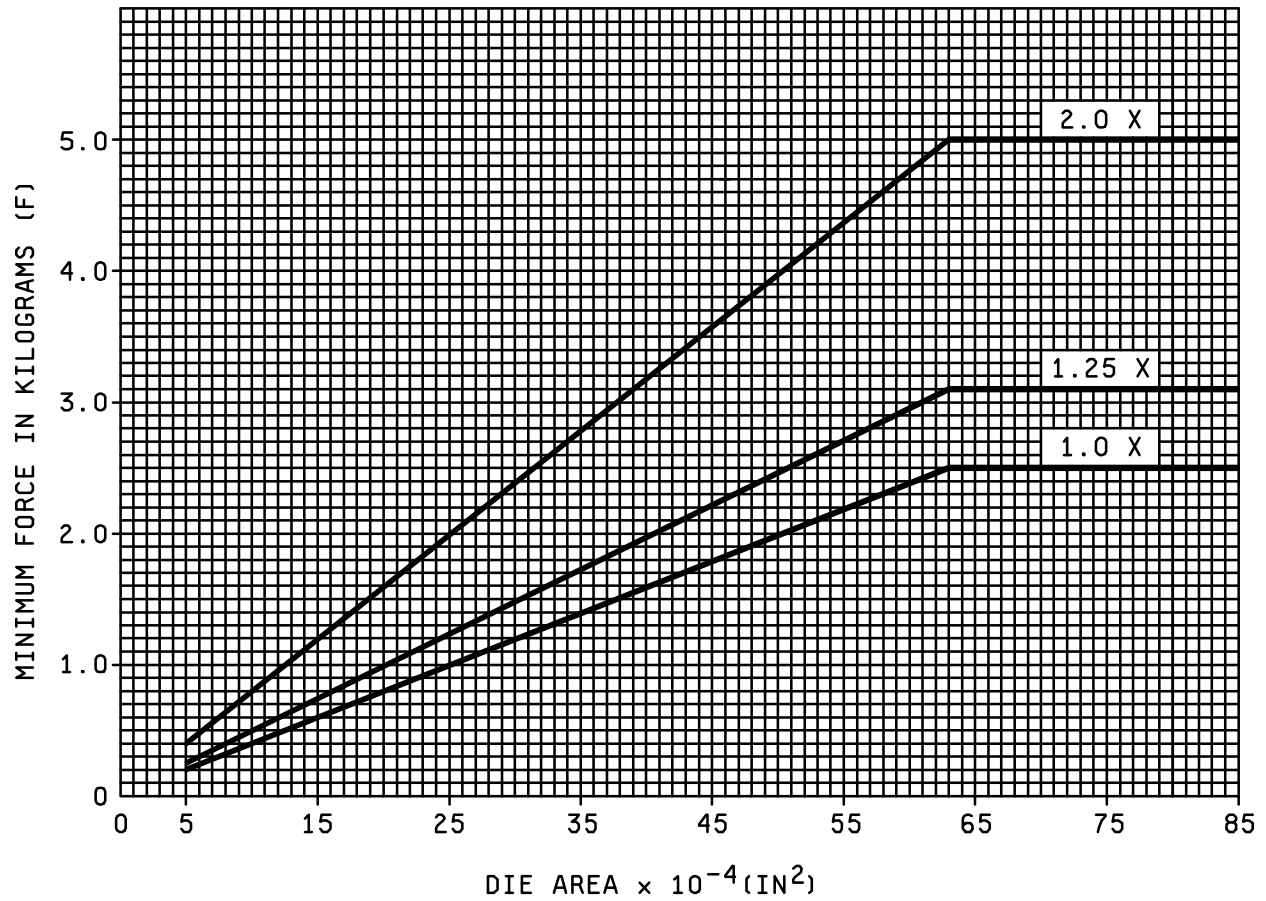


FIGURE 2019-3. The contact tool shall load against that edge of the die which forms an angle $\approx 90^\circ$ with the header/substrate.

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NOTES:

1. All die area larger than $64 \times 10^{-4} \text{ (IN}^2\text{)}$ shall withstand a minimum force of 2.5 kg or a multiple thereof (see 3.2).
2. All die area smaller than $5 \times 10^{-4} \text{ (IN}^2\text{)}$ shall withstand a minimum force (1.0X) of $0.04 \text{ kg}/10^{-4} \text{ (IN}^2\text{)}$ or a minimum force (2X) of $0.08 \text{ kg}/10^{-4} \text{ (IN}^2\text{)}$.

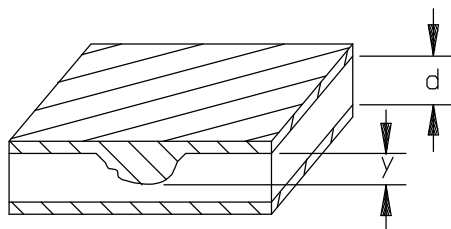
FIGURE 2019-4. Die shear strength criteria (minimum force versus die attach area).

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<u>Class H</u>	<u>Class K</u>
3.3.4 e. Metallized terminal not aligned as shown in the applicable drawing.	3.3.4 e. Same as class H.
f. Encapsulant preventing the metallized terminal from resting on the substrate bonding pads when the capacitor is in the bonding position except where the metallized terminal electrical contact is made by alternate means.	f. Same as class H.
g. Lifting, blistering or peeling of metallized terminal encapsulant.	g. Same as class H.

3.3.5 Parallel plate chip capacitor defects,
"low magnification". No element shall be acceptable that exhibits:

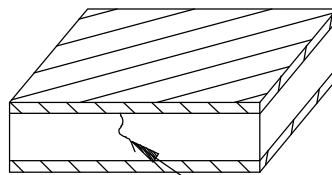
- | | |
|---|---------------------|
| a. Metallization that extends greater than 50 percent around the edge of the capacitor (see figure 2032-60h). | a. Same as class H. |
|---|---------------------|



REJECT -
 $y > d/2$

FIGURE 2032-60h. Class H metallization extension criterion.

- | | |
|---|---------------------------|
| 3.3.5 b. Evidence of cracks in the dielectric body (see figure 2032-61h). | 3.3.5 b. Same as class H. |
|---|---------------------------|



REJECT -
CRACK IN
DIELECTRIC

FIGURE 2032-61h. Class H crack in dielectric criterion.

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3.3.6 Inductor and transformer defects, "low magnification". No element shall be acceptable that exhibits:

- | | | | |
|------|--|----|------------------|
| a. | Peeling, lifting or blistering of winding metallization or insulation. | a. | Same as class H. |
| b. | Evidence of shorts between adjacent turns or windings. | b. | Same as class H. |
| * c. | Cracks or exposure of bare magnetic core material. Exposed bare magnetic core material is acceptable if by design. | c. | Same as class H. |
| d. | Pits or voids in the core insulation greater than 5.0 mils area that expose the magnetic core material. | d. | Same as class H. |
| e. | Separation less than 5.0 mils between wire termination points of the same or adjacent windings. | e. | Same as class H. |
| f. | Missing polarity identification unless by design. | f. | Same as class H. |
| g. | Operating metallization and multilevel thick film defects as described in 3.2.1 and 3.2.5 herein. | g. | Same as class H. |

3.3.7 Chip resistor defects, "low magnification". No element shall be acceptable that exhibits:

- | | | | |
|----|--|----|------------------|
| a. | Reduction of the resistor width resulting from voids, bubbles, nicks, or scratches, or a combination of these, that leaves less than 50 percent of the narrowest resistor width (see figure 2032-62h). | a. | Same as class H. |
|----|--|----|------------------|

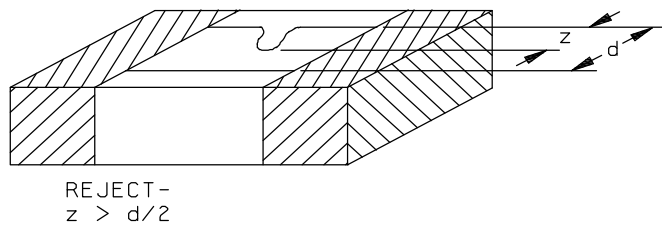


FIGURE 2032-62h. Class H resistor width reduction criterion.

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- 1/ All lots shall be selected for testing in accordance with the requirements of method 5007 herein.
- 2/ Unless otherwise specified, at the manufacturer's option, test samples for group B, bond strength (method 5005) may be randomly selected prior to or following internal visual (method 5004), prior to sealing provided all other specification requirements are satisfied (e.g., bond strength requirements shall apply to each inspection lot, bond failures shall be counted even if the bond would have failed internal visual exam). Test method 2010 applies in full except when method 5004, alternate 1 or alternate 2 (appendix A) is in effect (see 3.3).
- 3/ For class level B devices, this test may be replaced with thermal shock method 1011, test condition A, minimum.
- 4/ At the manufacturer's option, visual inspection for catastrophic failures may be conducted after each of the thermal/mechanical screens, after the sequence or after seal test. Catastrophic failures are defined as missing leads, broken packages, or lids off.
- 5/ See appendix A of MIL-PRF-38535, 40.6.3. The PIND test may be performed in any sequence after 3.1.4 and prior to 3.1.13.
- 6/ Class level S devices shall be serialized prior to initial electrical parameter measurements.
- 7/ Post burn-in electrical parameters shall be read and recorded (see 3.1.13, subgroup 1). Pre burn-in or interim electrical parameters (see 3.1.9 and 3.1.11) shall be read and recorded only when delta measurements have been specified as part of post burn-in electrical measurements.
- 8/ When specified in the applicable device specification, 100 percent of the devices shall be tested for those parameters requiring delta calculations.
- 9/ Dynamic burn-in only. Test condition F of method 1015 and 3.4.2 herein shall not apply.
- 10/ The reverse bias burn-in (see 3.1.12) is a requirement only when specified in the applicable device specification and is recommended only for a certain MOS, linear or other microcircuits where surface sensitivity may be of concern. When reverse bias burn-in is not required, interim electrical parameter measurements 3.1.11 are omitted. The order of performing the burn-in (see 3.1.10) and the reverse bias burn-in may be inverted.
- 11/ Functional tests shall be conducted at input test conditions as follows:
 $V_{IH} = V_{IH(min)} + 20 \text{ percent}$, -0 percent ; $V_{IL} = V_{IL(max)} + 0 \text{ percent}$, -50 percent ; as specified in the most similar military detail specification. Devices may be tested using any input voltage within this input voltage range but shall be guaranteed to $V_{IH(min)}$ and $V_{IL(max)}$.

CAUTION: To avoid test correlation problems, the test system noise (e.g., testers, handlers, etc.) should be verified to assure that $V_{IH(min)}$ and $V_{IL(max)}$ requirements are not violated at the device terminals.

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19 August 1994

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- * 12/ For class level B devices, the fine and gross seal tests (3.1.16) shall be performed separately or together, between constant acceleration (3.1.5) and external visual (3.1.19). For class level S devices, the fine and gross seal tests (3.1.16) shall be performed separately or together, between final electrical testing (3.1.15) and external visual (3.1.19). In addition, for class level S and level B devices, all device lots (sublots) having any physical processing steps (e.g., lead shearing, lead forming, solder dipping to the glass seal, change of, or rework to, the lead finish, etc.) performed following seal (3.1.16) or external visual (3.1.19) shall be retested for hermeticity and visual defects. This shall be accomplished by performing, and passing, as a minimum, a sample seal test (method 1014) using an acceptance criteria of a quantity (accept number) of 116(0), and an external visual inspection (method 2009) on the entire inspection lot (sublot). For devices with leads that are not glass-sealed and that have a lead pitch less than or equal to 1.27 mm (0.050 inch), the sample seal test shall be performed using an acceptance criteria of a quantity (accept number) of 15(0). If the sample fails the acceptance criteria specified, all devices in the inspection lot represented by the sample shall be subjected to the fine and gross seal tests and all devices that fail shall be removed from the lot for final acceptance. For class level S devices, with the approval of the qualifying activity, an additional room temperature electrical test may be performed subsequent to seal (3.1.16), but before external visual (3.1.19) if the devices are installed in individual carriers during electrical test.
- 13/ The radiographic (see 3.1.17) screen may be performed in any sequence after 3.1.8.
- 14/ Only one view is required for flat packages and leadless chip carriers having lead (terminal) metal on four sides.
- 15/ Samples shall be selected for testing in accordance with the specific device class and lot requirements of method 5005. See 3.5 of method 5005.
- 16/ External visual shall be performed on the lot any time after 3.1.17 and prior to shipment, and all shippable samples shall have external visual inspection at least subsequent to qualification or quality conformance inspection testing.
- 17/ The manufacturer shall inspect the devices 100 percent or on a sample basis using a quantity/accept number of 116(0). If one or more rejects occur in this sample, the manufacturer may double the sample size with no additional failures allowed or inspect the remaining devices 100 percent for the failed criteria and remove the failed devices from the lot. If the double sample also has one or more failures, the manufacturer shall be required to 100 percent inspect the remaining devices in the lot for the failed criteria. Reinspection magnification shall be no less than that used for the original inspection for the failed criteria.
- 18/ Radiation latch-up screen shall be conducted when specified in purchase order or contract. Latch-up screen is not required for SOS, SOI, and DI technology when latch-up is physically not possible. At the manufacturer's option, latch-up screen may be conducted at any screening operation step after seal.

3.3.2 Description of special electrical screening tests. The special electrical screens shall consist of a series of electrical tests each of which can be categorized as either a voltage stress test or a low level leakage test.

3.3.2.1 Voltage stress tests. The purpose of voltage stress tests is to eliminate those failure mechanisms which are voltage sensitive. These tests shall be designed such that each circuit element (including metallization runs) within the microcircuit is stressed by an applied voltage which approaches or exceeds (under current limited conditions) the breakdown voltage of the circuit element under test. For those elements which cannot be placed in a reverse bias mode, the applied voltage must be equal to or greater than 120 percent of the normal operating voltage. Any device which exhibits abnormal leakage currents at the specified applied voltage conditions shall be rejected. The number of stress tests being performed will vary from a few for a simple gate to many for MSI or LSI functions.

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19 August 1994

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METHOD 5008.9

TEST PROCEDURES FOR HYBRID AND MULTICHIP MICROCIRCUITS

Method 5008 is canceled effective 1 June 1993. It is superseded by MIL-PRF-38534. For Federal Stock classes other than 5962, the following paragraphs of MIL-PRF-38534 are provided to replace method 5008.

Superseded method 5008	* MIL-PRF-38534	Requirement
3.2 Element evaluation	C.3 Element evaluation	Element evaluation
3.3 Process control	C.4 Process control	Process control
3.4 Device screening	C.5 Device screening	Screening
3.5 Quality conformance evaluation	C.6 Conformance Inspection and Periodic Inspection	QCI

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NOTICE 4

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NOTICE 4

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
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I RECOMMEND A CHANGE:
1. DOCUMENT NUMBER
MIL-STD-883

2. DOCUMENT DATE
(001218)

3. DOCUMENT TITLE Microcircuits Test Method Standard

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)
5. REASON FOR RECOMMENDATION**6. SUBMITTER**

a. NAME (Last, First, Middle initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)
(1) Commercial
(2) AUTOVON
(If applicable)

7. DATE SUBMITTED
(YYMMDD)
8. PREPARING ACTIVITY

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