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HERMETICITY TESTING OF MICROELECTRONIC DEVICES

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HERMETICITY TESTING OF MICROELECTRONIC DEVICES

GENERAL INTRODUCTION

This standard is composed of several methods of determining the hermetic integrity of packaged micro-electronic devices. The methods relate to various conditions under which hermeticity testing may be needed and covers several ranges of sensitivity.

The standard is intended to relate to packages having four or more leads and containing a gas-filled cavity in which the monolithic or hybrid circuitry resides. This standard should not be used for either solid plastic or plastic sealed packages.

Since the bulk of testing in the industry is done using helium mass spectrometers, leak rates stated herein shall refer to standard cubic centimeters of helium at a pressure differential of one atmosphere. If a leak rate is given without qualifying units, it should mean helium, as previously stated. If a leak rate for air or other gas is intended, that information will accompany the leak rate.

The enclosed methods are written for the purpose of making a qualitative or quantitative determination. Point of acceptance or rejection of parts shall be based on agreement between purchaser and vendor. Such agreements should also govern certain other factors in the execution of some of the methods. For example, pressurization time with a tracer gas and pressure levels as well as allowable elapsed time between pressurizing and testing should be agreed upon and understood in advance by purchaser and vendor.

Since most of the leak tests proposed herein do not have the breadth of sensitivity to span the entire range of interest, they are usually paired to constitute a screen to detect a leaking part. An example of this is the use of a helium leak test to locate fine leaks in a group of parts, followed by a gross leak test such as one of the bubble tests to determine if any large leaks can be found. The two tests, when used together, span the usual range of interest.

It is worth pointing out that the helium test should be performed first since there is some hazard that fluids used for bubble testing may enter crevices and impair the accuracy of a tracer gas test.

Another matter of great concern is the possibility of false leak indications that can occur when tracer gas is trapped on the outside surface of parts under test. This gas can be released under the vacuum conditions of the test and give an indication of a leak where none exists.

Such things as mechanically attached parts, labels, adhesives, organic coatings, and finger prints can provide entrapments for tracer gas. No attempt should be made to test parts unless such items are removed and the parts cleaned.

The test methods which follow do not attempt to reference any pretesting treatments. It is recognized that thermal or mechanical shock often will induce leaks in weak packages. However, this pre-testing history properly belongs in the category of purchaser-vendor agreements.

METHOD 1 SAE METHOD FOR HERMETICITY TESTING OF
PACKAGED MICROELECTRONIC DEVICES
- HELIUM PRESSURIZATION METHOD -

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1.1 SCOPE

This procedure can be used to determine the hermetic integrity of microelectronic packaged devices containing an internal cavity which is evacuated or contains air or a gas.

1.2 DESCRIPTION OF METHOD

Microelectronic circuits and/or modules are placed in a sealed chamber and pressurized with helium so that the gas is forced into the module cavity if there are any defects in the seal. At the end of the pressurization period the modules shall be removed from the pressure chamber and within 30 minutes a maximum shall be placed into another chamber connected to the evacuating system of the mass spectrometer type leak detector. This second chamber shall be evacuated and helium leakage from a defective hermetically sealed circuit package shall be detected by the leak detector.

1.3 RANGE OF DETECTION

The range of detection is a function of the type of equipment used. For the typical mass spectrometer leak detector this range is from 10^{-6} to 10^{-9} atm-cc/sec.

1.4 MATERIALS AND EQUIPMENT

- 1.4.1 Mass spectrometer capable of detecting a tracer gas such as helium at a sensitivity level of at least 10^{-8} atm-cc/sec.
- 1.4.2 A suitable calibration standard for the mass spectrometer.
- 1.4.3 Pressurization chamber and helium source.

1.5 PROCEDURE

- 1.5.1 Place the modules to be tested in a helium pressure chamber and subject them to the designated pressure (psig) and time duration. The modules, shall not be subjected to pressure exceeding their rated limit.
- 1.5.2 Prior to the end of the pressurization period calibrate the leak detector using the prescribed leak rate standard. Calibration should be accomplished at the beginning of each test sequence and as often thereafter as necessary to assure accurate testing.
- 1.5.3 At the end of the pressurization period remove the modules from the helium pressure and leak test, following the procedure outlined by the manufacturer of each type of leak detector.
- 1.5.4 Program the test sequence so that all modules can be leak tested within 30 minutes after removal from the helium pressure chamber.

1.6 NOTES

If the surface condition of the module acts as a trap for helium atoms the residual effects can be diminished by cleaning in a suitable manner such as an air jet. This will also serve to increase the sensitivity of the leak detector.

Also, mechanically attached parts, labels, adhesives, organics and fingerprints can trap and retain helium on the outside of the package. This helium can be released during 1.5.3 and falsely indicate package leakage.

2.1 SCOPE

This test method is useful for determining the package leak rate of microelectronic devices that have been enclosed in such a fashion as to insure that the package ambient contains a known quantity of a tracer gas, such as helium.

2.2 DESCRIPTION OF METHOD

Microelectronic parts in packages containing a tracer gas, such as helium, are placed in the detection chamber of a mass spectrometer, that is calibrated for that gas. The chamber is evacuated to less than 0.2 micron of pressure and the equipment then senses the rate at which the tracer gas is being released from the unit. This apparent leak rate is then corrected to actual leak rate by applying the fraction of partial pressure known to be related to the tracer gas.

2.3 RANGE OF DETECTION

Range of detection is dependent upon the equipment used and the quantity of tracer gas contained within the package. Most helium mass spectrometers can detect from 10^{-5} to 10^{-8} cc/sec at one atmosphere of pressure differential or better. If, for example, the package contains 10% helium, by volume, and a leak rate of 5×10^{-7} is indicated by the machine then this reading must be increased by a factor of ten to be 5×10^{-6} . Larger leaks greater than 10^{-5} atm-cc/sec must be detected by a gross leak method since the tracer gas will be pumped out too rapidly to be noticed. The validity of this method is estimated to be accurate to within half a decade and is also dependent upon the accuracy of control over the gas fill operation.

2.4 MATERIALS AND EQUIPMENT

2.4.1 Mass spectrometer, capable of detecting a tracer gas, such as helium, to a sensitivity of at least 10^{-8} cc/sec at a differential of one atmosphere.

2.4.2 Calibration standard for 2.4.1.

2.4.3 Sample chamber, connected to 2.4.1.

2.5 PROCEDURE

The following steps and calculations are necessary to determine the true leak rate of parts containing a partial pressure of a tracer gas:

- 2.5.1 The sensitivity of the leak detector shall be checked, using an approved standard leak at the start of each test series and as often as necessary thereafter to insure proper operation.
- 2.5.2 Parts must be tested within 24 hours of either the filling time or the time at which they were removed from an atmosphere composed of the fill gas. Sealed, filled parts may remain in the fill gas atmosphere indefinitely before leak testing. The time between pressurization and testing is critical.
- 2.5.3 Test parts according to the procedure recommended by the manufacturer of the detection equipment and obtain a reading as determined by that method. The reading must be increased by a factor composed of the partial pressure, in atmospheres of the tracer gas, divided by the total package ambient pressure. For example, if a package is filled with 10% helium by volume at atmospheric pressure then a reading of 5×10^{-7} should be treated as follows: