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EIA-NEMA STANDARD

for

AIR-CONVECTION-COOLED LIFE TEST ENVIRONMENT FOR LEAD-MOUNTED SEMICONDUCTOR DEVICES

ELECTRONIC INDUSTRIES ASSOCIATION
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PURPOSE OF STANDARDS

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AIR-CONVECTION-COOLED LIFE TEST ENVIRONMENT FOR LEAD-MOUNTED SEMICONDUCTOR DEVICES

(From EIA Standards Proposal No. 882, this Standard was formulated under the cognizance of JEDEC Committee JS-12 on Government Specifications and Standards.)

FOREWORD

There is a definite need for a standard covering the requirements of the Life Test Environment for devices whose ratings are based on Natural-Air-Convection Cooling. Listed below are several requirements of such environments taken from MIL-Std.-750 and MIL-S-19500C.

1. Ref. MIL-Std.-750—Paragraph 4.3.1—Page 6

   Permissible temperature variation in environmental chambers.—When chambers are used, specimens under test shall be located only within the working area defined as follows:

   (a) Temperature variation within working area: The controls for the chamber shall be capable of maintaining the temperature of any single reference point within the working area within ± 2°C.

   (b) Space variation within working area: Chambers shall be so constructed that, at any given time, the temperature of any point within the working area shall not deviate more than ± 3°C from the reference point, except for the immediate vicinity of specimens generating heat.

2. Ref. MIL-S-19500C—Appendix A—Paragraph 20.22.1

   Ambient Temperature.—This is the air temperature measured below a semiconductor device in an environment of substantially uniform temperature, cooled only by Natural-Air Convection and not materially affected by reflective and radiant surfaces.

It becomes very difficult to meet these requirements, except on a small scale, without the use of forced-air movement in the working area. However, the use of higher-velocity air movement is not really permitted in an environment defined by Ambient Temperature and Natural-Air Convection.

This standard permits the use of a forced-air cooled-environment provided the average junction temperature is the same as that obtained under the ideal conditions of Natural-Air Convection.

This standard is limited to devices where most (> 90%) of the power dissipation is obtained by convection and radiation losses from the body of the device. A future standard will be prepared on devices where most of the power dissipation is obtained by thermal conduction from the junction to the leads and the mounting connections. (In this case, the leads and the mounting connections serve as heat sinks, and only a small amount of the power is dissipated by convection and radiation from the body of the device.)

I. Purpose

The purpose of this standard is to define the operational life test environmental conditions for lead-mounted, air-convection-cooled semiconductor devices, where most (> 90%) of the power dissipation is obtained by convection and radiation losses from the body of the device. It provides a means for equating, for life test purposes, the effects of a forced-air-cooled environment to that of a *Natural-Air-Cooled* environment. Thus forced air motion may be used to obtain reasonable temperature distribution in the life test area, where many devices are in close proximity while maintaining the same mean value of the junction temperature as would be obtained under a *Natural-Air-Cooled* environment at the same power dissipation level.

II. Scope

This standard is applicable to life testing of lead-mounted semiconductor devices intended for applications in a *Natural-Air-Cooled* environment where most (> 90%) of the power dissipation is obtained by convection and radiation losses from the body of the device.

III. Life Test Conditions To Be Specified

(*Natural-Air-Cooled Environment*)

A. *Stated Ambient Temperature* (T_A)

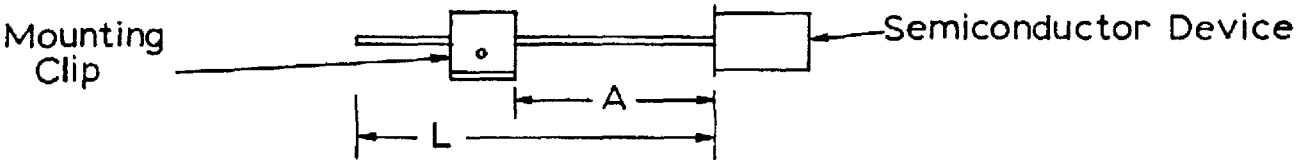
B. Electrical operating requirements at the *Stated Ambient Temperature* (T_A) with *Thermal Isolation* of the leads.

C. Life Test Mounting Conditions if different from *Table I.*

IV. Preferred Values of Dimension A

TABLE I

Mounting Code	Dimension L	Dimension A
a	< .500 in.	.188 ± .062 in.
b	.500 to 1.000 in.	.437 ± .062 in.
c	1.062 to 1.500 in.	.750 ± .062 in.
d	> 1.500 in.	1.250 ± .062 in.



"L" dimension is the minimum length of lead specified on the outline of the semiconductor device.

V. Required T_{A1} in the Actual Life Test Area

The T_{A1} required for any particular air velocity over the semiconductor device, variations in mounting conditions, and variations of the power loss in the device or its electrical operating conditions, is determined for a given set of conditions by varying the temperature of the circulating air until (T_J Avg.) mean of the semiconductor device is the same as that realized under a *Natural-Air-Cooled* environment at the *Stated Ambient Temperature* and stated power loss or electrical rating. *Ref. Appendix A.*

VI. Environment Conditions of the Working Area of the Life Test Environment

With the semiconductor devices energized for a sufficient period of time to have reached thermal equilibrium, the following conditions shall be met.

A. *Required Air Temperature* T_{A1}

(1) *The space and time variation* of the measured value of T_{A1} in the working area shall be within a tolerance of ± 5% or ± 5°C (whichever is greater) from the *Required Air Temperature* T_{A1}.

(2) The measured values of the T_{A1} air temperature are to be taken at various points in the Life Test Working Area at distances of .25 inches to 2 inches from the body of the semiconductor device on the inlet side of the air current flow.

VII. Required Life Test Temperature Measurements (See Note 1)

(1) Determination of [(T_J Avg.) Mean].
See Paragraph III and Appendix A.

(2) Determination of the Required T_{A1}
See Paragraph V.

(3) Space and Time Variations of T_{A1}
See Paragraph VI.

Note 1. If the ambient temperature of the life test working area meets the requirements of VI. A. (1), VI. A. (2) with an air velocity less than 120 ft/minute and the normal air convection currents are not impeded, it will not be necessary to determine either the Operating Junction Temperature (T_J Avg.) as required in Appendix A, or the Required Air Temperature T_{A1} as required in Paragraph V.

VIII. Large Life Test Areas

In the case of Large Life Test Areas, it may not be possible to meet the requirements of Paragraphs V and VI unless the working area is broken up into smaller areas. Then the air velocity, the *Required Air Temperature* T_{A1}, or changes in the power dissipation in the device or its electrical operating conditions, or all three variables can be adjusted in the smaller working areas until the requirements of V and VI are satisfied for the smaller working areas. Changes in the power dissipation or the electrical operating conditions are limited to ± 5% from the specified value in Paragraph III.

APPENDIX A

Reference Test Conditions for the determination of T_J Avg. under the Specified Life Test Requirements given in Paragraph III.

(1) Approximate minimum size of the enclosure: 10 in. cube.

(2) The Average Ambient Temperature (T_A) shall be controlled to a tolerance of ± 3% or ± 3°C (whichever is greater) from the *Stated Ambient Temperature.*

(3) The Average Wall Temperature of the enclosure shall be controlled to a tolerance of ± 3% or ± 3°C (whichever is greater) from the *Stated Ambient Temperature.*

(4) The emissivity of the walls of the enclosure shall be .8 or greater.

(5) The semiconductor device shall be located in approximately the center of the working space. See Table I for mounting details [except the *mounting clip is temperature controlled at* (T_A)].

(6) Adjust the T_A temperature to the specified value.

(7) With the device energized at the specified conditions, *adjust the mounting temperature* T_{MTD} until *it is equal to the Lead Temperature at a point .094 inches from the body.* This is to assure *Thermal Isolation* of the device. *See Paragraph III.*

(8) Measure T_J Avg. of the device.

(9) Repeat steps (6), (7) and (8) on a suitable sample of devices and obtain [(T_J Avg.) Mean].

(10) The [(T_J Avg.) Mean] obtained in Step (9) is used in obtaining T_{A1} in Paragraph V.

APPENDIX B

Junction Temperature Measurement

In the measurement of the T_J Avg. in either the Reference Conditions (APPENDIX A) or in the Actual Life Test Working Area (Paragraphs V and VII), it may not be possible to use the same Life Test operating conditions, but the same value of power loss in the device must be used when this measurement of T_J Avg. is made.

APPENDIX C

Symbols

(1) T_A—*Stated Ambient Temperature*

(2) T_{A1}—*Required Air Temperature* under Actual Life Test operating conditions.

(3) T_J Avg.—Average Value of the Junction Temperature of an individual device.

(4) [(T_J Avg.) Mean]—*Mean Value of the Life Test operating Junction Temperature* of many devices.

(5) T_{MTD}—Temperature of the Mounting Clip under the Reference Conditions of the test.

(6) T_L Avg.—Average Value of the Lead Temperature at a specified point of an individual device.

APPENDIX D

Definitions

(1) NATURAL-AIR-COOLED Environment

A *Natural-Air-Cooled* Environment in this standard is considered to be one in which the power loss in the semiconductor device is dissipated by means of *Low Velocity Air Currents* (those encountered in natural convection environments), by radiation losses from the surface of the device, and by an unspecified amount of conduction losses through the leads to the electrical connections.

(2) LOW VELOCITY AIR CURRENTS

Low Velocity Air Currents in this standard are defined as air currents which have a velocity less than 120 feet per minute.

(3) AMBIENT TEMPERATURE (Natural Air Convection)

This is the air temperature measured below a semiconductor device, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces.

(4) THERMAL ISOLATION

Thermal Isolation of the device from the mounting and electrical connections is defined as limiting the conduction losses through the leads to a value less than 10% of the total losses in the device when the device is operated in a Natural-Air-Cooled environment at the stated ambient temperature. The case is thermally insulated from the mounting and electrical connections except through a lead which could be grounded to the case.

(5) LEAD-CONDUCTION COOLED

A *Lead-Conduction Cooled* device is defined as one whose internal power losses are dissipated primarily (> 90%) by thermal conduction through the leads to the mounting connections.

(6) STATED AMBIENT TEMPERATURE T_A

The *Stated Ambient Temperature* is the specified temperature of the air in which the semiconductor device is to be operated at the specified life test operating conditions.

(7) REQUIRED AIR TEMPERATURE T_{A1}

The *Required Air Temperature* is the temperature to which the forced cooling air must be raised to compensate for the added cooling effect at higher air velocities.

(8) WORKING AREA

The *Working Area* is defined as that particular area in which the semiconductor devices are actually mounted and does not include adjacent areas.

(9) AVERAGE JUNCTION TEMPERATURE T_J Avg.

T_J Avg. is the average value of the junction temperature of a given semiconductor device when it is operated under specified conditions.

(10) MEAN VALUE OF THE LIFE TEST OPERATING JUNCTION TEMPERATURE

[(T_J Avg.) Mean] is the mean value of a sample of the individual semiconductor device junction temperatures *T_J Avg.* when they are operated under specified life test conditions.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