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EIA STANDARD

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Recommended Test Procedure for Semiconductor Thermal Dissipating Devices

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(From Standards Proposal No. 5236.16, formulated under the cognizance of the CE-2.0 Committee on EIA National Connector and Socket Standards).

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Engineering Department
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SUPPLEMENT TO COMPONENTS BULLETIN NO. 5RECOMMENDED TEST PROCEDURE FOR THERMAL DISSIPATING DEVICESSCOPE

The scope of this supplement to EIA Components Bulletin No. 5 is to present methods of instrumentation for plastic case semiconductors and integrated circuits for evaluation of thermal dissipating devices.

DISCUSSION

The need for this addendum arises from the increasing use of "plastic" or "economy" type devices. Components Bulletin No. 5 as it now exists, discusses devices with metal studs or flanges only.

The procedures and methods described in this supplement have been developed for and used in "laboratory" testing of heat dissipating components. Where correlation between laboratory data and systems evaluation is desired, additional instrumentation is required. The exact location of the additional thermocouples or other sensors depends on the type of heat dissipator under test. Therefore, instrumentation other than that recommended for laboratory conditions are not specified.

It is proposed that the "case" temperature measuring thermocouple no longer be attached to the case or outside shell of the device, as instrumented on the metal case semiconductors. Instead, it is proposed that it be attached to the metal substrate upon which the semiconductor chip is mounted.

The use of the metal chip supporting member as the location for the measuring thermocouple was selected for several reasons. The plastic material commonly used as the encapsulant has, generally, a very low thermal conductivity. Therefore, the ability of the heat to reach all areas of their transistor case is greatly reduced. To specify any location on the case as representative of the actual junction temperature under operation is misleading at best.

Investigation into the area of plastic semiconductor construction determined that most units have a metal platform on which the dice or chip is secured. The platform or dice pad is located where it is comparatively easy to attach a thermocouple to it without disturbing the chip. Mounting the thermocouple as close as possible to the chip insures optimum accuracy.

The size relation between the chip and its pad is usually not greater than four of five to one. Measuring the temperature of this area indicates an approximate junction temperature. The difference between actual junction temperature and the metal pad temperature is a function of the thermal resistance (θ) of the bonding technique used. In many instances, this is on the order of 1°C per watt or less.

Obtaining a temperature closer to the chip allows a more accurate indication of the effect that a heat dissipator/sink has upon the semiconductor junction temperature. In this manner, a majority of the guesswork involving conduction

path gradients is eliminated. This procedure provides an easily obtained, repeatable, and accurate temperature measuring point to get accurate data on the effects of a dissipator.

In system thermal evaluation, it is sometimes necessary to mount the case thermocouple to an easily accessible point, i.e., on a flange mounted device, under the screw head.

A case temperature comparison may be made by performing an additional test on a similar device mounting thermocouples in both places (under the screw head and close to the chip) to obtain correlation. But, for non-flange mounted devices, thermocouples should be attached to other places such as the tab, collector lead, or to the platform close to the chip.

With these points in mind, the following is then proposed as a supplement/addendum to EIA Component Bulletin No. 5.

It is proposed that the following paragraph and figures be added to EIA Components Bulletin No. 5. The purpose is to describe instrumentation techniques for plastic case transistors and integrated circuits.

1. GENERAL DISCUSSION

Relative information: Paragraph 1.1 through 6 and 8.1 through 10.3 of EIA Components Bulletin No. 5 are considered applicable to this Supplement.

The following information is for laboratory tests only. System thermal evaluations must be correlated to these procedures by additional specific case temperature measurements. This temperature data should be obtained using infrared equipment or thermocouples measuring the case surface temperature in a simulation of the system configuration. This data can be then used as correlation to identical measurements on actual equipment.

2. CASE CONFIGURATION

The plastic transistor can generally be classified into separate groups of similar case configuration. Each has its own shape, yet each has a supporting structure for leads and chips. It is this structure which is used to obtain mounting locations for the principle thermocouple. This thermocouple is attached as close as possible to the semiconductor chip or hot-spot.

2.1 Non-metallic Case Type

2.1.1 Plastic Case Type

Figures 1, 2 and 7 show the locations of the holes for these configurations. Any appropriate method of attaching a thermocouple may be used. If one of the device surfaces is to be used as a conduction plane, it must be kept free of thermocouple wires. This may be accomplished as shown in Figure 3 by inserting them in a small groove, cementing them in place with a suitable epoxy and sanding the epoxy to conform to the original surface.

2.1.2 Ceramic Cases

Where the case is of a material that is too hard for drilling without special equipment or a non-conductive material to prohibit welding, a bonding technique must be used.

If one of the device surfaces is to be used as a conduction plane, it must be kept free of thermocouple wires. This is shown in Figure 5.

3. CLEARING THERMOCOUPLE LEADS FROM TEST SPECIMENS

3.1 Dissipators

When mounting the thermocouple to the chip pad, it may become necessary to route the leads between the dissipator and the semiconductor. Whenever possible the dissipator should be relieved to allow the thermocouple leads to pass.