Microcircuit Handling and Storage Precautions

This section describes handling and storage risks, and needed precautions for microcircuits. Use this section to control the environment for which the microcircuit is used and in establishing procedures to safeguard microcircuits.

PEM moisture sensitivity

Moisture inside a PEM turns to steam and expands rapidly when the package is exposed to the high temperature of vapor phase reflow, infrared soldering, or, if the package is submerged in molten solder, wave soldering. Under certain conditions, the pressure from this expanding moisture can cause internal delamination of the plastic from the chip and/or leadframe, internal cracks that do not extend to the outside of the package, bond damage, wire necking, bond lifting, thin film cracking, or cratering beneath the bonds. In the most severe case, the stress can result in external package cracks. This is commonly referred to as the “popcorn” phenomenon because the internal stress causes the package to bulge and often crack with an audible “pop”. Surface mount devices (SMDs) are more susceptible to this problem than through-hole parts because they are exposed to higher temperatures during reflow soldering. The reason for this is that the soldering operation must occur on the same side of the boards as the SMD. For through-hole parts, the soldering operation occurs under the board, which shields the parts from the chip or mount pad interface to the outside package surface, which has been identified as a critical factor in determining moisture sensitivity. Test method JESD22-A112-A, “Moisture –Induced Stress Sensitivity for Plastic Surface Mount Devices”, and JEP113A, “Symbols and Labels for Moisture Sensitive Devices”, can be used to assist in selecting and designing in PEMs. Inspection for post reflow soldering often includes acoustic microscopy IAW JEDEC-STD-035 which will detect visually unseen, internal delaminations occurring as a result of “popcorning” conditions.

All PEMs have a moisture sensitivity level, which are levels 1 through 6 (See JEP113A “Symbols and Labels for Moisture Sensitive Devices”). Level 1 is the least sensitive to moisture and 6 the most. Through-hole PEMs are level 1-2 and surface-mount is usually a level 5-6. Even when the moisture sensitivity level is marked on the parts packaging, testing and/or monitoring should be performed. Test to JESD22-A112-A (“Moisture –Induced Stress Sensitivity for Plastic Surface Mount Devices”). Evaluations have been performed on PEMs with sensitivity levels marked and they tested differently than the labeled level. A number of parts marked level 1 or 2 were actually level 6, following an evaluation of the parts. Unless level 6 is acceptable, testing-monitoring should be done until a level of confidence is met.

Microcircuit Storage

The discussion on storage needs to be separated into part storage and dormant application storage. Hermetically sealed microcircuits that were QPL, QML, or were Military/NASA “Hi-Reliability” vintage, have been placed in storage for several years and used successfully. It has been proven that hermetically sealed parts can be stored as parts only, or in an application that sits dormant for years and then works. On the other hand, PEMs have not proven they can be stored for any given length of time. Non-military users do not normally store parts beyond a couple of months. Therefore, the military cannot rely on data from other industries to substantiate storage of PEMs. It has not been proven, but PEM part storage in a temperature controlled, clean and dry environment could probably be effective, for parts only, up to 7-8 years. Stored dormant in an application would be a totally different story. The general concern or question is can an application, like a missile system, sit dormant for years, maybe up to 20 years, and then the PEM function in the application. The example used by many to substantiate PEM usage in military applications is with Navy Sonobuoys. Although PEMs have been used in Navy Sonobuoys for some time, the facts do not suggest this special application qualify PEMs as reliable alternatives to standard military microcircuits with hermetic sealed packages. First, the Sonobuoy is a special, one-time use “throw-away” commodity not intended for the lengthy service life of up to 20 years required by typical tactical military systems. Sonobuoys are not stored for many years, as they are removed from service after 5 years typically (occasionally extended to 7-8 years), at which time they are either used for training or destroyed. The Sonobuoy deployment method includes consideration of a possible failure rate of up to 10%, which is not an acceptable level for tactical military hardware. The design includes a storage container with an “O” ring seal to minimize atmospheric exposure and desiccant is used to ensure a dry environment. The Sonobuoy unit also uses “O” rings to seal electronic compartments and a desiccant indicator is employed. “O” rings are very effective seals under even high pressure conditions, and under normal atmospheric pressures afford nearly a hermetic type seal. In reality, the PEMs used in Sonobuoys are subjected to less severe environments and reliability demands than either typical military or many commercial products. *(Note: On rare occasions, failure of units from a given lot has been as high as 20 to 40%. Also, there had been instances where the gases eluting from the plastics resulted in circuit failures negating the use of the Sonobuoy.)*

ESD

Microcircuits must be properly protected during test-handling insertion and all stages of manufacturing. Many microcircuits use high-impedance input stages, particularly metal oxide semiconductor (MOS) technology. This technology is quite sensitive to ESD. Precautions to ESD are simple. First, store the microcircuits in some fixture that shorts all the leads together. Second, the circuits must be handled with care, preferably by ESD trained personnel, grounded by a ground strap during work operations. To reduce ESD at the source, assembly and test areas should not be carpeted. The moisture in the air should be regulated at a 40 or 50 percent humidity level. Soldering irons should be designed to prevent electric potential to be collected or generated at the tip during use. Grounded soldering tips may be required. Equipment containing these sensitive microcircuits should not be handled while wires are still hanging loose. The ESD section under Library provides background information relative to the impact of ESD charges on microcircuit reliability.

Glass seal

Many hermetically sealed packages use glass-to-metal seals as the final package closure. Since the leads and lead frame go through this glass closure and since the glass, which is used, is not maximized for strength, great care must be taken in handling leads. Excessive bending of the lead or the transmittal of forces into the lead during a clipping operation can cause the glass to develop mircocracks, which expose the internal cavity of the microcircuit to the contamination of the outside environment.

Lead soldering

A common practice is to preprocess the leads of microcircuits before soldering. Two such processes, which lead to problems, are hot-tin dipping of the leads and chemical lead brightening. Hot-tin dipping must be precisely controlled to have a short dwell time, and the solder dip must not touch the body of the microcircuit or the lead frame above the shoulder of the lead. Lack of control exposes the microcircuit, in particular the glass-to-metal seal, to an excessive temperature charge, causing degradation of the microcircuit internally or micro-cracking of the glass.

Reforming leads

The reforming of microcircuit leads requires great care in the design of proper tools that minimize the strain during attachment of leads to the package. In cases where it is questionable whether any process step has damaged the hermetic-seal capability of the package, a good practice is to run a trial sample of parts through the process in question.

Surfaces

In using microcircuits, handle all surfaces carefully, which are electrically connected to one of the terminals, to make sure they are not in inadvertently energized. It is common for metallized regions of the top and bottom ceramic dual-in-line packages to be connected to one terminal of the microcircuit. When using microcircuits, it is essential that they not be inserted into a socket or equipment that is energized. It is essential that the ground pin be connected firmly before any other leads have voltage current applied to them, and that microcircuits be operated totally within the voltage-current ratings established by the manufacturer.

PEM temperature sensitivity

PEMs have limited operating temperature capability (typically +159°C – the glass transition temperature of most encapsulants) and for this reason must be protected from the heat of soldering baths and soldering irons. Plastic packages cannot give 100 percent protection to the microcircuit against various contamination liquids, so these microcircuits must be sealed and stored in a relatively dry and uncontaminated atmosphere. When active cleaning baths are used as part of the assembly process, additional less active cleaning baths must follow to remove all traces of the active cleaning baths, which may become a source of destruction to the plastic microcircuit. Most plastic packages have a small area on the end of the package through which the microcircuit chip has been mounted. It is electrically connected to the circuit, and proper precautions must prevent bringing it into contact with any other potential.