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Moisture Sensitive Devices - Not A Dry Subject

Moisture sensitivity of plastic body IC packages is not a dry subject. It is a very real and serious issue among assemblers. Though the problem has existed since the onset of SMT, it is only in recent years that the subject has received the widespread attention it requires.

The thermo-set epoxy bodies of IC appear to be impermeable to moisture but are quite to the contrary. Over time, the plastic encapsulant absorbs moisture from the atmosphere surrounding it. Of course how much moisture is absorbed is affected by the actual plastic compound, the shipping and storage conditions as well as the ambient humidity on the production line. Things get steamy during reflow soldering as the components are exposed to a relatively rapid change in temperature. The trapped moisture turns to superheated steam and the sudden change in vapor pressure, in turn, causes the package to swell. How much expansion takes place again depends upon the composition of the plastic, the amount of moisture actually absorbed, the temperature, the rate of heating and the thickness of the plastic. When the resulting pressure exceeds the flexural strength of the plastic compound, the package may crack, or, at the very least, interfacial delamination can occur. Bear in mind that the rate of diffusion varies with each package. Sometimes, the cracking will cause the component to literally pop off the PCB assembly. This has been called the "popcorn effect". But in many cases, the defect goes undetected until the product fails in the field.

IPC/JEDEC J-STD-033 addresses the problem of Moisture Sensitive Devices (MSD). It contains handling, packing, shipping and implementation recommendations and guidelines. In summation, the manufacturer of an MSD component must test and classify the device based upon a maximum floor life at 30 deg. C at 60% Relative Humidity (prior to reflow). The component is dry-packed with proper identification prior to shipment to the assembler. Theoretically, once the dry bags are opened, the components must be assembled and reflowed within the specified time limits.

One interesting misconception about MSDs is that the clock stops with regard to exposure time when previously exposed MSDs are re-sealed in dry bags or stored in dry cabinets. The return of MSDs to a dry environment when not on the placement machine is common (and good) practice, but life is never that simple, is it? In reality, once the components have been exposed to ambient conditions for more than an hour, that additional moisture is in there. Moisture diffusion at ambient temperature is a very slow process. In fact, it has been shown that the existing moisture gradient will *continue to diffuse toward the center of the package*, nearer to the die interface where it has the propensity for doing the most damage.

Therefore, proper handling requires that the total cumulative exposure time for the component must be tracked through the manufacturing process, from incoming, repacking (i.e. from matrix tray to reel), on and off the component placement system until the component is placed on the PCBA and headed for the reflow oven. Thus proper care and handling of MSDs can be a logistical nightmare.

Some very clever people at a recently formed company called Cogiscan have come up with a very practical solution. Imagine, if you will, a tracking system that monitors the whereabouts and whatabouts of MSDs from when they first enter the assembly facility until they are placed by the pick and place machine - just what the doctor ordered !

Cogiscan has developed a MSD tracking system that incorporates an advanced automatic identification technology called Radio Frequency Identification (RFID). Trays and reels have RFID transponders temporarily attached to them. These tags contain a programmable memory chip that stores all the relevant component information, including the expiration date and time.

For reels, the RFID chip and antenna are enclosed in small, thin disk. The disk is affixed to the reel in an inexpensive clear adhesive pouch which is placed on the surface of the reel. Of course when the reel is used up, the disk is removed for later re-programming and re-use. For matrix trays, the RFID system is contained in a small, innocuous, spring-loaded plastic molded clip that is designed to attach to the tab at the end of a JEDEC spec tray. The clips are easily removed for re-use. Both the clips and disks are designed to withstand standard bake conditions. A small footprint workstation contains a CPU with appropriate hardware and software for communication with the tags.

In a typical configuration, the reels and trays of MSDs would have the tags attached and initialized at incoming receiving inspection or the stockroom. The tags would next be initialized at the workstation and all the appropriate information about the component would be recorded onto the tag, including moisture sensitivity data. Additional component data can also be recorded including quantity, lot number, date code, and receiving report number. For existing part numbers, this would be retrievable from the database. The maximum floor life will be automatically adjusted based upon monitored (ambient) temperature and relative humidity -a J-STD-033 dream come true.

Workstations are located throughout the assembly area - wherever MSDs are handled outside their drybags. The tags are updated at such times by simply passing them by the antenna which is contained in a specially designed support tray. The operator is guided through the appropriate operation by simple to use (idiot-proof, perhaps?) computer menu. Thus each time the components are moved to a different environment - in and out of dry bags, in and out of dry cabinets, bake ovens and placement machines - the tags are updated. The software calculates the remaining floor life based upon the complete history of exposure and the IPC/JEDEC standard.

These guys have thought of everything. Information can be read directly from the labels on existing dry bags via a barcode reader. And yes, the system provides a warning when the parts approach and reach the expiration of their floor life. And yes, the potential of this tracking methodology goes beyond MSD (use your imagination) but what a great, urgently needed start.

This system makes J-STD-033 usable with an easy to operate and economical system. It reduces human error including unnecessary bake out which impede component solderability as well as bogs down the material flow.

Cool technology rescues our industry once again. Hey, we're all in this together.

References:

Monette, Francois, "Critical Manufacturing Issues with Moisture Sensitive Devices", Cogiscan White Paper, Cogiscan, Inc., Bromont, Quebec, Canada

Shook, R.L. and Goodelle, J.P. "Handling of Highly-Moisture Sensitive Components - An Analysis of Low-Humidity Containment and Baking Schedules", Lucent Technologies, Allentown, PA

IPC/JEDEC Standard J-STD-033, JEDEC - EIA, Arlington, VA

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