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RoHS makes impact on circuit design

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RoHS compliance occupied many employees in all sectors of the electronics industry for significant amounts of time pre-July 2006. RoHS related activity continues post-implementation and there is a lot of fall-out from the legislation.

Away from RoHS, industry trends for next-generation systems continue driving component and circuit design. Higher speeds, low-voltage/high-current operation and greater component densities, are just some of the factors testing the technical expertise and capability of component manufacturers.

Not really home and dry

For the most fortunate passive component manufacturers, the net effect of RoHS legislation was just to require them to change the tin/lead terminations on devices to a lead-free substitute. In these cases components were seen to suffer no adverse affects, either physically or in terms of performance, due to their exposure to the increased reflow temperatures associated with using lead-free solders.

Other components get off less lightly, for example certain types of devices housed in plastic packages. These may originally have been designed for safe exposure to temperatures some 30°C to 40°C lower than the 260°C reflow temperature considered by the National Electronics Manufacturing Initiative (NEMI) to be the benchmark for lead-free processes.

Higher temperatures can cause plastic bodied devices to deform, melt or burn, so changes in mould compounds may be required to bolster heat resistance. More robust and resilient compounds are often more expensive than the 'standard' temperature versions they are replacing.

For certain sizes and formats of liquid electrolyte capacitors, compliance to RoHS legislation creates some particularly serious challenges. Because of their construction, these devices sometimes require more characterization and changes to their construction than other types of component.

Comprising a sealed metal can containing liquid impregnated materials, liquid electrolyte capacitors do not have the ideal construction to be exposed to very high temperatures. Once again these devices will have been designed for safe exposure for pre-legislation reflow temperatures. Higher temperatures may affect the liquid electrolyte and, in certain cases, cause the aluminium capacitor can to bulge due to the expansion of the materials inside. In the most spectacular illustrations of this cases have been known to explode during an elevated temperature reflow process.

Combinations of approaches such as thickening case walls and modifying the electrolyte have helped overcome the problems and enable many liquid electrolyte capacitors to achieve compliance.

Another issue is that the arrival of RoHS legislation has hastened obsolescence for many older parts. This is especially true for certain ICs, but also, to a more limited extent, for capacitors and other passive components. In a situation where demand for a particular device is low, manufacturers may make the decision to discontinue the part number rather than update it to achieve compliance.

Component obsolescence has always been something that electronics designers have had to deal with. In recent years it has been an increasing problem and now RoHS legislation has created an extra surge in the number of components reaching end-of-life.

High temperature and board design

Lead-free solders are more difficult to work with than their lead/tin predecessors. The exclusion of lead from solders has resulted in some undesirable characteristics that have had to be countered by taking steps such as changing the size and spacing of etched copper traces and pads on the PCB. Potential problems include poor wetting of pads and plated vias, higher surface tension giving rise to an increased risk of tomb stoning, and PCB warping.

With double-sided PCBs typically undergoing two SMT reflows plus a wave soldering pass, followed in some cases by selective and hand soldering, the potential for component damage due to the higher process temperatures is significant. Designers need to minimize the number of heat cycles and try to attach the more sensitive components in the latter processes.

Circuit designs set specification requirements

While the challenges created by RoHS have captured the headlines, the industry-wide tendency towards lower voltage, higher current circuit designs with faster operating speeds has continued. It is a trend fuelled by the ever-decreasing supply voltage requirements of silicon ICs.

At the same time, higher level functionality in electronics equipment means that despite the lower voltages, overall circuit power levels have not decreased. These factors have created a demand for capacitors with the lowest possible ESR.

Additionally, higher levels of circuit integration on silicon are creating the chance to satisfy consumer desire for smaller products. In order for the potential to shrink products to be fully realized, passive components, including capacitors, need to downsize too.

Component manufacturers have addressed the need for smaller, low ESR capacitors by introducing several device formats and constructions:

Polymer cathode SMT tantalum electrolytic capacitors - using polymer in place of manganese dioxide for the cathode gives low ESR, high ripple current and suppression of combustion under failure. Housed in small form factor, flat molded chip packages, these capacitors can be used as a direct alternative to tantalum or impedance aluminum electrolytic parts. Typical applications include DC-DC converters, power supplies and voltage regulator modules.

Polymer electrolyte SMT solid aluminum electrolytic - replacing the liquid electrolyte with solid polymer results in an ultra-low ESR, high RCR device. Substituting the liquid electrolyte also overcomes the problem of dry out. This helps to promote ultra long life expectancy at high temperature. Being identical in size makes polymer electrolyte capacitors ideal for replacing multiple chip tantalum devices.

Hybrid electrolyte SMT aluminum electrolytic capacitors - a gap has existed in the market for a capacitor that fell somewhere between liquid and solid electrolyte devices in terms of performance and cost. hybrid electrolyte capacitors - part solid, part liquid - emerged to fill this gap. They provide ESR and ripple current ratings that fall between those of solid electrolyte and liquid electrolyte parts.

RoHS legislation provided a thorough examination of the technical capabilities of passive component manufacturers. For those designing and developing capacitors - already well occupied in meeting the call for smaller, lower ESR parts to work in high-speed environments - it created an additional set of demands. The large number of RoHS-compliant suffixed part numbers on the market today are a clear indication that the challenge has been met successfully.

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