How US Design Engineers Can Meet Global Legislation Challenges (Part 1)

By Gary Nevison, Newark

Designers of electronic and electrical equipment are increasingly challenged to design new products that comply with legislation that applies in the markets where their products will be sold. As more US manufacturers sell their products internationally, design engineers not only need to consider legislation in the U.S., but also the rest of the world.

Most of the legislation that affects design engineers is environmental in nature, restricting hazardous materials in products, requiring recycling at end-of-life or requiring designs that have lower environmental impacts. It is always preferable to preempt legislation by using good eco-design rather than to be forced to change a product's design later, so I have included some suggestions from ERA Technology, a UK engineering consultancy we have worked with extensively to facilitate compliance for our customers and ourselves.

U.S. and Canada
Currently, there is very little federal legislation in the U.S. and Canada that design engineers need to consider since most regulations concerning recycling, product restrictions and marking have been on the local level. For example, most states and provinces are now either planning or already have legislation that requires recycling of certain types of electrical equipment at end-of-life. And, most states have either banned or are planning to ban landfill disposal of televisions, computers and monitors. A landfill ban means compulsory recycling and although this does not necessarily affect the equipment's design, good design can reduce the cost of recycling.

Design considerations that can make recycling easier, include the following: &#149 Design products for easy dismantling into their major parts (PCBs, enclosures) which can be recycled separately and economically.
&#149 Removing screws is time consuming, whereas plastic clips can be undone more quickly, therefore, using as few metal screws as possible is a good idea. For example, attach PCBs to enclosures using plastic clips so that they can be easily pulled.
&#149 Marking larger plastic parts with the type of plastic (and flame retardant) aids in the recycling of plastics. Single types have a value and can be sold, whereas

unidentified mixtures have very little value.
&#149 Avoid metal inserts in plastic moldings since they reduce the value of the plastic to zero.
&#149 Avoid attaching labels to plastic parts that are incompatible with recycling.
&#149 Consider metal housings because these are easier to recycle and the recycled metal has value, but avoid combining metals as much as is feasible. Steel, copper and aluminum have the most value when free from each other. (Note: although metals have a higher value and are easier to recycle than plastics, they are heavier, and so they increase transport costs.)
&#149 It is better to use one type of plastic for the enclosure and any large moldings. Do not attach labels or include metal inserts. Heat welding is preferable to adhesives.

Federal U.S. legislation is now being considered that would ban polybrominated biphenyl (PBB) flame retardants and two polybrominated diphenyl ether (PBDE) flame retardants. These substances are already banned by many states and in Canada. There are also proposals for federal restrictions on mercury that follow legislation already introduced in many states. Mercury was widely used in relays, switches and thermostats, but the state bans have resulted in most of these being replaced by mercury-free substitutes. Design engineers should be aware, however, that performance is not identical: contact resistance may be higher, mercury-free alternatives suffer from switch bounce and lifetimes tend to be shorter. California's proposed Bill AB1109 plans to restrict the amount of mercury in fluorescent lamps (similar to the EU's RoHS) and also to restrict lead in certain types of lamps.

State restrictions on mercury, PBB and the two PBDE flame retardants vary in their detail, but it is advisable for designers to avoid these materials wherever possible as restrictions will always tighten in the future. California has already introduced legislation that is a copy of the EU RoHS directive, although the scope presently only covers displays above a certain size. When enacted, this will have a significant impact on design engineers, as they will need to choose components that do not contain the six specified hazardous substances: lead, mercury, hexavalent chromium, cadmium, PBB and PBDE.

Some vendors of older types of components will not supply compliant versions due to the cost of changing production, and many are also making older products obsolete. This affects equipment design, forcing designers to make changes to circuit layouts to avoid non-compliant parts. Where older microprocessors have to be replaced, new software may well have to be written for the newer parts.

While we have no compulsory federal eco-design legislation, the US Energy Star program now covers over 50 types of products, mainly electrical equipment. Energy Star is used worldwide and although it is voluntary, many manufacturers aim to design new products with lower energy consumption. Clearly, energy-efficient products will have a sales advantage, particularly to cost-sensitive businesses that increasingly look at energy consumption as a criteria for the purchase of new equipment.

On the local level, eco-design legislation is being proposed in California as part of

two new bills: Bill AB1109 is to regulate the energy efficiency of lighting, increase recycling at end-of-life and reduce hazardous materials &#151 less mercury and lead. This proposed bill is supported by lighting manufacturers, and it is similar to some parts of the Energy Using Product directive, WEEE and RoHS in the EU.

Also in California, Bill AB722 proposes to ban the sale of “general service incandescent lamps” as of 2012. This will include some types of halogen lamps, and it is aimed at restricting the sale of inefficient lighting and promoting more energy efficient types. California is following the EU and Australia which are proposing similar legislation. California clearly sees energy efficiency as an important issue and more legislation should be expected.

EU RoHS and Beyond

Adopted by the EU in early 2003, the Restriction of Hazardous Substances directive came into force July 1, 2006, affecting eight categories of electrical equipment. RoHS restricts the use of six hazardous substances in products, although exemptions apply where no substitutes exist. This directive has already had a profound effect on the electronics industry and design engineers in particular. The main impact is the restriction of lead in solders. All of the most useful alternatives are different and have higher melting points. This results in PCBs being assembled at a higher temperature which can cause damage to both laminate and components.

This potential damage can be minimized by measures such as &#151
&#149 Avoid use of heat sensitive components that will be damaged at the reflow temperature. Plastic connectors and surface mount electrolytic capacitors are examples of components with low maximum reflow temperatures.
&#149 Use high Tg laminate to avoid flexing and warping during reflow. This is not always necessary, but it will often be with thick multi-layer PCBs.
&#149 All solders can suffer from thermal fatigue. The behavior of tin/lead is understood as it has been in use for many decades, but lead-free solders are relatively new. Research has shown that at high strain levels, lead-free solder bonds fail earlier than their tin/lead counterparts. This is based on accelerated testing, and so the true situation is not known with certainty, but it would appear to be sensible to avoid high strain situations in lead-free designs. This means avoiding large chip resistors, leadless ceramic chip carriers and J-lead ICs having alloy 42 lead-frames in types of equipment that will experience large temperature changes in use.
&#149 Lead-free solderable coatings are usually pure tin, but tin-bismuth and tin-copper are also used. All of these can be susceptible to tin whiskers which can cause short circuits. However, failures that can be attributed to tin whiskers are rare. There are published strategies for minimizing the risk and one of the most comprehensive is from iNEMI. Designers can help to minimize the risk by not using custom tin plated parts, unless this is unavoidable, and by also avoiding fine pitch component terminations.

Another issue that affects design engineers is that IC vendors do not always offer lead-free versions of some older components. Many have already become obsolete earlier than planned due to this legislation. Where an RoHS-compliant version of an IC (such as a microprocessor) is not available, the design engineer will be forced to

redesign the circuitry with newer ICs, and often new software will be required. This can be both time-consuming and expensive, and it may result in the early withdrawal of products if future sales would be insufficient to fund redesign. For new product designs that are currently outside the scope of RoHS, it will be advisable to design these as RoHS-compliant as the scope may broaden in the future to include these.

China RoHS
China has adopted legislation, widely called China RoHS, which has many differences compared to EU RoHS. China RoHS is being introduced in several stages, and initially, Stage 1 requires labeling only. There are no substance restrictions or design requirements. Stage 2 will introduce substance restrictions. The exact details are unknown, since this is under discussion, but this will probably be based on those in the EU RoHS directive. The China RoHS legislation also includes requirements (Article 9) that equipment designers comply with industry or national standards for prevention and control of pollution.

Article 10 requires manufacturers to design for recycling and to follow industrial or national standards. Finally, Article 15 requires manufacturers to use non-toxic, readily degradable and recyclable materials (in accordance with standards). Standards to describe how these are to be achieved have not yet been published and no drafts are available yet. It is probable that it will be some time before any obligatory design requirements are imposed, but designers should be aware of the possibility, and to consider good eco-design now to preempt any future restrictions.

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