

LEAD MAKES AN ELECTRONIC EXIT

Lead and other hazardous materials are coming out of electronic products. Test equipment has an exemption, but it still must be recycled.

MARTIN ROWE, SENIOR TECHNICAL EDITOR

First unleaded gasoline debuted, then it was unleaded paint, and now electronics is losing its lead. As new European Union (EU) regulations governing the use of lead in electronics and the disposal of electronic products go into effect, many manufacturers are scrambling to redesign their products and devise new recycling policies. Complying with the EU requirements can be difficult, but similar regulations are also being devised in countries such as China and Japan, so it's becoming mandatory for manufacturers to "get the lead out."

As of August 13, 2005, electronic products sold into the EU had to comply with Directive 2002/96/EC on waste electrical and electronic equipment (WEEE), which requires manufacturers to provide a means for recycling the materials in their products (Ref. 1). In addition, by July 1, 2006, many electronic products sold into the EU must be free of hazardous substances, as dictated by Directive 2002/95/EC (Ref. 2), which covers the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS). Of the six substances restricted by the RoHS directive, lead

is the most prominent in electronic products (Ref. 3). Because of its "mission-critical" nature, test-and-measurement equipment is currently exempt from RoHS but not from WEEE (see "Why exempt?" p. 40).

To learn about the difficulties manufacturers face in complying with the directives, I spoke with representatives of two North American companies that have taken the first steps toward compliance. On November 18, 2005, Sealevel Systems (Liberty, SC) announced an RoHS-compliant PCI board that adds serial ports to computers. On December 7, Exfo (Vanier, QC, Canada) announced that its telecom-test products were in compliance with the WEEE directive when it went into effect in August.

Compliance achieved

Sealevel's COO, Ben O'Hanlan, said that the company decided in 2004 to research how to produce an RoHS-compliant product. O'Hanlan put manufacturing manager Mike Demos in charge of the project.

"The road to RoHS compliance is exhausting," claimed Demos. "We worked with 17 component manufacturers and three distribu-



COMPLIANCE

tors to get the RoHS-compliant parts we needed. We changed 46% of the board's components, and we changed our PCB plating and reflow processes to remove the banned materials."

Because Sealevel was such an early adopter of RoHS, the company had difficulty procuring lead-free ICs, connectors, and passive components. Demos had to contend with long lead times—as much as 16 weeks for many parts. "I feel sorry for companies that are just starting out," said Demos. "If you don't have your parts orders in by now, you won't meet the deadline."

Electronics manufacturers must change their reflow processes to comply with the RoHS directive, but lead-free solders introduce manufacturing problems. The tin/silver/copper (SnAgCu, also called SAC) solder alloy seems the most promising, but it melts at 217°C, as opposed to 183°C for traditional tin/lead (63% Sn, 37% Pb) solder. **Figure 1** shows the reflow profile that Sealevel uses for its RoHS-compliant boards. Maximum temperature is 234°C.

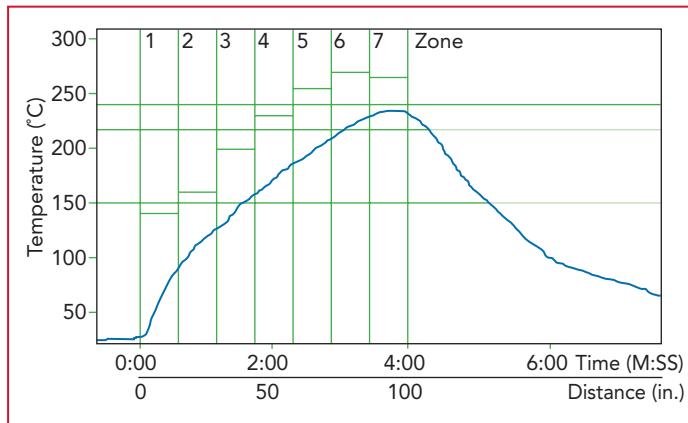


FIGURE 1. The reflow temperature reaches 234°C, but the time a board spends at that temperature is short enough to prevent permanent deforming of the PCB laminate. Courtesy of Sealevel Systems.

Standard FR4 PCB laminate material softens at such temperatures because of its low glass transition temperature (T_g) of about 140°C. T_g is the temperature where a polymer substance such as PCB laminate begins to lose its glass-like properties and take on rubber-like properties. Working with a contract manufacturer, Demos chose FR408 PCB laminate because of its T_g of 180°C.

Although the reflow temperature exceeds a laminate's T_g, the time that the laminate spends in its "rubbery" state is short enough to avoid permanent deformation. T_g, however, shouldn't be your

only concern. "Many manufacturers are concentrating solely on the T_g as the primary metric," said Demos, "but the coefficient of thermal expansion (CTE) in the z-axis is equally important. The CTE of FR408 is 65 ppm/°C while that of standard FR4 is 165 ppm/°C. Too much thermal expansion can cause a laminate to crack."

In addition to changing its PCB laminate, Sealevel needed a way to identify RoHS-compliant serial-interface boards because

the company is building both compliant and noncompliant versions of its product. Sealevel can't discontinue the noncompliant version because some customers still insist on it.

Although Sealevel's RoHS-compliant board uses the same circuit layout as the noncompliant version, the contract manufacturer needed a new solder-paste screen because of residual lead used in the noncompliant screen. That provided an opportunity for marking the boards.

Sealevel added a pair of identifier pads with gold plating (**Figure 2**) to both versions of the PCB. During solder pasting,

Why exempt?

While the vast majority of electronic products must comply with the RoHS directive by July 1, there are exceptions—most notably, military and medical electronics (category 8) and test, measurement, and monitoring equipment (category 9). These products require a higher level of reliability than, for example, consumer products.

"Don't expect this exemption to last forever," warned Jeffrey Bock, RoHS lead program director at TÜV Rheinland. "The exemption on measurement equipment will probably end between 2008 and 2010." Many test equipment manufacturers recognize this and have begun to transition their product lines to lead free. "Even if you claim an exemption today," added Bock, "if your competitor's products comply with RoHS, then the market will force you to comply."

Test products such as ATE systems, data-acquisition and control systems and their components, and most bench test equipment are sold only to businesses. But some test products such as handheld DMMs are sold to consumers, and Bock argues that they could fall outside

category 9. Jim Cavoretto, CTO at Fluke, argued to the contrary. "The RoHS directive doesn't apply to DMMs," he said, "because they're defined in category 9 as monitoring and control instrumentation. A small percentage of test equipment does find its way to consumers, but it's still out of the scope of the directive."

At Sealevel Systems, management had to decide if the serial-interface board was RoHS exempt because it is mainly used as part of a measurement system. "We chose to comply," said COO Ben O'Hanlan, "because the product can be used in other applications."

Despite the exemption for test and measurement equipment, numerous test equipment manufacturers are converting to lead-free products. For example, AEMC Instruments intends to comply by the July 1 deadline, and National Instruments and Agilent Technologies have statements on their Web sites that say they plan to comply. In fact, NI has already produced RoHS-compliant versions of the ICs used in its IEEE 488 controllers.

Martin Rowe



COMPLIANCE

the solder screen for the compliant board lets solder paste pass through to the pad marked “RoHS,” while the screen for the noncompliant board passes solder to the “Non-RoHS” pad. Thus, the boards are clearly labeled based on which pad is covered with solder.

RoHS and test

Sealevel engineers had to test the compliant cards to ensure that they would function properly despite being subjected to higher reflow temperatures. Prototype boards went through numerous thermal cycles before testing. Demos put the boards through a 0°C to 70°C cycle for three weeks, a -20°C to 80°C cycle for one week, and a -40°C to 100°C cycle for another week.

Sealevel’s management chose to go for compliance on the interface card even though it could have argued that the product is exempt from RoHS based on its primary use in measurement systems. “Sooner or later, all of our products will have to comply with RoHS,” said O’Hanlan, “so we decided to start the transition early.”

Jeffrey Bock, RoHS lead program director at TUV Rheinland, sees the move toward compliance as inevitable. “As soon as one company complies with RoHS,” he said, “its competitors will feel pressure to do the same or be seen as behind. Some telecom rack-mount equipment that’s professionally installed is RoHS exempt, but some manufacturers have already begun to comply,” he added. “That’s forcing competitors to comply.”

WEEE requirements

Communications test-equipment maker Exfo is also moving toward RoHS compliance. The company has started receiv-

ing compliant parts, which it can use with its noncompliant reflow process. Once Exfo can get all the compliant parts it needs, it will switch to the compliant reflow process.

In the meantime, Exfo has announced that its products comply with the WEEE directive, which requires that manufacturers provide a means of reclaiming and recycling the content of their products sold into EU countries. “The WEEE directive is the minimum that countries must translate into legislation, while RoHS must be translated as is,” said Stephen Bull, VP of R&D at Exfo. “The WEEE directive can vary from country to country within the EU. The paths to

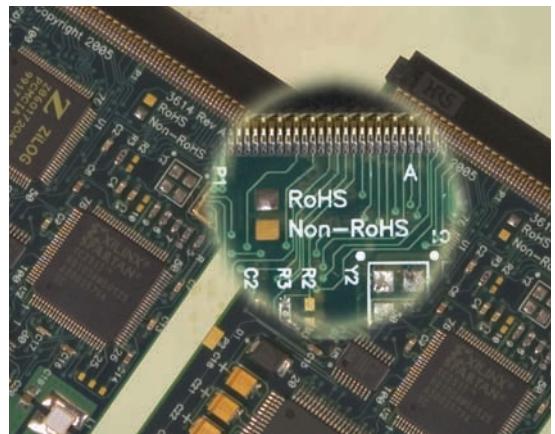


FIGURE 2. Solder on a pad indicates whether a board is RoHS compliant. Courtesy of Sealevel Systems.

recycling are still confusing and differ.”

In general, manufacturers or distributors who introduce an electronic product for sale in EU countries must take responsibility for its recycling. They must work with an EU recycler partner—one or more for each country—who will properly dispose of the products. Manufacturers must provide end-of-life instructions, making them available through a phone number or online. The instructions tell customers to send a product to the manufacturer’s recycling partner, and depending on the country,

GET MORE INFORMATION



The online version of this article contains links to sites where you can learn more about the RoHS and WEEE directives and their impact on electronics manufacturers. www.tmworld.com/2006_03



COMPLIANCE

either the original manufacturer or the distributor must pay for the shipping. Each manufacturer or distributor must also establish a secure Web site for providing dismantling instructions to the recycling partners.

To comply with the WEEE directive, Exfo places a symbol (**Figure 3**) on its

telecom products that indicates that the product must be recycled in the EU. “Fifty percent of our telecom products’ weight must be recyclable and 70% must be recoverable,” noted project manager Marc Turgeon. According to Turgeon, “recyclable” means that a part can be reused to make another product, while “recover-

able” means that a part can have value once disassembled. For example, it contains usable energy and can be burned.

To meet the weight requirements (called the “recycling rate”), a manufacturer must provide disassembly instructions. In addition, it must provide information on materials used in the product. TUV Rheinland’s Bock noted that recyclers have machines that can separate recyclable materials from assembled circuit boards. The recycler then processes the



FIGURE 3. Exfo affixes this logo to its products to indicate that they must be recycled in the EU.

materials into a form that makes them reusable.

Manufacturers and distributors have several options to provide funds for recycling. Exfo’s Bull noted that the customer pays a recycling fee to the producer (manufacturer, distributor, or importer) at the time of purchase. In some countries, the producer passes on the recycling fee to a government association that pays for the recycling. In other countries, each producer must contribute to its own recycling fund.

The RoHS and WEEE directives force manufacturers to make their products more environmentally friendly and more easily recycled. The EU is leading the way, and US manufacturers will need to comply with regulations in order to remain competitive in worldwide markets. T&MW

REFERENCES

1. Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE). europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_037/l_03720030213en0240038.pdf.
2. Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS). europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_037/l_03720030213en00190023.pdf.
3. The five substances other than lead are cadmium, hexavalent chromium, mercury, polybrominated biphenyls, and polybrominated diphenyl ethers. According to Molex, the five others have little use in electronic products. www.molex.com/leadfree.