A review of four case studies of product conversions.

With the next RoHS compliance deadline approaching in July 2014, many electronics manufacturers that were exempted from the 2006 mandate will soon be forced to comply.

The initial conversion of consumer and other electronics was painful and costly at all levels of the supply chain. But over the past six years, many valuable lessons have been learned that can ease the transition for the next wave of products pursuing compliance. Furthermore, the higher reliability products with longer lifecycles typically use older packaging and PCB technology, and therefore are excellent candidates for cost reductions as their designs are updated.

Keys to a successful, economically advantageous conversion include thoroughly reviewing the product's design, identification of cost-reduction opportunities and allotting adequate time for testing and qualification.

The first step in any RoHS conversion activity is a thorough analysis of the product's bill of materials (BoM). The BoM should be reviewed, or "scrubbed," for availability of RoHS-compliant components, for compliant components that are or will soon become obsolete, and for opportunities to transition through-hole (PTH) component to surface mount (SMT).

The BoM scrub will indicate one of three situations:

1. Complete set of RoHS-compliant parts are available.

2. Some parts are not available as RoHS compliant.

3. Some parts are not available as RoHS compliant, and others face obsolescence issues.

Each scenario requires different actions to complete the product conversion.

If a complete set of RoHS-compliant components is available, the conversion is very straightforward and relatively easy. The BoM is updated, and a design for manufacture (DfM) review is conducted. The primary purpose of the DfM review in this situation is to update the land patterns for Pb-free processing using the original PCB layout. The layout is updated to reflect the new footprints and, whenever possible, incorporate other DfM opportunities identified in the review. After the layout is updated, the fab drawing is then updated to indicate the new RoHS-compliant material and process requirements.

The product with the updated BoM, layout and fabrication drawing gets prototyped, tested and validated using standard manufacturing processes and practices. Following validation of the compliant product, final documentation is prepared and production is started. With the fully

RoHS-compliant assembly now in production, the conversion process is considered complete.

If a complete set of RoHS-compliant parts is not available, the process requires several extra steps that take a little more time and cost a little more money. Alternate components must be researched, selected and approved. In some cases multiple parts may be required to satisfy the functional requirements of the unavailable components. A new BoM must be generated, and when complete, a DfM review is conducted. Because the new BoM will likely require a new PCB layout, more DfM opportunities may be incorporated during the re-layout phase. The new PCB design will dictate a new fabrication documentation package.

With the added steps of identifying new components and the new PCB layout complete, the conversion process now follows the same path as the product with simpler updates. It is prototyped, tested and validated. Then the final documentation is prepared, production is launched, and the conversion is finalized.
If a complete set of RoHS-compliant parts is not available and component maturity or obsolescence issues signal the need for redesign, the conversion process again requires more added steps, time and cost. Alternate components are identified, a new BoM is generated, and a DfM review is conducted. However, eliminating the antiquated or obsolete components may require major mechanical, electrical or electronic redesign. The new design will also need a complete new set of documentation.

As with the other two conversion situations, the design now progresses through the same prototype, test and validation phases; the final documentation is prepared; production is begun, and the process is completed.

Figure 1 depicts the RoHS conversion process and outlines the key engineering activity in the green boxes. Every conversion starts with a thorough BoM scrub. This is arguably the most important part of the conversion process, as its results determine the conversion path. Failure to identify exact drop-in replacements or impending obsolescence issues at the earliest stage can result in expensive setbacks and course corrections at later stages of the project.

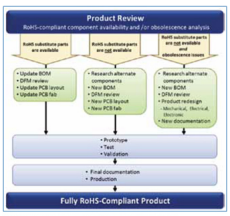

FIGURE 1. Overview of RoHS conversion process.

Every conversion concludes with the same activities: prototyping, testing, validating, documenting and producing. Depending on the end-use of the product, testing and validating times can vary dramatically. When planning to meet conversion deadlines, validation requirements should be carefully considered.
In between the BoM scrub and the prototype build, a lot of engineering takes place. The

following four case studies describe the key engineering activity in each conversion process.

Case 1: Remote display keypad for medical device. Figure 2 shows before and after images of a medical manufacturer's device user interface module. This is an example of an extremely simple RoHS conversion. The BoM scrub indicated that all but one part was available in Pb-free surface finish, and the one missing component was easy to replace. The scrub also identified a major cost reduction opportunity: updating the PTH transistors to SMT packages. The SMT components are less expensive than the PTH ones, and the SMT assembly process is far more cost-efficient than PTH assembly. The new components fit within the footprints of the previous components, so updating the layout was fast and easy.

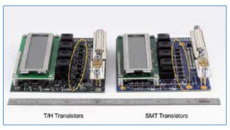

FIGURE 2. RoHS conversion of remote display and keypad.

The savings achieved by the SMT migration completely offset the higher costs of Pb-free PCBs, components, and assembly. The net savings on the RoHS-compliant product was 2% per assembly. While this is not considered a substantial cost reduction, it is still far preferable to the anticipated cost increase.

Case 2: Analytical equipment controller boards. Before and after images of an industrial controller assembly are shown in **Figure 3**. This conversion required a replacement module with the exact same interface and functionality as the original to guarantee seamless integration into the final product. The BoM review indicated that the age of this product and its extensive use of PTH components offered multiple opportunities for cost reduction through redesign:

- Conversion of PTH to SMT components reduced main board area by 40%.
- Relocating opto-isolator to main PCB eliminated daughter card assembly.
- Reducing the component count and cost reduced the total BoM cost.
- PTH to SMT conversion reduced labor cost.
- Electrical redesign reduced cost of major components by using new, higher-capability processor chips. Logic and motor controls were consolidated into one processor, which also performed hardware control functions that were previously executed externally.

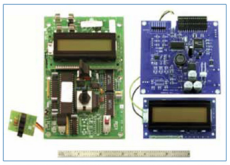
FIGURE 3. RoHS conversion of controller assembly for measurement and test equipment.

The reduction in PCB and manufacturing costs, and the benefits of component consolidation resulted in an overall savings of 31% per assembly.

Case 3: Real-time clock. The RoHS conversion of the real time clock and RAM backup module shown in **Figure 4** was driven primarily by obsolescence. When faced with component obsolescence, the easiest option is often to purchase enough components to supply the product through the end of its lifecycle. In this case, however, the lifetime buy was not a viable option because the product had 10 years left in its lifecycle and required a five-year shelf life. The old modules were manufactured with internal batteries that would last at least five years but nowhere near 15 years.

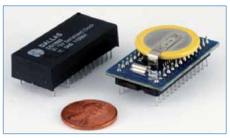

FIGURE 4. RoHS conversion of real-time clock.

The new design had to address battery life issues and meet FDA requirements. Because the only alternative was complete redesign, RoHS compliance was added to its list of specifications. The redesign incorporated the following features:

- RoHS compliance.
- Battery installed at time of shipping final product, maximizing its shelf life and enabling easy replacement in the field.
- The exact form, fit and function of the new component exempted it from FDA recertification, saving the medical device manufacturer additional resources, time and money.

In addition to this redesign achieving RoHS compliance, extending the shelf life of the product and minimizing regulatory expenses, this conversion reduced the cost by a staggering 52% per assembly.

Case 4: Embedded process control board. Like Case 3, the conversion of the controller boards shown in **Figure 5** was also driven by component obsolescence. These assemblies had two obsolete components, and more pending. One of the components was sourced through brokerage at 8X its original price! And like Case 2, extensive use of PTH technology made this a perfect candidate for redesign, even if the obsolescence issues were not considered.

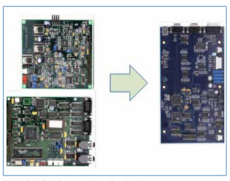

FIGURE 5. RoHS conversion of embedded processor

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