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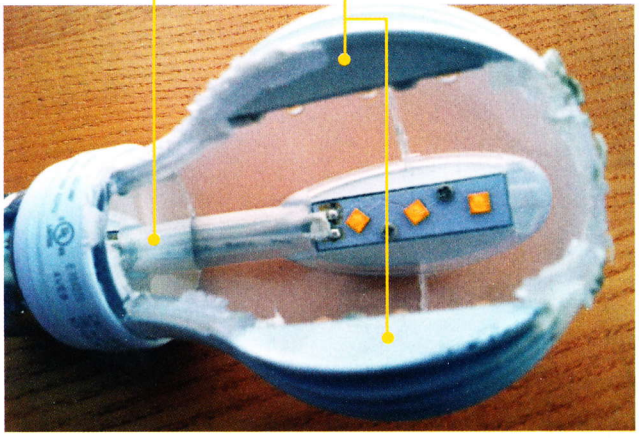
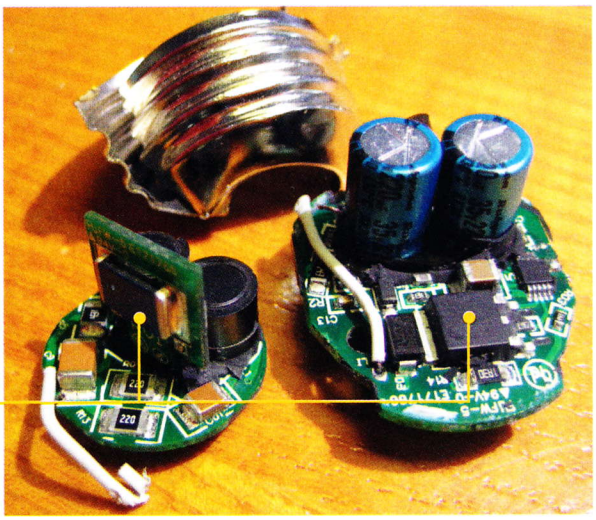
LED light shrinks size, cost with nonisolated driver

LED-bulb prices are dropping. A year ago you could expect to pay $50 for a Philips dimmable 60W-replacement LED bulb, while today you can go to Best Buy and purchase its house-brand 8W, 800 lumens Insignia 60W-replacement bulb for just $17. What has changed in LED-bulb design to allow this price drop? Tearing apart the bulb gives us a look into some design trends in LED lighting, such as how the LEDs are placed within the bulb and what driver architecture is used.

The Insignia bulb has a shape similar to the familiar incandescent light, with the addition of three metal heat-sink fins and a plastic bulb instead of glass.

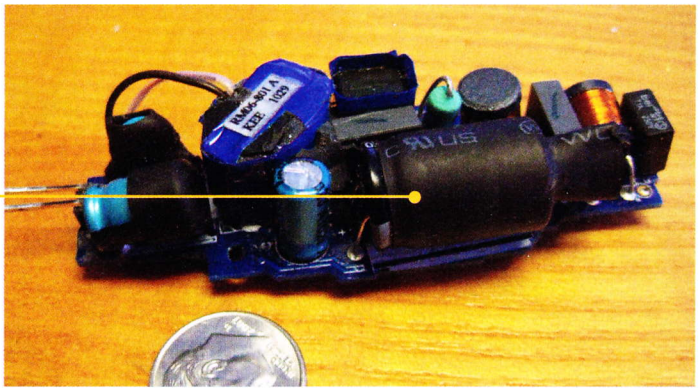
The plastic bulb cover was removed with a Dremel tool, exposing the six Cree white LEDs that illuminate the bulb's light-mixing chamber, which allows an even glow with no pixelation. The metal fins on which the LEDs are mounted serve both to elevate the LEDs and as heat sinks. At the bottom of the mixing chamber is a paper-thin aluminum reflector that helps reflect the light up and out of the bulb. All of the electronics for this bulb lie beneath the mirror in the base of the bulb, in a separate and encapsulated compartment.

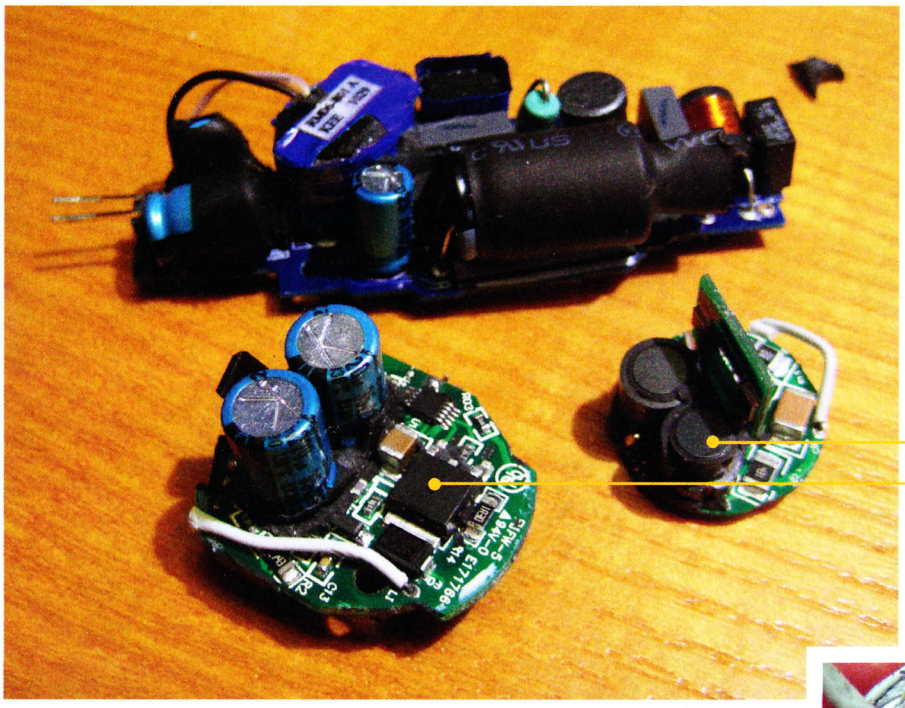




Removing the rubbery potting compound shows that the electronics are mounted on two PCBs that nestle together. Here, the PCBs are separated and next to the bulb's base.

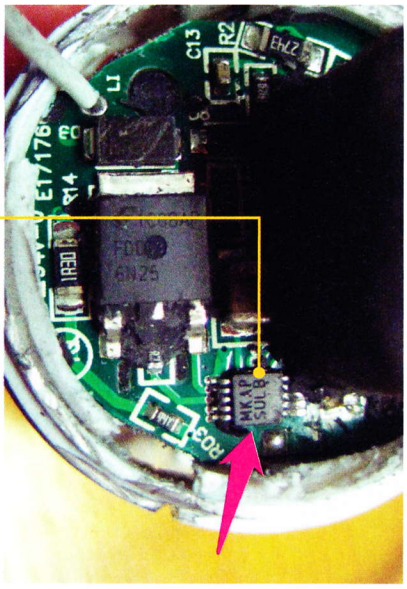
For comparison purposes, the driver electronics are shown for an LED-light teardown from about a year ago. Not only is the packaging quite different, but also there are a lot more electronics. For example, the older design has three electrolytic capacitors and a very large transformer.





The two different generations of drivers are shown side by side: The Insignia driver has just two relatively small e-caps. This setup raises the question: What LED-driver IC does the bulb use, and how does it allow such a tiny driver?

Question answered: The "SUL B" on the tiny IC is the marking for the Texas Instruments LM3445. There is no transformer, indicating that the LED-driver design is nonisolated. The incandescent-bulb design itself is nonisolated. If you broke the glass in an incandescent bulb while it was plugged in, you would have direct access to the ac-line power. Clearly, nonisolated designs can be made fully compliant with UL specifications. Note: While a nonisolated ac/dc LED-driver design can both be safe and meet UL specifications, developing and testing a nonisolated offline LED driver in the lab requires stringent lab-safety procedures.



Dimming is an important bulb characteristic for the US market. I used a Lutron Maestro dimming switch, with a programmable dimming control, and did a side-by-side comparison with an incandescent bulb. The Insignia dimmed consistently and smoothly, with a dimming profile similar to the incandescent bulb. Watch a video of the dimming test at http://bit.ly/145ROBK.