Powering Organic LEDs

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Organic light emitting diodes (OLEDs) are poised to break out well beyond their primary applications in cell phone subdisplays over the next several years. According to DisplayBank, a South Korean market research firm, this rapidly emerging technology is set to grow by 64 percent this year (from about 61 million units in 2005 to about 100 million units in 2006) as manufacturers of digital still cameras, MP3 players, handheld gaming devices, and other portable systems take advantage of OLEDs.

Driving that growth will be the technology's numerous advantages over conventional LCD technology. OLEDs function by placing a series of organic thin films between two conductors. This light emissive technology requires no backlight, so it offers a much simpler architecture than TFT or active matrix LCDs. It also offers a thinner profile, a key consideration in space-constrained portable systems. Better yet, OLEDs bring these advantages, deliver fuller colors, and provide wider viewing angle while consuming less current.

That's not to say that this exciting new display technology has matured to a point comparable to more established LCD technologies. Challenges still abound. Yield remains a problem, especially as display size increases. Today, the large majority of OLEDs are restricted to relatively small sizes. It will be a few years before the technology competes for notebook computer screens, but manufacturers are making progress.

Cost also remains a liability. OLEDs are still more expensive than comparable LCDs. Display operating life is a challenge as well. Only recently have manufacturers managed to build OLEDs capable of lasting longer than the average cell phone lifetime. Clearly, however, as manufacturing processes mature and manufacturers gain experience, the premium between OLEDs and existing LCD solutions, and the difference in operating life, will shrink and eventually disappear.

Power Management Challenges

As display manufacturers gradually increase yield and drive down costs, portable system designers adopting OLEDs face another challenge -- how to power this new display technology. While OLEDs offer a wide range of attractive advantages over conventional LCDs, they present a significantly different output voltage and load profile. Current generation OLEDs require output voltage levels ranging from 10V to 18V, significantly higher than the voltage available from a typical single-cell Lithium-ion/polymer battery and much higher than what current non-inductive DC/DC power supplies can offer. Also, the pulsating load profile of the OLED requires its power supply to be able to adjust to quick load changes while maintaining an accurate output voltage. As a result, OLEDs need to be powered by a switch-mode DC/DC boost (step-up) converter providing fast load transient response.

Moreover, OLEDs require boost converters that can also provide a control mechanism to easily manage their dimming or brightness levels -- a feature known as dynamic voltage control. A current 1.5-inch OLED sub-display requires two output voltage levels ranging between 10V and 18V, while even more levels may be required for future designs. Dynamic voltage control requires quick transitions between output voltages, as determined by the OLED brightness required. This places additional demands on the design of the boost control and feedback compensation.

Stable operation is a key concern in boost converters. Typical boost converter ICs require feedback compensation to ensure stable operating characteristics. This can make it difficult for the designer to stabilize the feedback control loop under all operating conditions. The power supply must be able to transition between different output voltage and load states quickly and cleanly, while avoiding oscillations which may impact the quality of the display.

From a portable system designer's point of view, leakage current is another imposing obstacle when using a boost converter. Portable systems designers must minimize leakage current in their design to maximize battery life and extend the battery life cycle. Given the inherent configuration of a switching boost converter, however, leakage current between the power source and the output load occurs when the display is disabled. Even a small leakage current can have dramatic negative effect on the standby life of a battery-powered device.

New Advances

Power management semiconductor manufacturers have begun to address these issues, but very few step-up converters on the market today provide a comprehensive solution. What should a designer look for in a step-up converter to power OLEDs?

The first consideration should be fast transient response. Some of the step-up converters recently introduced to the market employ switching frequencies as high as 2MHz to provide rapid response to load transients. AnalogicTech's AAT1230 step-up converter, for instance, combines a 2MHz switching frequency with a hysteretic control mechanism which offers ultra-fast transient response and ensures stability over a wide input range without additional compensation components. Figure 1 illustrates the response speed of the AAT1230 compared with a typical boost converter. In addition, the device's high switching frequency permits the use of a small 2.2µH inductor and 2.2µF capacitors.

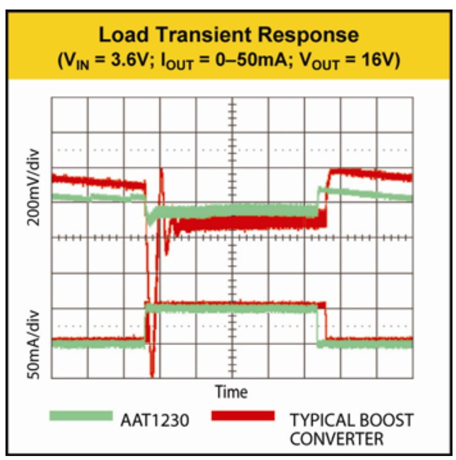

Figure 1. AAT1230 vs. Typical Boost Converter

Traditionally, portable systems designers address the leakage current issue by adding an external MOSFET and controller to disconnect the output load from the power source when the display is inactive. This approach effectively minimizes leakage losses; however, since it requires additional external components, it also complicates the design and drives up cost. Recently, power management semiconductor manufacturers have begun to address this issue by integrating a series disconnect switch into the boost converter package. This new approach effectively isolates the load from the power source when disabled. It can reduce leakage current to less than 1µA, while also reducing solution size and cost.

Control mechanisms are also rapidly changing. Some of the step-up converters on the market today allow the designer to support current OLED modules dynamically by activating two different reference levels through a logic pin. Future OLED applications will require more sophisticated control mechanisms to program output brightness to a wide variety of different levels. To meet these requirements, designers should look for step-up converters that allow them to dynamically program the output voltage at different levels through a serial bus interface. System designers will be challenged to provide fast, stable output transitions under all input and output voltage and loading conditions.

Finally, board real estate comes at a premium in every portable design. Reducing product footprint is key to driving down cost and ensuring market success. Designers should seek step-up converters in the smallest package possible. The size of external inductors and capacitors should be minimized by using DC/DC boost converters which operate at a high switching frequency.

Conclusion

With their distinct advantages in terms of brightness, viewing angle, footprint, and power consumption, OLEDs will undoubtedly play an increasingly pivotal role in portable system design over the next few years. The introduction of high frequency, compact boost converters capable of delivering fast, stable transient response, minimizing leakage current, and supporting dynamic voltage programmability will vastly simplify and speed the adoption of this exciting new display technology.