Selecting an LCD backlight driver

CCFLs are still the backlights of choice for a wide range of applications, and inverters produce the high-voltage ac that they require

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Powering and packaging the high-voltage inverters that drive the CCFLs that backlight today's LCDs can be a challenge. When it comes to placement and interconnection, these inverters require a different thought process than a typical low-power converter.

Display flicker or unexplainable system "glitches" are signs that there might be a problem with the way that the display and inverter were integrated or packaged together in the final product, so correcting problems at the onset is the least expensive fix. Properly selecting an inverter during the design phase will help avoid the common pitfalls that can occur and lead to a problem-free product development cycle.

Understand the lamp

Before thinking about an inverter, though, engineers should understand the lamp characteristics of the LCD display they plan to power. A typical CCFL contains a low-pressure mercury-argon vapor that emits UV light which bombards a phosphor coating that emits visible light, which illuminates the LCD from behind.

CCFLs have a given life, generally defined as the time at which the lamp operates at 50% brightness at the manufacturer's recommended current or no longer starts at its specified striking voltage. Operating CCFLs at higher-than-recommended currents or at extreme temperatures can greatly reduce their lifetime.

Factors to consider

Proper inverter selection and integration will help avoid LCD "flicker" and system "glitches". Here are five basic rules for matching a dc/ac inverter to a CCFL:

1. The starting voltage from inverter must meet or exceed the kick-off voltage
2. The operating voltage must meet requirement generated by the lamp
3. The supply current must precisely match the lamp current specification
4. The operating frequency must be compatible with lamp and LCD requirements
5. The waveforms must have minimum distortion from the lamp

When choosing an inverter, consider the conditions that the LCD and its CCFL backlight will have to perform in. A standard off-the-shelf inverter will work OK in some applications, but if it has to deal with input-voltage transients, unregulated supply voltages, severe environments or restricted packaging, you must carefully consider how to diminish or overcome the challenges these conditions present.

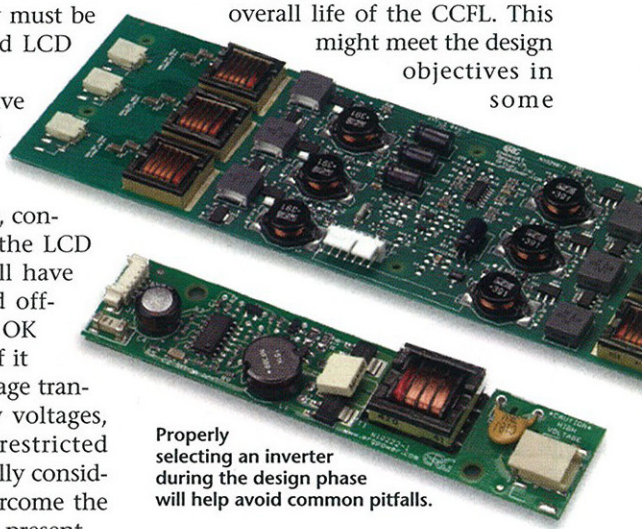
Stray capacitance

The minimum starting voltage can change under various circumstances, and starting temperature is a critical factor. When the lamp is new, it may take considerably less voltage to start, but with age or operation at lower temperatures, the lamp starting voltage requirements can increase, and the inverter must have sufficient starting voltage to overcome the increased demand.

The operating frequency of the lamps is typically 40 to 60 kHz, and stray capacitance at these frequencies can significantly increase the starting voltage required by the lamp. Keeping lamp lead lengths to a minimum is essential. In our engineers' experience, stray capacitance is identified as a cause of early design problems 90% of the time.

Beware of aggressive drivers

Overdriving the inverter can produce a very good image on the LCD in the short term, but it compromises the overall life of the CCFL. This might meet the design objectives in some cases, but, generally, reduced operating life is unacceptable and may affect panel warranty.



Properly selecting an inverter during the design phase will help avoid common pitfalls.

Controlling brightness

The two most common techniques used to control brightness in CCFL backlighting are analog dimming and digital (a.k.a. PWM, or pulse width modulation) dimming. Analog dimming is the simplest technique to implement. An applied dc voltage directly controls the output current of the inverter. The inverter operates

continuously, and power supply requirements are reduced since there is little input ripple current and additional filtering of the power supply is not required.

However, the dimming range available using this technique is limited – typically in the range of 4:1 and, while suitable for applications where the ambient light levels are fixed (such as office environments), it won't do for displays that must be equally legible in bright daylight or at nighttime, requiring a much wider dimming range.

With today's TFT LCDs offering a brightness of up to 1,000 nits, PWM dimming has become the technique of choice since it is less display-sensitive and offers more flexibility in choosing brightness levels, with dimming ratios up to 3,000:1. Onboard PWM preserves screen readability in conditions ranging from high ambient light to nighttime environments, and mates directly with the controller card dimming signal, typically an analog voltage from 0 to 5 V, making integration that much easier.

However, PWM dimming is possible only with an inverter that is specifically designed for it. As many applications require custom-designed LCDs (for example, automotive,), a custom-designed inverter that matches the LCD specs exactly is of critical importance. One size does not fit all.

Where will the inverter be used?

Applications using LCDs in home or office products demand few special environmental considerations for CCFL inverters. If you plan to put a display in a sealed package such as in a service kiosk that stands outside in hot sunlight, a gas pump that has to operate at below-freezing temperatures, or automotive displays that need to provide instant-on operation when starting a car in northern Minnesota in the winter, the inverter must reliably ignite the CCFL and keep within its operational temperature range.

The effects encountered when equipment operates at high altitudes also will influence a design. As altitude increases, air becomes less dense and its breakdown voltage decreases. Because CCFLs operate at a high voltage, arcing can occur. (Arcing may not appear, though, until equipment has operated for several hours.) Designers can eliminate arcing by increasing the space between high-voltage components and other conductors, by applying conformal coatings, or by encapsulating components.

For applications demanding absolute high reliability, encapsulated alternatives to the typical open frame inverter are available. A vacuum-encapsulated design ensures reliable CCF lamp ignition, even in harsh environments. It provides a solution for CCFL-backlit flat panel displays where compact size, high efficiency, and resistance to shock, vibration, or humidity of the power source are critical, such as in medical diagnostic equipment, industrial instrumentation, POS displays, and embedded designs.