Low-Voltage Current Sink Controls High-Voltage LED String

By Jon Kraft

Most portable products with displays that use white light emitting diode (WLED) backlights also need auxiliary LED lighting. Two ICs are generally needed: an inductive boost to obtain maximum efficiency (>80%) for the backlight LEDs; and a charge pump to allow independent control of each auxiliary LED. In addition, each IC requires a programmable current sink for brightness control or color blending, so the cost and complexity can increase quickly. This design tip shows how a single programmable LED driver can be combined with a low-cost boost converter to achieve a flexible, high-efficiency, easy-to-program solution. Figure 1 shows an implementation using the ADP1612 (see Figure 2) boost converter and the ADP8860 (see Figure 3) parallel LED driver.



Figure 1. ADP1612 boost converter and ADP8860 LED driver implement programmable drive for backlight and auxiliary LEDs.

In this application, FB of the ADP1612 boost converter is connected to D2, one of the current sinks on the ADP8860 LED driver. The 5-V Zener diode protects that current sink in case of a fault or rapid shutdown. The OVP Zener diode protects the output capacitor, C_{OUT} , and the ADP1612 in case of an open-circuit fault in one of the backlight LEDs.

When current sink D2 is off, the voltage on FB is pulled to V_{IN} , shutting down the ADP1612. When D2 turns on, the voltage on FB is pulled low, and the boost starts switching. The ADP1612 regulates the output voltage to provide 1.2 V on FB and thus on D2. This is enough to allow accurate current regulation. As the current through D2's current sink changes, the ADP1612 automatically scales the output voltage to deliver exactly enough voltage to power the LEDs and the current sink. The ADP8860 has independent control of each sink, so the same programming used for the auxiliary LEDs can also be applied to the backlight LEDs.

Step-Up DC-to-DC Switching Converters Operate at 650 kHz/1300 kHz

The ADP1612 and ADP1613 step-up converters are capable of supplying over 150 mA at voltages as high as 20 V, while operating with a single 1.8-V to 5.5-V supply or single 2.5-V to 5.5-V supply, respectively. Integrating a 1.4-A/2.0-A, 0.13- Ω power switch with a current-mode, pulse-width modulated regulator, their output varies less than 1% with changes in input voltage, load current, and temperature. The operating frequency is pin-selectable and can be optimized for high efficiency or minimum external component size: at 650 kHz they provide 90% efficiency; at 1.3 MHz their circuit implementation occupies the smallest space, making them ideal for space-constrained environments in portable devices and liquid-crystal displays. The adjustable soft-start circuit prevents inrush currents-ensuring safe, predictable start-up conditions. The ADP1612/ADP1613 consume 2.2 mA in the switching state, 700 µA in the nonswitching state, and 10 nA in *shutdown* mode. Available in an 8-lead MSOP package, they are specified from -40°C to +85°C and priced at \$1.50/\$1.20 in 1000s.

7-Channel Smart LED Driver Includes Charge Pump, I²C Interface

The ADP8860 smart LED driver-which combines a programmable charge-pump driver with automatic phototransistor controlchanges current density according to ambient light conditions, eliminating the need for a processor and allowing significant power savings in mobile displays. As many as six LEDs can be independently driven at up to 30 mA; a seventh LED can be driven at up to 60 mA. Light intensity thresholds, min/max LED current, and fade in/out times are all programmable via the I²C interface. The two-capacitor charge-pump can source 240 mA. Automatic gain selection of $1\times$, $1.5\times$, or $2\times$ maximizes its efficiency. Safety features include soft start, undervoltage lockout, and short-circuit-, overvoltage-, and overtemperature protection. Operating with a single 2.5-V to 5.5-V supply, the ADP8860 consumes 4.5 mA in switching mode and 0.3 μ A in standby mode. Available in 20-lead LFCSP and 20-ball WLCSP packages, it is specified from -40°C to +85°C and priced from \$1.36 in 1000s.

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Figure 2. ADP1612/ADP1613 block diagram.



Figure 3. ADP8860 functional block diagram.