

TPS60230 White LED Charge Pump Used in Smart Phone Displays, LCD Backlight, and Keyboard Lighting

ABSTRACT

The TPS60230 is a complete solution for driving up to five white light-emitting diodes from a single-cell Li-ion battery or power source up to 6.5 V. The device is optimized for white LED supplies in backlit color display applications. The reference design and applications examples shown in this guide describe typical applications such as smart phone display, LCD backlight, and keyboard lighting applications.

1 TPS60230 Characteristics:

- Regulated Output Current With 0.4% Matching
- Drives up to 5 LEDs at 25 mA Each
- LED Brightness Control Through PWM Control Signal
- High Efficiency by Fractional Conversion With 1x and 1.5x Modes
- 1 MHz Switching Frequency
- 2.7-V to 6.5-V Operating Input Voltage Range
- Internal Softstart Limits Inrush Current
- Low Input Ripple and Low EMI
- Overcurrent and Overtemperature Protected
- Undervoltage Lockout With Hysteresis
- Ultra-Small 3mm x 3mm QFN Package

2 TPS60230 Reference Design

The reference schematic shown in [Figure 1](#) contains the TPS60230 high-efficiency charge-pump-based LED driver. It is designed to operate from a single-cell Li-ion battery, and drive up to five white LEDs at up to 20 mA each. Efficiency is improved by switching between a 1.0x and 1.5x mode, based on the input voltage.

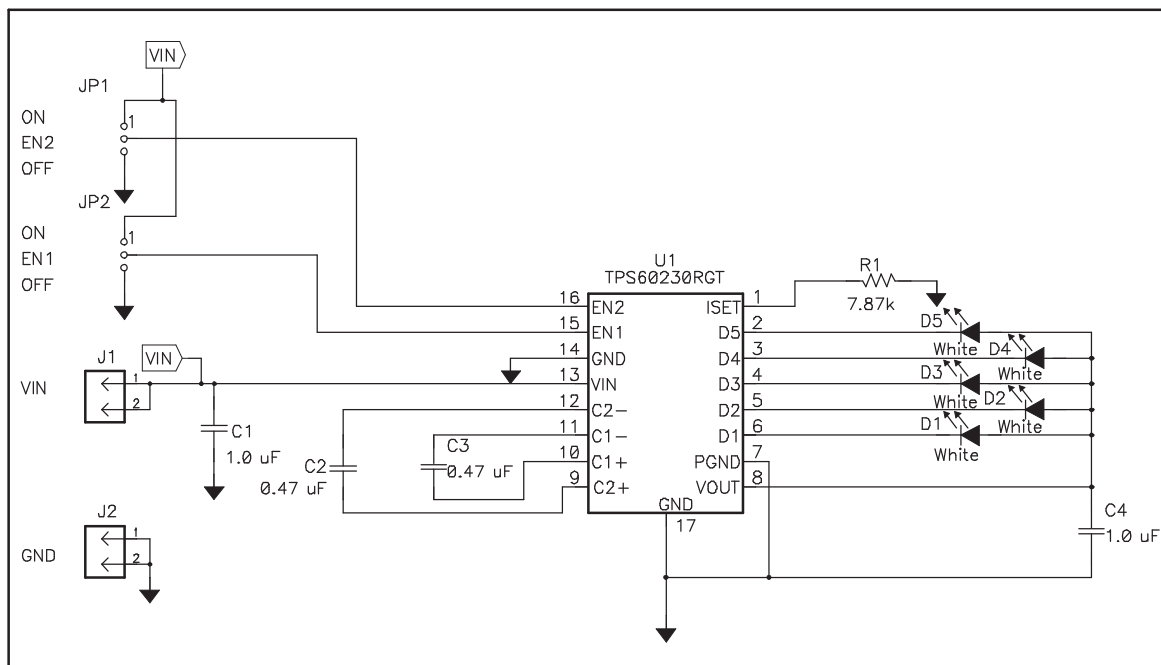


Figure 1. TPS60230 Reference Schematic

2.1 Bill of Materials

Qty	Ref Des	Description	Size	Mfr	Part Number
2	C1, C4	Capacitor, ceramic, 1.0 μ F, 6.3V, X5R, 10%	603	TDK	C1608X5R0J105KT
2	C2, C3	Capacitor, ceramic, 0.47 μ F, 10V, X5R, 10%	603	TDK	C1608X5R1A474KT
5	D1–D5	Diode, LED, White, 30mA	1210	Lumex	SML-LX2832UWC-TR
2	J1, J2	Header, 2-pin, 100 mil spacing, (36-pin strip)	0.100 \times 2	Sullins	PTC36SAAN
2	JP1, JP2	Header, 2-pin, 100 mil spacing, (36-pin strip)	0.100 \times 3	Sullins	PTC36SAAN
1	R1	Resistor, chip, 7.87k Ω , 1/16W, 1%	603	Std	Std
1	U1	IC, white LED charge pump current source	0.80 \times 0.80	TI	TPS60230RGT
1	—	PCB, 1.55 in \times 1.195 in \times 0.062 in		Any	HPA047
2	—	Shunt, 100 mil, black	0.100	3M	929950-00

3 Sample Circuits for Various WLED Applications Using the TPS60230

The design in Figure 2 shows a typical application of a smart phone display with the resistors connected in parallel. This method can also be used to connect a Liquid Crystal (LC) display with only two connections for the white LEDs.

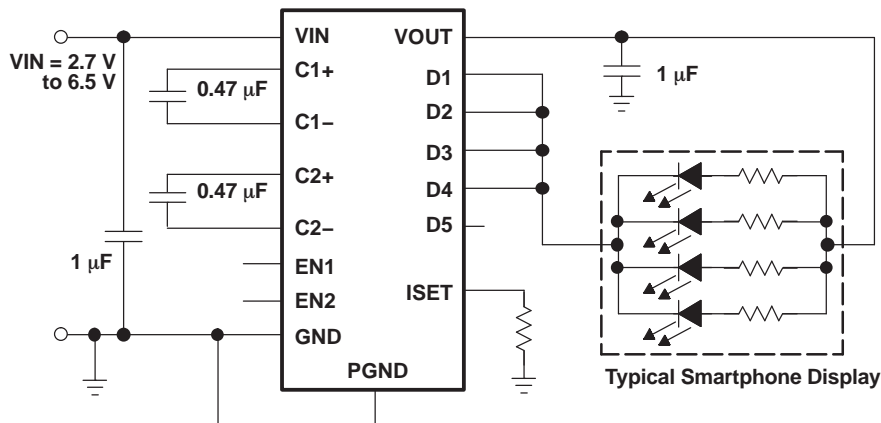


Figure 2. Smartphone Circuit

The following design, Figure 3, shows how the ISET pin can be used to connect an analog DC signal in the range of 0 mV to 600 mV for analog dimming of the white LEDs. With the device enabled, the LED current varies linearly with respect to the signal into the 6-k Ω resistor. To clarify, a 0-mV signal provides the maximum current. As the signal into the 6-k Ω resistor increases, the LED current decreases until it reaches 0 A, and the signal reaches 600 mV.

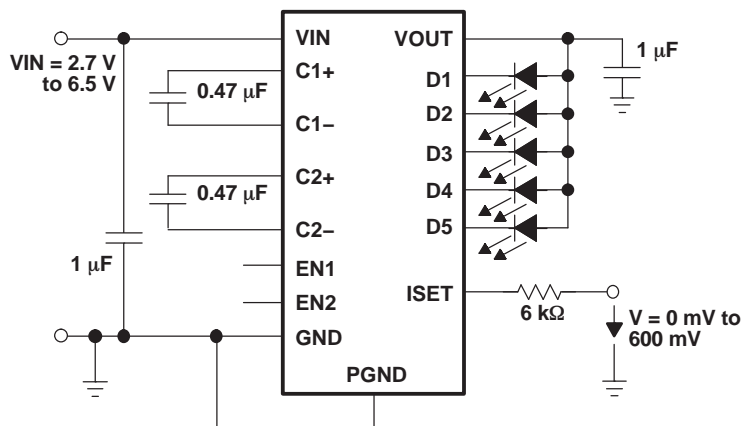


Figure 3. Analog Dimming

The design shown in [Figure 4](#) is a typical application using 2 white LEDs and 6 green LEDs for LCD backlight and keyboard lighting. The TPS60230 can be used to power any kind of LED, making it possible to mix white LEDs with color LEDs which have a lower forward voltage. The LED with the highest forward voltage (typically the white LED) has to be connected to D1, because the output voltage of the charge pump is regulated in such a way as to keep the voltage drop from D1 to GND at 400mV.

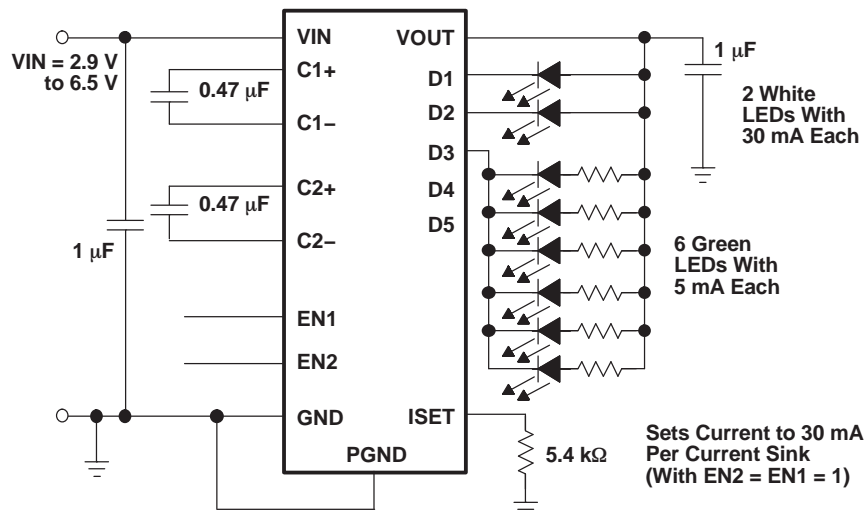


Figure 4. LCD Backlight and Keyboard Lighting

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