APPLICATION NOTE 3287

White-LED Driver Provides 64-Step Logarithmic Dimming

This circuit drives as many as four white LEDs in parallel from a 3.3V source, and adjusts the total LED current from 1mA to 106mA, in 64 steps of 1dB each.

The circuit of **Figure 1** is designed for portable-power applications that require white LEDs with adjustable, logarithmic dimming levels. It drives as many as four white LEDs from a 3.3V source, and adjusts the total LED current from 1mA to 106mA in 64 steps of 1dB each. The driver is a charge pump that mirrors the current I_{SET} (sourced from U3's SET terminal), to produce a current of ($215I_{SET}$ ±3%) through each LED. Internal circuitry maintains the SET terminal at 0.6V.
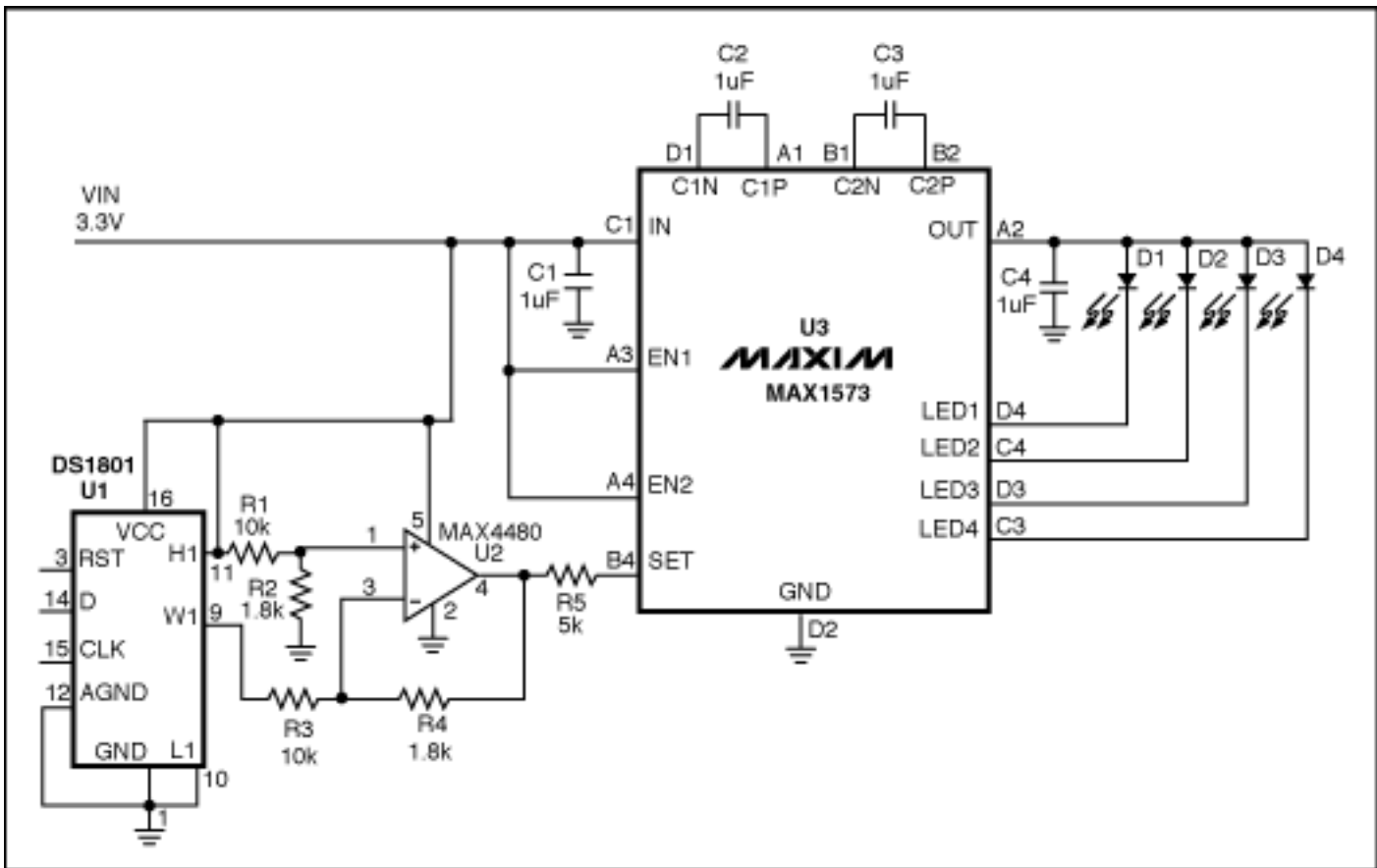

Figure 1. This circuit provides a logarithmic-dimming capability for white LEDs.

To control the LED brightness, op amp U2 monitors the difference between the high-side voltage and the wiper voltage of digital potentiometer U1. The op amp then multiplies that voltage by a gain to set the maximum output current. Zero resistance at the pot's W1 terminal corresponds to minimum LED current, and therefore minimum brightness. Because the SET voltage is fixed (at 0.6V), any voltage change at the left side of R5 changes I_{SET}, and the resulting change in LED currents changes their brightness level. R5 sets the maximum LED current:

$$R5 = 215 \times 0.6 / I_{LED(Desired)}$$

where ILED is the current through one LED.

U1 is a digital potentiometer with logarithmic taper and an analog-voltage wiper for which each tap corresponds to 1dB of attenuation between H1 and W1 (pins 11 and 9). It contains two pots controlled by a 16-bit code via a 3-wire serial interface. To set the LED current, drive RST-bar high and clock 16 bits into the D terminal of U1, starting with the LSB. Each pulse at CLK enters a bit into the register.

The circuit uses only one pot, so bits 0 through 7 are "don't care" bits. Bits 8 through 14 determine the wiper position: bits 8 through 13 set the code, and bit 14 is "mute." (Logic one at bit 14 produces the lowest-possible output current by setting the left side of R5 at approximately 0.599V.) After entering all 16 bits, enter the code and change the brightness level by driving RST-bar high. **Figure 2** shows the logarithmic relationship between an LED current and the pot's input code.
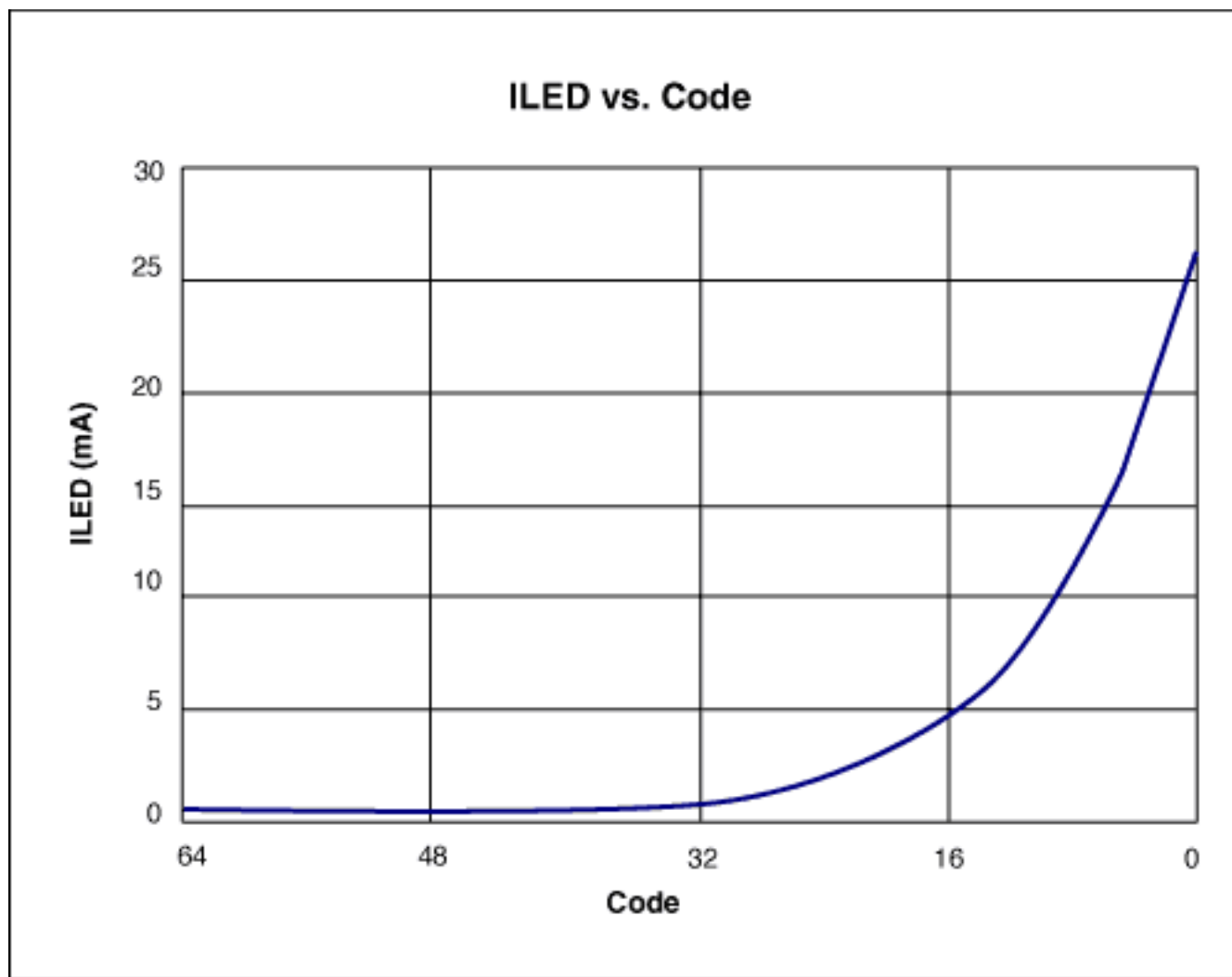

Figure 2. LED current vs. input code for the Figure 1 circuit.

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Application Note 3287: http://www.maxim-ic.com/an3287

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