Texas Instruments

Application Report
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LED Driver – Paralleled Outputs Provide High-Current Outputs

Michael Day

PMP - Portable Power DC-DC Applications

ABSTRACT

This application report describes how to use the TLC5922, TLC5923, and TLC5924 to drive high-current LEDs. These ICs are designed to provide 16 individually controllable constant-current sinks. However, the 16 outputs can be connected in parallel to increase the current drive capability. Paralleling the outputs of these ICs allows the TLC5922, TLC5923, and TLC5924 to drive high-power LEDs such as the OSRAM Golden DRAGON™ and LUMILEDS Luxeon series of high-current LEDs.

The Texas Instruments family of TLC5922/23/24 constant-current LED drivers provide up to 80 mA of constant-current sink for driving multiple LEDs. These LED drivers provide features such a 1% current matching, 7-bit dot correction, controlled inrush current, error detection, and a 30-MHz data bus, and are ideal for applications such as large-screen LED displays, LED signboards, and LED backlighting.

High-current LEDs such as the OSRAM Golden DRAGON™ require up to 500 mA of forward current and provide a high-intensity light output that is used in applications such as automotive lighting, reading lamps, architectural lighting, LCD and TFT backlighting, and marker lights. The TLC5922/23/24 can be configured to provide the higher currents required to drive these types of LEDs. The IC's output stage consists of a current mirror, which closely resembles a constant-current source. As with current sources connected in parallel, the TLC5922/23/24 outputs can be connected in parallel to achieve a higher current drive capability. The total drive current is the sum of the individual drive currents. When connected in parallel, each output can be individually programmed to sink different currents. Table 1 provides examples of the maximum LED drive current with different numbers of paralleled outputs. Note that the maximum LED current is determined by the number of paralleled outputs times 80 mA.

Table 1. Maximum LED Drive Current With Different Numbers of Paralleled Outputs

Paralleled Outputs	LED Current Range (mA)	Number of LEDs per TLC5922/23/24
1	0–80	16
2	0–160	8
3	0–240	5
6	0–480	2
8	0–640	2
16	0–1280	1

Figure 1 shows a TLC5922/23/24 configured to drive four Golden DRAGON white LEDs. Because each output is capable of 80 mA, paralleling four TLC5922/23/24 outputs allows the IC to drive each LED with up to 320 mA. The TLC5923 allows the user to control LED brightness with either analog or PWM dimming. R1 sets the maximum current per channel to 80 mA.

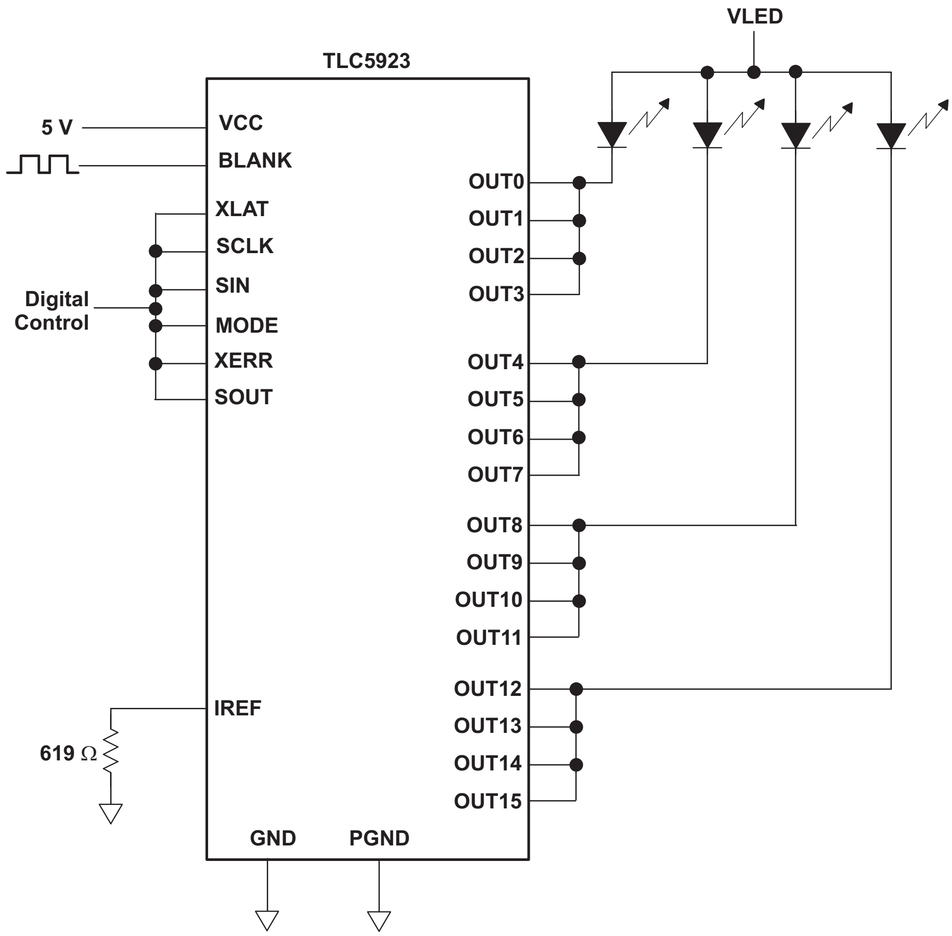

Figure 1. TLC5922/23/24 Configuration Driving Four White LEDs

Figure 2 shows each TLC5922/23/24 output current as well as the total current through D1. The LED current is equal to the sum of the output currents. Each output is programmed with a dot correction value of 127, which drives the full 80 mA per channel. The LED is programmed to full brightness with these settings.

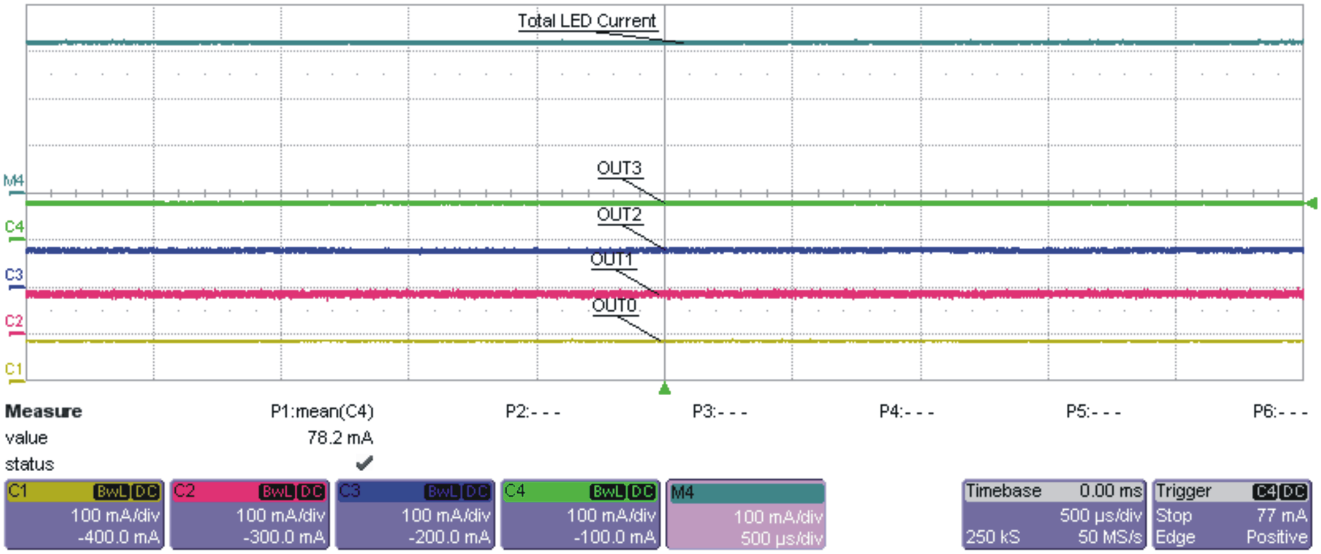

Figure 2. TLC5922/23/24 Output Current and Total Current Through D1

Figure 3 shows the LED programmed to 30% brightness with analog dimming. Using analog dimming, the DC current through the LED is reduced to 30% of the maximum value. Full current is 320 mA; therefore, 30% dimming is achieved by setting the current to 30% × 320 mA = 96 mA. This is also equivalent to programming each output to 24 mA. Analog dimming with the TLC5922/23/24 is achieved by programming each channel's dot correction to a value less than 127. The correct dot correction value is calculated with Equation 1.

$$\text{Dot Correction} = \frac{I_{out} \times 127}{I_{max}} = \frac{24\text{ mA} \times 127}{80\text{ mA}} = 38.1 \tag{1}$$

This dot correction value is rounded down to 38.

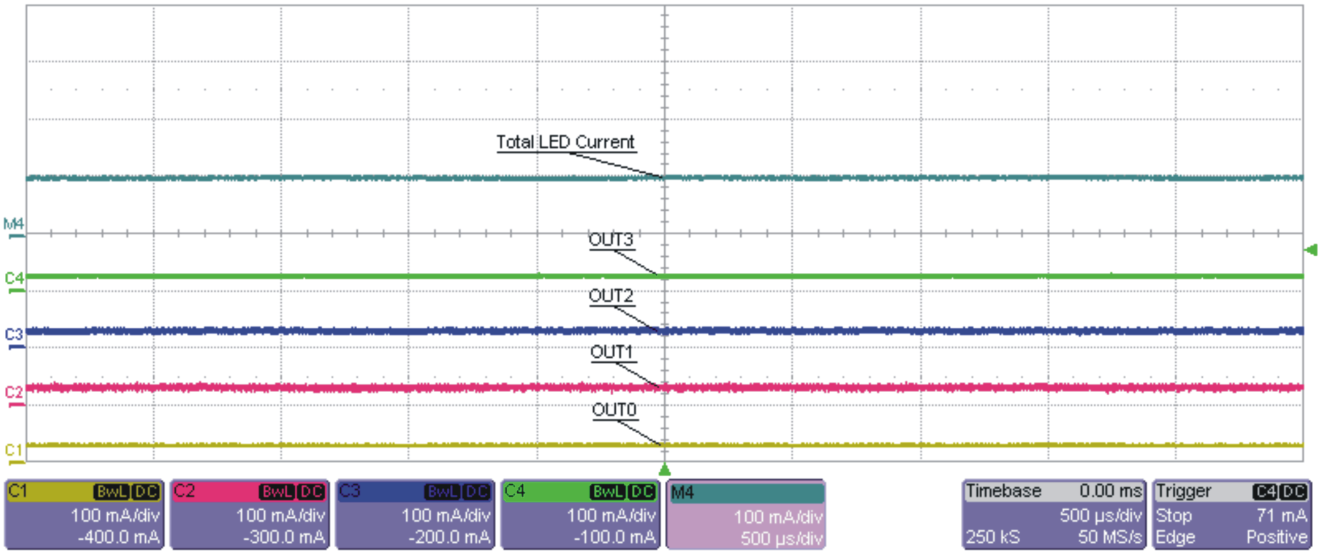

Figure 3. LED Programmed to 30% Brightness

Figure 4 also shows the LED programmed to 30% brightness with analog dimming. In this example, not all output currents are equal: OUT0 = 40 mA, OUT1 = 40 mA, OUT2 = 16 mA, and OUT3 = 0 mA. Each output's dot correction values, which are calculated with Equation 1, are listed as follows.

- OUT0 = 64
- OUT1 = 64
- OUT2 = 25
- OUT3 = 0

This example shows that output currents do not need to be equal to generate the desired LED current. Both analog dimming examples show that the sum of the currents in the paralleled outputs equal the total LED current.

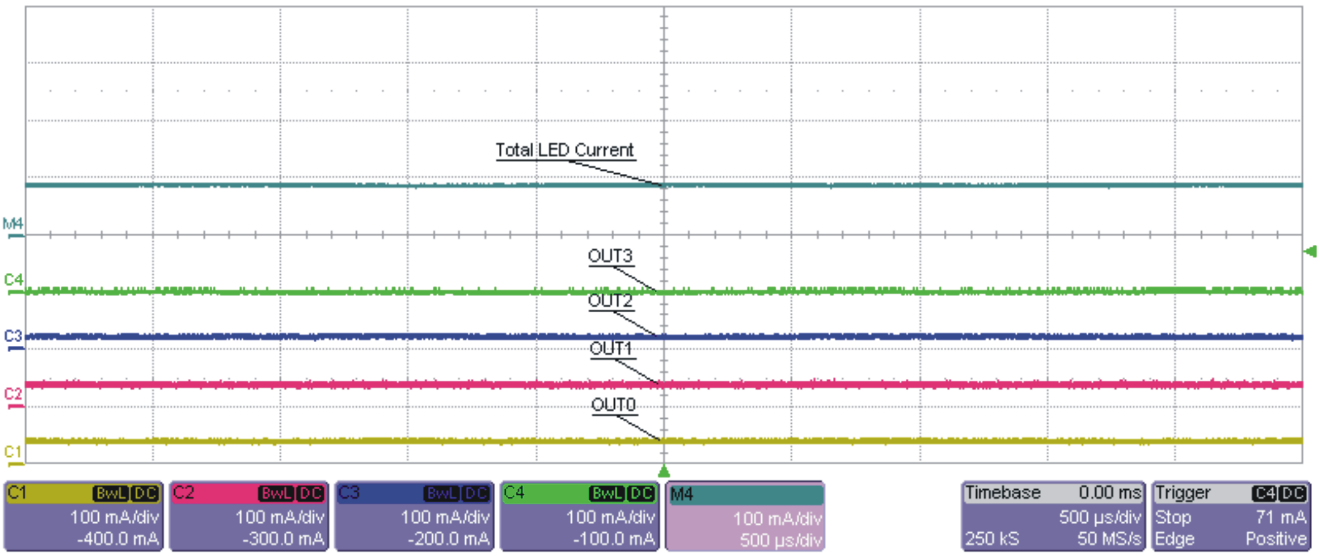

Figure 4. 30% Analog Dimming — Unequal Output Currents

Figure 5 shows the LED programmed to 30% brightness with PWM dimming. PWM dimming is achieved by driving the LED with 100% current for part of the PWM period and with 0% current for the remainder of the period. The ratio of the time with 100% current to the total PWM period is the duty cycle. LED brightness is directly proportional to the duty cycle. PWM dimming with the TLC5922/23/24 is achieved by first programming the dot correction to 127, which sets the outputs to full current. Next, a PWM signal is applied to the BLANK pin to turn the outputs on and off. This drives the LED with 320 mA for part of the time and with 0 mA for the rest of the time. LED brightness is proportional to the duty cycle of the BLANK signal because the human eye averages the pulsed LED brightness. The PWM frequency must be above 60 Hz so that the pulses are not visible to the human eye. Most systems use PWM frequencies between 200 Hz and several kHz. Note that the BLANK signal controls all outputs; so, multiple LEDs cannot be dimmed to a different brightness with PWM dimming. If PWM dimming of multiple LEDs is required, consider using the TLC5940 or TLC5941. These ICs provide both analog and PWM dimming.

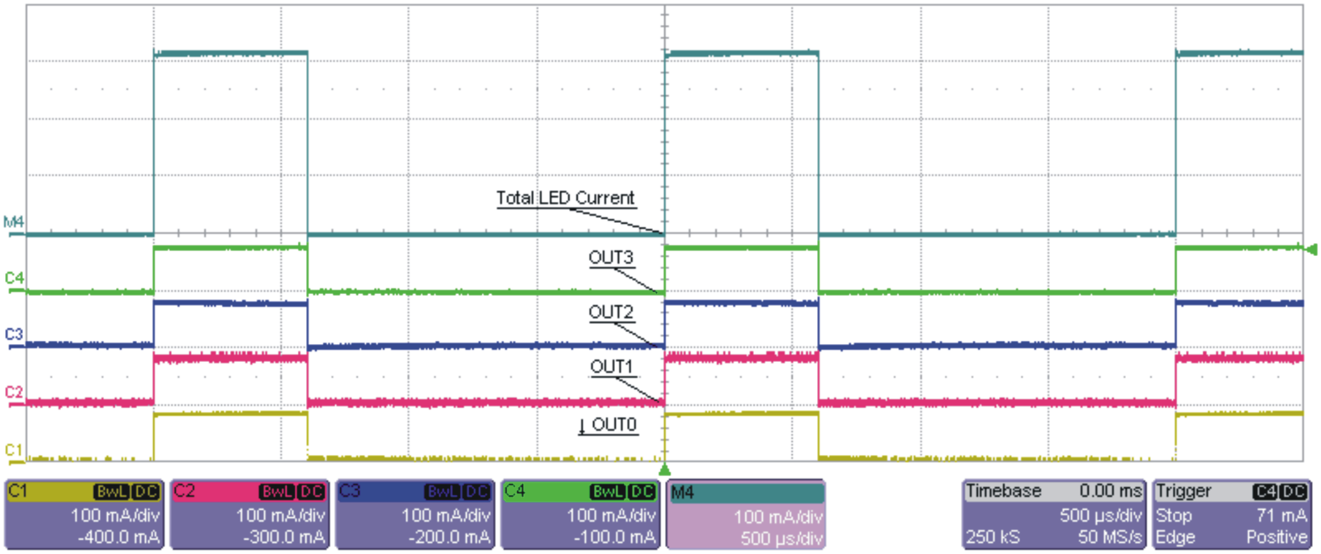

Figure 5. 30% PWM Dimming — 500 Hz

The preceding examples show that the TLC5922/23/24 outputs can be paralleled to achieve higher drive capabilities. They also show the ICs' capability to provide both analog and PWM dimming.

References

1. *TLC5922, LED Drive* data sheet (SLVS486)
2. *TLC5923, 16-Channel LED Driver With Dot Correction* data sheet (SLVS550)
3. *TLC5924, 16-Channel LED Driver With Dot Correction and Pre-Charge FET* data sheet (SLVS626)
4. *TLC5924EVM User's Guide* (SLVU187)

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Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265