Introduction

This design is a Constant Current LED Driver with SPI control. LEDs are current-driven devices whose brightness is proportional to their forward current. Forward current can be controlled in two ways. The first method is using the LED voltage and current curve to determine what voltage needs to be applied to the LED to generate the desired forward current. The second, preferred method of regulating LED current is to drive the LED with a constant-current source. The constant-current source eliminates changes in current due to variations in forward voltage. Preferably, the input power supply regulates the voltage across a current-sense resistor. The power-supply reference voltage and the value of the current-sense resistor determine the LED current.

The LED current is set using the following equation:

$$I_{LED} = \frac{V_{REF}}{R}$$

Where R is connected between the V_{REF} pin and GND.

The maximum I_{LED} is limited by output pin characteristics. The typical current for one output pin is 24 mA at VDD=3.3V, and 68 mA at VDD=5.0 V.

The application circuit can be seen in Figure 2.

LED constant current circuit design

As shown in Figure 1, a dual constant current LED driver with SPI control can be implemented using SPI, DAC0, two analog comparators (ACMP0 and ACMP1) and two 2-bit LUTs (LUT2 and LUT3).

LED constant current circuit analysis

When this device is powered on, the output pins (LED1_1, LED1_2, LED2_1 and LED2_2) are LOW.

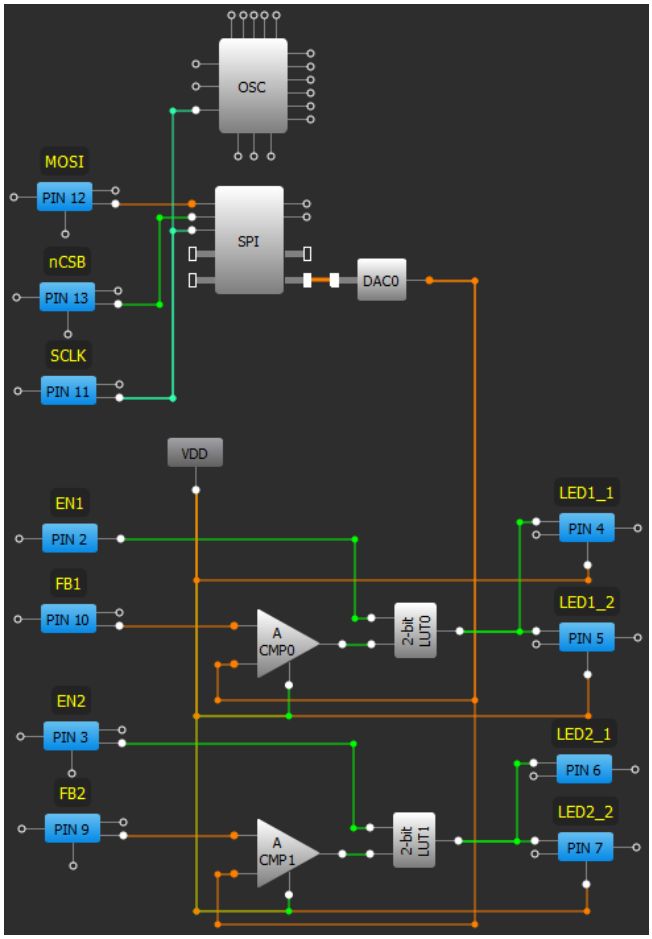

Figure 1. LED constant current circuit design

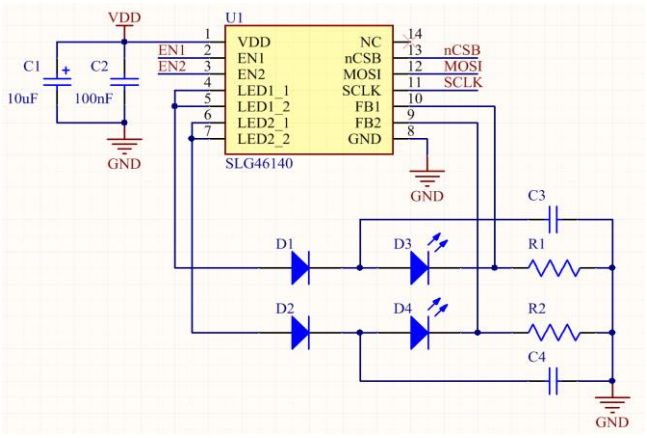

Figure 2. LED constant current typical application circuit

The EN1 (PIN 2) and the EN2 (PIN 4) are independently enabled for each pair of output pins.

When EN1 is HIGH, the output pins LED1_1 and LED1_2 are enabled. When EN2 is HIGH, the output pins LED2_1 and LED2_2 are enabled. When EN1 is LOW, the output pins LED1_1 and LED1_2 are disabled. When EN2 is LOW, the output pins LED2_1 and LED2_2 are disabled.

Vref is set via SPI code, ranging in value of 0V at SPI code = 0, to 1V at SPI code = 255. Capacitors C3, C4 help smooth the digital on-off switching behavior of the output pairs as they regulate the average current. The functionality waveforms that describe the device operation are shown in Figures 3 through 8.

Components: D1 – 1N4148, D3 – GNL-5013URC, R1 – 100 Ohm, C3 – 100 nF

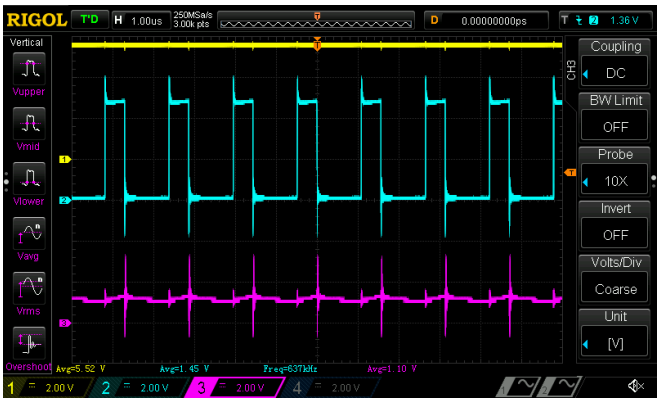

Figure 3. Device functionality then SPI code 255 at VDD 5.5V

Channel 1 (yellow/top line) – PIN#1 (VDD)
Channel 2 (light blue/2nd line) – PIN#4 (LED1_1)
Channel 3 (magenta /bottom line) – PIN#10 (FB1)

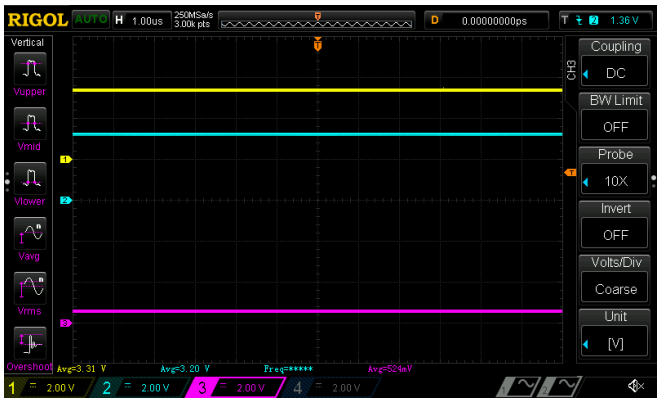

Figure 4. Device functionality then SPI code 255 at VDD 3.3V

Channel 1 (yellow/top line) – PIN#1 (VDD)
Channel 2 (light blue/2nd line) – PIN#4 (LED1_1)
Channel 3 (magenta /bottom line) – PIN#10 (FB1)

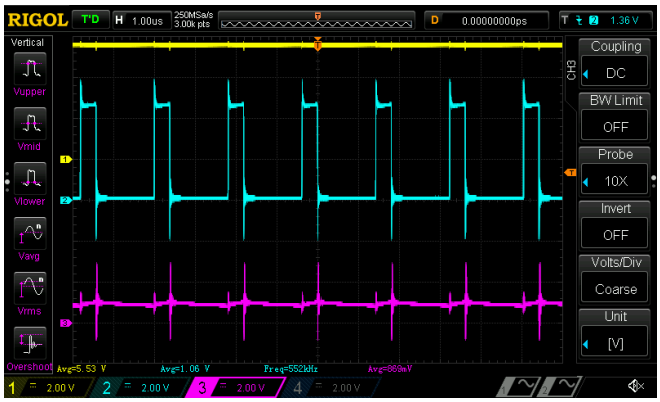

Figure 5. Device functionality then SPI code 192 at VDD 5.5V

Channel 1 (yellow/top line) – PIN#1 (VDD)
Channel 2 (light blue/2nd line) – PIN#4 (LED1_1)
Channel 3 (magenta /bottom line) – PIN#10 (FB1)

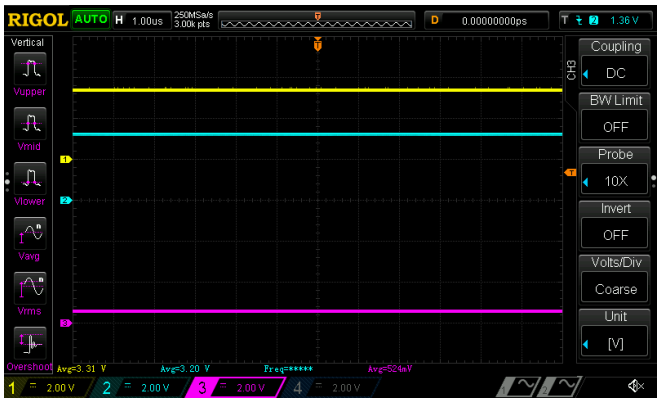

Figure 6. Device functionality then SPI code 192 at VDD 3.3V

Channel 1 (yellow/top line) – PIN#1 (VDD)
Channel 2 (light blue/2nd line) – PIN#4 (LED1_1)
Channel 3 (magenta /bottom line) – PIN#10 (FB1)

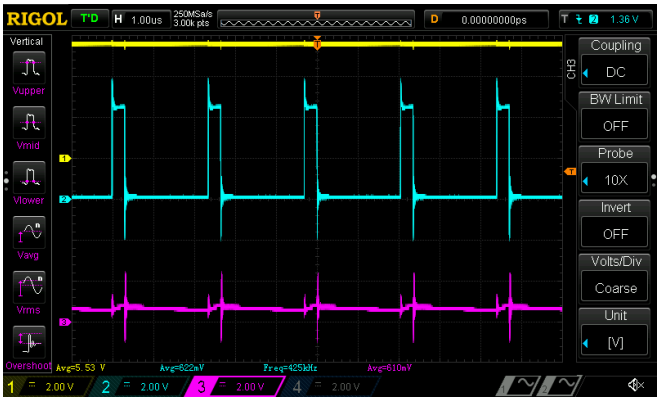

Figure 7. Device functionality then SPI code 128 at VDD 5.5V

Channel 1 (yellow/top line) – PIN#1 (VDD)
Channel 2 (light blue/2nd line) – PIN#4 (LED1_1)
Channel 3 (magenta /bottom line) – PIN#10 (FB1)

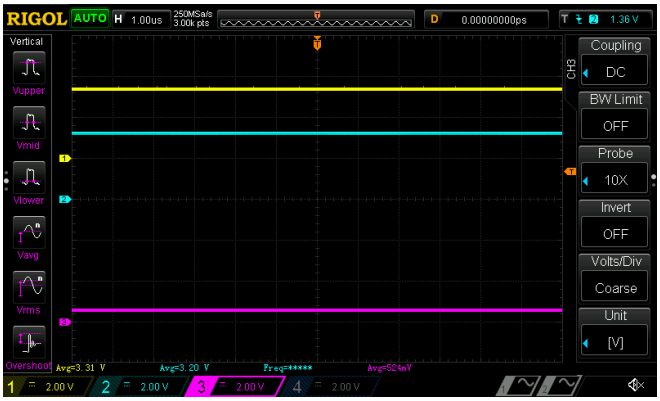

Figure 8. Device functionality then SPI code 128 at VDD 3.3V

Channel 1 (yellow/top line) – PIN#1 (VDD)
Channel 2 (light blue/2nd line) – PIN#4 (LED1_1)
Channel 3 (magenta /bottom line) – PIN#10 (FB1)

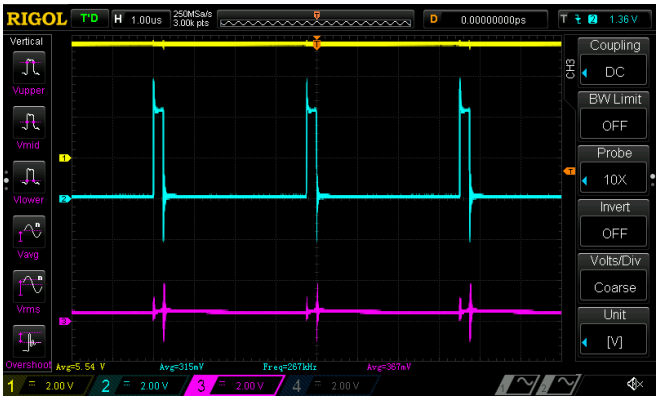

Figure 9. Device functionality then SPI code 64 at VDD 5.5V

Channel 1 (yellow/top line) – PIN#1 (VDD)
Channel 2 (light blue/2nd line) – PIN#4 (LED1_1)
Channel 3 (magenta /bottom line) – PIN#10 (FB1)

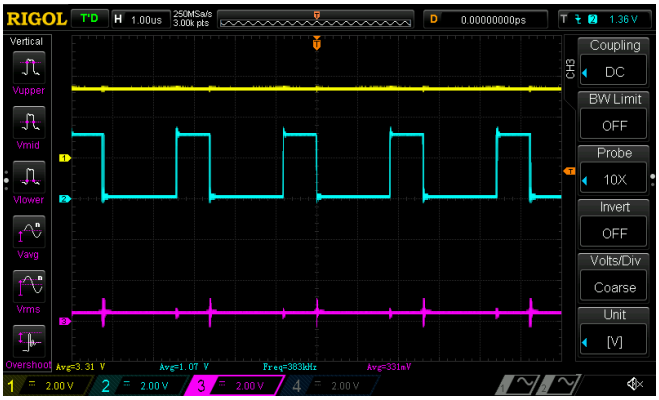

Figure 10. Device functionality then SPI code 64 at VDD 3.3V

Channel 1 (yellow/top line) – PIN#1 (VDD)
Channel 2 (light blue/2nd line) – PIN#4 (LED1_1)
Channel 3 (magenta /bottom line) – PIN#10 (FB1)

Conclusion

A constant current LED driver with SPI control can be easily implemented using a Green PAK IC. It has low power consumption, small board area footprint, and only a few external components needed to complete the design.

Related Files

Programming code for **GreenPAK Designer**.

About the Author

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Background: Oleg Gorodechny received Bachelor's degree in "Computer Science" in 2009 and Master's degree in "Information Control Systems and Technologies" in 2011 from Lviv Polytechnic National University. Since 2011 he has been working as a design engineer, and in 2013 he began to work for Silego Technology Inc. as an application engineer. Currently he designs analog circuits and their applications.

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A	Oleg Gorodechny	10/21/2014	New application note

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