# Low Power Constant Brightness LED with SPI
# SLG46140V

A low power constant brightness LED with SPI control is implemented using the SLG46140V IC. The design features SPI, DAC, two analog comparators, and LUTs to regulate current through two independent LED channels. Output current is set digitally via SPI, allowing precise brightness control. The solution is compact, energy-efficient, and suitable for applications requiring programmable LED control.

## Contents



## 1. Terms and Definitions

| | |
|---|---|
| IC | Integrated Circuit |
| LED | Light Emitting Diode |
| SPI | Serial Peripheral Interface |

## 2. References

For related documents and software, please visit:

GreenPAK Programmable Mixed-Signal Products | Renesas

Download our free Go Configure Software Hub [1] to open the .gp files [2] and view the proposed circuit design. Use the GreenPAK development tools [3] to freeze the design into your own customized IC in a matter of minutes. Renesas provides a complete library of application notes [4] featuring design examples as well as explanations of features and blocks within the Renesas IC.

[1] GreenPAK Designer Software, Software Download and User Guide, Renesas Electronics

[2] AN-1053 Low Power Constant Brightness LED with SPI.gp, Design file, Renesas Electronics

[3] GreenPAK Development Tools, GreenPAK Development Tools Webpage, Renesas Electronics

[4] GreenPAK Application Notes, GreenPAK Application Notes Webpage, Renesas Electronics

# 3. Introduction

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.

# 4. LED Constant brightness Circuit Design

As shown in Figure 1, a dual constant brightness 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).

# 5. LED Constant brightness Circuit Analysis

When this device is powered on, the output pins (LED1_1, LED1_2, LED2_1 and LED2_2) are LOW. The EN1 (PIN 2) and the EN2 (PIN 4) are independently enabled for each pair of output pins.

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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 exposed via SPI code, ranges the values of 0V at SPI code = 0 to 1V at SPI code = 255. Capacitors C3, C4 are helping to smooth the 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 5, 6, 7 and 8.

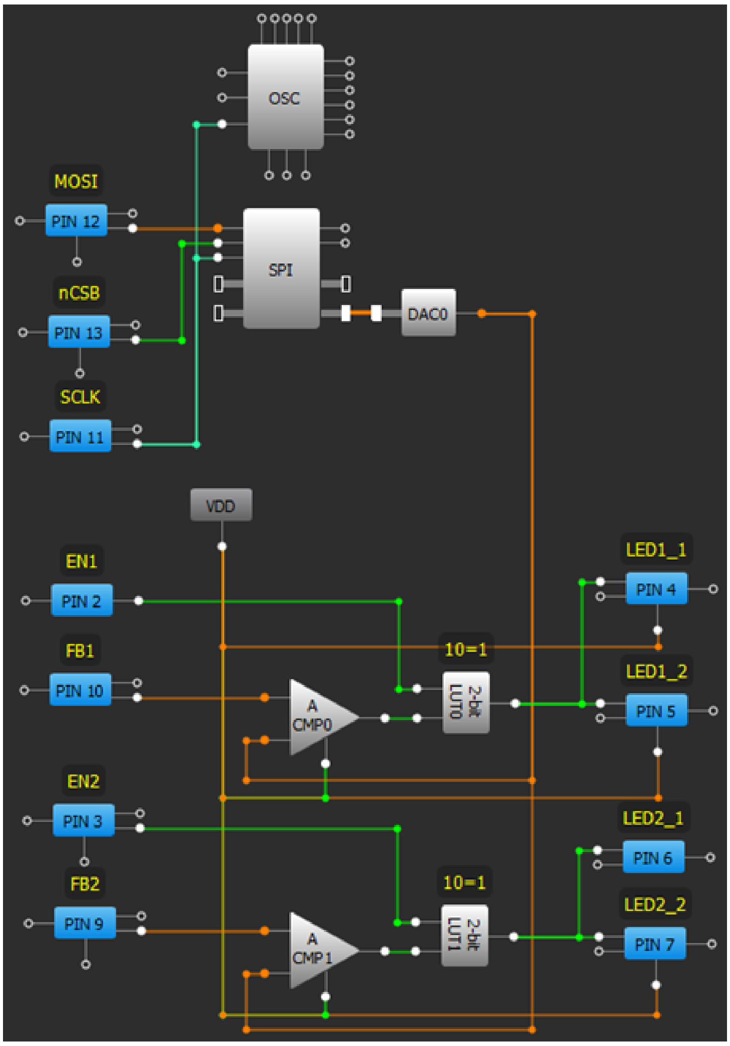


**Figure 2: LED constant brightness circuit design**

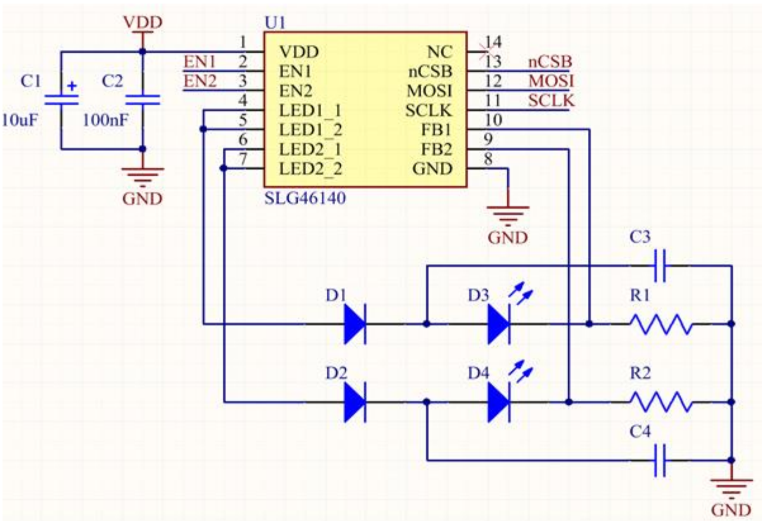


**Figure 1: LED constant brightness typical application circuit**

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

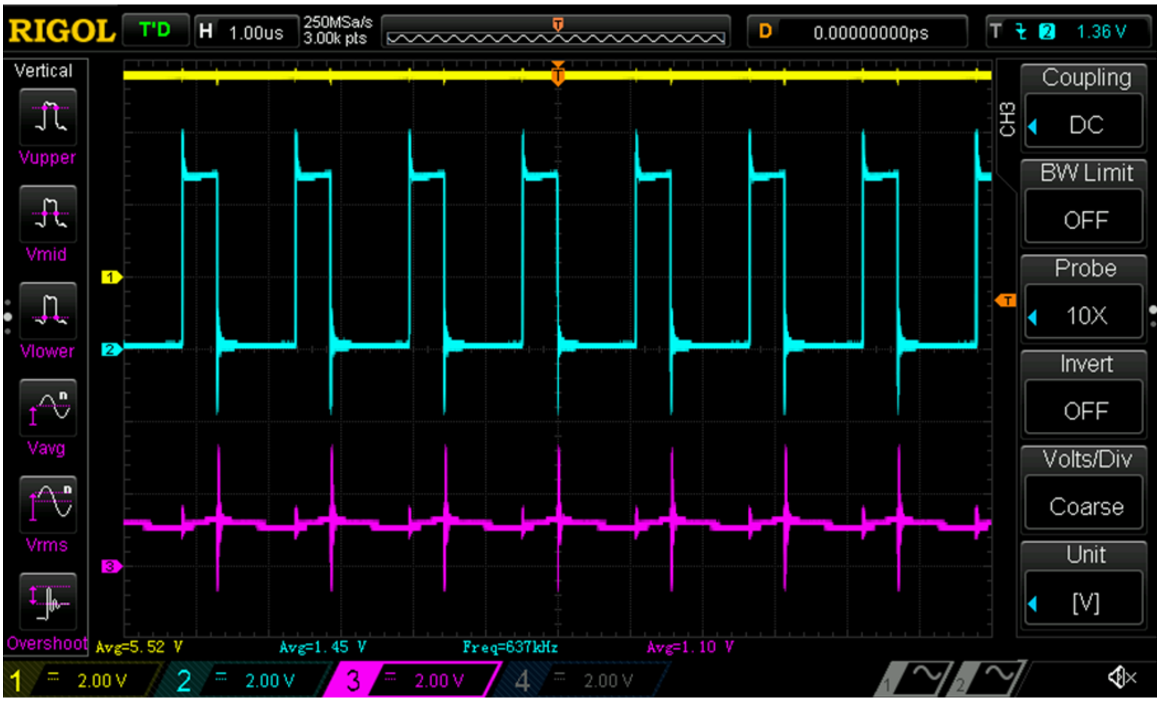


**Figure 3: Device functionality then SPI code 255 at VDD 5.5V**

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)

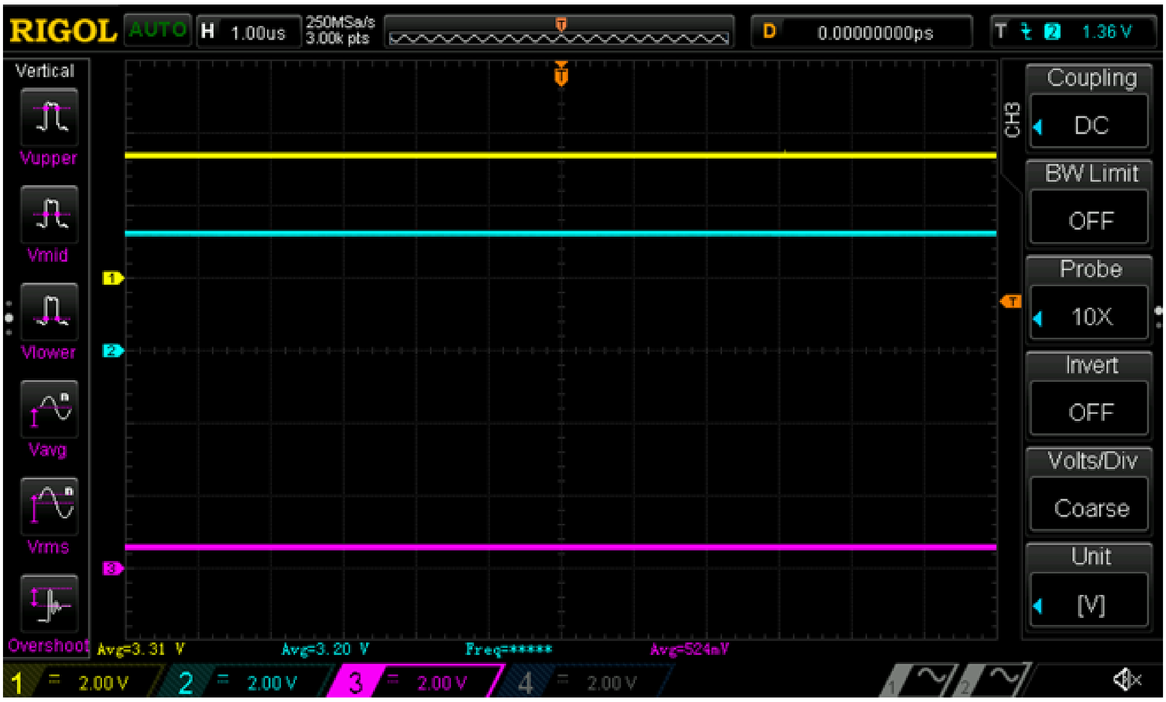


**Figure 4: Device functionality then SPI code 255 at VDD 3.3V**

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)

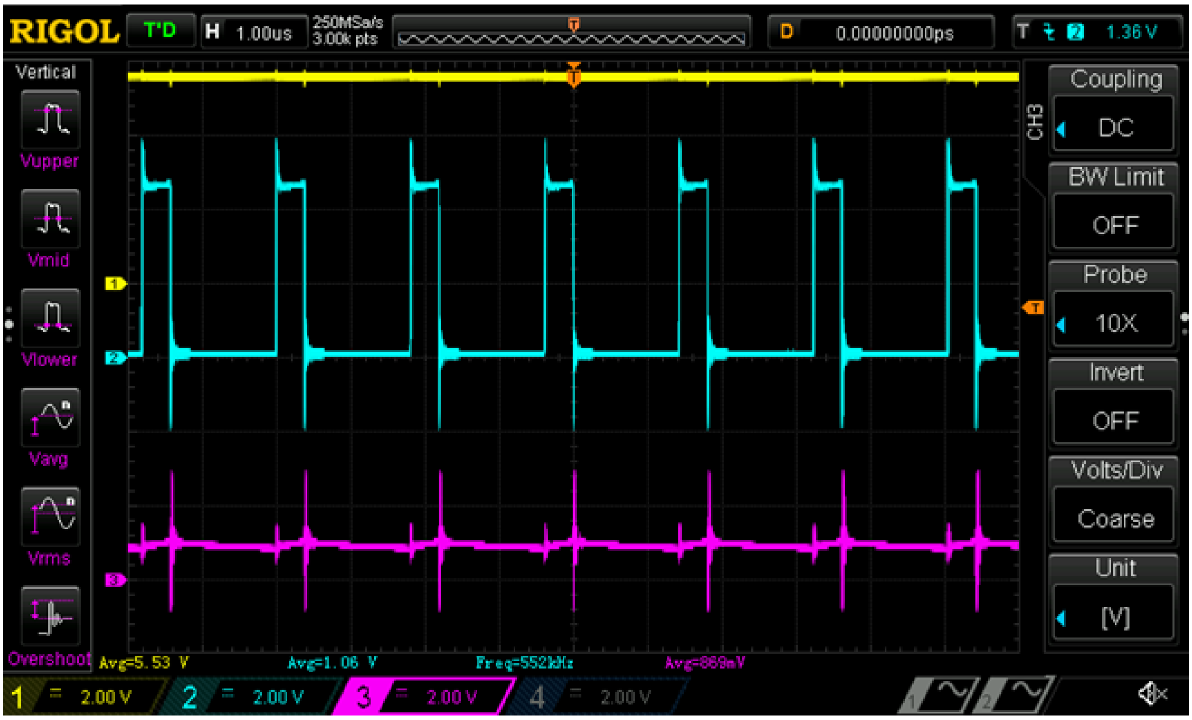


**Figure 5: Device functionality then SPI code 192 at VDD 5.5V**

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)

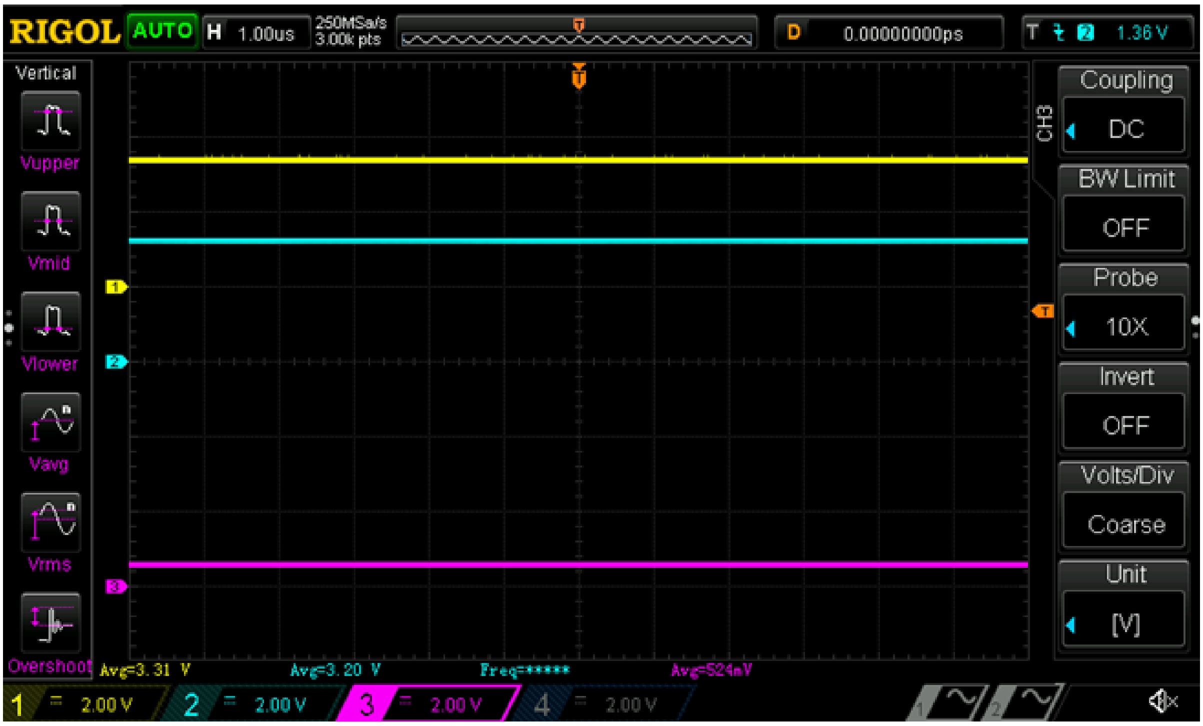


**Figure 6: Device functionality then SPI code 192 at VDD 3.3V**

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)

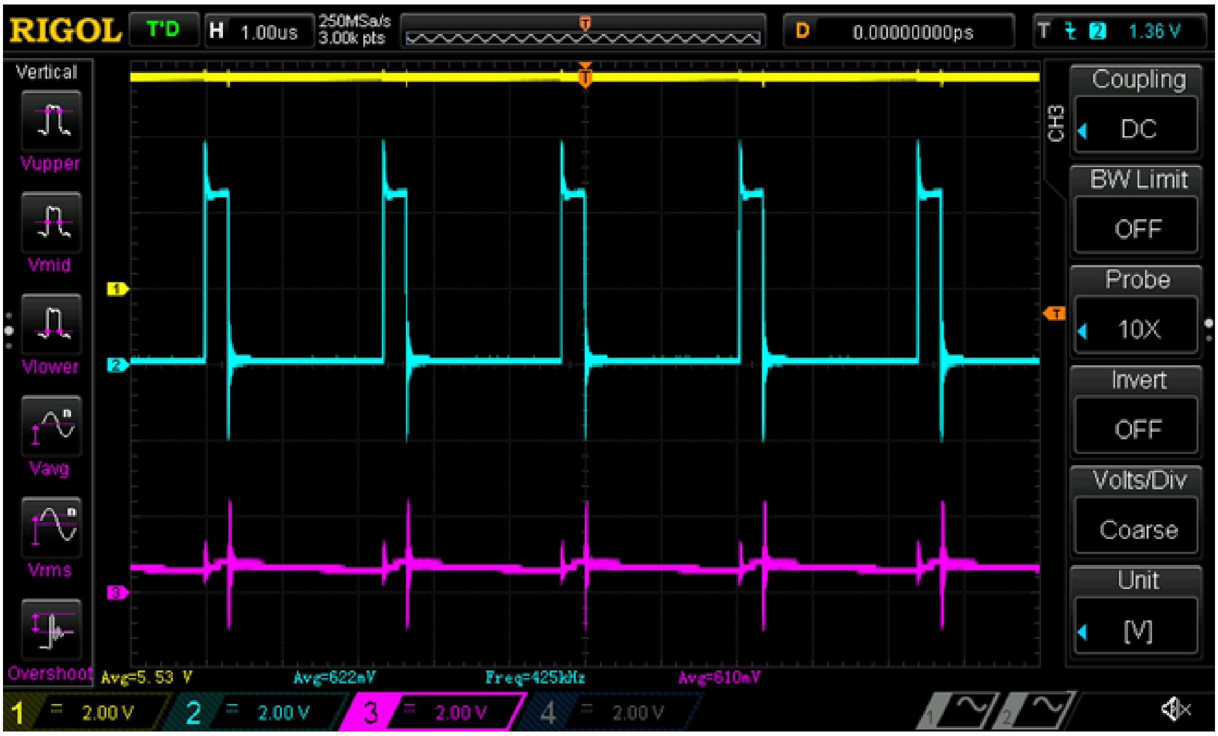


**Figure 7: Device functionality then SPI code 128 at VDD 5.5V**

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)

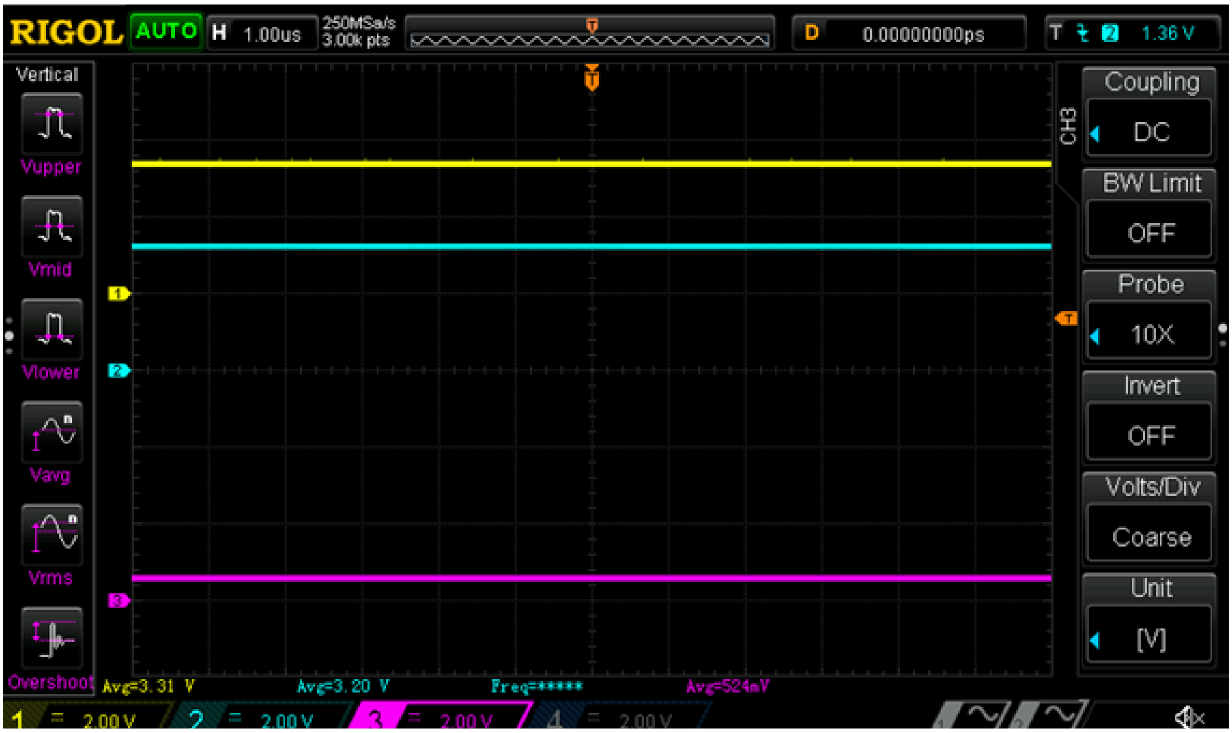


**Figure 8: Device functionality then SPI code 128 at VDD 3.3V**

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)

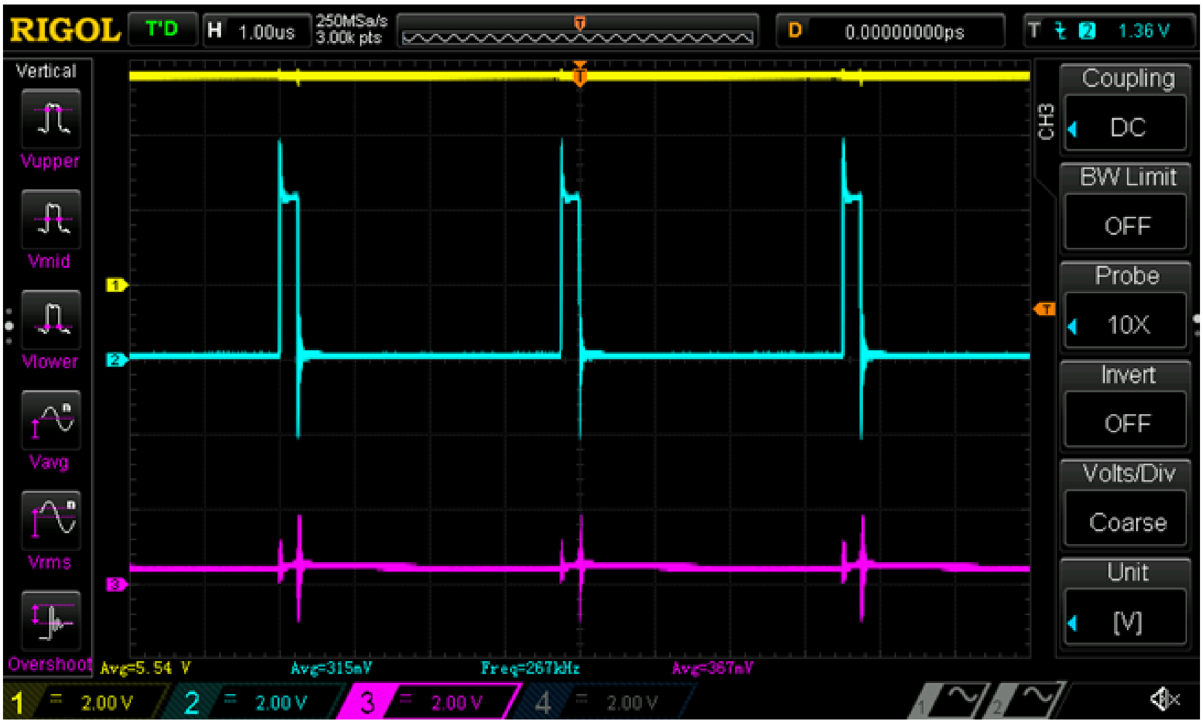


**Figure 9: Device functionality then SPI code 64 at VDD 5.5V**

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)

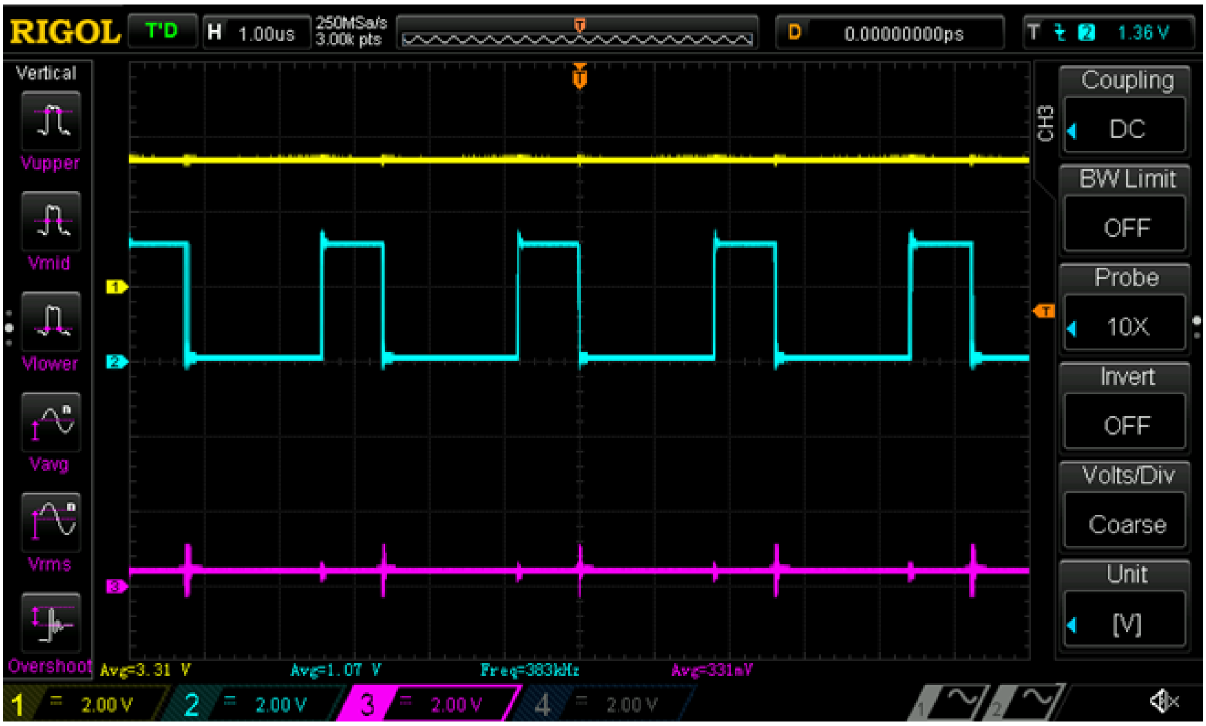


**Figure 10: Device functionality then SPI code 64 at VDD 3.3V**

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)

# 6. Conclusion

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

# 7. Revision History

| Revision | Date | Description |
|---|---|---|
| 1.00 | Oct 21, 2014 | Initial release. |

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