Application Note

LED Lamp Driver

AN-CM-301

Abstract

This application note describes the High Voltage GreenPAK IC configurated as a LED driver with brightness and color temperature control.

The application note comes complete with design files which can be found in the Reference section.

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1 Terms and Definitions

CCMP	Current Comparator
CMP	Comparator
DC	Direct Current
GPO	General Purpose Output
HV	High Voltage
LED	Light Emitting Diode
MCU	Microcontroller Unit
PWM	Pulse-Width Modulation

2 References

For related documents and software, please visit:

https://www.dialog-semiconductor.com/configurable-mixed-signal.

Download our free GreenPAK™ Designer software [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. Dialog Semiconductor provides a complete library of application notes [4] featuring design examples as well as explanations of features and blocks within the Dialog IC.

[1]   GreenPAK Designer Software, Software Download and User Guide, Dialog Semiconductor

[2]   AN-CM-301, LED Lamp Driver.gp, GreenPAK Design File, Dialog Semiconductor

[3]   GreenPAK Development Tools, GreenPAK Development Tools Webpage, Dialog Semiconductor

[4]   GreenPAK Application Notes, GreenPAK Application Notes Webpage, Dialog Semiconductor

[5]   SLG47105, Datasheet, Dialog Semiconductor

Author: Serhii Prykhodko

3   Introduction

This application note describes the HV PAK configuration for LED control. Since LEDs have high efficiency and brightness, this makes them leaders in many lighting applications.

In this case, the SLG47105 [5] is configured as the LED driver with four buttons to control LED brightness and color temperature. These features are useful for LED table lamps (see Figure 1) or other lighting devices.

Figure 1:Example LED Table Lamp

LED Lamp Driver

4 Construction and Control
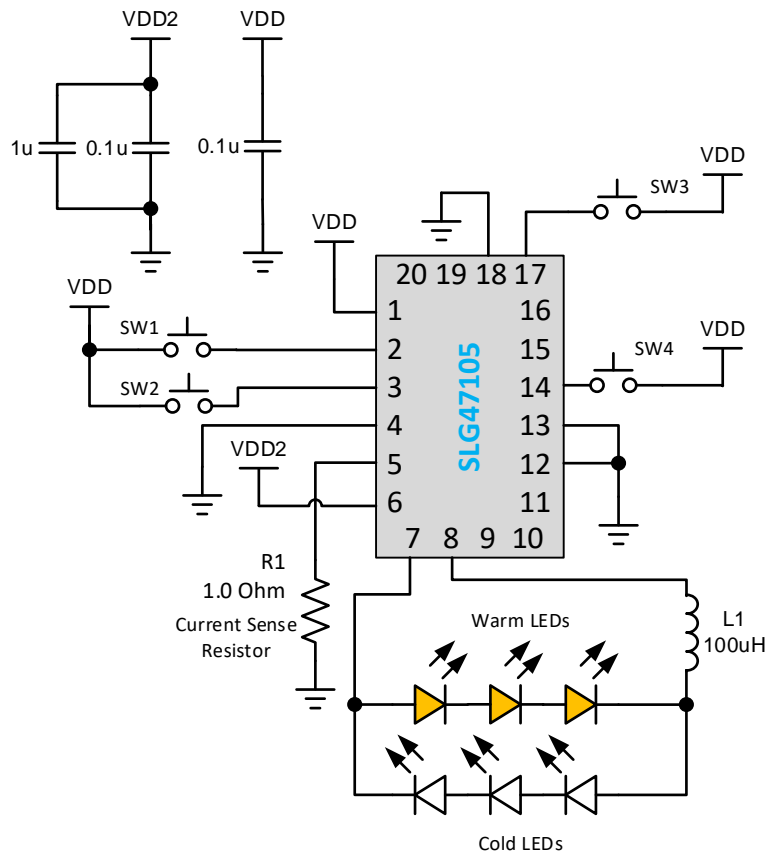
Figure 2: Typical Application Circuit

The design has four inputs for the LED driver control, as shown on Figure 2:

- PIN#3 – increase lamp brightness
- PIN#17 – decrease lamp brightness
- PIN#14 – shift color temperature to the warm range
- PIN#2 – shift color temperature to the cold range

The general block diagram can be found in Figure 3.

Figure 3: Block Diagram
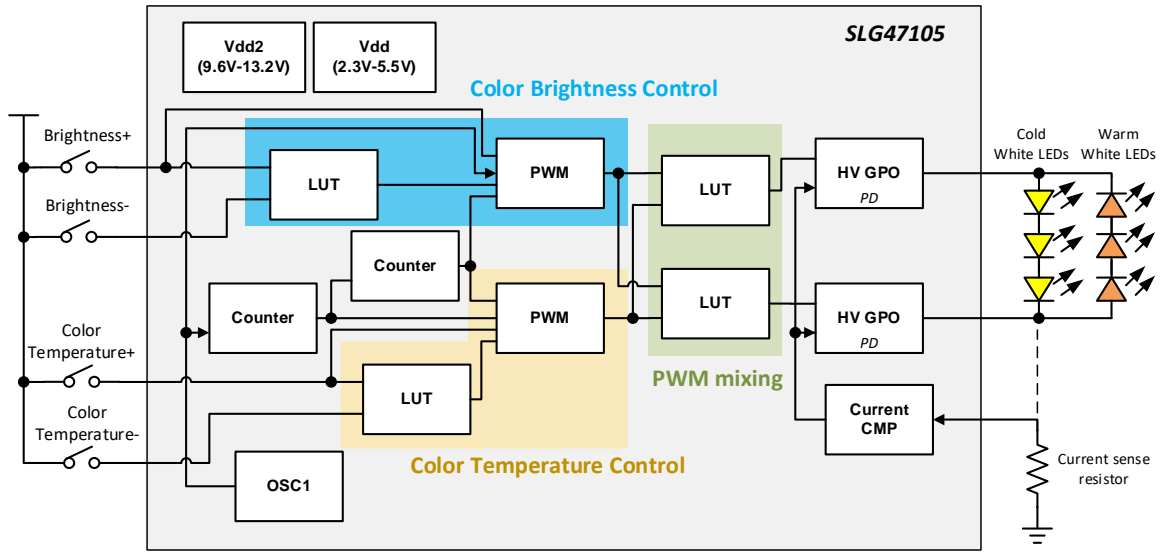
Table 1: LEDs used in this example

Name	Current, mA	Voltage, V	Power, W	Emitted Color	Peak Wavelength, nm
GNL-5630UWC-Y50	150	3.2	0.5	Warm While	2800K-3200K
GNL-5630UWC-C50	150	3.2	0.5	Cold White	5500K-7000K

In this design example, LEDs were used without a PCB. Because of the resulting thermal limitations, the LED current was limited to 100 mA.

Current CMP disables HV OUTs when LED current is higher than 100 mA.

Current Comparator V_{ref} calculation:

$$V_{ref\_CCMP} = I_{LED\_MAX} * GAIN_{CCMP} * R_{SENSE} = 100\,mA * 8 * 1\,Ohn = 800\,mV$$

The power supply voltage for three LEDs connected in series should be higher than 9.6 V (3.2 V x 3). Maximum voltage is 13.2 V for the SLG47105.

Figure 4 and Figure 5 show LEDs connected to an Evaluation board with warm and cold LEDs each alternately turned fully on. Buttons SW1, SW4 allow setting color temperature anywhere in between.

Figure 4: Warm LEDs On, Cold LEDs Off

Figure 5: Cold LEDs On, Warm LEDs Off

5   HV PAK Design

Figure 6: Design View

LED Lamp Driver
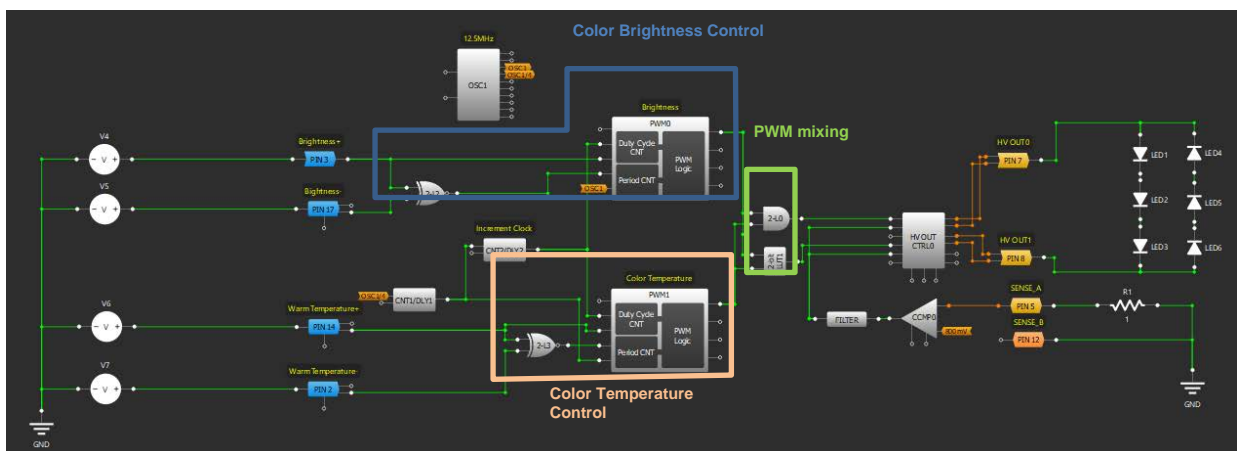
5.1   Design Operation

There are two PWM blocks, as shown in Figure 6.

The PWM0 block generates 49 kHz frequency and controls the general LEDs brightness (for cold and warm LED strings together) using the PWM duty cycle. The duty cycle can be changed by PIN3 (increase) and PIN17 (decrease) in a range from 0 % to 100 %. The HIGH level on PIN3 or PIN17 disables the PWM0 KEEP signal through NXOR 2-L2, and CNT2 starts to clock the duty cycle. KEEP signal is active when PIN3 and PIN17 are LOW or HIGH together.

The PWM1 block generates a PWM signal with 120 Hz frequency to control LEDs color temperature. When PWM1 OUT is HIGH, then only warm LEDs are turned on, and when OUT is LOW – only cold LEDs are turned on. The PWM1 duty cycle can be changed by PIN14 (increase) and PIN2 (decrease). The buttons for PWM1 work similarly to PWM0 control buttons.
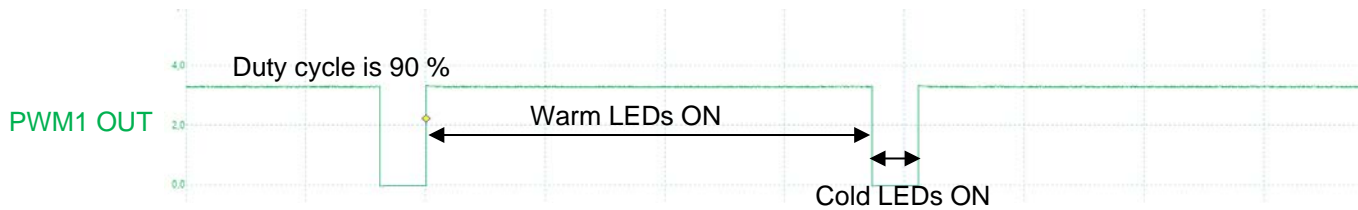

Figure 7: PWM1 OUT Signal

PWM1 signal is modulated by PWM0 signal, as shown on Figure 8. As a result, the general brightness depends on the PWM0 duty cycle and the color temperature depends on the PWM1 duty cycle.
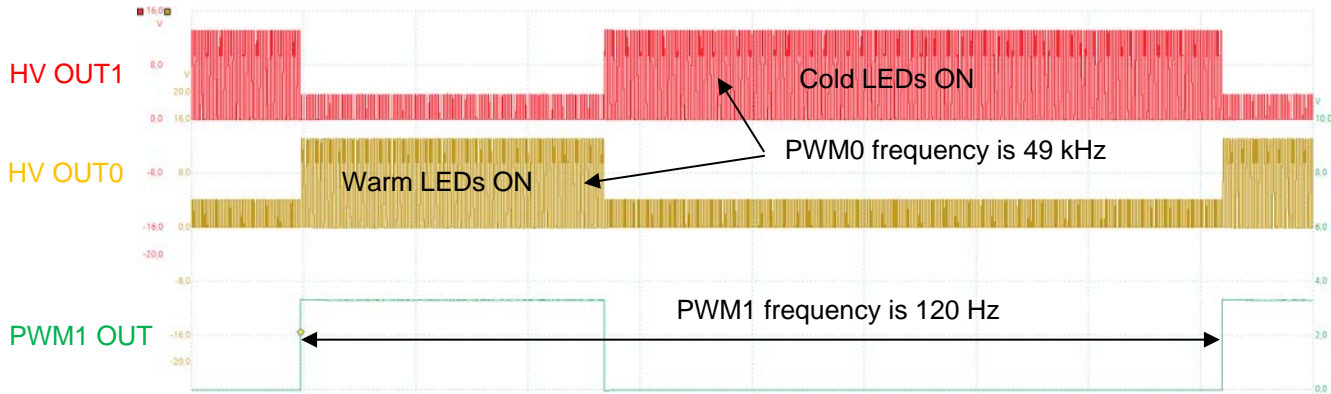

Figure 8: Modulated PWM1 Signal

5.2 Current Limitation

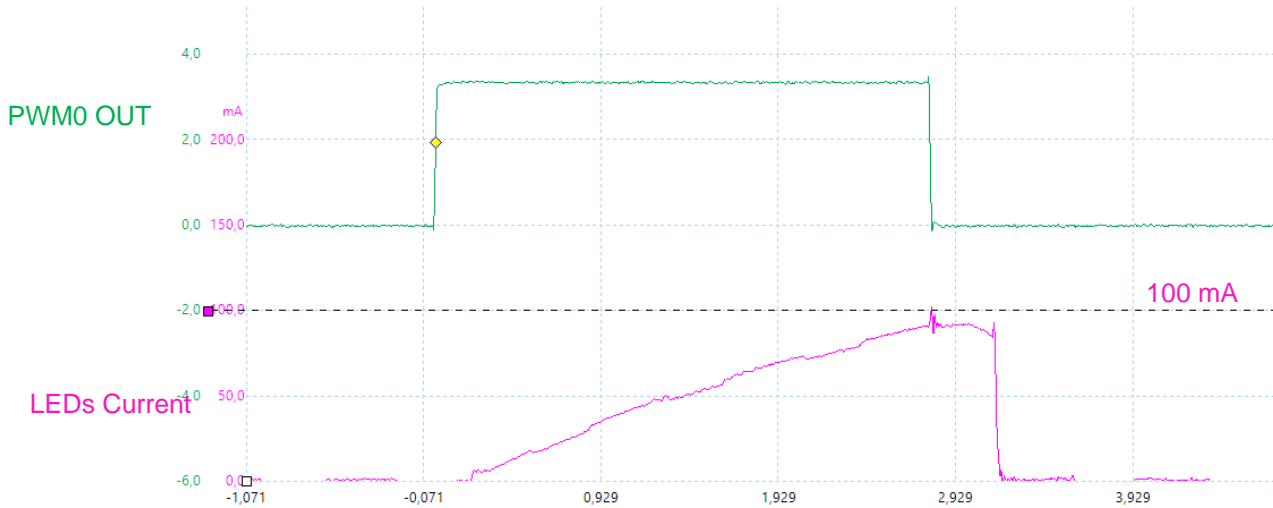The CCMP turns off HV OUTs when current is higher than 100 mA, see Figure 9.
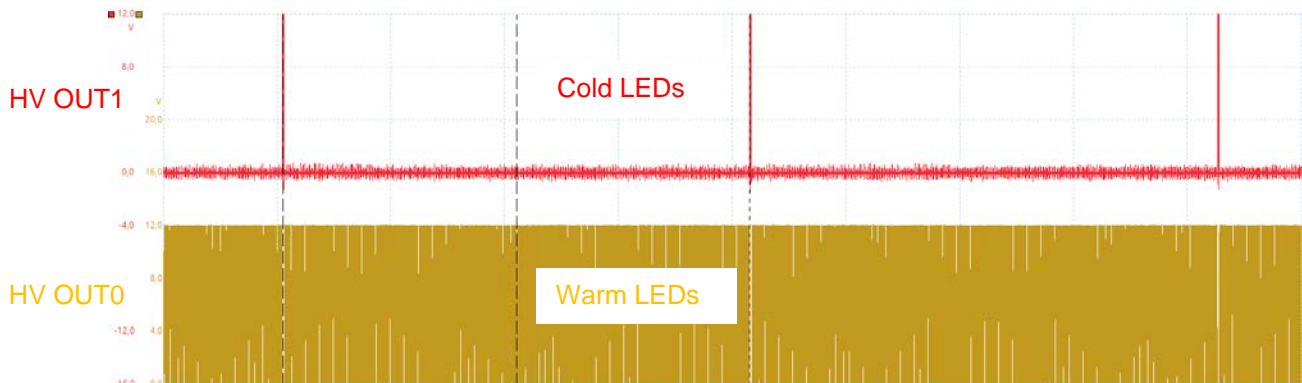

Figure 9: Current Limitation

6 Waveforms

Figure 10: Warm LEDs On Max Brightness
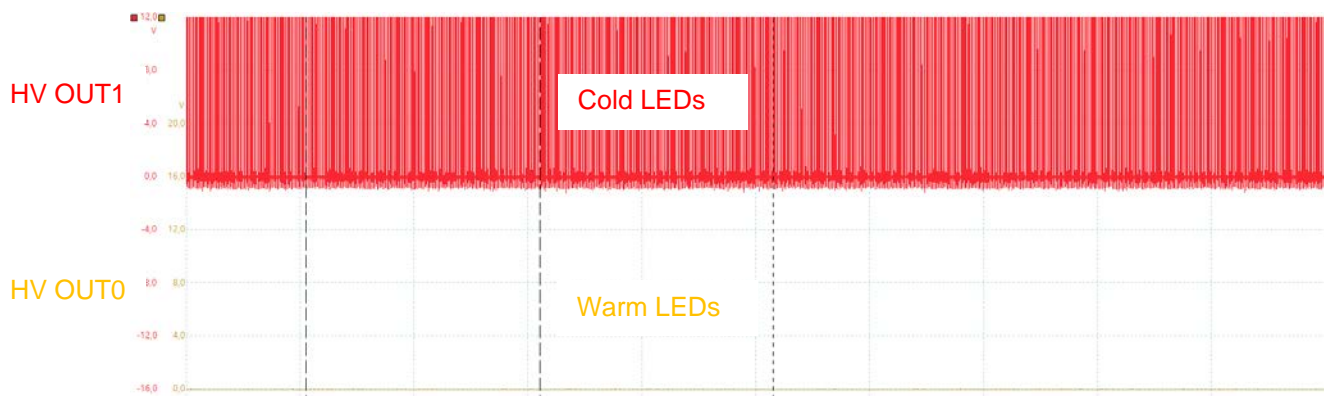
Figure 11: Cold LEDs On Max Brightness
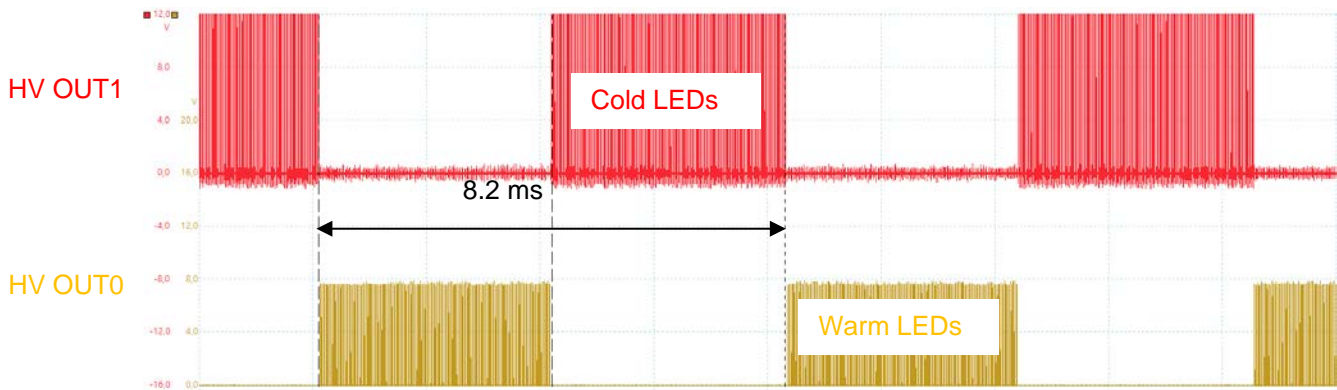
Figure 12: Cold LEDs 50 % and Warm LEDs 50 % Brightness

7 Conclusion

The application note describes how to configure the HV PAK for advanced LED control. The driver has a flexible configurable control logic, PWM frequency, and current limit. The HV PAK can control loads with current up to 2 A per one output, so it is possible to create powerful solutions using a single small GreenPAK IC, all with minimum external components.

Revision History

Revision	Date	Description
1.0	24-Nov-2020	Initial version.

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Status Definitions

Status	Definition
DRAFT	The content of this document is under review and subject to formal approval, which may result in modifications or additions.
APPROVED or unmarked	The content of this document has been approved for publication.

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Contacting Dialog Semiconductor

United Kingdom (Headquarters)	North America	Hong Kong	China (Shenzhen)
Dialog Semiconductor (UK) LTD	*Dialog Semiconductor Inc.*	*Dialog Semiconductor Hong Kong*	*Dialog Semiconductor China*
Phone: +44 1793 757700	Phone: +1 408 845 8500	Phone: +852 2607 4271	Phone: +86 755 2981 3669
Germany	**Japan**	**Korea**	**China (Shanghai)**
Dialog Semiconductor GmbH	*Dialog Semiconductor K. K.*	*Dialog Semiconductor Korea*	*Dialog Semiconductor China*
Phone: +49 7021 805-0	Phone: +81 3 5769 5100	Phone: +82 2 3469 8200	Phone: +86 21 5424 9058
The Netherlands	**Taiwan**		
Dialog Semiconductor B.V.	*Dialog Semiconductor Taiwan*		
Phone: +31 73 640 8822	Phone: +886 281 786 222		
Email:	**Web site:**		
enquiry@diasemi.com	www.dialog-semiconductor.com		

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