

Description

The AL5802LP4 combines a high-gain NPN transistor with a pre-biased NPN transistor to make a simple small footprint LED driver.

The LED current is set by an external resistor connected from R_{EXT} Pin (2) to GND Pin (1). The internal high-gain transistor develops approximately 0.6V across the external resistor.

The AL5802LP4's open-collector output can operate from 0.8V to 30V making it suitable for industry standard 5V to 24V power supplies without additional components.

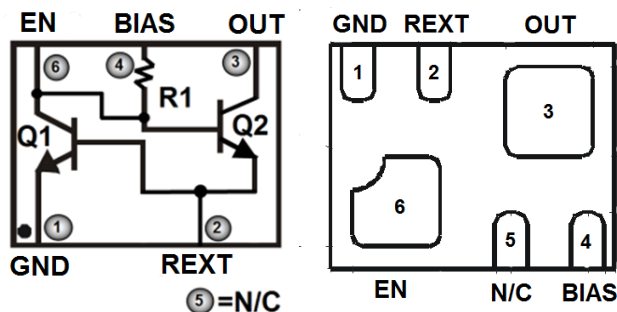
PWM dimming of the LED current can be achieved by either driving the BIAS Pin (4) with a low impedance voltage source, or driving the EN Pin (6) with an external open-collector NPN transistor or open-drain N-Channel MOSFET.

The AL5802LP4 is available in a X2-DFN1310-6 package and is ideal for driving up to 120mA current.

Features

- Reference Voltage V_{REXT} = 0.65V
- -40 to +125°C Temperature Range
- 0.8V to 30V Open-Collector Output
- Negative Temperature Co-Efficient – Automatically Reduces the LED Current at High Temperatures
- Low Thermal Impedance, Small Footprint X2-DFN1310-6 Package with Exposed Pads
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Pin Assignments



Internal Schematic
(Top View)

(Bottom View)

Mechanical Data

- Case: X2-DFN1310-6
- Case Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: NiPdAu (Lead-Free) Plating. Solderable per MIL-STD-202, Method 208 ^(e4)
- Weight: 0.0013 grams

Applications

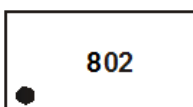
- Linear LED Driver
- LED Signs
- Offline LED Luminaries

Ordering Information (Note 8)

| Device | Qualification | Packaging | Tape and Reel | |
|-----------|---------------|--------------|-------------------|--------------------|
| | | | Quantity | Part Number Suffix |
| AL5802LP4 | Commercial | X2-DFN1310-6 | 3,000/Tape & Reel | -7 |

Note: 8. For packaging details, go to our website at <http://www.diodes.com/products/packages.html>.

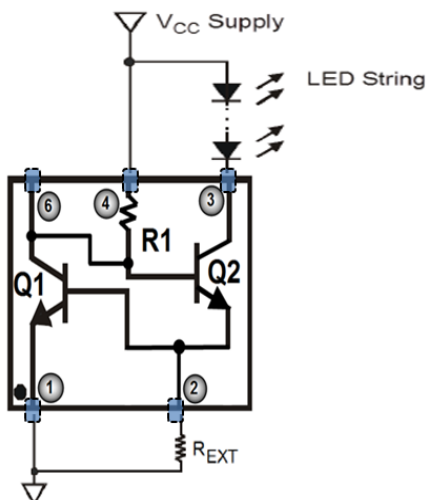
Marking Information



802 = Product Type Marking Code

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
 2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
 3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Typical Application Circuit



Pin Descriptions

| Pin Number | Name | Function |
|------------|------------------|--|
| 1 | GND | Ground Reference Point for Setting LED Current |
| 2 | R _{EXT} | Current Sense Pin LED current sensing resistor should be connected from here to GND |
| 3 | OUT | Open-Collector LED Driver Output |
| 4 | BIAS | Biases the Open Collector Output Transistor |
| 5 | N/C | No Connection |
| 6 | EN | Enable Pin for PWM Dimming Provides access to the base of Q2 and collector of Q1 |

Functional Block Diagram

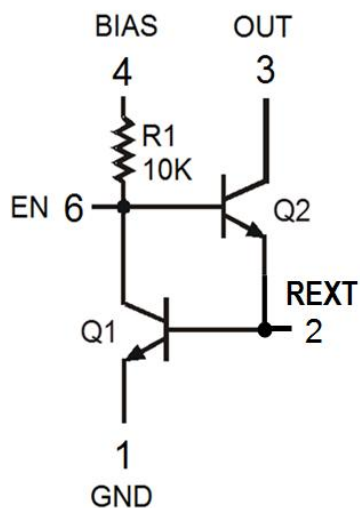


Figure 1 Block Diagram

Absolute Maximum Ratings

| Symbol | Characteristics | Values | Unit |
|-------------------|--------------------------------|-------------|------|
| V _{OUT} | Output Voltage Relative to GND | 30 | V |
| V _{BIAS} | BIAS Voltage Relative to GND | 30 | V |
| V _{FB} | LED Voltage Relative to GND | 6 | V |
| V _{EN} | EN Voltage Relative to GND | 6 | V |
| V _{REXT} | REXT Voltage Relative to GND | 6 | V |
| I _{OUT} | Output Current | 120 | mA |
| T _J | Operating Junction Temperature | -40 to +150 | °C |
| T _{ST} | Storage Temperature | -55 to +150 | °C |

These are stress ratings only. Operation outside the absolute maximum ratings may cause device failure. Operation at the absolute maximum rating for extended periods may reduce device reliability.

Package Thermal Data

| Characteristic | Symbol | Value | Unit |
|--|------------------|-------|------|
| Power Dissipation (Note 4) @T _A = +25°C | P _D | 0.36 | W |
| Thermal Resistance, Junction to Ambient Air (Note 4) @T _A = +25°C | R _{θJA} | 347 | °C/W |

Recommended Operating Conditions

| Symbol | Parameter | Min | Max | Unit |
|-------------------|-------------------------------------|-----|------|------|
| V _{BIAS} | Supply Voltage Range | 4.5 | 30 | V |
| V _{OUT} | OUT Voltage Range | 0.8 | 30 | |
| I _{LED} | LED Pin Current (Note 5) | 10 | 100 | mA |
| T _A | Operating Ambient Temperature Range | -40 | +125 | °C |

Notes: 4. Device mounted on FR-4 PCB, 2oz with minimum recommended pad layout.
5. Subject to ambient temperature, power dissipation and PCB.

Electrical Characteristics: NPN Transistor – Q1 (@T_A = +25°C, unless otherwise specified.)

| Symbol | Characteristic | Test Condition | Min | Typ | Max | Unit |
|----------------------|---|---|-----------|--------|----------|------|
| V _{(BR)CEO} | Collector-Emitter Breakdown Voltage (Note 6) (Note 7) | I _C = 1.0mA, I _B = 0 | 40 | — | — | V |
| V _{(BR)EBO} | Emitter-Base Breakdown Voltage | I _E = 10μA, I _C = 0 | 6.0 | — | — | V |
| I _{CEX} | Collector Cutoff Current (Note 7) | V _{CE} = 30V, V _{EB(OFF)} = 3.0V | — | — | 50 | nA |
| I _{BL} | Base Cutoff Current (Note 7) | V _{CE} = 30V, V _{EB(OFF)} = 3.0V | — | — | 50 | nA |
| h _{FE} | DC Current Gain | I _C = 1.0mA, V _{CE} = 1.0V I _C = 10mA, V _{CE} = 1.0V | 70 100 | — — | — 300 | — |
| V _{CE(SAT)} | Collector-Emitter Saturation Voltage (Note 6) | I _C = 10mA, I _B = 1.0mA | — | — | 0.20 | V |
| V _{BE(SAT)} | Base-Emitter Saturation Voltage | I _C = 10mA, I _B = 1.0mA | 0.65 | — | 0.85 | V |
| V _{BE(ON)} | Base-Emitter Turn-On Voltage | V _{CE} = 1.20V, I _C = 2.0mA | 0.30 | — | 1.10 | V |

Electrical Characteristics: NPN Pre-biased Transistor – Q2 (@T_A = +25°C, unless otherwise specified.)

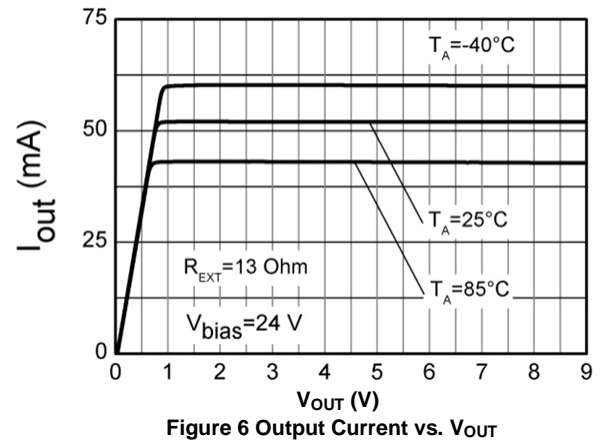
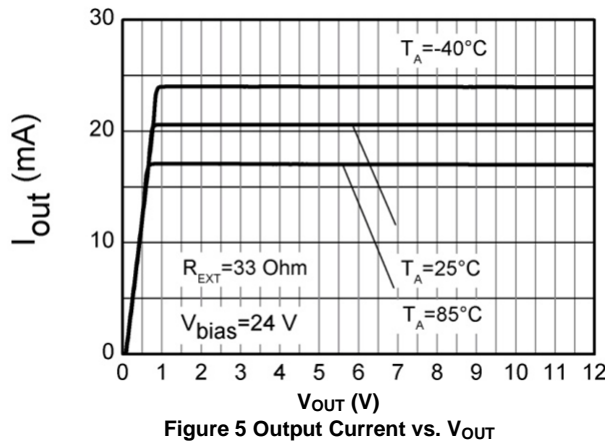
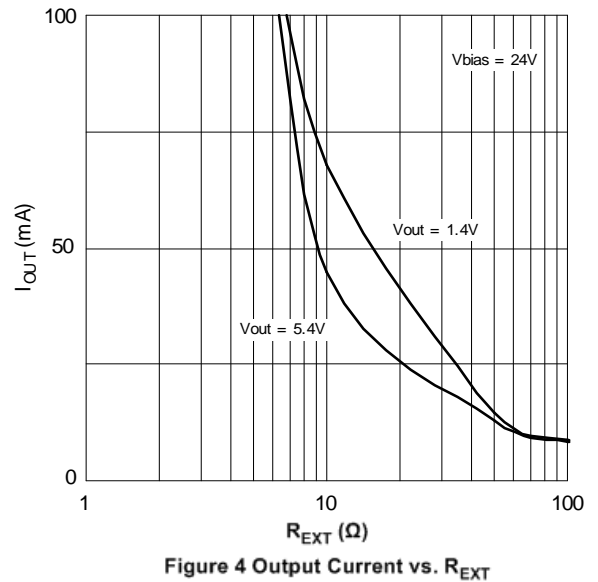
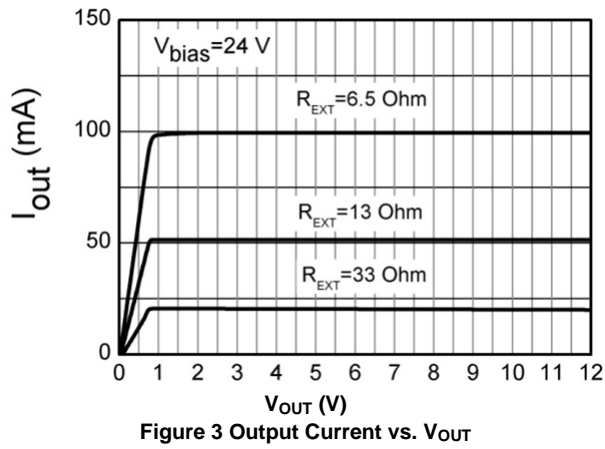
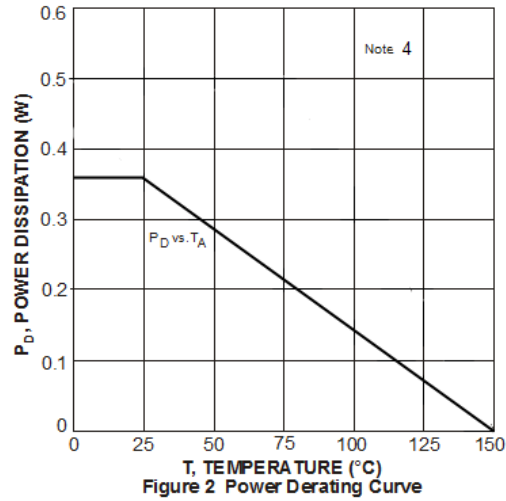
| Symbol | Characteristic | Test Condition | Min | Typ | Max | Unit |
|----------------------|---|--|------|-----|------|------|
| V _{(BR)CBO} | Collector-Base Breakdown Voltage | I _C = 50μA, I _E = 0 | 30 | — | — | V |
| V _{(BR)CEO} | Collector-Emitter Breakdown Voltage (Note 6) | I _C = 1mA, I _B = 0 | 30 | — | — | V |
| V _{(BR)EBO} | Emitter-Base Breakdown Voltage (Note 7) | I _E = 50μA, I _C = 0 | 5.0 | — | — | V |
| I _{CBO} | Collector Cutoff Current | V _{CB} = 30V, I _E = 0 | — | — | 0.5 | μA |
| I _{EBO} | Emitter Cutoff Current (Note 7) | V _{EB} = 4V, I _C = 0 | — | — | 0.5 | μA |
| V _{CE(SAT)} | Collector-Emitter Saturation Voltage (Note 6) | I _C = 10mA, I _B = 1mA | — | — | 0.3 | V |
| V _{BE(ON)} | Base-Emitter Turn-On Voltage | V _{CE} = 5.0V, I _C = 2.0mA | 0.30 | — | 1.10 | V |
| h _{FE} | DC Current Gain (Note 6) | V _{CE} = 5V, I _C = 150mA | 100 | — | — | — |
| R ₁ | Input Resistance | — | 7 | 10 | 13 | kΩ |

*Characteristics of transistor only.

Notes: 6. Short duration pulse test used to minimize self-heating effect.

7. Guaranteed by design and tested only at the wafer level for single die. These parameters cannot be tested at the finished good level due to test conditions changed after packaging multi-dies to form an application circuit.

Thermal Characteristics



Typical Performance Characteristics (Continued)

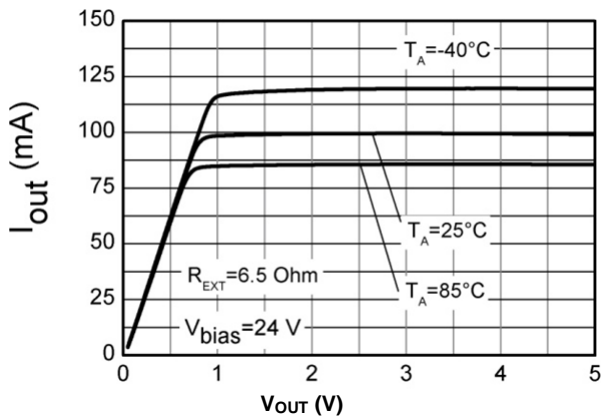


Figure 7 Output Current vs. V_{OUT}

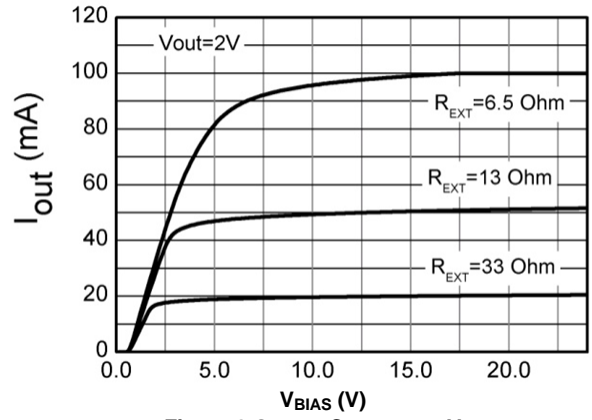


Figure 8 Output Current vs. V_{BIAS}

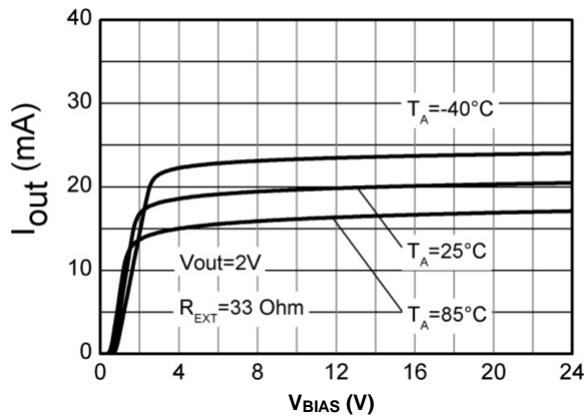


Figure 9 Output Current vs. V_{BIAS}

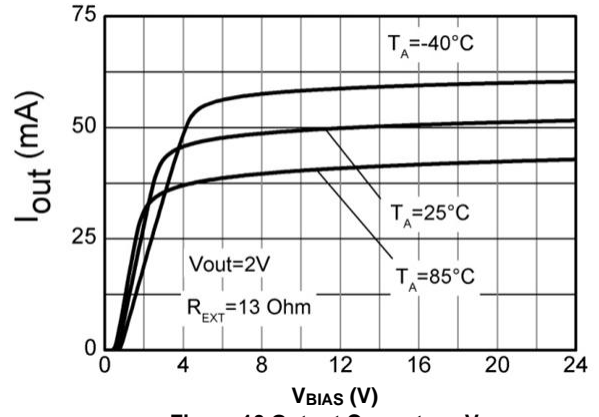


Figure 10 Output Current vs. V_{BIAS}

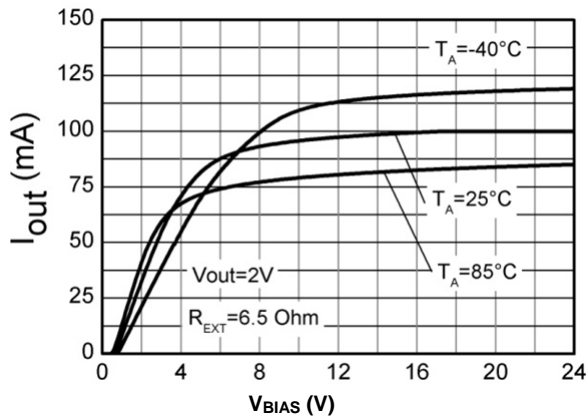


Figure 11 Output Current vs. V_{BIAS}

Application Information

The AL5802LP4 is designed for driving low current LEDs with typical LED currents of 10mA to 100mA. It provides a cost effective way of driving low current LEDs compared with more complex switching regulator solutions. Furthermore, it reduces the PCB board area of the solution as there is no need for external components like inductors, capacitors and switching diodes.

Figure 12 shows a typical application circuit diagram for driving an LED or string of LEDs. The NPN transistor Q1 measures the LED current by sensing the voltage across an external resistor R_{EXT} . Q1 uses its V_{BE} as reference to set the voltage across R_{EXT} and controls the base current into Q2. Q2 operates in linear mode to regulate the LED current. The LED current is:

$$I_{LED} = V_{BE(Q1)} / R_{EXT}$$

From this, for any required LED current the necessary external resistor R_{EXT} can be calculated from:

$$R_{EXT} = V_{BE(Q1)} / I_{LED}$$

Two or more AL5802LP4 can be connected in parallel to construct higher current LED strings as shown in Figure 13.

Consideration of the expected linear mode power dissipation must be factored into the design, with respect to the AL5802LP4's thermal resistance.

The maximum voltage across the device can be calculated by taking the maximum supply voltage less the voltage across the LED string.

$$V_{CE(Q2)} = V_{CC} - V_{LED} - V_{BE(Q1)}$$

$$P_D = V_{CE(Q2)} * I_{LED} + (V_{CC} - V_{BE(Q2)} - V_{BE(Q1)})^2 / R_1$$

As the output current of AL5802LP4 increases, it is necessary to provide appropriate thermal relief to the device. The power dissipation supported by the device is dependent upon the PCB board material, the copper area and the ambient temperature. The maximum dissipation the device can handle is given by:

$$P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$$

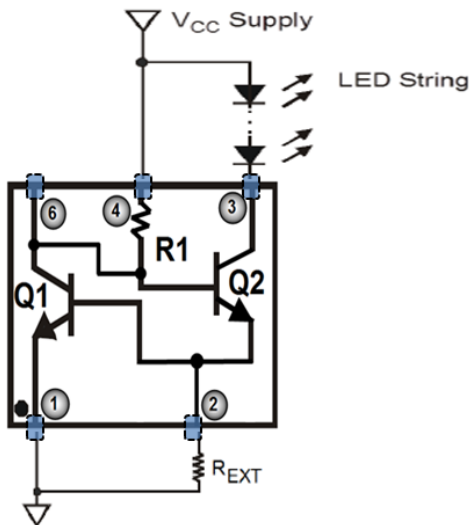


Figure 12 Typical Application Circuit for Linear Mode Current Sink LED Driver

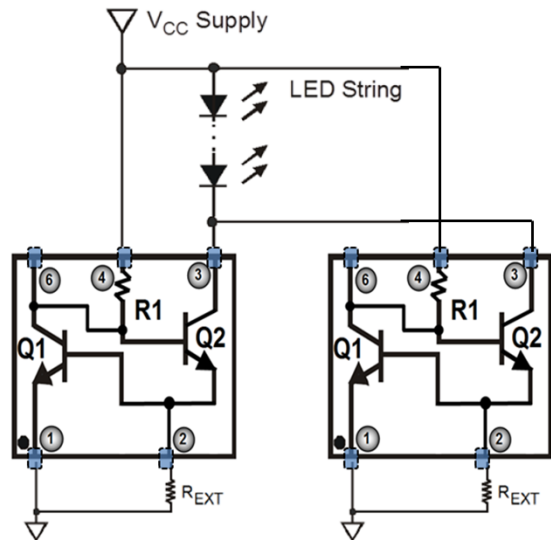


Figure 13 Application Circuit for Increasing LED Current

Application Information (Continued)

PWM dimming can be achieved by driving the EN Pin. An external open-collector NPN transistor or open-drain N-Channel MOSFET can be used to drive the EN Pin as shown in Figure 14. Dimming is achieved by turning the LEDs ON and OFF for a portion of a single cycle. The PWM signal can be provided by a micro-controller or analog circuitry. Figure 16 is a typical response of LED current vs. PWM duty cycle on the EN Pin.

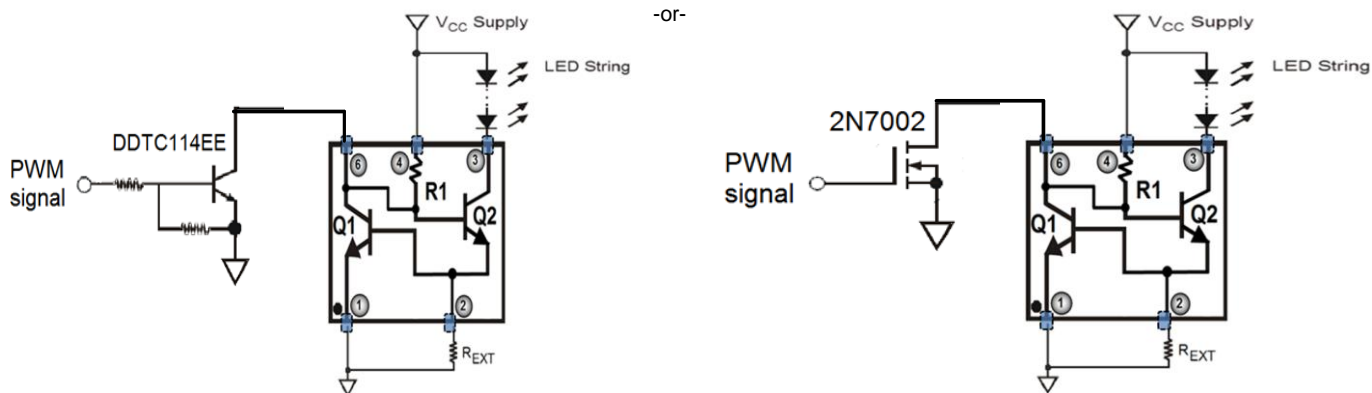


Figure 14 Application Circuits for LED Driver with PWM Dimming Functionality

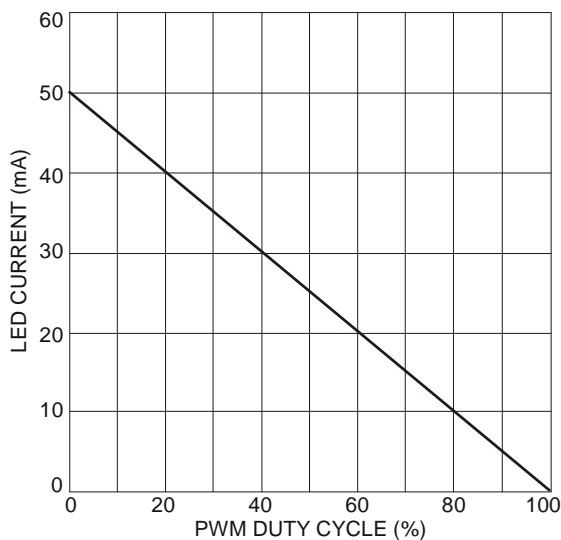


Figure 15 Typical LED Current Response vs. PWM Duty Cycle for $R_{EXT} = 13\Omega$ at 400Hz PWM Frequency

To remove the potential of incorrect connection of the power supply damaging the lamp's LEDs, many systems use some form of reverse polarity protection.

One solution for reverse input polarity protection is to simply use a diode with a low V_F in-line with the driver/LED combination. The low V_F increases the available voltage to the LED stack and dissipates less power. A circuit example is presented in Figure 16 using Diodes Incorporated's SBR (Super Barrier Rectifier) technology. An SDM10U45LP (0.1A/45V) is shown, providing exceptionally low V_F for its package size of 1mm x 0.6mm, equivalent to an 0402 chip style package. Other reverse voltage ratings are available on Diodes' website, such as the SBR02U100LP (0.2A/100V) or SBR0220LP (0.2A/20V).

Automotive applications commonly use this method for reverse battery protection.

Application Information (cont.)

A second approach, shown in Figure 17, improves upon the method shown in Figure 16. Whereas the method in Figure 16 protects the light engine, it will not function until the problem is diagnosed and corrected.

The method shown in Figure 17 not only provides reverse polarity protection, it also corrects the reversed polarity, allowing the light engine to function.

The BAS40BRW incorporates four low V_F , Schottky diodes into a single package and allows more voltage to be available for the LED stack and dissipates less power than standard rectifier bridges.

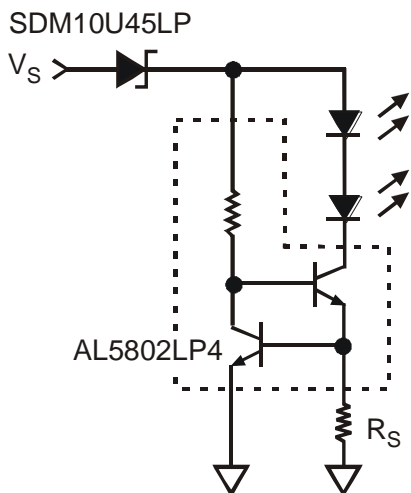


Figure 16 Application Circuit for LED Driver with Reverse Polarity Protection

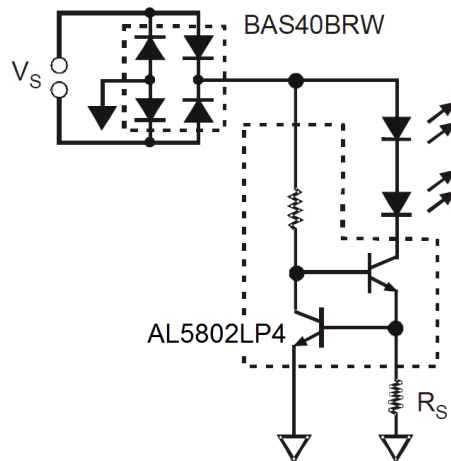
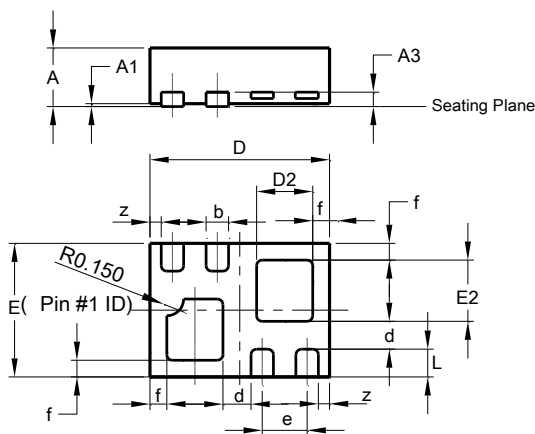


Figure 17 Application Circuit for LED Driver with Assured Operation Regardless of Polarity

Package Outline Dimensions

Please see AP02001 at http://www.diodes.com/_files/datasheets/ap02001.pdf for the latest version.

X2-DFN1310-6

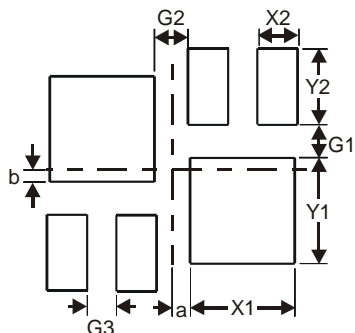


| X2-DFN1310-6 | | | |
|-----------------------------|------|-------|------|
| Dim | Min | Max | Typ |
| A | — | 0.40 | — |
| A1 | 0 | 0.05 | 0.02 |
| A3 | — | — | 0.13 |
| b | 0.10 | 0.20 | 0.15 |
| D | 1.25 | 1.38 | 1.30 |
| d | — | — | 0.25 |
| D2 | 0.30 | 0.50 | 0.40 |
| E | 0.95 | 1.075 | 1.00 |
| e | — | — | 0.35 |
| E2 | 0.30 | 0.50 | 0.40 |
| f | — | — | 0.10 |
| L | 0.20 | 0.30 | 0.25 |
| Z | — | — | 0.05 |
| All Dimensions in mm | | | |

Suggested Pad Layout

Please see AP02001 at http://www.diodes.com/_files/datasheets/ap02001.pdf for the latest version.

X2-DFN1310-6



| Dimensions | Value (in mm) |
|------------|---------------|
| G1 | 0.16 |
| G2 | 0.17 |
| G3 | 0.15 |
| X1 | 0.52 |
| X2 | 0.20 |
| Y1 | 0.52 |
| Y2 | 0.375 |
| a | 0.09 |
| b | 0.06 |

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

This document is written in English but may be translated into multiple languages for reference. Only the English version of this document is the final and determinative format released by Diodes Incorporated.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2016, Diodes Incorporated

www.diodes.com