LED DRIVER, 30V, LINEAR, ADJUSTABLE, CURRENT SINK

Description

The AL5802LP combines a high-gain NPN transistor with a pre-biased NPN transistor to make a simple, small footprint LED driver.

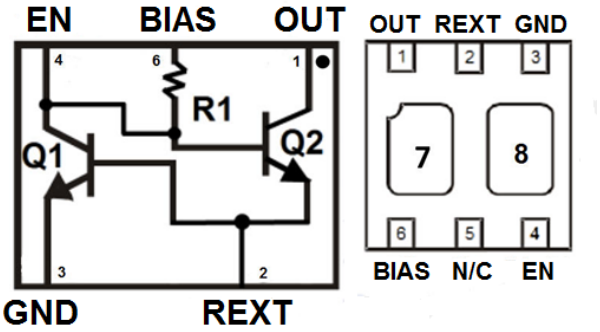
The LED current is set by an external resistor connected from R_{EXT} pin (2) to GND pin (3), and the internal high-gain transistor develops approximately 0.6V across the external resistor.

The AL5802LP'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 (6) with a low impedance voltage source, or driving the EN pin (4) with an external open-collector NPN transistor or open-drain N-Channel MOSFET.

The AL5802LP is available in a U-DFN1616-6 (Type F) package and is ideal for driving 10mA to 120mA LED currents.

Pin Assignments



Internal Schematic (Top View)

(Bottom View)

Package: U-DFN1616-6 (Type F)

- The collector of Q2 is connected to pin 1 and pad 7 which is on the underside of the package
- Pad 8 is electrically tied to the collector of Q1 and to the base of Q2, i.e. it is common with terminal 4

Features

- Reference Voltage V_{REXT} = 0.65V
- -40 to +125°C Operating Temperature Range
- 0.8V to 30V Open-Collector Output
- Negative Temperature Coefficient – Automatically Reduces the LED Current at High Temperatures
- Low Thermal Impedance, Small Footprint DFN1616-6 Package with Exposed Pads
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

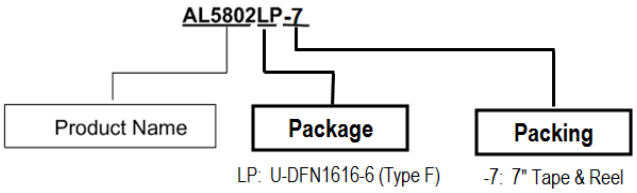
Mechanical Data

- Case: U-DFN1616-6 (Type F)
- Case Material: Molded Plastic, "Green" Molding Compound; UL Flammability Classification Rating 94-V-0.
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – NiPdAu over Copper Leadframe; Solderable per MIL-STD-202, Method 208e4
- Weight: 0.005 grams (Approximate)

Applications

- Linear LED Driver
- LED Signs
- Offline LED Luminaries

Ordering Information (Note 4)

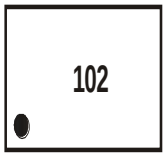


Device	Qualification	Packaging	Tape and Reel	
			Quantity	Part Number Suffix
AL5802LP	Commercial	U-DFN1616-6 (Type F)	3,000/Tape & Reel	-7

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.
4. For packaging details, go to our website at http://www.diodes.com/products/packages.html.

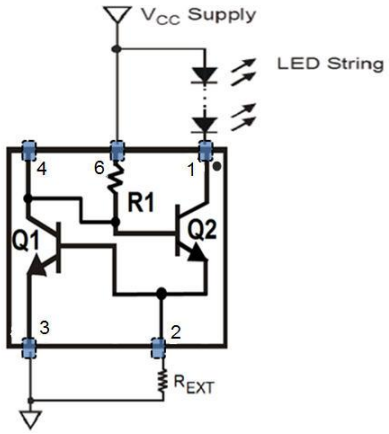
© Diodes Incorporated

Marking Information



102 = Product Type Marking Code

Typical Application Circuit



Pin Descriptions

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

Functional Block Diagram

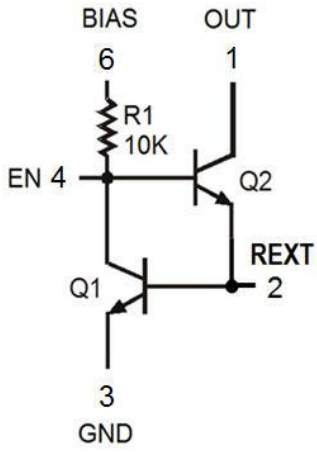


Figure 1 Block Diagram

© Diodes Incorporated

Absolute Maximum Ratings (Note 5)

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	150	mA
T_{OP}	Operating Temperature	-40 to +150	°C
T_{STG}	Storage Temperature	-55 to +150	°C

Note: 5. These are stress ratings only. Operation outside the absolute maximum ratings may cause device failure. Operation at the absolute maximum rating for extended periods of time may reduce device reliability.

Package Thermal Data

Characteristic	Symbol	Value	Unit
Power Dissipation (Note 6) @ T_A = +25°C	P_D	0.44	W
Thermal Resistance, Junction to Ambient Air (Note 6) @ T_A = +25°C	$R_{\theta JA}$	284	°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 7)	10	120	mA
T_A	Operating Ambient Temperature Range	-40	+125	°C

Notes: 6. Device mounted on FR-4 PCB, single-sided, 2oz copper trace weight with minimum recommended pad layout.
7. Subject to ambient temperature, power dissipation and PCB substrate material selection.

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 (Notes 8 & 9)	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 Cut-Off Current (Note 9)	V_{CE} = 30V, $V_{EB(OFF)}$ = 3.0V	—	—	50	nA
I_{BL}	Base Cut-Off Current (Note 9)	V_{CE} = 30V, $V_{EB(OFF)}$ = 3.0V	—	—	50	nA
h_{FE}	DC Current Gain	I_C = 100µA, V_{CE} = 1.0V I_C = 1.0mA, V_{CE} = 1.0V I_C = 10mA, V_{CE} = 1.0V	40 70 100	— — —	— — 300	—
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage (Note 8)	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} = 1.50V, I_C = 2.0mA	0.30	—	1.10	V

Notes: 8. Short duration pulse test used to minimize self-heating effect.
9. Guaranteed by design and tested only at the wafer level for single die. These parameters cannot be tested at the finished goods level due to the testability of the device changed after packaging multiple dies to form an application circuit.

© Diodes Incorporated

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 8)	I_C = 1mA, I_B = 0	30	—	—	V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage (Note 9)	I_E = 50µA, I_C = 0	5.0	—	—	V
I_{CBO}	Collector Cut-Off Current	V_{CB} = 30V, I_E = 0	—	—	0.5	µA
I_{EBO}	Emitter Cut-Off Current (Note 9)	V_{EB} = 4V, I_C = 0	—	—	0.5	µA
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage (Note 8)	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 8)	V_{CE} = 5V, I_C = 150mA	100	—	—	—
R_1	Input Resistance	—	7	10	13	kΩ

Notes: 8. Short duration pulse test used to minimize self-heating effect.
9. Guaranteed by design and tested only at the wafer level for single die. These parameters cannot be tested at the finished goods level due to the testability of the device changed after packaging multiple dies to form an application circuit.

Thermal Characteristics

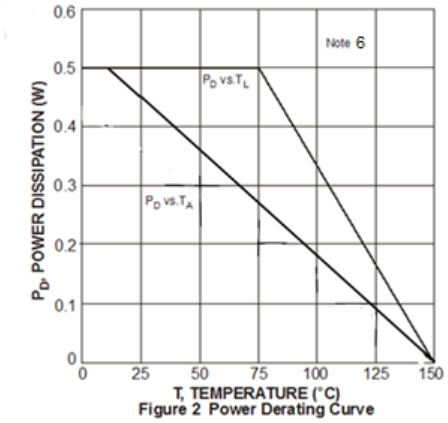


Figure 2 Power Derating Curve

Typical Performance Characteristics

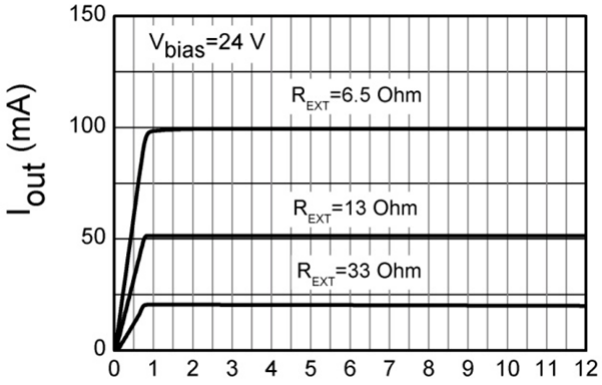


Figure 3 Output Current vs. V_{OUT}

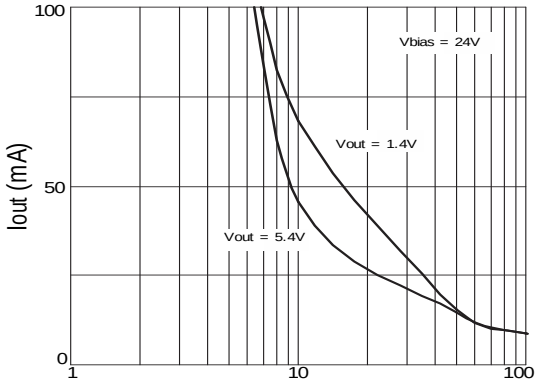
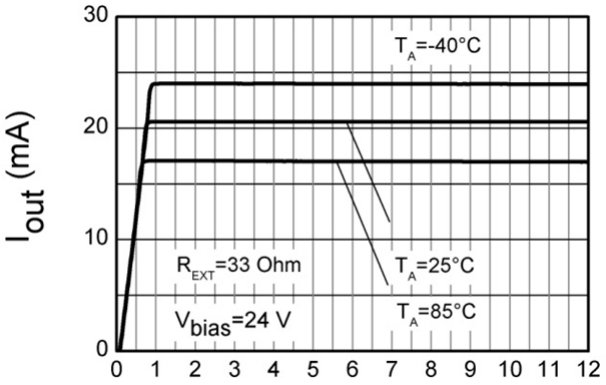


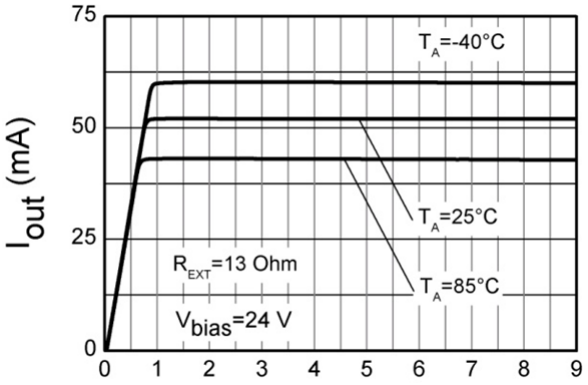
Figure 4 Output Current vs. Rext

© Diodes Incorporated

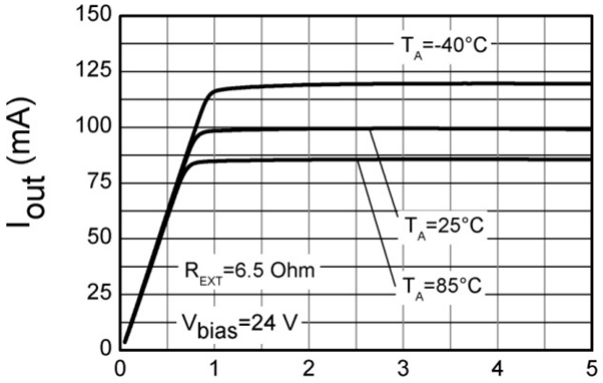
Typical Performance Characteristics (continued)



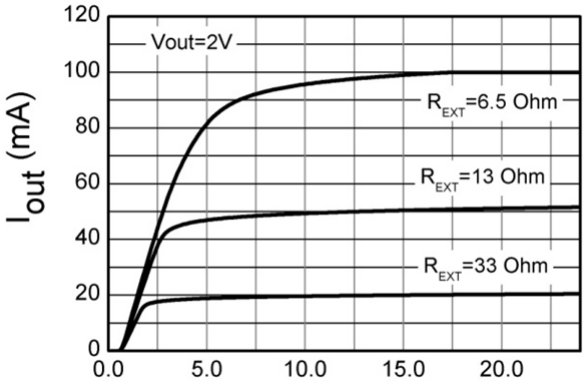
V_{OUT} (V)
Figure 5 Output Current vs. V_{OUT}



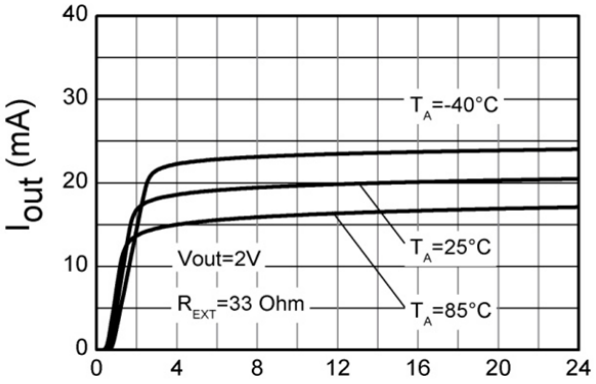
V_{OUT} (V)
Figure 6 Output Current vs. V_{OUT}



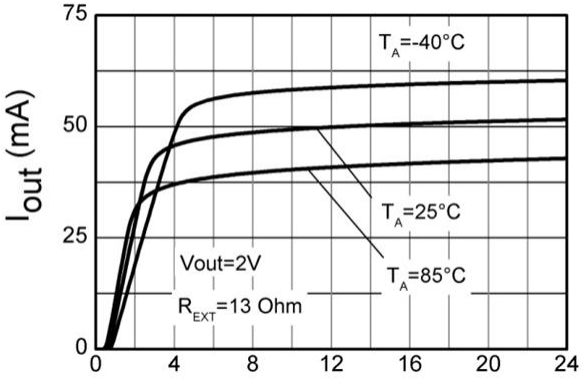
V_{OUT} (V)
Figure 7 Output Current vs. V_{OUT}



V_{BIAS} (V)
Figure 8 Output Current vs. V_{BIAS}



V_{BIAS} (V)
Figure 9 Output Current vs. V_{BIAS}



V_{BIAS} (V)
Figure 10 Output Current vs. V_{BIAS}

© Diodes Incorporated

Typical Performance Characteristics (cont.)

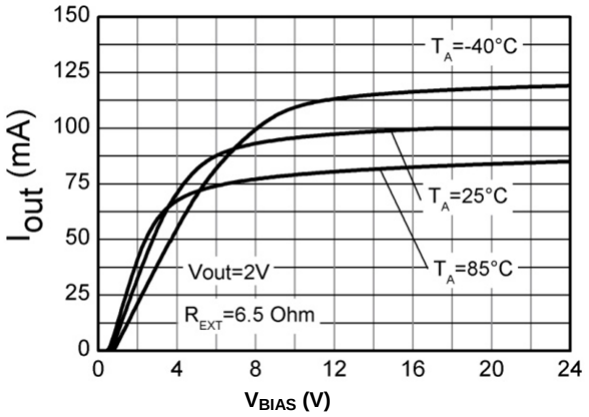


Figure 11 Output Current vs. V_{BIAS}

Application Information

The AL5802LP is designed for driving low current LEDs with typical LED current range of 10mA to 100mA. It provides a cost-effective way for 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 a 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 expressed as follows:

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

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

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

Two or more AL5802LP devices 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 AL5802LP'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 AL5802LP increases, it is necessary to provide appropriate thermal relief to the device. The power dissipation supported by the device is dependent upon the properties of the PCB board material, the copper pad areas and the ambient temperature. The maximum dissipation the device can handle is given as follows:

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

© Diodes Incorporated

Application Information (continued)

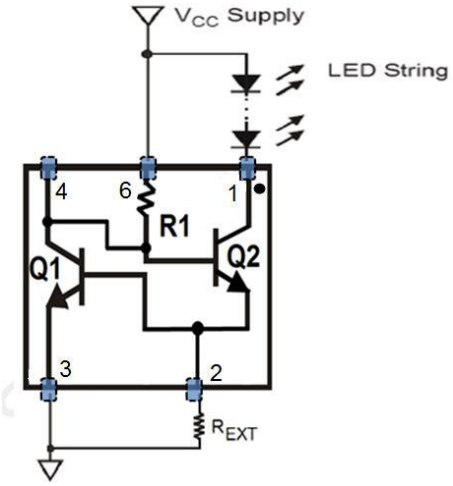


Figure 12 Typical Application Circuit for Linear Mode Current Sink LED Driver

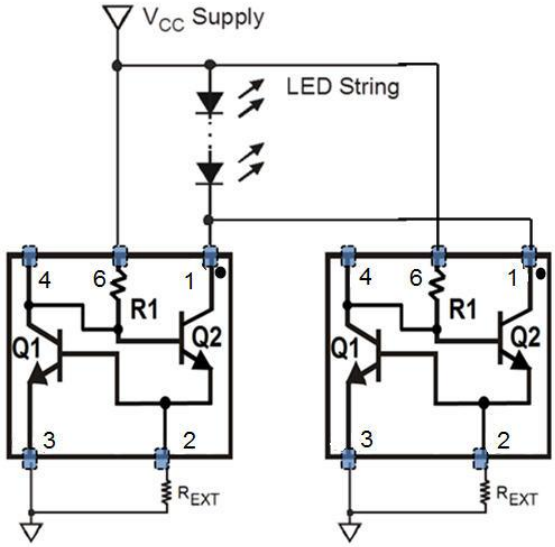


Figure 13 Application Circuit for Increasing LED Current

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 15 is a typical response of LED current vs. PWM duty cycle on the EN pin.

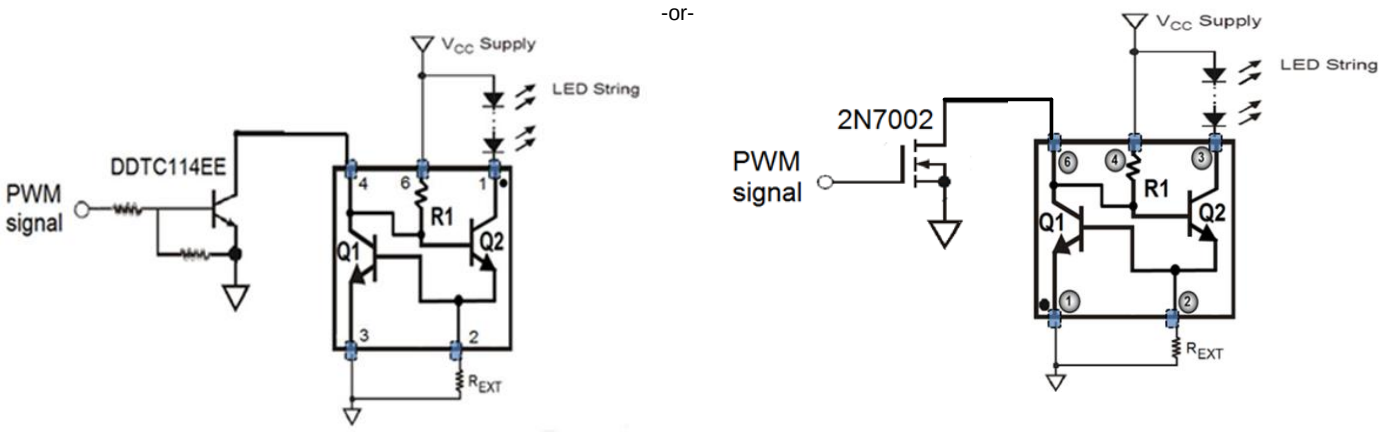


Figure 14 Application Circuits for LED Driver with PWM Dimming Functionality

© Diodes Incorporated

Application Information (cont.)

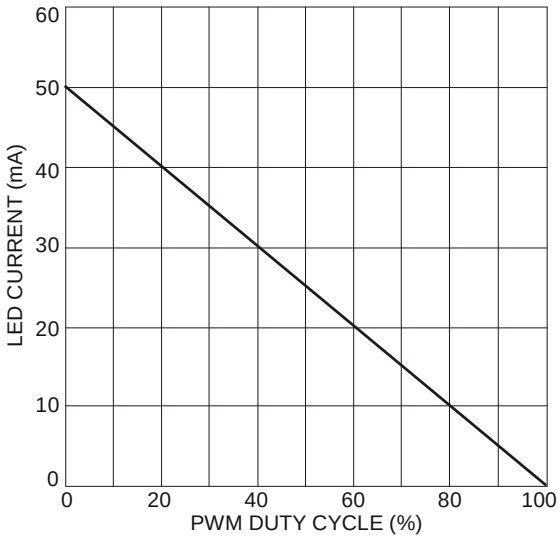


Figure 15 Typical LED Current Response vs. PWM Duty Cycle for R_{EXT} = 13Ω at 400Hz PWM Frequency

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 of the series connected diode increases the available voltage to the LED stack and dissipates less power. A circuit example is presented in Figure 16 using Diodes Inc. 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 also available on Diodes Inc.'s website such as the SBR02U100LP (0.2A/100V) or SBR0220LP (0.2A/20V).

Automotive applications commonly use this method for reverse battery protection.

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 has been 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 available for the LED stack and dissipates less power than standard rectifier bridges.

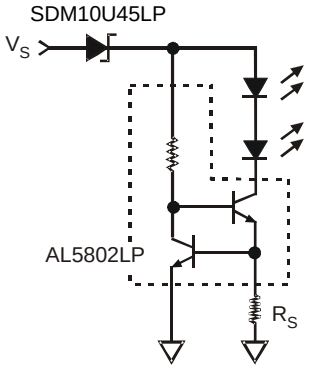


Figure 16 Application Circuit for LED Driver with Reverse Polarity Protection

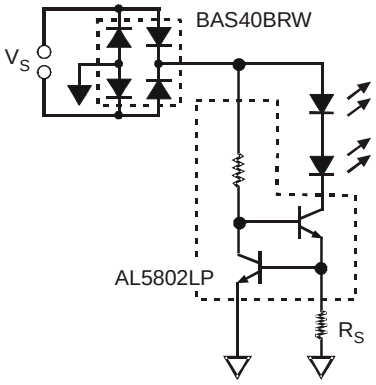


Figure 17 Application Circuit for LED Driver with Assured Operation Regardless of Polarity

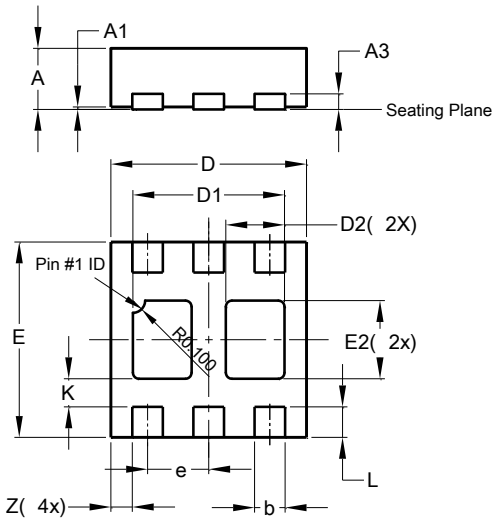
SBR is a registered trademark of Diodes Incorporated

© Diodes Incorporated

Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

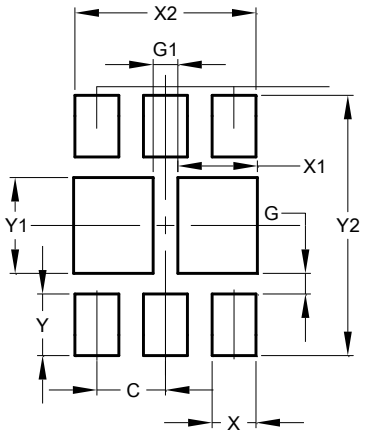
U-DFN1616-6 (Type F)



U-DFN1616-6 (Type F)			
Dim	**Min**	**Max**	**Typ**
A	0.45	0.55	0.50
A1	0	0.05	0.02
A3	—	—	0.127
b	0.20	0.30	0.25
D	1.55	1.65	1.60
D1	1.14	1.34	1.24
D2	0.38	0.58	0.48
E	1.55	1.65	1.60
E2	0.54	0.74	0.64
e	—	—	0.50
K	—	—	0.23
L	0.15	0.35	0.25
Z	—	—	0.175
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.



Dimensions	Value (in mm)
C	0.500
G	0.150
G1	0.180
X	0.320
X1	0.580
X2	1.320
Y	0.450
Y1	0.700
Y	1.900

© Diodes Incorporated

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