

Description

The AL5802 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 REXT pin (6) to GND pin (4). The internal high gain transistor develops approximately 0.6V across the external resistor.

The AL5802'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 (2) with a low impedance voltage source, or driving the EN pin (3) with an external open-collector NPN transistor or open-drain N-channel MOSFET.

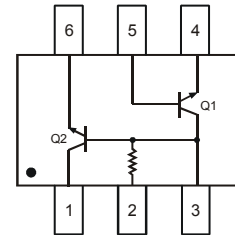
The AL5802 is available in the SOT26 (SC74R) package and is ideal for driving 20mA to 120mA LED currents.

Features

- Reference voltage VRSET = 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 SOT26 with copper lead-frame
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen- and Antimony-Free. "Green" Device (Note 3)**
- **For automotive applications requiring specific change control (i.e.: parts qualified to AEC-Q100/101/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please refer to the related automotive grade (Q-suffix) part. A listing can be found at <https://www.diodes.com/products/automotive/automotive-products/>.**
- **This part is qualified to JEDEC standards (as references in AEC-Q) for High Reliability. <https://www.diodes.com/quality/product-definitions/>**

Pin Assignments

(Top View)



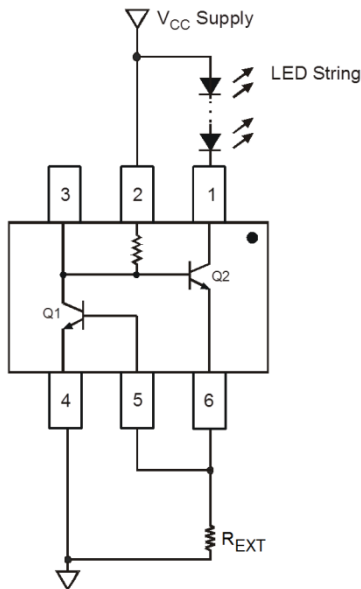
SOT26

Applications

- Linear LED drivers
- LED signs
- Offline LED luminaries

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
 2. See <https://www.diodes.com/quality/lead-free> 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 | OUT | Open-collector LED driver output |
| 2 | BIAS | Biases the open collector output transistor |
| 3 | EN | Enable pin for PWM dimming. Provides access to the base of Q2 and collector of Q1 |
| 4 | GND | Ground reference point for setting LED current |
| 5 | FB | Feedback pin. Should be connected to pin 6. |
| 6 | REXT | Current sense pin. LED current sensing resistor should be connected from here to GND. |

Functional Block Diagram

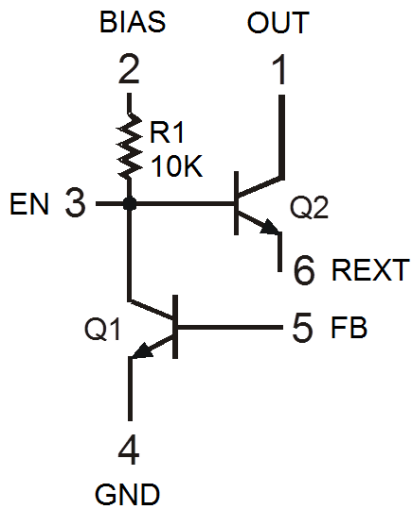


Fig. 1 Block Diagram

Absolute Maximum Ratings

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.

| Symbol | Characteristics | Values | Unit |
|-------------------|---------------------------------------|-------------|------|
| V _{OUT} | Output voltage relative to GND | 30 | V |
| V _{BIAS} | BIAS voltage relative to GND (Note 4) | 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 _J | Operating junction temperature | -40 to +150 | °C |
| T _{ST} | Storage temperature | -55 to +150 | °C |

Note: 4. With pins 5 and 6 connected together.

Package Thermal Data

| Characteristic | Symbol | Value | Unit |
|---|------------------|-------|------|
| Power Dissipation (Note 5) @ T _A = +25°C | P _D | 0.37 | W |
| Power Dissipation (Note 6) @ T _A = +25°C | | 0.87 | |
| Thermal Resistance, Junction to Ambient Air (Note 5) @ T _A = +25°C | R _{θJA} | 335 | °C/W |
| Thermal Resistance, Junction to Ambient Air (Note 6) @ T _A = +25°C | | 143 | |

Notes: 5. Device mounted on FR-4 PCB, 2oz with minimum recommended pad layout.
6. Device mounted on 25mm x 25mm 2oz copper board.

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 |

Note: 7. Subject to ambient temperature, power dissipation and PCB.

Electrical Characteristics – NPN Transistor – Q1 (@ $T_A = +25^\circ\text{C}$, unless otherwise specified.)

| Symbol | Characteristic | Test Condition | Min | Typ | Max | Unit |
|---------------|---|---|-----------------|-------------|---------------|------|
| $V_{(BR)CEO}$ | Collector-Emitter Breakdown Voltage (Note 8) | $I_C = 1.0\text{mA}, I_B = 0$ | 40 | — | — | V |
| $V_{(BR)EBO}$ | Emitter-Base Breakdown Voltage | $I_E = 10\mu\text{A}, I_C = 0$ | 6.0 | — | — | V |
| I_{CEX} | Collector Cutoff Current | $V_{CE} = 30\text{V}, V_{EB(OFF)} = 3.0\text{V}$ | — | — | 50 | nA |
| I_{BL} | Base Cutoff Current | $V_{CE} = 30\text{V}, V_{EB(OFF)} = 3.0\text{V}$ | — | — | 50 | nA |
| h_{FE} | DC Current Gain | $I_C = 100\mu\text{A}, V_{CE} = 1.0\text{V}$ $I_C = 1.0\text{mA}, V_{CE} = 1.0\text{V}$ $I_C = 10\text{mA}, V_{CE} = 1.0\text{V}$ | 40 70 100 | — — — | — — 300 | — |
| $V_{CE(SAT)}$ | Collector-Emitter Saturation Voltage (Note 8) | $I_C = 10\text{mA}, I_B = 1.0\text{mA}$ | — | — | 0.20 | V |
| $V_{BE(SAT)}$ | Base-Emitter Saturation Voltage | $I_C = 10\text{mA}, I_B = 1.0\text{mA}$ | 0.65 | — | 0.85 | V |

Electrical Characteristics – NPN Pre-biased Transistor – Q2 (@ $T_A = +25^\circ\text{C}$, unless otherwise specified.)

| Symbol | Characteristic | Test Condition | Min | Typ | Max | Unit |
|---------------|---|--|-----|-----|-----|---------------|
| $V_{(BR)CBO}$ | Collector-Base Breakdown Voltage | $I_C = 50\mu\text{A}, I_E = 0$ | 30 | — | — | V |
| $V_{(BR)CEO}$ | Collector-Emitter Breakdown Voltage (Note 8) | $I_C = 1\text{mA}, I_B = 0$ | 30 | — | — | V |
| $V_{(BR)EBO}$ | Emitter-Base Breakdown Voltage | $I_E = 50\mu\text{A}, I_C = 0$ | 5.0 | — | — | V |
| I_{CBO} | Collector Cut-Off Current | $V_{CB} = 30\text{V}, I_E = 0$ | — | — | 0.5 | μA |
| I_{EBO} | Emitter Cut-Off Current | $V_{EB} = 4\text{V}, I_C = 0$ | — | — | 0.5 | μA |
| $V_{CE(SAT)}$ | Collector-Emitter Saturation Voltage (Note 8) | $I_C = 10\text{mA}, I_B = 1\text{mA}$ | — | — | 0.3 | V |
| h_{FE} | DC Current Gain (Note 9) | $V_{CE} = 5\text{V}, I_C = 150\text{mA}$ | 100 | — | — | — |
| R_1 | Input Resistance | — | 7 | 10 | 13 | k Ω |

*Characteristics of transistor only.

Note: 8. Short duration pulse test used to minimize self-heating effect.

Thermal Characteristics

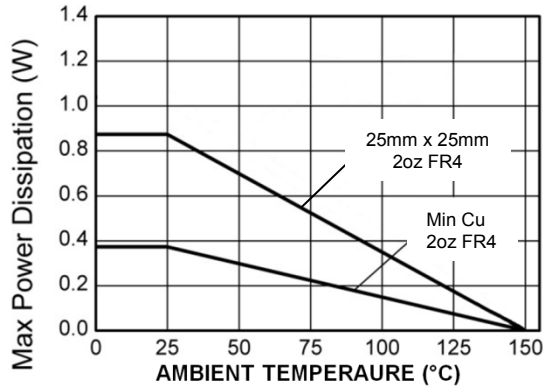


Fig. 2 Derating Curve

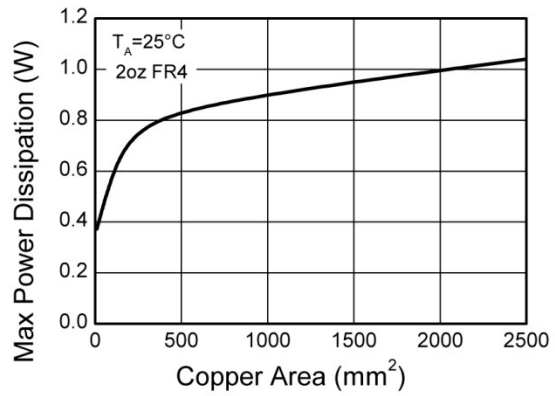


Fig. 3 Max Power vs. Area

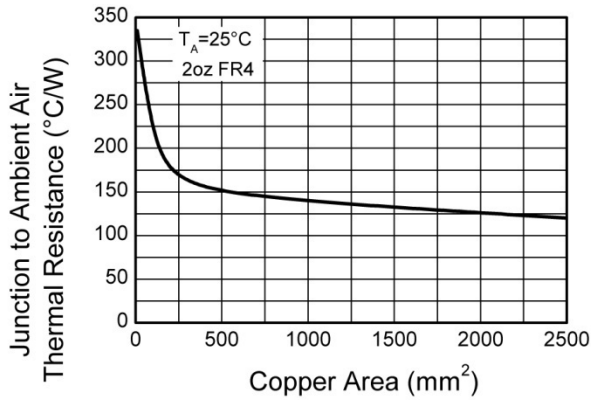


Fig. 4 Thermal Resistance vs. Area

Typical Performance Characteristics

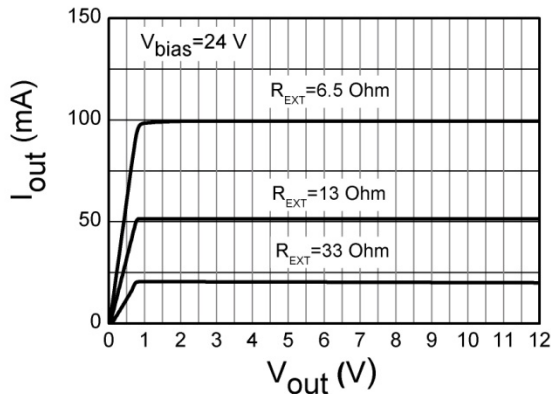


Fig. 5 Output Current vs. V_{OUT}

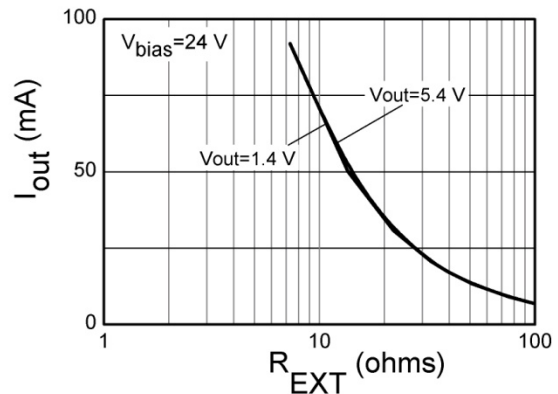


Fig. 6 Output Current vs. R_{EXT}

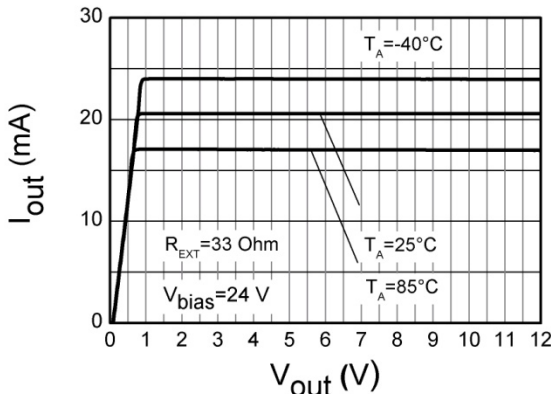


Fig. 7 Output Current vs. V_{OUT}

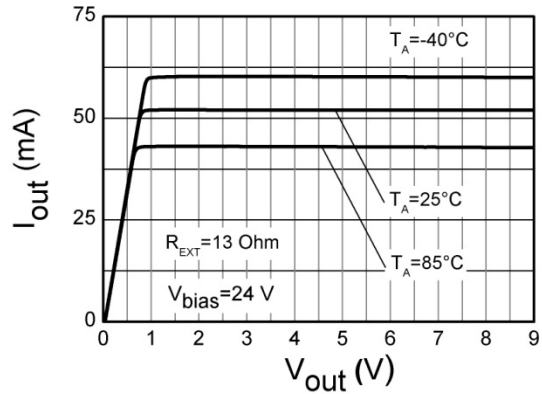


Fig. 8 Output Current vs. V_{OUT}

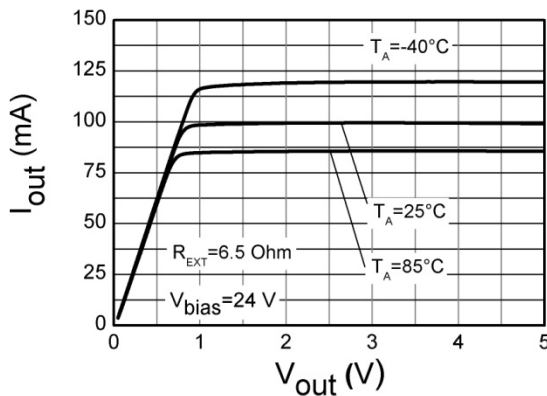


Fig. 9 Output Current vs. V_{OUT}

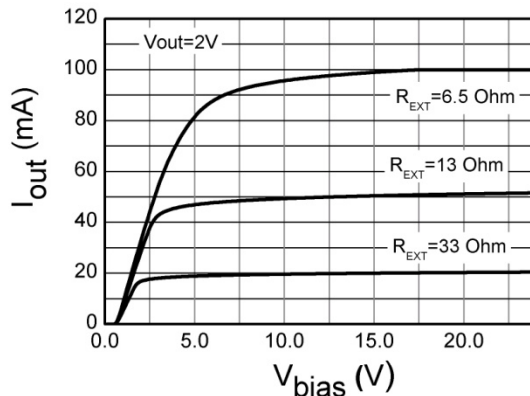


Fig. 10 Output Current vs. V_{BIAS}

Note: 10. V_{OUT} in the "Output Current vs. V_{OUT} " graphs limited by power dissipation in the device.

Typical Performance Characteristics (continued)

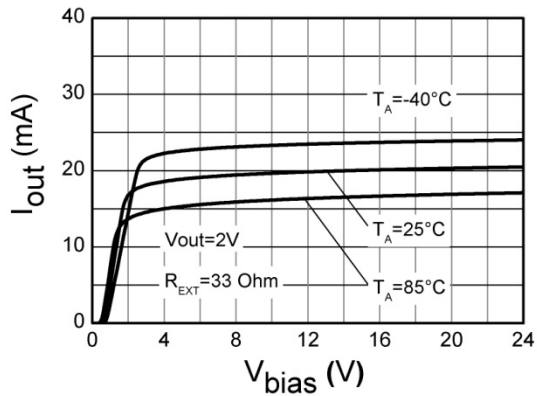


Fig. 11 Output Current vs. V_{BIAS}

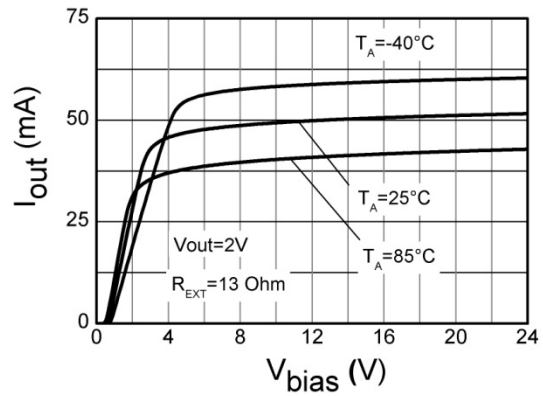


Fig. 12 Output Current vs. V_{BIAS}

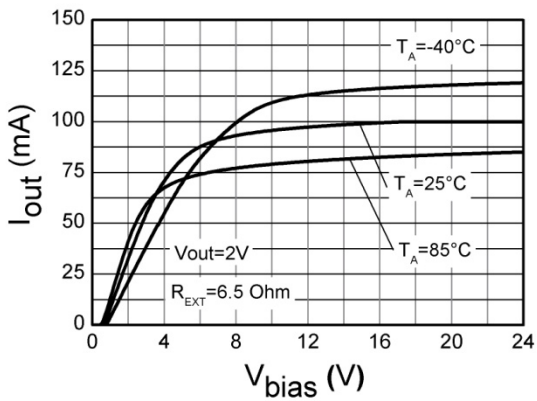


Fig. 13 Output Current vs. V_{BIAS}

Application Information

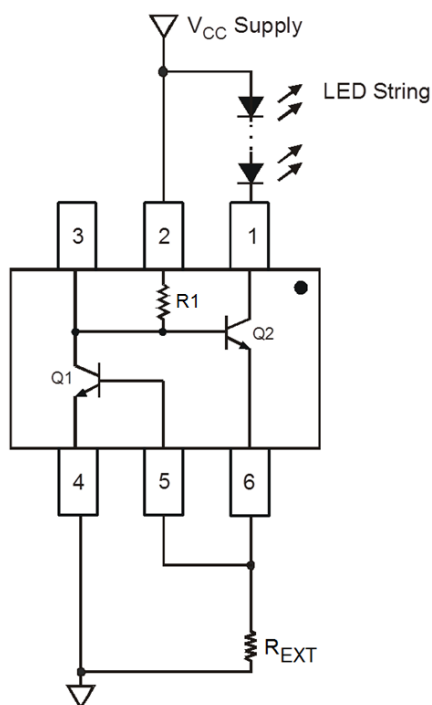


Fig. 14 Typical Application Circuit for Linear Mode Current Sink LED Driver

The AL5802 is designed for driving low current LEDs with a typical LED current of 20mA to 100mA. It provides a cost effective way for driving low current LEDs compared to 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 14 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 the external resistor R_{EXT} . Q1 uses its V_{BE} as a reference to set the voltage across the R_{EXT} and to control 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, necessary LED currents by the external resistor R_{EXT} can be calculated from,

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

Two or more AL5802 devices can be connected in parallel to construct higher current LED strings, as shown in Figure 15.

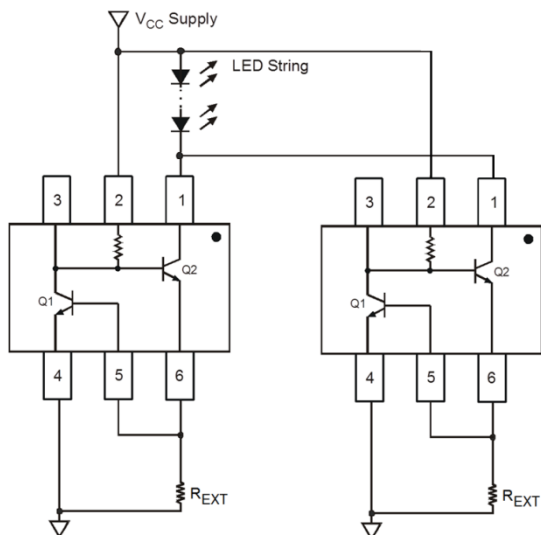


Fig. 15 Application Circuit for Increasing LED Current

Consideration of the expected linear-mode power dissipation must be factored into the design with respect to the AL5802's thermal resistance. The maximum voltage across the device can be calculated by using the maximum supply voltage and 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 AL5802 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,

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

Refer to the thermal characteristic graphs on page 5 for selecting the appropriate PCB copper area.

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 16. 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 17 is a typical response of LED current vs. PWM duty cycle on the EN pin.

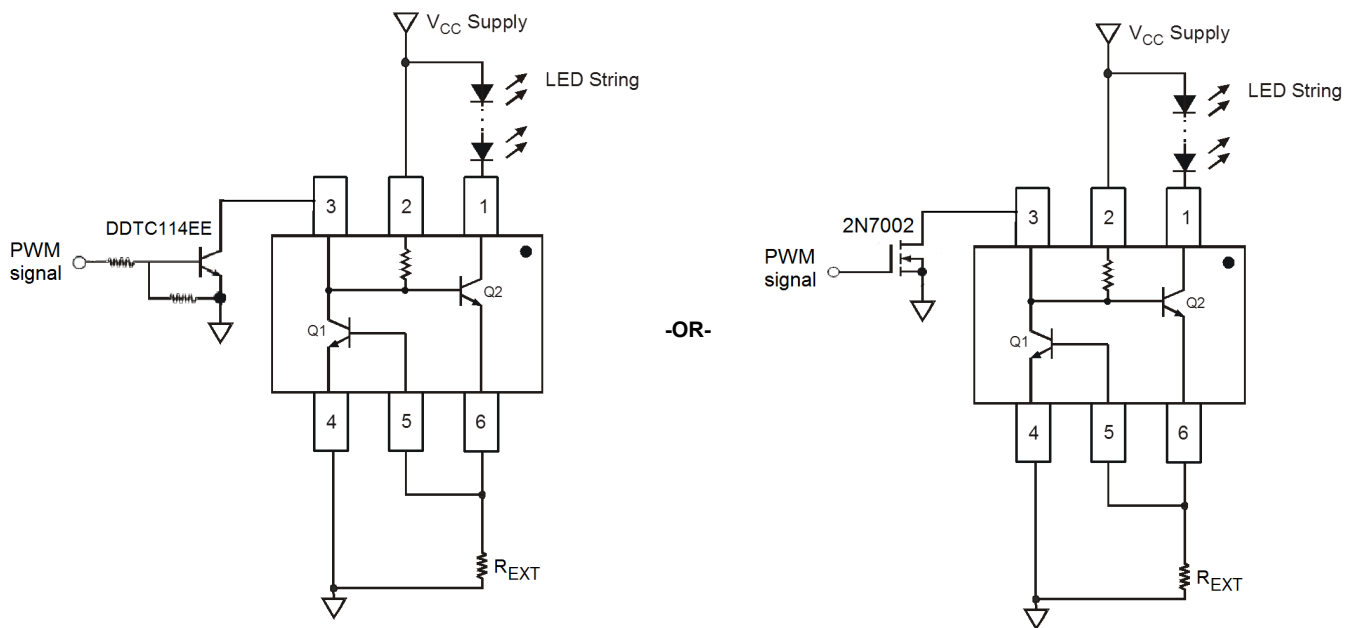


Fig. 16 Application Circuits for LED Driver with PWM Dimming Functionality

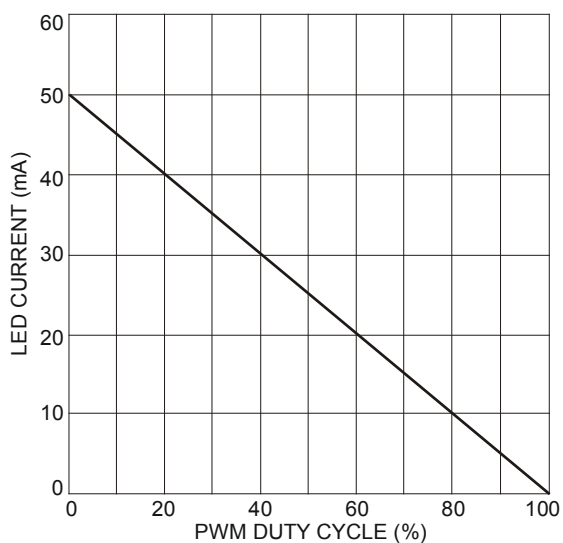


Fig. 17 Typical LED current response vs. PWM duty cycle for $R_{EXT} = 13\Omega$ at 400Hz PWM frequency

Application Information (continued)

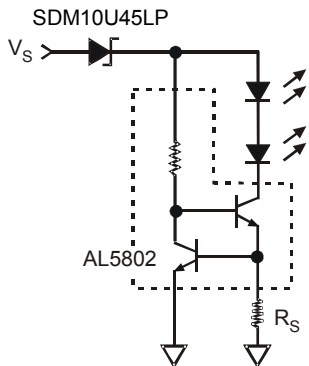


Fig. 18 Application circuit for LED driver with reverse polarity protection

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 Fig. 18 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 0402 chip style package. Other reverse voltage ratings are also 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.

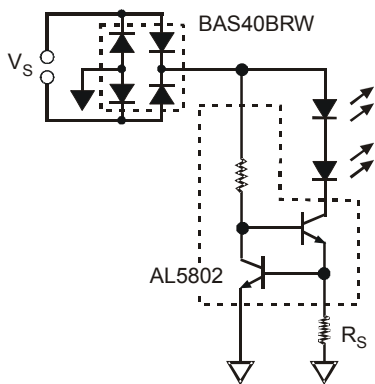


Fig. 19 Application circuit for LED driver with assured operation regardless of polarity

A second approach, shown in Fig. 19, improves upon the method shown in Fig. 18. Whereas the method in Fig. 18 protects the light engine, it will not function until the problem has been diagnosed and corrected.

The method shown in Fig. 19 not only provides reverse polarity protection, it also corrects the reversed polarity, allowing the light engine to function.

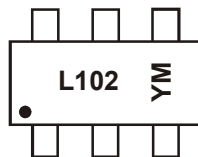
The BAS40BRW incorporates four low V_F , Schottky diodes into a single package, allowing more voltage available for the LED stack and dissipating less power than that of standard rectifier bridges.

Ordering Information (Note 11)

| Device | Qualification | Packaging | Tape and Reel | |
|--------|---------------|---------------|--------------------|--------------------|
| | | | Quantity | Part Number Suffix |
| AL5802 | Commercial | SOT26 (SC74R) | 3,000/Tape & Reel | -7 |
| AL5802 | Commercial | SOT26 (SC74R) | 10,000/Tape & Reel | -13 |

Note: 11. For packaging details, go to our website at <https://www.diodes.com/design/support/packaging/diodes-packaging/>.

Marking Information



L102 = Product Type Marking Code
 YM = Date Code Marking
 Y = Year (ex: B = 2014)
 M = Month (ex: 9 = September)

Date Code Key

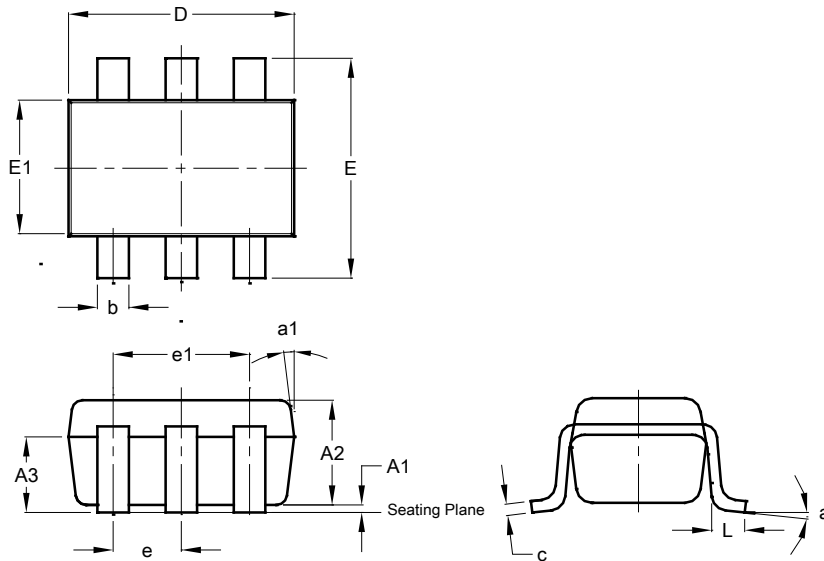
| Year | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|------|------|------|------|------|------|------|------|------|------|
| Code | Y | Z | A | B | C | D | E | F | G |

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Code | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | O | N | D |

Package Outline Dimensions

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

SOT26 (SC74R)

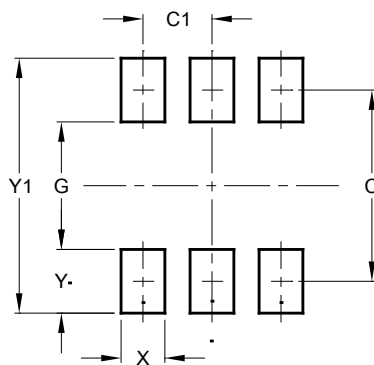


| SOT26 (SC74R) | | | |
|----------------------|-------|------|------|
| Dim | Min | Max | Typ |
| A1 | 0.013 | 0.10 | 0.05 |
| A2 | 1.00 | 1.30 | 1.10 |
| A3 | 0.70 | 0.80 | 0.75 |
| b | 0.35 | 0.50 | 0.38 |
| c | 0.10 | 0.20 | 0.15 |
| D | 2.90 | 3.10 | 3.00 |
| e | - | - | 0.95 |
| e1 | - | - | 1.90 |
| E | 2.70 | 3.00 | 2.80 |
| E1 | 1.50 | 1.70 | 1.60 |
| L | 0.35 | 0.55 | 0.40 |
| a | - | - | 8° |
| a1 | - | - | 7° |
| All Dimensions in mm | | | |

Suggested Pad Layout

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

SOT26 (SC74R)



| Dimensions | Value (in mm) |
|------------|---------------|
| C | 2.40 |
| C1 | 0.95 |
| G | 1.60 |
| X | 0.55 |
| Y | 0.80 |
| Y1 | 3.20 |

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