

## Description

The AL5809 is a constant current linear LED driver and provides a cost-effective two pin solution. It has an excellent temperature stability of 20 ppm/°C and current accuracy  $\pm 5\%$  regulated over a wide voltage and temperature range. The AL5809 comes in various fixed output current versions removing the need for external current setting resistors creating a simple solution for the linear driving of LEDs. It supports both the high-side and low-side driving of LED chains.

The AL5809 turns on immediately and can swing from 2.5V up to 60V enabling drive long LED chains. The floating ground, 60V voltage rating between input and output pins designed to withstand the high peak voltage incurred in offline applications.

The AL5809 is available in thermally robust package POWERDI-123 or SOD-123 package.

## Features

- Robust power package up to 1.2W for POWERDI-123
- -40°C to +125°C temperature range
- $\pm 5\%$  LED current tolerance over temperature
- (15mA, 20mA, 30mA, 40mA, 50mA, 60mA, 90mA, 120mA, and 150mA) available in POWERDI-123 package
- (15mA, 20mA, 30mA, 40mA and 50mA) available in SOD-123 package, and other current options available by request
- Constant current with low temperature drift and high power supply rejection ratio
- 2.5V to 60V operating voltage between two terminals.
- Available in PowerDi-123 and SOD-123 in **"Green" Molding Compound (No Br, Sb) (Note 1) with Lead-Free Finish/RoHS Compliant (Notes 2 & 3)**

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

## Pin Assignments



## Applications

- Offline LED Lamps
- LED Power Supplies
- White Goods
- LED Signs
- Instrumentation Illumination

## Typical Applications Circuit



**Pin Descriptions**

| Pin Name | Pin Number (PowerDi-123) | Function   |
|----------|--------------------------|--|
| In       | 1                        | LED current input terminal.<br>For low side LED string application, connect the LED cathode terminal to the "In" terminal. For high side LED string application, connect the LED anode terminal to the "Out" terminal.   |
| Out      | 2                        | LED Current Output terminal.<br>For low side LED string application, connect the LED anode terminal to the "Out" terminal. For high side LED string application, connect the LED cathode terminal to the "Out" terminal. |

**Functional Block Diagram**



**Absolute Maximum Ratings**

| Symbol      | Parameters                         | Ratings     | Unit |
|-------------|------------------------------------|-------------|------|
| $V_{InOut}$ | "In" Voltage Relative to "Out" Pin | 80          | V    |
| $I_{InOut}$ | LED Current from "In" to "Out"     | 180         | mA   |
| ESD HBM     | Human Body Model ESD Protection    | 4           | kV   |
| ESD MM      | Machine Model ESD Protection       | 400         | V    |
| $T_J$       | Operating Junction Temperature     | -40 to +175 | °C   |
| $T_{ST}$    | Storage Temperature                | -55 to +150 | °C   |

Caution: Stresses greater than the 'Absolute Maximum Ratings' specified above, may cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions exceeding those indicated in this specification is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions for extended periods of time.

Semiconductor devices are ESD sensitive and may be damaged by exposure to ESD events. Suitable ESD precautions should be taken when handling and transporting these devices.

## Package Thermal Data

| Package     | $\theta_{JC}$<br>Thermal Resistance<br>Junction-to-Case | $\theta_{JA}$<br>Thermal Resistance<br>Junction-to-Ambient | $P_{DIS}$<br>$T_A = +25^\circ\text{C}, T_J = +125^\circ\text{C}$ |
|-------------|---|--|--|
| PowerDi-123 | 27.15°C/W   | 148.61°C/W (Note 4)  | 0.68W  |
| PowerDi-123 | 17.81°C/W   | 81.39°C/W (Note 5)   | 1.24W  |
| SOD-123     | 69.56°C/W   | 278.42°C/W (Note 6)  | 0.36W  |

Notes:

4. Test condition for PowerDi-123: Device mounted on 25.4mm x 25.4mm FR-4 PCB (10mm x 10mm 1oz copper, minimum recommended pad layout on top layer and thermal vias to bottom layer ground plane). For better thermal performance, larger copper pad for heatsink is needed.
5. When mounted on 50.8mm x 50.8mm GETEK PCB with 25.4mm x 25.4mm copper pads.
6. Test condition for SOD-123: Device mounted on FR-4 PCB with 50.8mm x 50.8mm 2oz copper, minimum recommended pad layout on top layer and thermal vias to bottom layer with maximum area ground plane. For better thermal performance, larger copper pad for heatsink is needed.

## Recommended Operating Conditions

| Symbol      | Parameter                                    | Min | Max  | Unit |
|-------------|--|-----|------|------|
| $V_{InOut}$ | "In" Voltage Range Relative to "Out" Pin     | 2.5 | 60   | V    |
| $I_{InOut}$ | LED Current (Note 7)                         | 15  | 150  | mA   |
| $T_A$       | Operating Ambient Temperature Range (Note 8) | -40 | +125 | °C   |

Notes:

7. The LED operating current is determined by the AL5809 current option index XXX, AL5809-XXXS/P1-7.
8. The Maximum LED current is also limited by ambient temperature and power dissipation such that junction temperature should be kept less than or equal to +125°C.

## Electrical Characteristics ( $V_{InOut} = 3.5\text{V}$ ) (Note 9)

| Symbol      | Parameter  | Conditions  | Min   | Typ   | Max | Unit  |    |
|-------------|--|---|---|-------|-----|-------|----|
| $V_{InOut}$ | In-Out Supply Voltage                              | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$   | 2.5   | —     | 60  | V     |    |
| $I_{InOut}$ | LED Current Accuracy<br>(±5% for over temperature) | AL5809-15S1-7<br>AL5809-15P1-7                      | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 14.25 | 15  | 15.75 | mA |
|             |  | AL5809-20S1-7<br>AL5809-20P1-7                      | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 19    | 20  | 21    |    |
|             |  | AL5809-30S1-7<br>AL5809-30P1-7                      | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 28.5  | 30  | 31.5  |    |
|             |  | AL5809-40S1-7<br>AL5809-40P1-7                      | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 38    | 40  | 42    |    |
|             |  | AL5809-50S1-7<br>AL5809-50P1-7                      | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 47.5  | 50  | 52.5  |    |
|             |  | AL5809-60P1-7                                       | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 57    | 60  | 63    |    |
|             |  | AL5809-90P1-7                                       | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 85.5  | 90  | 94.5  |    |
|             |  | AL5809P-1201-7                                      | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 114   | 120 | 126   |    |
|             |  | AL5809-150P1-7                                      | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 142.5 | 150 | 157.5 |    |
| $I_{LINE}$  | $I_{InOut}$ Current Line Regulation                | $V_{InOut} = 2.5\text{V}$ to $60\text{V}$ (Note 10) | $T_A = +25^\circ\text{C}$                         | —     | 1   | %/V   |    |
| $V_{MIN}$   | Minimum Power Up Voltage                           | Increase $V_{InOut}$ (Note 11)                      | $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ | 1     | 1.5 | 2     | V  |
| $T_{SHDN}$  | Thermal Shutdown                                   | —   | —   | —     | 145 | —     | °C |
| $T_{HYS}$   | Thermal Shutdown Hysteresis                        | —   | —   | —     | 30  | —     | °C |

Notes:

9. All voltages unless otherwise stated are measured with respect to OUT pin.
10. Measure the percentage degree of LED current variation when  $V_{InOut}$  varies from 2.5V to 60V for each current option.
11. Apply the power linearly to the chip until the device starts to turn on.

**Application Information**

**Description**

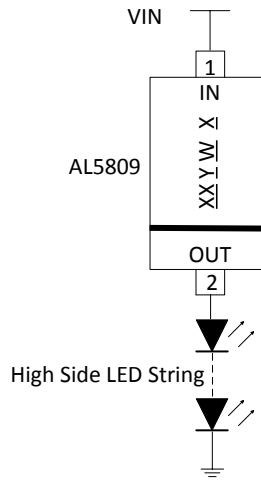
The AL5809 is a constant current linear LED driver and can be placed in series with LEDs as a High Side or a Low Side constant current regulator. The AL5809 offers various current settings from 15mA up to 150mA and different current settings available upon request (contact: Diodes local sale office at <http://www.diodes.com>).

**Simple LED String**

The AL5809 can be placed in series with LEDs as a Low Side/High Side constant current regulator. The number of LEDs can vary from one to as many as supported by the input supply voltage. The designer needs to calculate the maximum voltage between In and Out by taking the maximum input voltage less the voltage across the LED string (Figures 1 and 2).



**Figure 1 Low Side LED String Tapping**



**Figure 2 High Side LED String Tapping**

The AL5809 can also be used on the high side of the LEDs, see Figure 2. The minimum system input voltage can be calculated by:

$$V_{IN(min)} = V_{LED\_CHAIN} + 2.5V \quad \text{Where } V_{LED\_CHAIN} \text{ is the LED chain voltage.}$$

The LED current can be increased by connecting two or more AL5809 in parallel shown in Figure 3.



**(a) Low Side Configuration**

**(b) High Side Configuration**

**Figure 3 Higher LED current by parallel configuration of AL5809**

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**PWM Dimming**

The AL5809 can be used to provide LED current dimming driving the Out pin via the MOSFET switch to ground (Figure 4). The Out pin current is then effectively switched on and off causing the LED current to turn on and off.



(a) PWM Dimming by External MOSFET

(b) PWM Dimming by Power Supply VIN ON/OFF

Figure 4 PWM Dimming

**Typical Performance Characteristics (15mA, 20mA, 30mA, 40mA, 50mA) PDI options**



Figure 5 LED Current vs. VInOut



Figure 6 Startup Minimum Operating Voltage



Figure 7 LED Current vs. Ambient Temperature



Figure 8 LED Current Accuracy (%) vs. VInOut across Temperature



Figure 9 THSD of 20mA Current Option



Figure 10 THSD of 40mA Current Option

**Typical Performance Characteristics (60mA, 90mA, 150mA) PDI options**

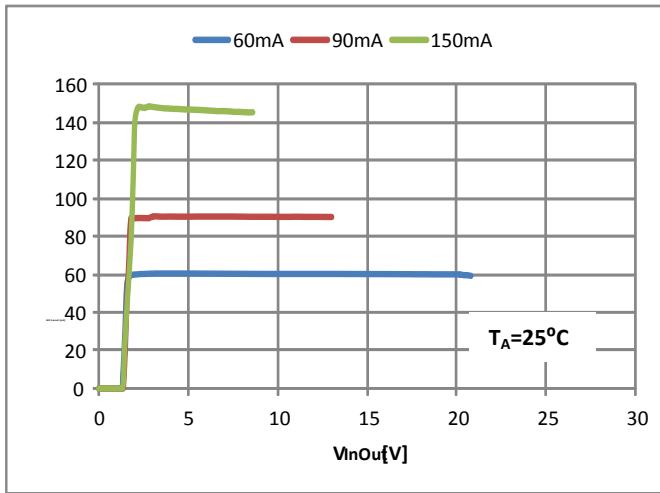


Figure 11 LED Current vs. VinOut

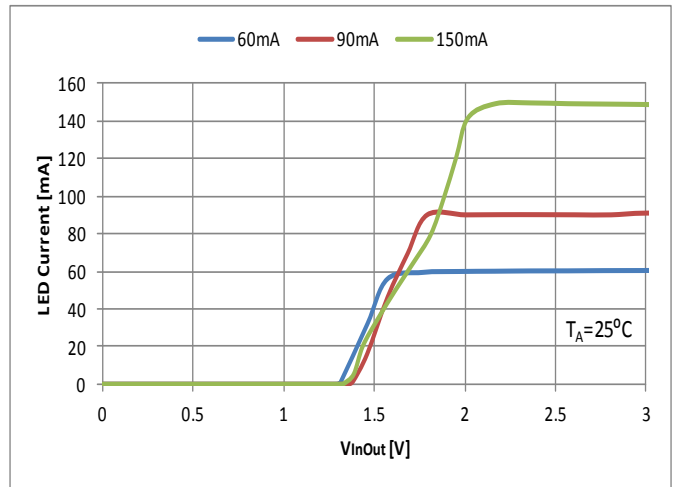


Figure 12 Startup Minimum Operating Voltage

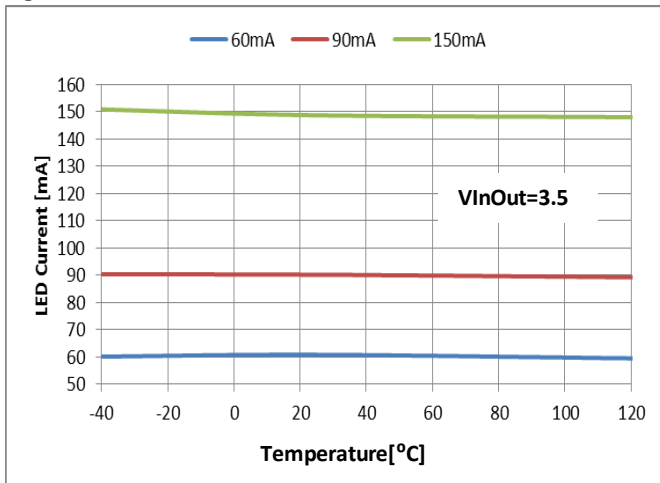


Figure 13 LED Current across Temperature

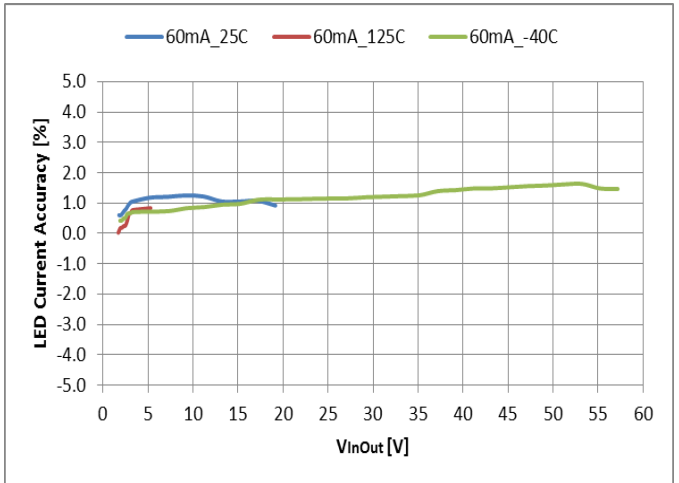


Figure 14 LED Current Accuracy (%) vs. VinOut across Temperature

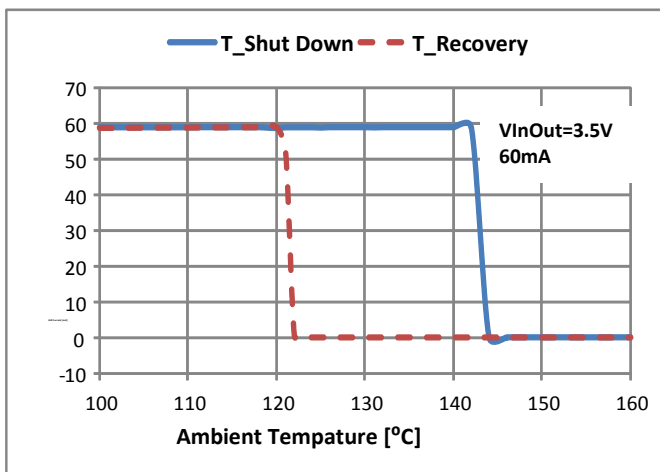


Figure 15 THSD of 60mA Current Option

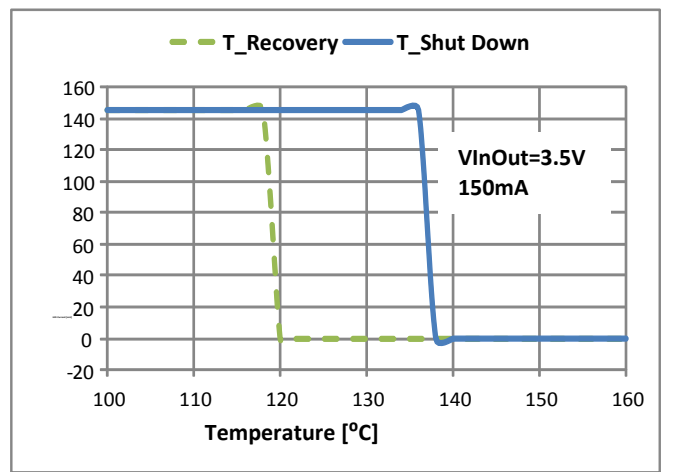


Figure 16 THSD of 150mA Current Option

**Typical Performance Characteristics**



Figure 17 Power Dissipation vs. Ambient Temperature @  $T_J = 145^\circ\text{C}$



Figure 18 Maximum  $V_{InOut}$  vs. Temperature



Figure 19 Maximum  $V_{InOut}$  vs. Temperature



Figure 20 PWM Dimming 90mA vs. Duty Cycle



Figure 21 PWM Dimming 150mA vs. Duty Cycle

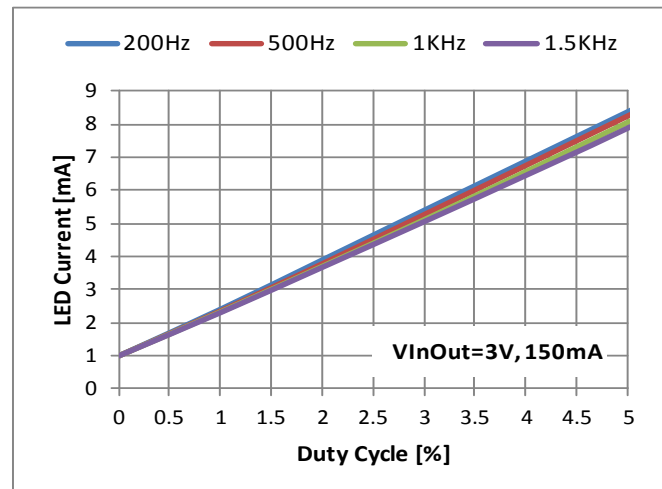


Figure 22 Area Zoom In within Duty Cycle 5% of Figure 21



Ordering Information

AL5809 - XXX XX - 7



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| Part Number    | LED Current Opion | Package Code | Packaging (Notes 12 & 13) | 7" Tape and Reel  |                    |
|----------------|-------------------|--------------|---------------------------|-------------------|--------------------|
|                |                   |              |                           | Quantity          | Part Number Suffix |
| AL5809-15P1-7  | 15mA              | P1           | PDI123                    | 3000/ Tape & Reel | -7                 |
| AL5809-20P1-7  | 20mA              | P1           | PDI123                    | 3000/ Tape & Reel | -7                 |
| AL5809-30P1-7  | 30mA              | P1           | PDI123                    | 3000/ Tape & Reel | -7                 |
| AL5809-40P1-7  | 40mA              | P1           | PDI123                    | 3000/ Tape & Reel | -7                 |
| AL5809-50P1-7  | 50mA              | P1           | PDI123                    | 3000/ Tape & Reel | -7                 |
| AL5809-60P1-7  | 60mA              | P1           | PDI123                    | 3000/ Tape & Reel | -7                 |
| AL5809-90P1-7  | 90mA              | P1           | PDI123                    | 3000/ Tape & Reel | -7                 |
| AL5809-120P1-7 | 120mA             | P1           | PDI123                    | 3000/ Tape & Reel | -7                 |
| AL5809-150P1-7 | 150mA             | P1           | PDI123                    | 3000/ Tape & Reel | -7                 |
| AL5809-15S1-7  | 15mA              | S1           | SOD-123                   | 3000/ Tape & Reel | -7                 |
| AL5809-20S1-7  | 20mA              | S1           | SOD-123                   | 3000/ Tape & Reel | -7                 |
| AL5809-30S1-7  | 30mA              | S1           | SOD-123                   | 3000/ Tape & Reel | -7                 |
| AL5809-40S1-7  | 40mA              | S1           | SOD-123                   | 3000/ Tape & Reel | -7                 |
| AL5809-50S1-7  | 50mA              | S1           | SOD-123                   | 3000/ Tape & Reel | -7                 |

Notes: 12. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at [http://www.diodes.com/products/lead\\_free.html](http://www.diodes.com/products/lead_free.html).  
 13. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

**Marking Information**



| Part Number    | Package | Identification Code |
|----------------|---------|---------------------|
| AL5809-15P1-7  | PDI123  | C1                  |
| AL5809-20P1-7  | PDI123  | C2                  |
| AL5809-30P1-7  | PDI123  | C3                  |
| AL5809-40P1-7  | PDI123  | C4                  |
| AL5809-50P1-7  | PDI123  | C5                  |
| AL5809-60P1-7  | PDI123  | C6                  |
| AL5809-90P1-7  | PDI123  | C7                  |
| AL5809-120P1-7 | PDI123  | C8                  |
| AL5809-150P1-7 | PDI123  | C9                  |
| AL5809-15S1-7  | SOD-123 | D1                  |
| AL5809-20S1-7  | SOD-123 | D2                  |
| AL5809-30S1-7  | SOD-123 | D3                  |
| AL5809-40S1-7  | SOD-123 | D4                  |
| AL5809-50S1-7  | SOD-123 | D5                  |

**Package Outline Dimensions** (All dimensions in mm.)

Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for the latest version.

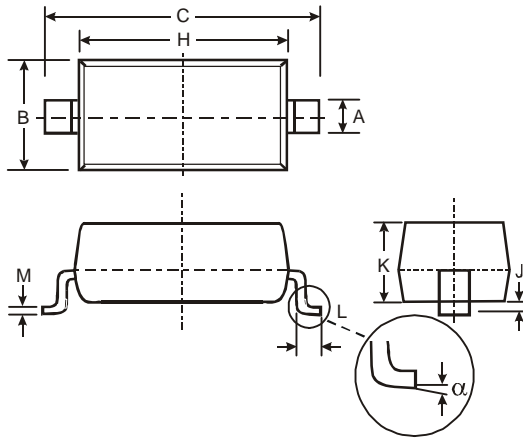
**(1) PowerDI-123 type B**



| POWERDI <sup>®</sup> 123B |      |      |      |
|---------------------------|------|------|------|
| Dim                       | Min  | Max  | Typ  |
| A                         | 3.50 | 3.90 | 3.70 |
| B                         | 2.60 | 3.00 | 2.80 |
| C                         | 1.63 | 1.93 | 1.78 |
| D                         | 0.93 | 1.00 | 0.98 |
| E                         | 0.85 | 1.25 | 1.00 |
| H                         | 0.15 | 0.25 | 0.20 |
| L                         | 0.50 | 0.80 | 0.65 |
| All Dimensions in mm      |      |      |      |

**Package Outline Dimensions** (All dimensions in mm.) (cont.)

(2) SOD-123



| SOD123               |          |      |
|----------------------|----------|------|
| Dim                  | Min      | Max  |
| A                    | 0.55 Typ |      |
| B                    | 1.40     | 1.70 |
| C                    | 3.55     | 3.85 |
| H                    | 2.55     | 2.85 |
| J                    | 0.00     | 0.10 |
| K                    | 1.00     | 1.35 |
| L                    | 0.25     | 0.40 |
| M                    | 0.10     | 0.15 |
| α                    | 0        | 8°   |
| All Dimensions in mm |          |      |

**Suggested Pad Layout**

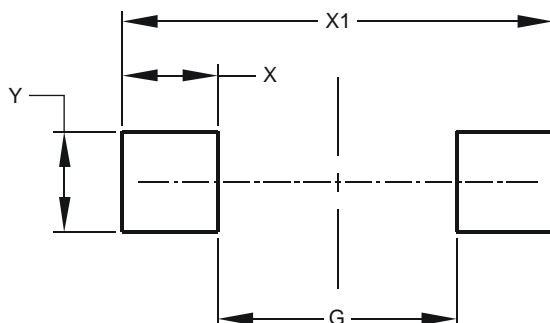
Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.

(1) PowerDI-123 (Use PowerDI-123 B type Pad Layout)



| Dimensions | Value (in mm) |
|------------|---------------|
| G          | 2.000         |
| X          | 4.100         |
| X1         | 1.050         |
| Y1         | 1.500         |

(2) SOD-123



| Dimensions | Value (in mm) |
|------------|---------------|
| G          | 2.250         |
| X          | 0.900         |
| X1         | 4.050         |
| Y          | 0.950         |

**Taping Orientation**

The taping orientation of the other package type can be found on our website at <http://www.diodes.com/datasheets/ap02007.pdf>.

(1) PowerDI-123 Type B



(2) SOD-123



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