

## Description

The AL5812 is an adjustable Linear LED driver offering excellent temperature stability and output handling capability. The AL5812 simplifies the design of linear and isolated or non-isolated LED drivers by setting the LED current with standard value resistors.

The AL5812 has an open drain output that can swing from 1V up to 60V enabling it drive long LED chains. Its low 0.5V  $R_{SET}$  pin is outside of the LED current path and so accuracy is maintained while minimizing the required overheads to regulate the LED current. This reduces its power dissipation when compared to traditional linear LED drivers. This makes it ideal for driving LEDs up to 150mA (commonly referred to as  $\frac{1}{2}W$  LEDs).

Longer LED chains can be driven by tapping  $V_{CC}$  from the chain, where the chain voltage may exceed 60V.

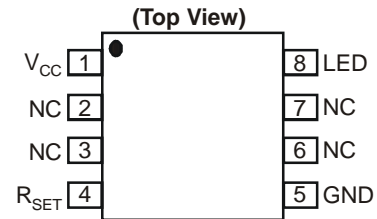
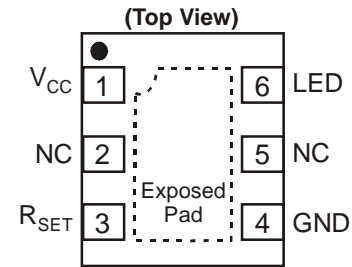
The AL5812 is available in the exposed pad MSOP-8EP and U-DFN3030-6 packages.

## Features

- Low Reference Voltage ( $V_{RSET} = 0.5V$ )
- $-40^{\circ}C$  to  $+125^{\circ}C$  Temperature Range
- $\pm 3\%$  LED Current Tolerance
- Low Temperature Drift
- 1V to 60V Open-Drain Output
- High Power Supply Rejection
- MSOP-8EP and U-DFN3030-6
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

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> 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.

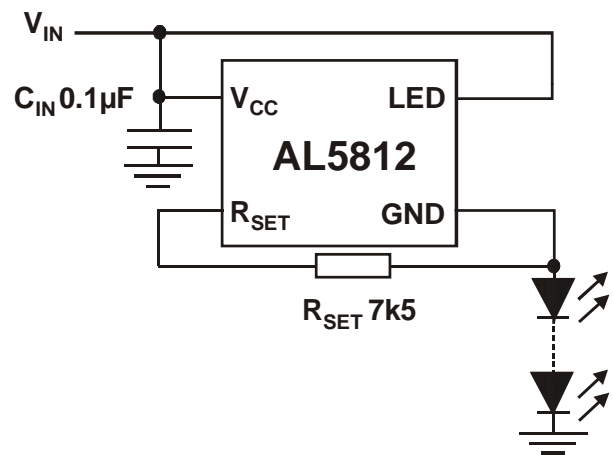
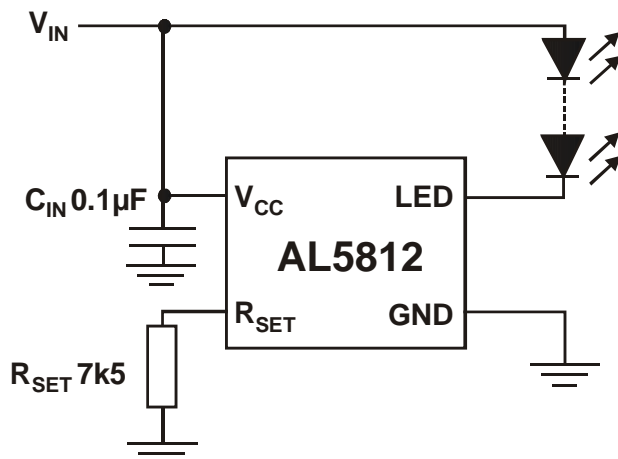
## Pin Assignments


**MSOP-8EP**

**U-DFN3030-6**

## Applications

- Isolated Offline LED Converters
- Linear LED Driver
- LED Signs
- Instrumentation Illumination

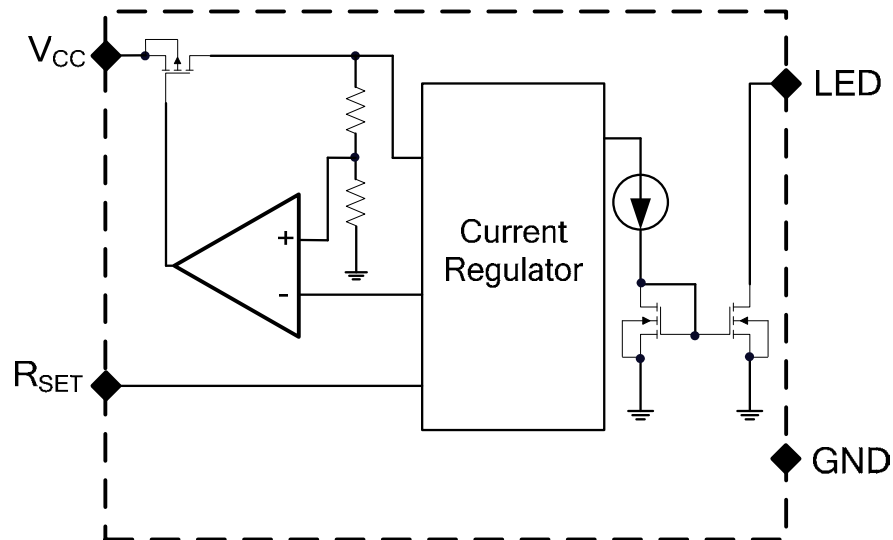
## Typical Applications Circuit



## Pin Descriptions

Pin Name	Pin Number (MSOP8-EP)	Pin Number (U-DFN3030-6)	Function
V <sub>CC</sub>	1	1	Power Supply Input. Connect a 0.1µF ceramic capacitor between V <sub>CC</sub> and GND as close as possible to the device.
R <sub>SET</sub>	4	3	LED Current Setting Pin. Connect a resistor from this pin to GND: $I_{LED} = 750/R_{SET}$ May also be used to provide PWM dimming functionality.
GND	5	4	Ground Reference Point of Device.
LED	8	6	LED Current Sink Output.
NC	2, 3, 6, 7	2, 5	No Connection.
EP	EP	EP	Exposed Pad (bottom). Used to improve thermal impedance of package. It must be connected to GND directly underneath the package but not used as sole GND potential terminal.

## Functional Block Diagram



**Absolute Maximum Ratings** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

Symbol	Parameters	Ratings	Unit
V <sub>CC</sub>	Supply Voltage Relative to GND Pin (Note 4)	-0.3 to +66	V
V <sub>LED</sub>	LED Pin Voltage Relative to GND Pin (Note 4)	-0.3 to +66	V
V <sub>RSET</sub>	R <sub>SET</sub> Pin Voltage Relative to GND	-0.3 to +6	V
I <sub>LED</sub>	LED Pin Current Sink Current Range	165	mA
ESD HBM	Human Body Model ESD Protection	1	kV
ESD CDM	Charged Device Model ESD Protection	1.2	kV
T <sub>J</sub>	Operating Junction Temperature	-40 to +150	°C
T <sub>ST</sub>	Storage Temperature	-55 to +150	°C

Note: 4. V<sub>CC</sub> pin can be greater or smaller than V<sub>LED</sub>; neither should go below GND.

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	θ <sub>JC</sub> Thermal Resistance Junction-to-Case (Note 7)	θ <sub>JA</sub> Thermal Resistance Junction-to-Ambient (Note 7)	P <sub>DIS</sub> T <sub>A</sub> = +25°C, T <sub>J</sub> = +125°C (Note 7)
MSOP-8EP	39	90°C/W (Note 5)	1.1W
U-DFN3030-6	14	69°C/W (Note 6)	1.47W

- Notes:
5. Test condition for MSOP-8EP: Device mounted on FR-4 PCB (51mm x 51mm 2oz copper, minimum recommended pad layout on top layer and thermal vias to bottom layer ground plane. For better thermal performance, larger copper pad for heat-sink is needed.
  6. Test condition for U-DFN3030-6: Device mounted on FR-4 PCB (51mm x 51mm 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 heat-sink is needed
  7. Dominant conduction path via exposed pad.

**Recommended Operating Conditions** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
V <sub>CC</sub>	Supply Voltage Range Relative to GND Pin	3.5	60	V
V <sub>LED</sub>	LED Pin Output Voltage Range Relative to GND Pin	1	60	
I <sub>LED</sub>	LED Pin Current (Notes 8 & 9)	10	150	mA
T <sub>A</sub>	Operating Ambient Temperature Range	-40	+125	°C

- Notes:
8. For improved accuracy LED current should be greater than 60mA.
  9. 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** (@ $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 3.5\text{V}$ ,  $V_{LED} = 1\text{V}$  (Note 10),  $R_{SET} = 7.5\text{k}\Omega$  unless otherwise specified.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
$V_{RSET}$	$R_{SET}$ Voltage	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$		0.5		V	
$I_{LED}$	$I_{LED}$ Current Accuracy	$R_{SET} = 12.5\text{k}\Omega$		57	60	63	mA
		$R_{SET} = 4.99\text{k}\Omega$	$T_A = +25^\circ\text{C}$	142.5	150	157.5	
		$R_{SET} = 7.5\text{k}\Omega$	$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$	97	100	103	
			95		105		
$REG_{LINE}$	LED Current Line Regulation	$V_{CC} = 3.5\text{V}$ to $60\text{V}$		$T_A = +25^\circ\text{C}$ 0.25		%	
UVLO	Under Voltage Lockout			$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ 2		V	
$I_{CC}$	Supply Current	$3.5\text{V} \leq V_{CC} \leq 60\text{V}$	$T_A = +25^\circ\text{C}$		320	400	$\mu\text{A}$
			$T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$			500	
$I_{LEAK}$	LED Pin Leakage Current	$V_{CC} = V_{LED} = 60\text{V}$ $R_{SET} = \text{Open Circuit}$				1	$\mu\text{A}$
$T_{SHDN}$	Thermal Shutdown			155		$^\circ\text{C}$	
$T_{HYS}$	Thermal Shutdown Hysteresis			20		$^\circ\text{C}$	

Note: 10. All voltages unless otherwise stated are measured with respect to GND pin.

**Typical Performance Characteristics**

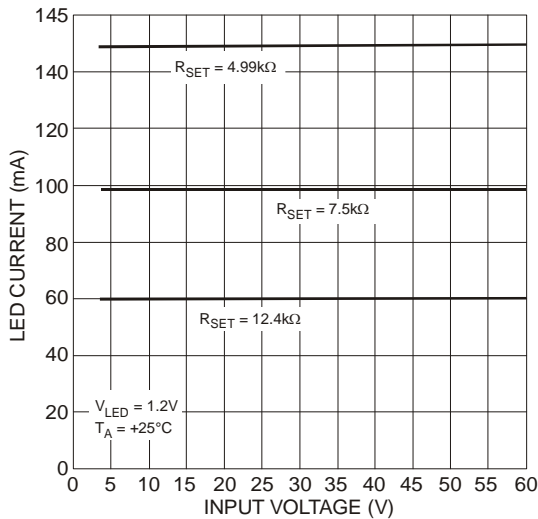


Figure 1 LED Current vs. Input Voltage

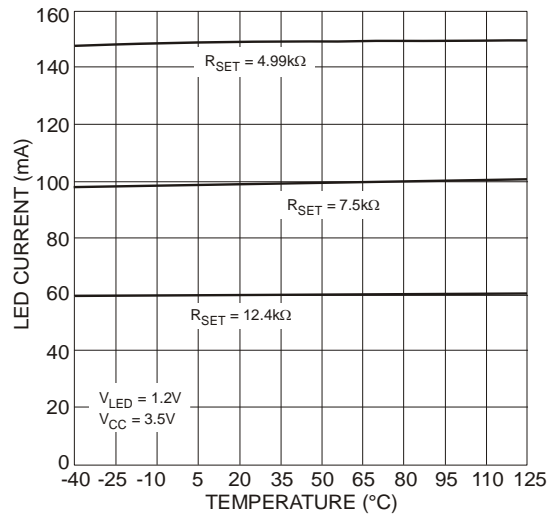


Figure 2 LED Current vs. Ambient Temperature

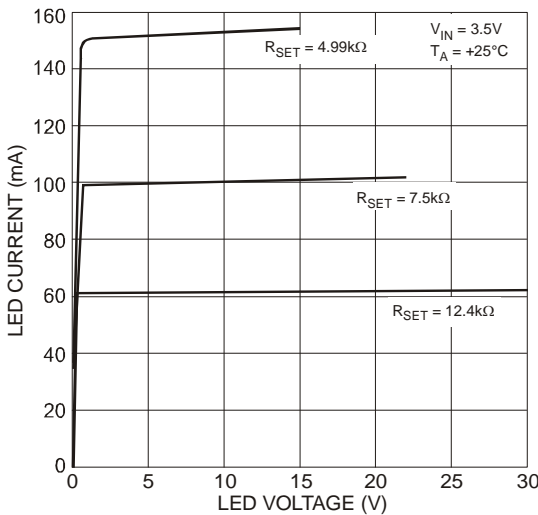


Figure 3 LED Current vs. LED Pin Voltage (Note 11)

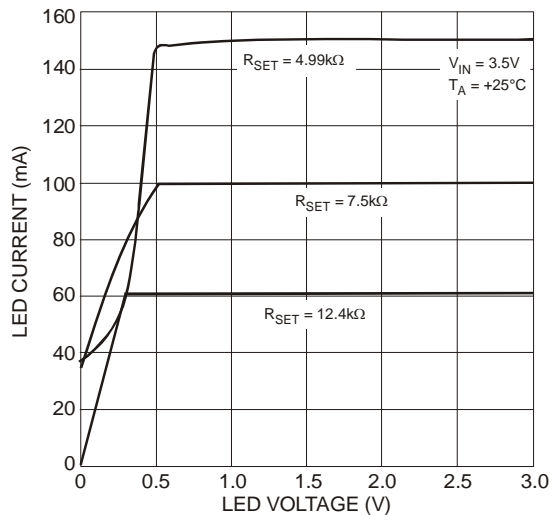


Figure 4 LED Current vs. LED Pin Voltage Zoomed

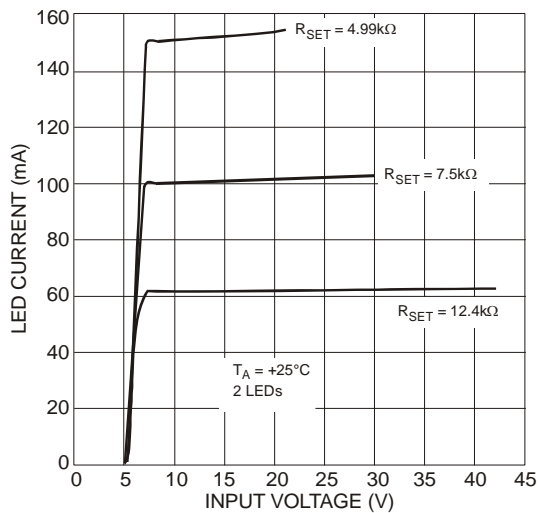


Figure 5 LED Current vs. Input Voltage - 2 LEDs (Note 11 & 12)

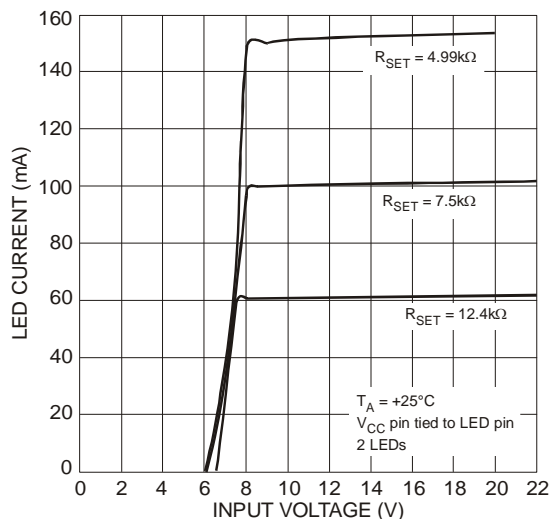


Figure 6 LED Current vs. Input Voltage 2 LEDs - High Side Drive (Notes 11, 12 & 13)

- Notes:
- 11. These curves have been limited at larger input voltages due to power dissipation.
  - 12. Lower input voltage range is limited by the LED chain voltage
  - 13. The AL5812 has its V<sub>CC</sub> pin connected to its LED pin, which are connected to the positive input supply voltage. R<sub>SET</sub> is connected to AL5812 GND pin, which is connected to the anode of the LED chain. This creates a high side driver of the LED chain. See Figure 15.

**Typical Performance Characteristics** (cont.)

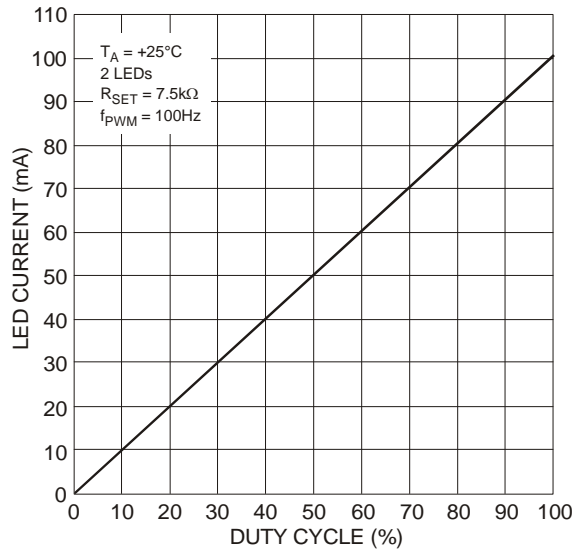


Figure 7 LED Current vs. PWM Duty Cycle

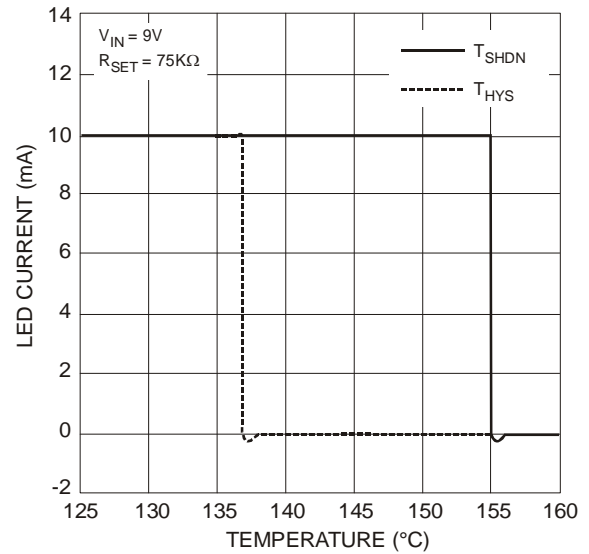


Figure 8 LED Current vs.  $T_{SHDN}$

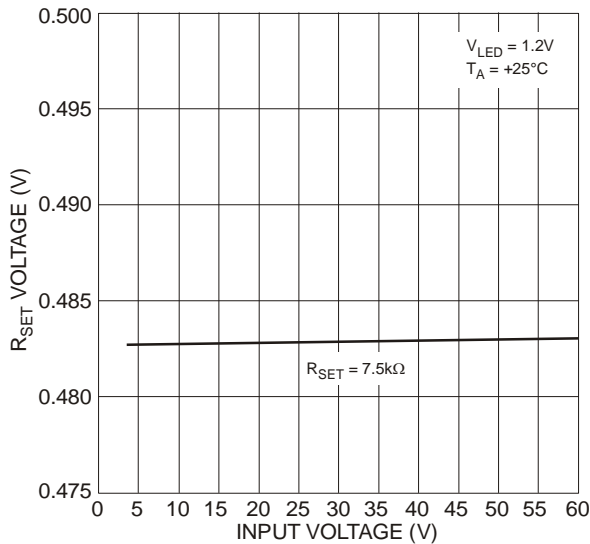


Figure 9  $R_{SET}$  Voltage vs. Input Voltage

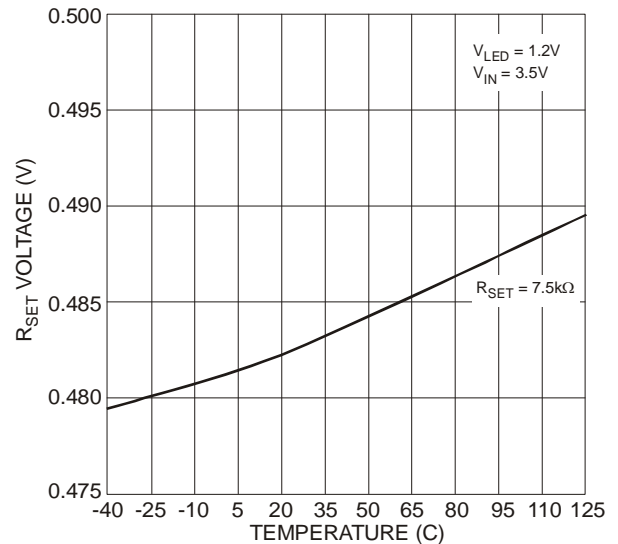


Figure 10  $R_{SET}$  Voltage vs. Ambient Temperature

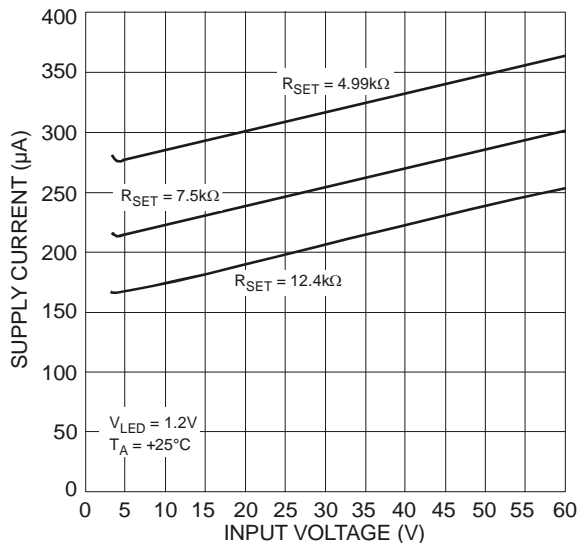


Figure 11 Supply Current vs. Input Voltage

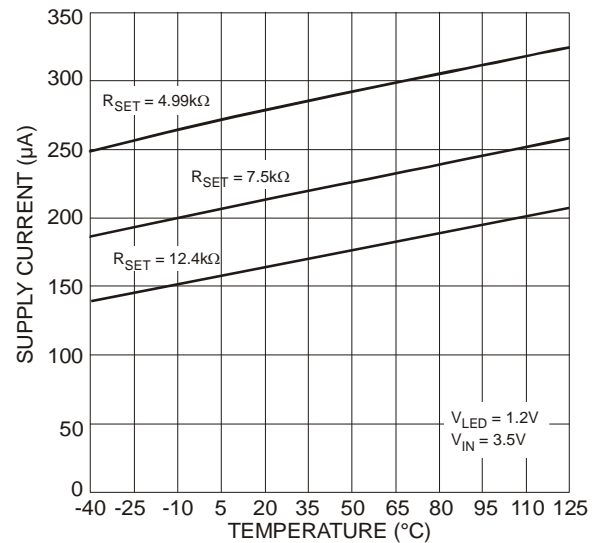


Figure 12 Supply Current vs. Ambient Temperature

## Application Information

### Description

The AL5812 is a Linear LED driver and in normal operation has the LEDs connected to the same potential as its  $V_{CC}$  pin and regulates the LED current by sinking current into to its LED pin see Figure 13.

The LED current is set by the use of an external resistor,  $R_{SET}$ , connected from the  $R_{SET}$  pin to GND. This resistor supplies the bias current of the AL5812 together with current regulator to set the LED current.

The nominal LED current is determined by this equation:

$$I_{LED} = 1500 * \frac{0.5}{R_{SET}} \quad \text{where 1500 is the current ratio between the LED pin current and } R_{SET} \text{ pin current.}$$

With  $R_{SET} = 7.5k$

$$I_{LED} = 1500 * \frac{0.5}{7.5k} = 100mA$$

The AL5812 with its 60V capability on its supply pin,  $V_{CC}$ , and its LED drive pin allows it to operate from supply rails up to 60V and/or directly drive LED chains up to 60V as shown in Figures 13 and 14. The voltage applied to the  $V_{CC}$  pin can be greater or lower than the voltage applied to the LED string. Figure 14 shows where you might control it from a 5-V rail but power the rails from a 12V rail.

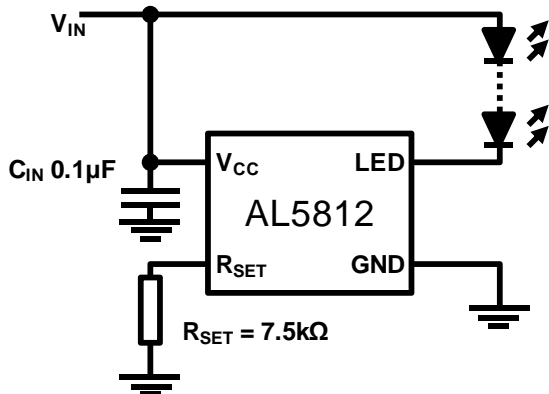


Figure 13 Low Side Current LED Setting

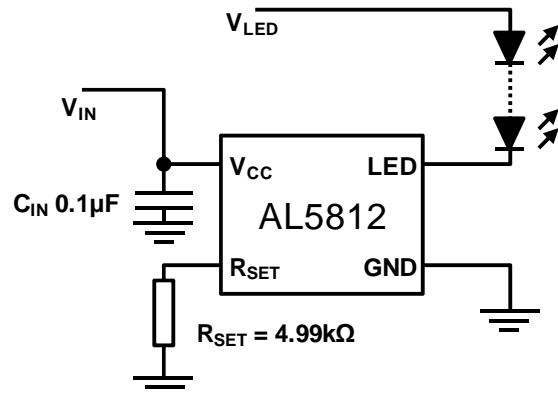


Figure 14 Low Side Drive – Separate Supplies

### High Voltage Operation

An extension of Figure 14 is to derive the power for the AL5812 from the LED chain itself see Figure 15. LED chains greater than 60V can be driven in this manner as long PWM dimming is not utilized.

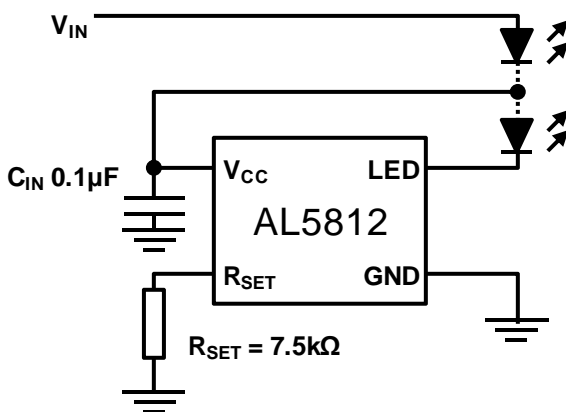


Figure 15 Low Side LED String Tapping

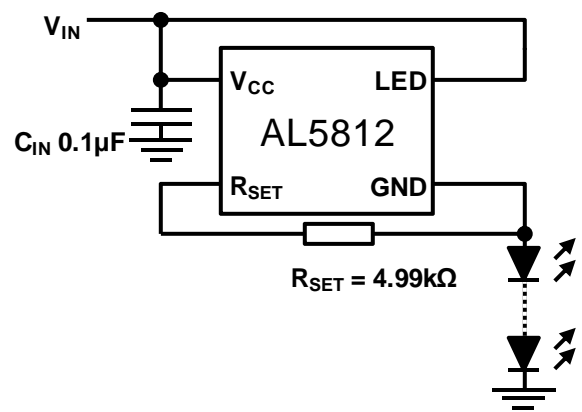


Figure 16 High Side Current LED String

The AL5812 can also be used on the high side of the LEDs, see Figure 16. This is a simple way of extending the maximum LED chain voltage, however, it does increase the minimum system input voltage to:

$$V_{IN(min)} = V_{LED\_CHAIN} + 3.5V.$$

Where

$V_{LED\_CHAIN}$  is the LED chain voltage.

**Application Information** (cont.)

**PWM Dimming**

The AL5812 can be used to provide LED current dimming driving the R<sub>SET</sub> pin via the current setting resistor (R<sub>SET</sub>) and a series MOSFET switch to ground (Figure 17). The R<sub>SET</sub> pin current is then effectively switched on and off causing the LED current to turn on and off. The linearity is shown in Figure 18.

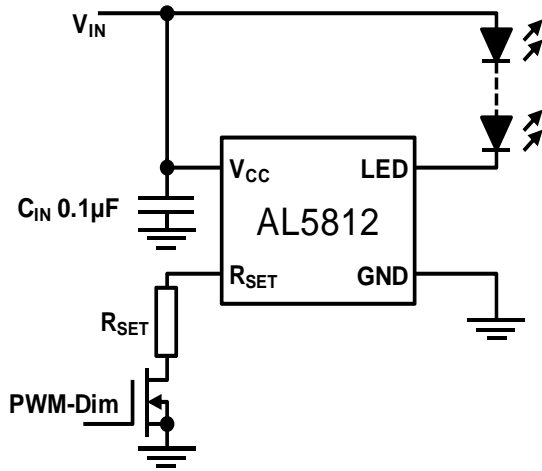


Figure 17 PWM Dimming

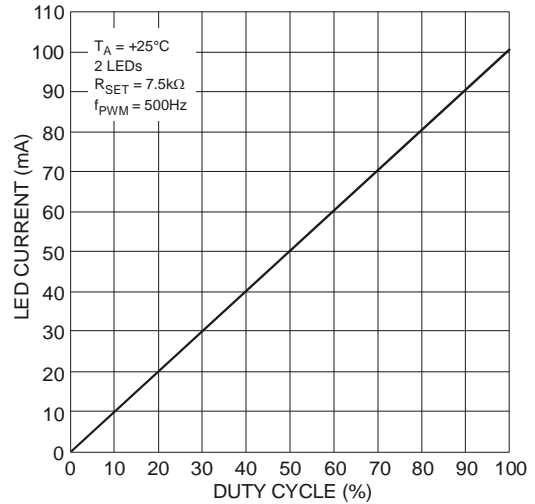


Figure 18 PWM Dimming Linearity

**Thermal Considerations**

When designing linear LED drivers careful consideration must be given to:

1. the power dissipation within the LED driver and
2. PCB layout/heat sinking.

A Linear LED driver has to be able to handle the large potential input voltage variations due to the supply voltage tolerance and also the variation in LED forward voltage due to binning and temperature.

This can result in a large potential difference across the LED driver resulting in a larger than anticipated power dissipation.

For example in an 12V powered system with a 5% output voltage tolerance; the input voltage could typically vary from 12.6V down to 11.4V driving 3 LEDs with a voltage varying from 3V to 3.5V at 100mA. This means that the LED driver has to cope with a voltage drop across varying from approximately 3.6V to 0.9V. This means that the power dissipation of the AL5812 could be as much as 366mW.

Figure 19 below shows how the AL5812's power dissipation capability varies with package; these values will vary with PCB size and area of metal associated with the ground plane used for heat sinking. By increasing the area on the top layer the thermal impedance of both packages could be improved.

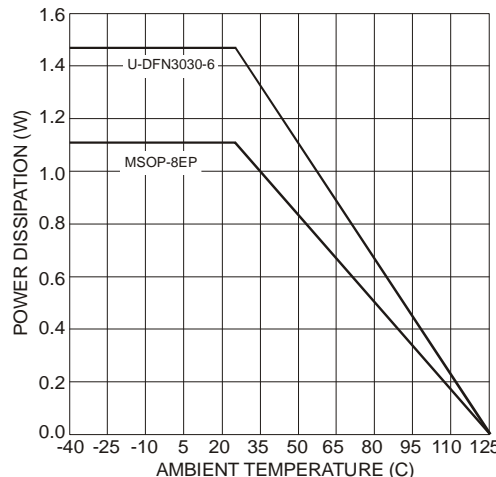
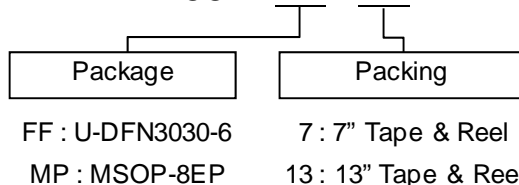


Figure 19 Power Dissipation Derating



## Ordering Information

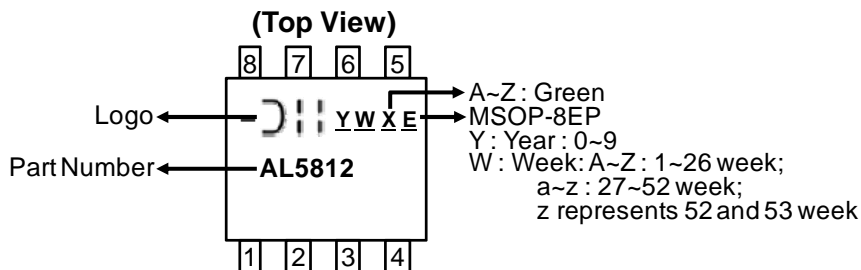
### AL5812XX-XX



Device	Package Code	Packaging	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
AL5812MP-13	MP	MSOP-8EP	2500/Tape & Reel	-13
AL5812FF-7	FF	U-DFN3030-6	3000/Tape & Reel	-7

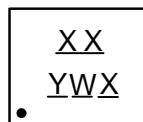
## Marking Information

### (1) MSOP-8EP



### (2) U-DFN3030-6

#### ( Top View )



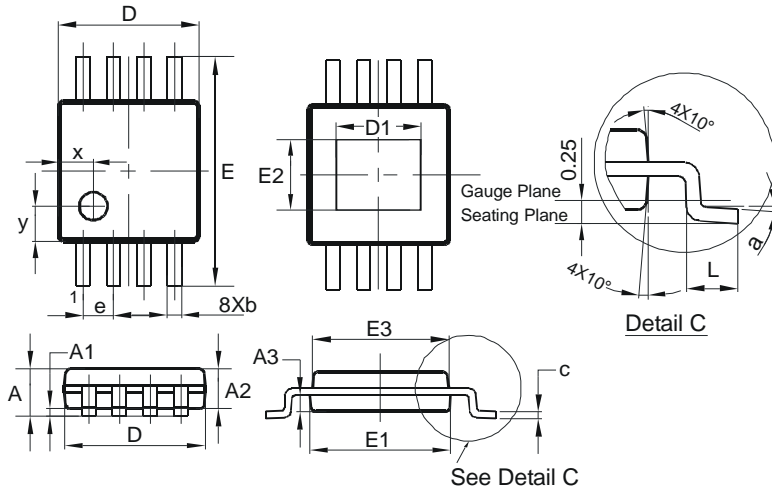
XX : Identification Code  
Y : Year : 0~9  
W : Week : A~Z : 1~26 week;  
a~z : 27~52 week; z represents  
52 and 53 week  
X : A~Z : Green

Part Number	Package	Identification Code
AL5812FF-7	U-DFN3030-6	B9

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

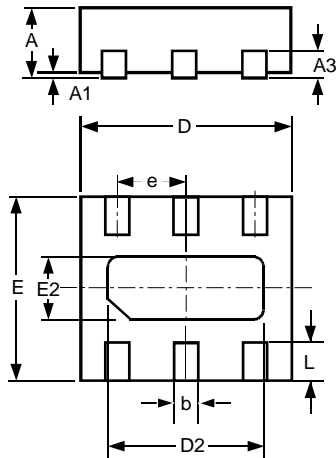
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

**(1) MSOP-8EP**



MSOP-8EP			
Dim	Min	Max	Typ
A	-	1.10	-
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
D1	1.60	2.00	1.80
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E2	1.30	1.70	1.50
E3	2.85	3.05	2.95
e	-	-	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	-	-	0.750
y	-	-	0.750
All Dimensions in mm			

**(2) U-DFN3030-6**

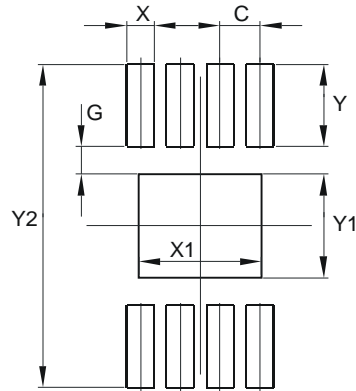


U-DFN3030-6			
Dim	Min	Max	Typ
A	0.57	0.63	0.60
A1	0	0.05	0.02
A3	—	—	0.15
b	0.29	0.39	0.34
D	2.9	3.1	3.0
D2	2.65	2.85	2.75
E	2.9	3.1	3.0
e	—	—	1.205
E2	1.76	1.96	1.86
L	0.30	0.60	0.45
All Dimensions in mm			

## Suggested Pad Layout

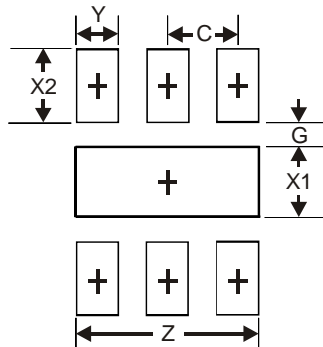
Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for latest version.

### (1) MSOP-8EP



Dimensions	Value (in mm)
C	0.650
G	0.450
X	0.450
X1	2.000
Y	1.350
Y1	1.700
Y2	5.300

### (2) U-DFN3030-6



Dimensions	Value (in mm)
Z	2.75
G	0.57
X1	1.86
X2	0.45
Y	0.34
C	1.205

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