60V, LINEAR 75mA ADJUSTABLE CURRENT LED DRIVER

Description

The AL5811 is a Linear LED driver with an adjustable LED current up to 75mA offering excellent temperature stability and output handling capability. The AL5811 simplifies the design of linear and isolated or non-isolated LED drivers by setting the LED current with standard value resistors.

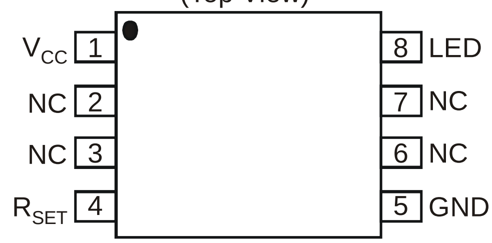
The AL5811 has an open drain output that can swing from 1V up to 60V enabling it drive long LED chains. Its low 0.5V R_{SET} pin is outside of the LED current path and so accuracy is maintained while minimizing the required overhead to regulate the LED current. This reduces its power dissipation when compared to traditional linear LED drivers. This makes it ideal for driving LEDs up to 75mA.

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

The AL5811 is available in the exposed pad MSOP-8EP and U-DFN3030-6 packages.

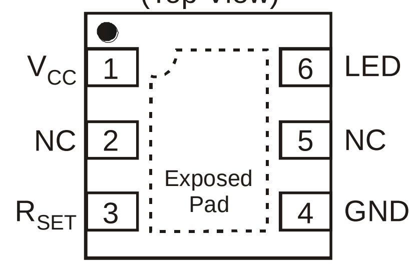
Pin Assignments

(Top View)



MSOP-8EP

(Top View)



U-DFN3030-6

Features

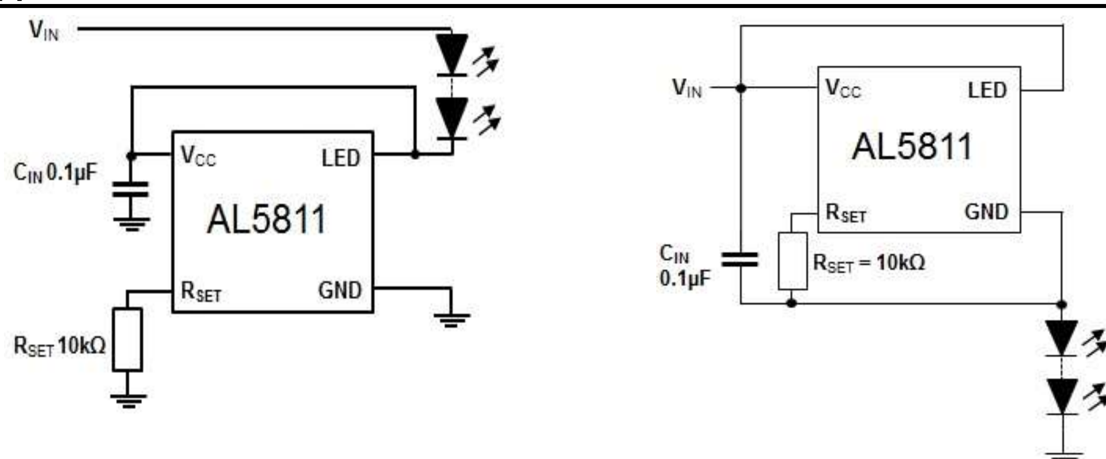
- Low Reference Voltage (V_{RSET} = 0.5V)
- -40°C to +125°C Temperature Range
- ±6% Typical LED Current Tolerance
- Low Temperature Drift
- 1.0V to 60V Open-Drain Output
- High Power Supply Rejection
- MSOP-8EP and U-DFN3030-6
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Applications

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

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.

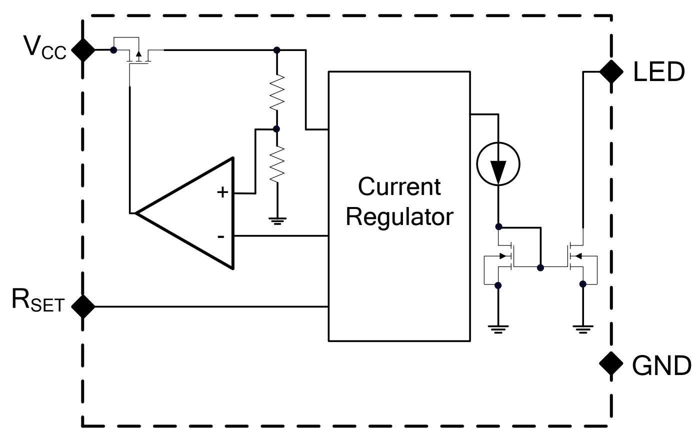
Typical Applications Circuit



Pin Descriptions

Pin Name	Pin Number		Function
	MSOP-8EP	U-DFN3030-6	
V_{CC}	1	1	Supply Input. Connect a 0.1µF ceramic capacitor between V_{CC} and GND as close as possible to the device.
R_{SET}	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 Connection.
NC	2, 3, 6, 7	2, 5	Unused
EP	Exposed Pad	Exposed Pad	Exposed Pad (bottom). Used to improve thermal impedance of package. It must be connected to GND directly underneath the package.

Functional Block Diagram



Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameters	Ratings	Unit
V_{CC}	Supply Voltage Relative to GND Pin (Note 4)	-0.3 to +66	V
V_{LED}	LED Voltage Relative to GND Pin (Note 4)	-0.3 to +66	V
V_{RSET}	R_{SET} Voltage Relative to GND Pin	-0.3 to +6	V
I_{LED}	LED Pin Current Sink Current Range	85	mA
ESD HBM	ESD Protection - Human Body Model	1	kV
ESD CDM	ESD Protection - Charged Device Model	1.2	kV
T_J	Operating Junction Temperature	-40 to +150	°C
T_{ST}	Storage Temperature	-55 to +150	°C

Notes: 4. V_{CC} pin can be greater or smaller than V_{LED}; 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_{JC} Thermal Resistance Junction-to-Case (Note 5)	θ_{JA} Thermal Resistance Junction-to-Ambient (Note 5)	P_{DIS} T_A = +25°C, T_J = +125°C
MSOP-8EP	37	85°C/W (Note 6)	1.2W
U-DFN3030-6	13	71°C/W (Note 7)	1.40W

Notes: 5. Dominant conduction path via exposed pad.
6. 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.
7. 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

Recommended Operating Conditions (@T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
V_{CC}	Supply Voltage Range Relative to GND Pin	2.0	60	V
V_{LED}	OUT Voltage Range Relative to GND Pin	1.0	60	
I_{LED}	LED Pin Current (Notes 8 & 9)	10	75	mA
T_A	Operating Ambient Temperature Range	-40	+125	°C

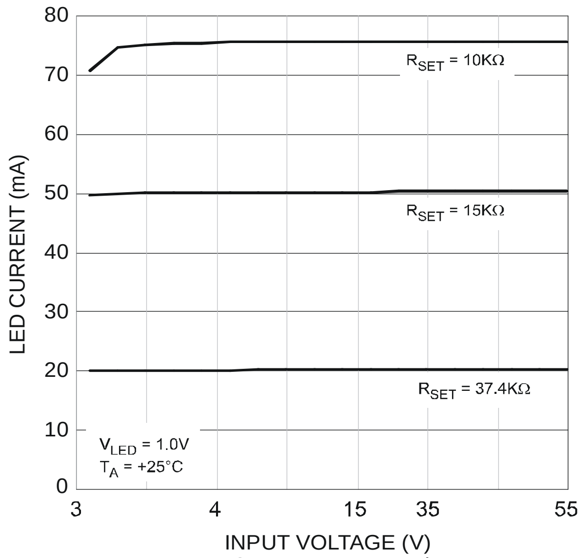
Notes: 8. Maximum LED current is also limited by ambient temperature and power dissipation such that junction temperature should be kept less than or equal +125°C.
9. For V_{CC} < 3.5V, Maximum LED current is 50mA.

Electrical Characteristics (@T_A = +25°C, V_{CC} = 2.0V, V_{LED} = 1.0, R_{SET} = 15kΩ, unless otherwise specified.) (Note 10)

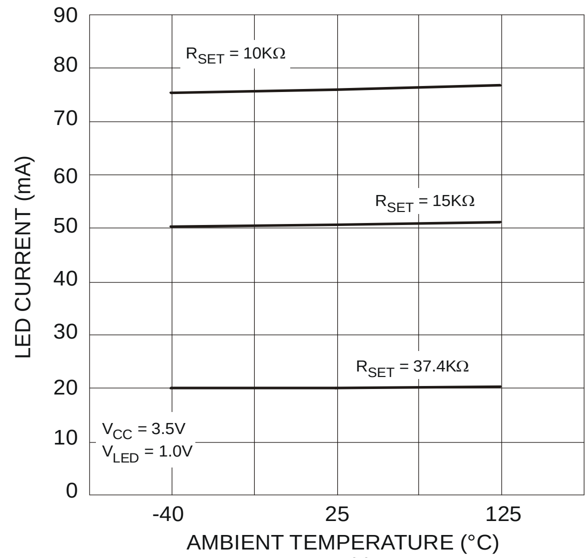
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{RSET}	R_{SET} Voltage	—	T_A = -40°C to +125°C	—	0.5	—	V
I_{LED}	I_{LED} Current Accuracy	R_{SET} = 82.5kΩ	T_A = +25°C	7.9	9	10.1	mA
		R_{SET} = 37.5kΩ		18	20	22	
		R_{SET} = 10kΩ, V_{CC} = 3.5V		70	75	80	
		R_{SET} = 15kΩ		47	50	53	
			T_A = -40°C to +125°C V_{CC} = 3.5V to 60V	46	50	54	
		R_{SET} = 82.5kΩ	T_A = -40°C to +125°C V_{CC} = 2.0V to 3.5V	7.65	9	10.35	
		R_{SET} = 15kΩ		43	50	58	
REG_{LINE}	LED Current Line Regulation	V_{CC} = 3.5V to 60V	T_A = +25°C	—	0.25	—	%
I_{CC}	Supply Current	2.0V ≤ V_{CC} ≤ 60V	T_A = +25°C	—	200	300	µA
			T_A = -40°C to +125°C	—	—	350	
I_{LEAK}	LED Pin Leakage Current	V_{CC} = 60V; V_{LED} = 60V R_{SET} = Open Circuit	T_A = +125°C	—	—	1	µA
T_{SHDN}	Thermal Shutdown	—	—	—	+155	—	°C
T_{HYS}	Thermal Shutdown Hysteresis		—	—	+20	—	°C

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

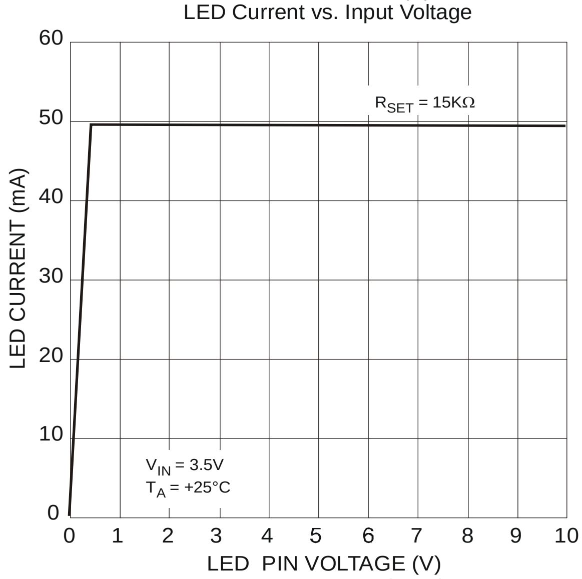
Typical Performance Characteristics



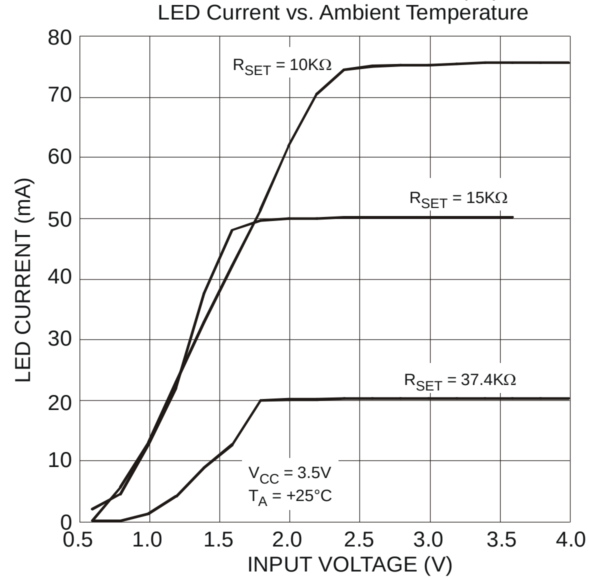
LED Current vs. Input Voltage



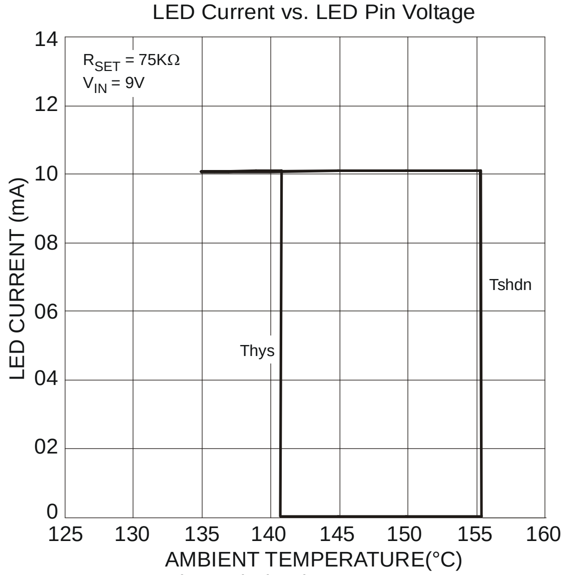
LED Current vs. Ambient Temperature



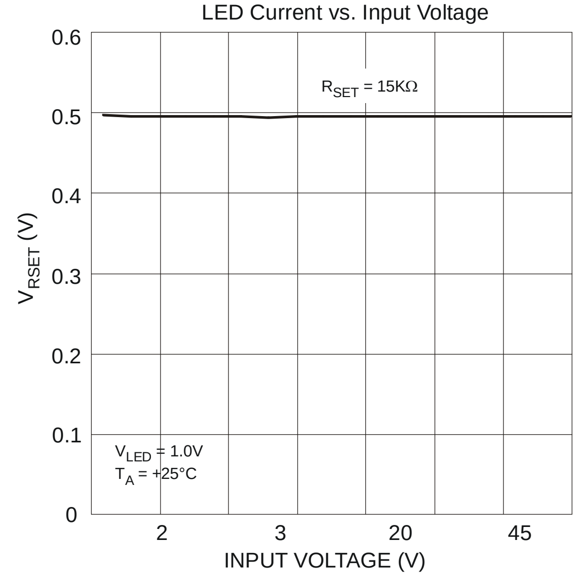
LED Current vs. LED Pin Voltage



LED Current vs. Input Voltage

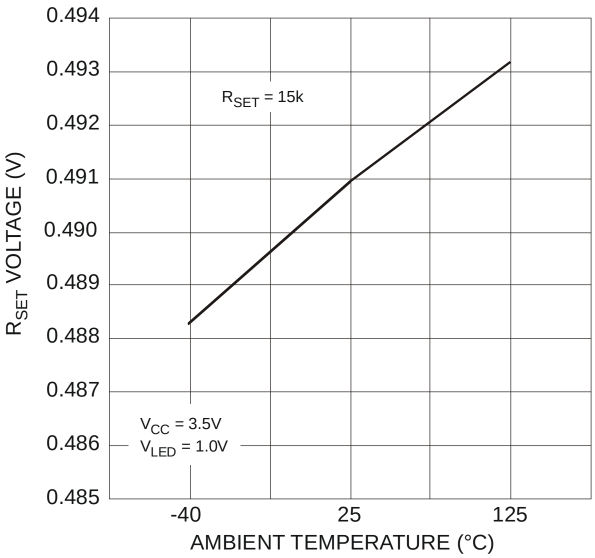


Thermal Shutdown MSOP-8EP

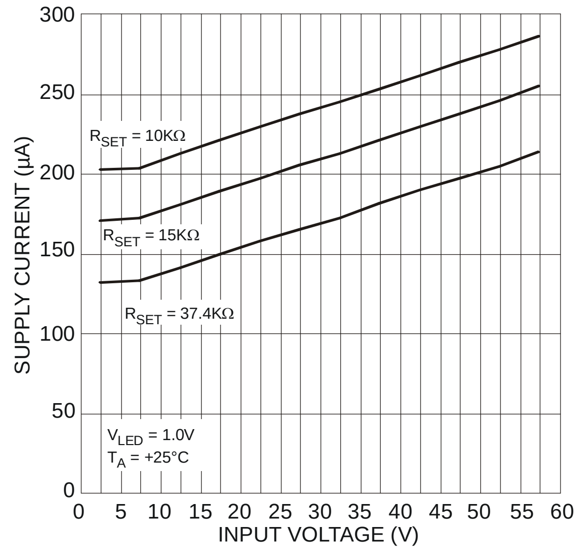


R_{SET} Voltage vs. Input Voltage

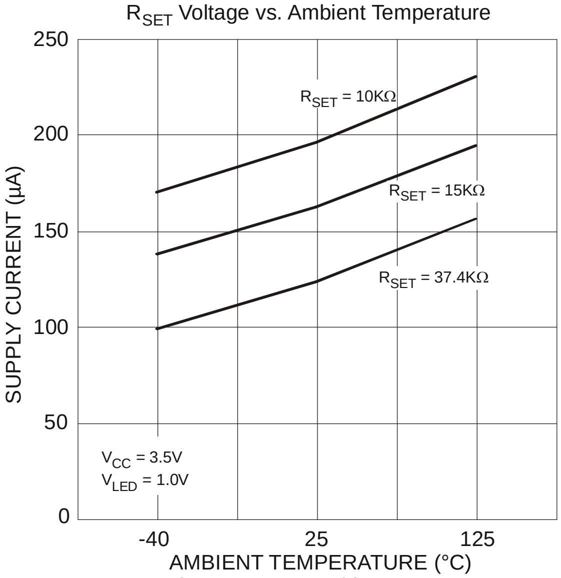
Typical Performance Characteristics (Continued)



R_{SET} Voltage vs. Ambient Temperature

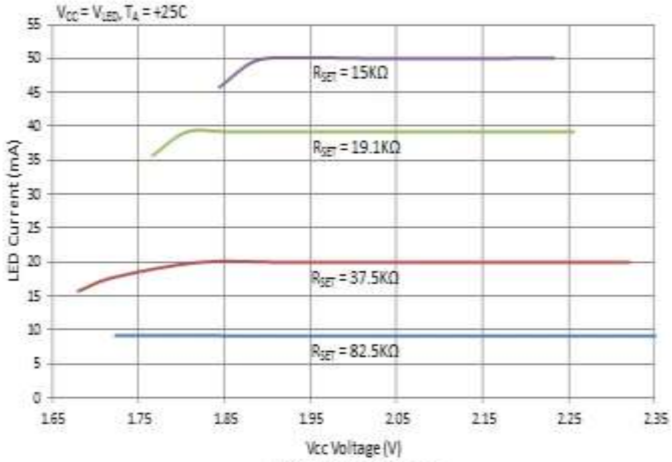


Supply Current vs. Input Voltage

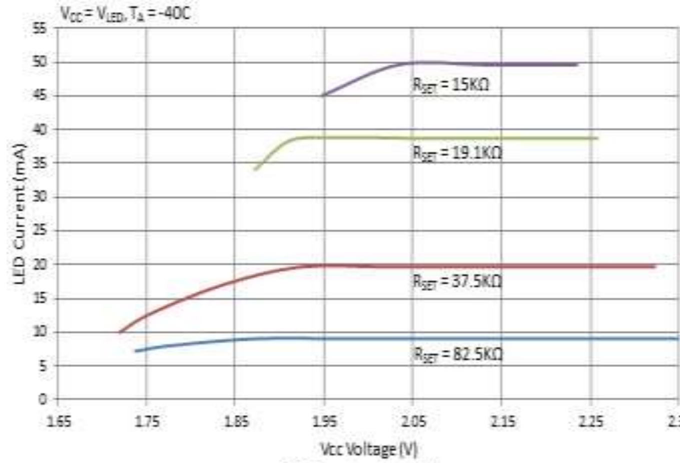


Supply Current vs. Ambient Temperature

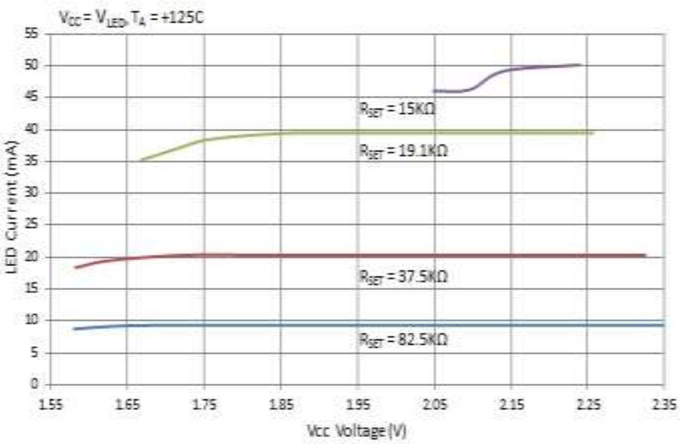
Typical Performance Characteristics (Cont.)



LED Current vs. Vc Voltage



LED Current vs. Vcc Voltage



LED Current vs. Vcc Voltage

Application Information

Description

The AL5811 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. 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 AL5811 together with current regulator to set the LED current.

The LED current is determined by this equation:

$$I_{LED} = 1500 * \frac{0.5}{R_{SET}}$$

Where: 1500 is the current ratio between the LED pin current and R_{SET} pin current.

With R_{SET} = 15k

$$I_{LED} = 1500 * \frac{0.5}{15k} = 50mA$$

The AL5811 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 1 and 2. The voltage applied to the V_{CC} pin can be greater or lower than the voltage applied to the LED string. Figure 2 shows where you might power the AL5811 from a 5V rail and power the LED string from a 12V rail.

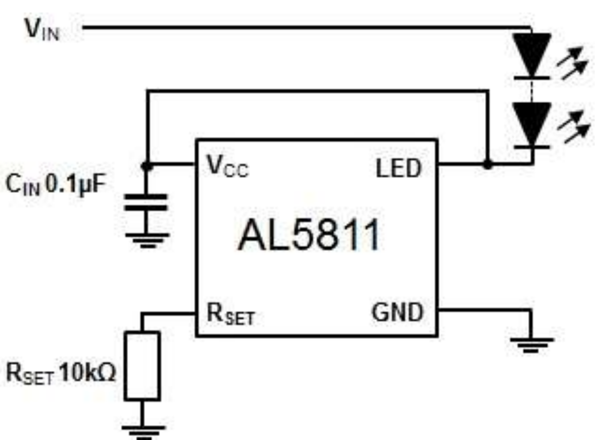


Figure 1 Low Side Current LED Setting

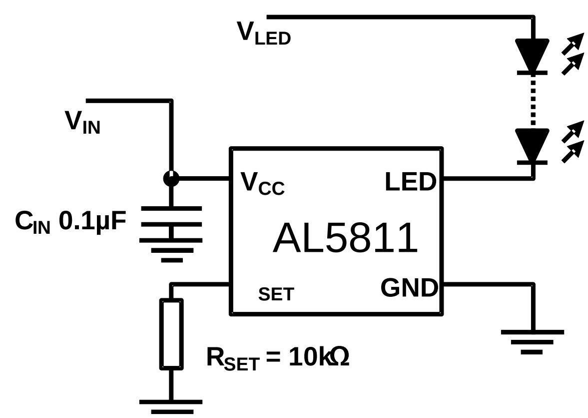


Figure 2 Low Side Current LED Setting (Non-Dimming Application Only)

Application Information (Continued)

High Voltage Operation

An extension of Figure 2 is to derive the power for the AL5811 from the LED chain itself, see Figure 3. LED chains greater than 60V can be driven in this manner as long PWM dimming is not utilized.

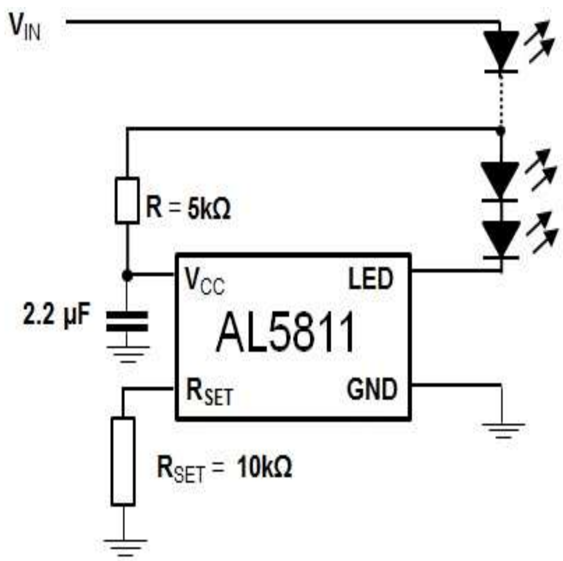


Figure 3 Low Side LED String Tapping (Non-Dimming Application Only)

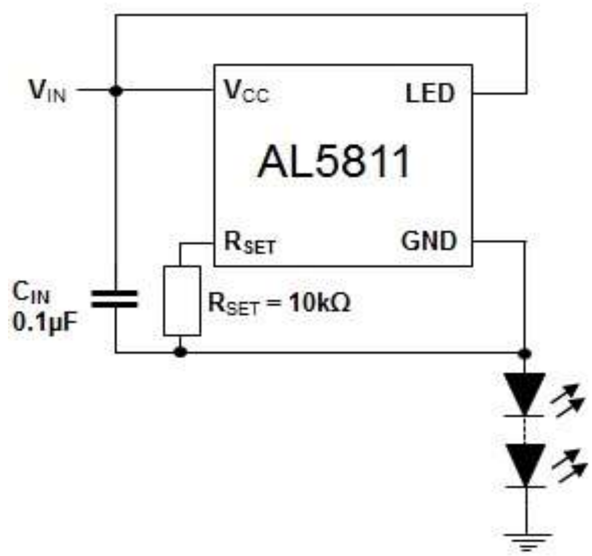


Figure 4 High Side Current LED String (V_{CC} to GND >= 2.0V)

Figure 2 shows the use of RC delay to match the power time delay between V_{CC} and LED pin. The AL5811 can also be used on the high side of the LEDs, see Figure 3. This is a simple way of extending the maximum LED chain voltage, however, it does increase the minimum system input voltage to:

$$V_{IN(MIN)} = V_{LED\_CHAIN} + 2.0V$$

Where:

V_{LED_CHAIN} is the LED chain voltage

Application Information (Cont.)

PWM Dimming

LED current dimming can be achieved by driving the R_{SET} pin via the current setting resistor (R_{SET}) and series MOSFET switch to ground (Figure 5). The R_{SET} pin current is then effectively switched on and off causing the LED current to turn on and off.

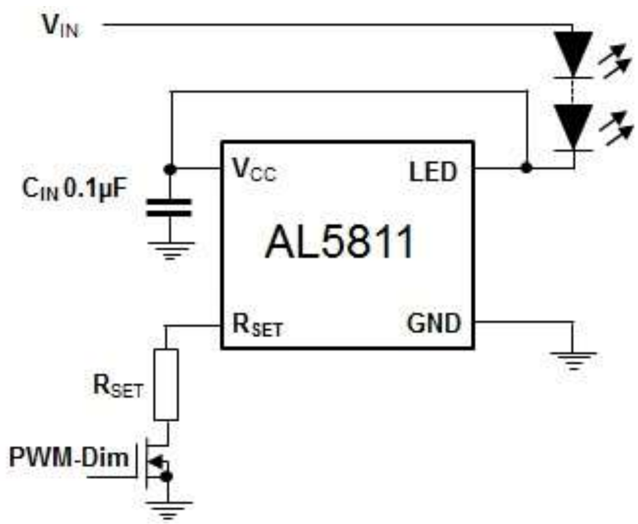


Figure 5 PWM Dimming

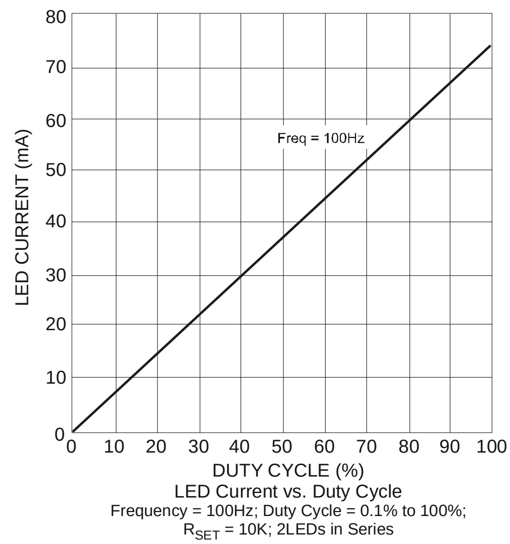


Figure 6 PWM Dimming Linearity

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 a 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 75mA. 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 AL5811 could be as much as 270mW.

Figure 7 below shows how the AL5811'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.

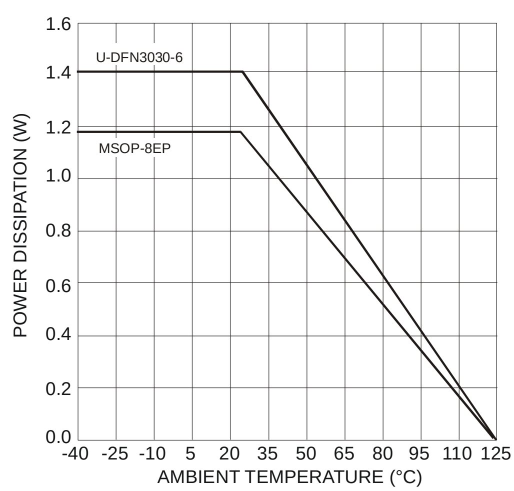
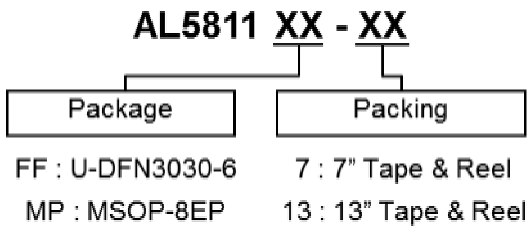


Figure 7 Power Dissipation Derating

Ordering Information (Note 11)

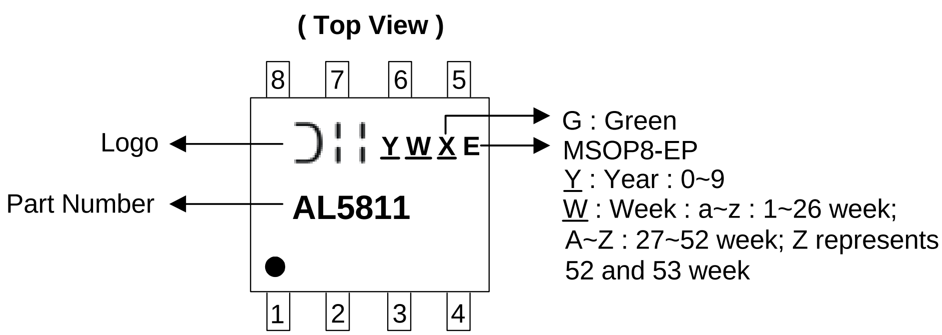


Part Number	Package Code	Packaging	7"/13" Tape and Reel	
			Quantity	Part Number Suffix
AL5811MP-13	MP	MSOP-8EP	2,500/Tape & Reel	-13
AL5811FF-7	FF	U-DFN3030-6	3,000/Tape & Reel	-7

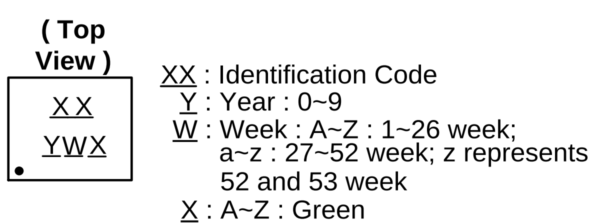
Note: 11. For packaging details, go to our website at http://www.diodes.com/products/packages.html.

Marking Information

(1) MSOP-8EP



(2) U-DFN3030-6

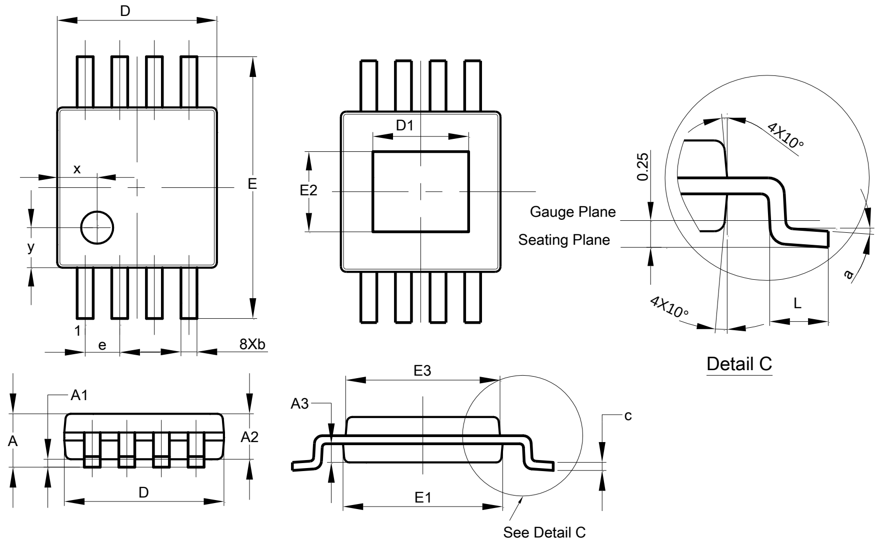


Part Number	Package	Identification Code
AL5811FF-7	U-DFN3030-6	A9

Package Outline Dimensions

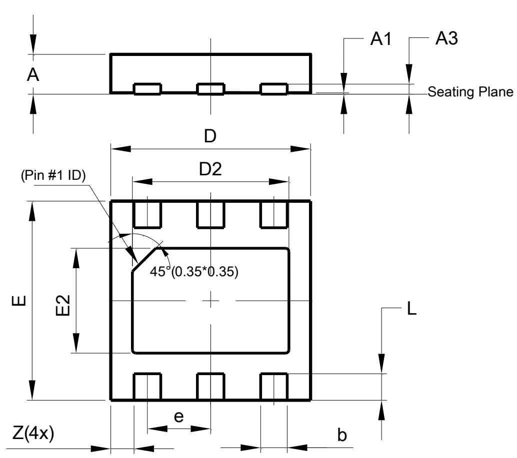
Please see http://www.diodes.com/package-outlines.html for the latest version.

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			

U-DFN3030-6

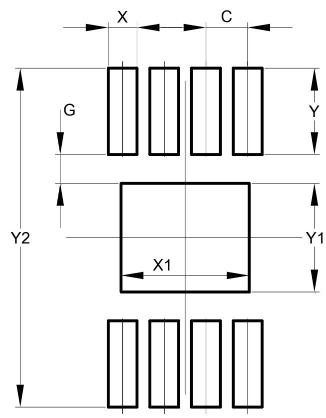


U-DFN3030-6			
Dim	**Min**	**Max**	**Typ**
A	0.57	0.63	0.60
A1	0	0.05	0.02
A3	-	-	0.15
b	0.35	0.45	0.40
D	2.95	3.05	3.00
D2	2.25	2.45	2.35
E	2.95	3.05	3.00
E2	1.48	1.68	1.58
e	-	-	0.95
L	0.35	0.45	0.40
Z	-	-	0.35
All Dimensions in mm			

Suggested Pad Layout

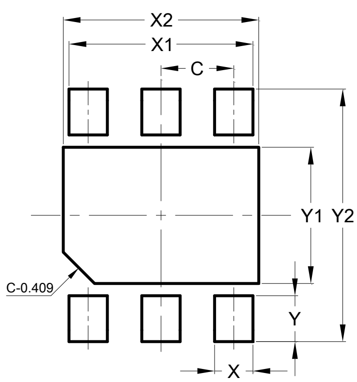
Please see http://www.diodes.com/package-outlines.html for the latest version.

MSOP8-EP



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

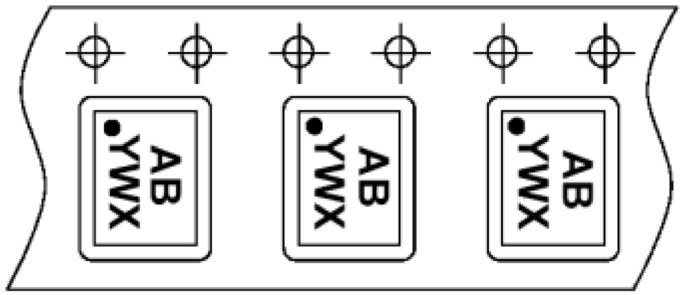
U-DFN3030-6

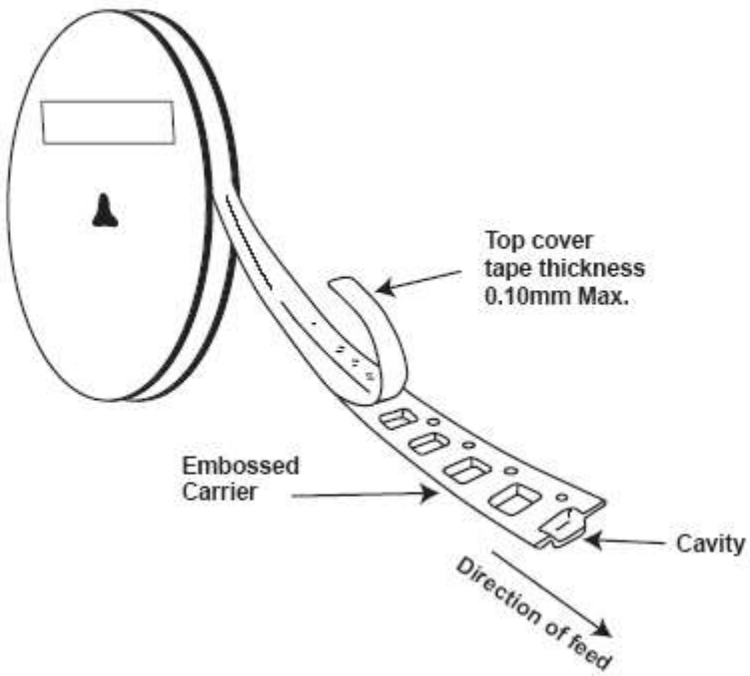


Dimensions	Value (in mm)
C	0.950
X	0.500
X1	2.400
X2	2.550
Y	0.600
Y1	1.780
Y2	3.300

Taping Orientation (Note 12)

U-DFN3030-6





Note: 12. The taping orientation of the other package type can be found on our website at http://www.diodes.com/datasheets/ap02007.pdf.