Description

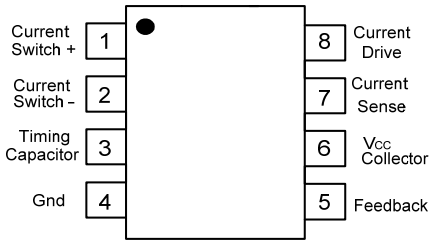
The AL8811 is a monolithic control circuit containing the primary functions required for DC-to-DC converters. These devices consist of an internal temperature compensated reference, comparator, controlled duty cycle oscillator with an active current limit circuit, driver and high current output switch. This series is specifically designed for incorporating in Boost, Buck and voltage-inverting applications with a minimum number of external components.

Features

- Operation from 3.0V to 20V Input
- Low Standby Current
- Current Limiting
- Output Switch Current to 1.6A
- Output Voltage Adjustable
- Frequency Operation to 100 kHz
- Precision 2% Reference
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Pin Assignments

(Top View)



MSOP-8

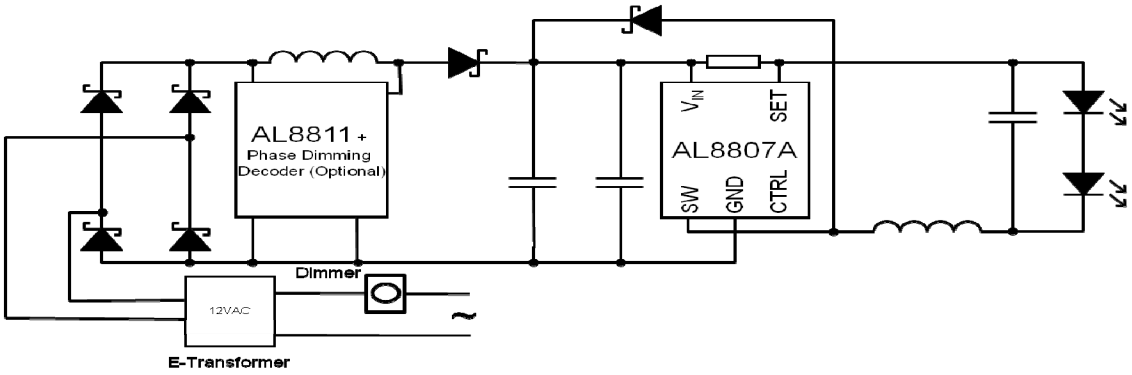
Applications

- Low Voltage LED Lighting such as MR-16
- General Purpose DC-DC Converter

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 Application Diagram

Electronic Transformer compatible MR16 lamp Simplified Schematic

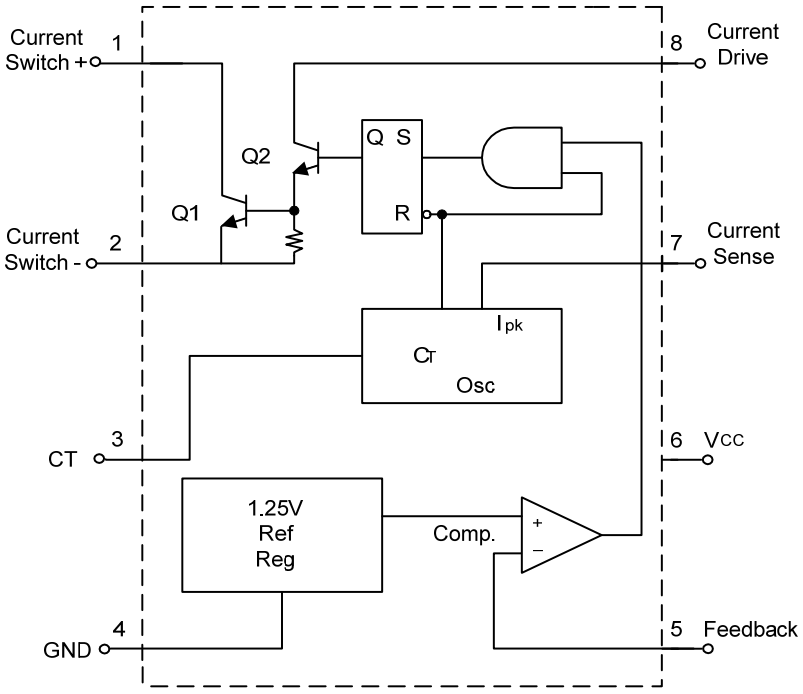


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Pin Descriptions

Pin Name	Pin Number	Descriptions
Current Switch+	1	Internal switch transistor collector: Connect to Inductor for boost converter. Connect to V_{CC} for Buck or Inverting converter
Current Switch-	2	Internal switch transistor emitter: Connect to GND for boost converter Connect to Inductor for buck or inverting converter
CT	3	Timing Capacitor to control the switching frequency
GND	4	
Feedback	5	Feedback pin for inverting input of internal comparator
VCC	6	Supply voltage pin
Current Sense	7	Peak Current Sense Input by monitoring the voltage drop across an external current sense resistor to limit the peak current through the switch
Current Drive	8	Current drive collector: Normally connected to V_{CC} directly or via a resistor.

Functional Diagram



(Top View)

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

Symbol	Parameter	Rating	Unit
V_{CC}	Power Supply Voltage	20	V
V_{IR}	Comparator Input Voltage Range	-0.3 to +36	V
$V_{C\ (SWITCH)}$	"Current Switch +" Collector Voltage	36	V
$V_{E\ (SWITCH)}$	„Current Switch –„ Emitter Voltage (V_{PIN} 1 = 36V)	36	V
$V_{CE\ (SWITCH)}$	"Current Switch" Collector to Emitter Voltage	36	V
$V_{C\ (DRIVER)}$	"Current Drive" Collector Voltage	36	V
$I_{C\ (DRIVER)}$	"Current Drive" Collector Current	100	mA
I_{SW}	"Current Switch" Current	1.6	A
P_D	Power Dissipation (Note 4)	600	mW
θ_{JA}	Thermal Resistance	130	°C/W
T_{MJ}	Maximum Junction Temperature	+150	°C
T_{STG}	Storage Temperature Range	-65 to +150	°C
ESD HBM	Human Body Model ESD Protection	1	kV
ESD MM	Machine Model ESD Protection	150	V

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.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{CC}	Supply Voltage	3	20	V
T_{OP}	Operating Junction Temperature Range	-40	+105	°C

Electrical Characteristics (@ V_{CC} = 5V, T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Min	Typ	Max	Unit
OSCILLATOR					
f_{OSC}	Frequency (V_{PIN} 5 = 0V, C_T = 1.0nF, T_A = +25°C)	24	33	42	kHz
I_{CHG}	Charge Current (V_{CC} = 5.0V to 20V, T_A = +25°C)	24	30	42	µA
I_{DISCHG}	Discharge Current (V_{CC} = 5.0V to 20V, T_A = +25°C)	140	200	260	µA
I_{DISCHG}/ I_{CHG}	Discharge to Charge Current Ratio (Pin 7 to V_{CC}, T_A = +25°C)	5.2	6.5	7.5	—
$V_{IPK\ (SENSE)}$	Current Limit Sense Voltage (I_{CHG} = I_{DISCHG}, T_A = +25°C)	300	400	450	mV
OUTPUT SWITCH (Note 4)					
$V_{CE(sat)}$	Saturation Voltage, Darlington Connection (I_{SW} = 1.0A, Pins 1, 8 connected)	—	1.0	1.3	V
$V_{CE(sat)}$	Saturation Voltage, Darlington Connection (I_{SW} = 1.0A, ID = 50mA, Forced ß ≈ 20)	—	0.45	0.7	V
h_{FE}	DC Current Gain (I_{SW} = 1.0A, V_{CE} = 5.0V, T_A = +25°C)	50	75	—	—
$I_{C(off)}$	Collector Off-State Current (V_{CE} = 20V)	—	0.01	100	µA
COMPARATOR					
V_{th}	Threshold Voltage T_A = +25°C	1.225	1.25	1.275	V
$Reg_{(LINE)}$	Threshold Voltage Line Regulation (V_{CC} = 3.0V to 20V)	—	1.4	6.0	mV
TOTAL DEVICE					
I_{CC}	Supply Current (V_{CC} = 5.0V to 20V, C_T =1.0nF, Pin 7 = V_{CC}, $V_{PIN\ 5}$ > V_{th} Pin 2 = Gnd, remaining pins open)	—	—	3.5	mA

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Typical Performance Characteristics

Figure 1. Vce(sat) versus Ie

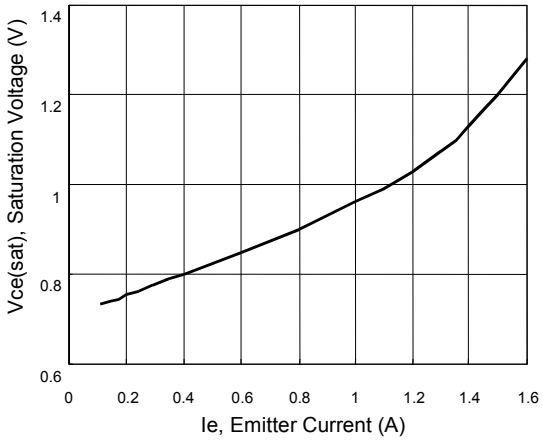


Figure 2. Reference Voltage versus Temp.

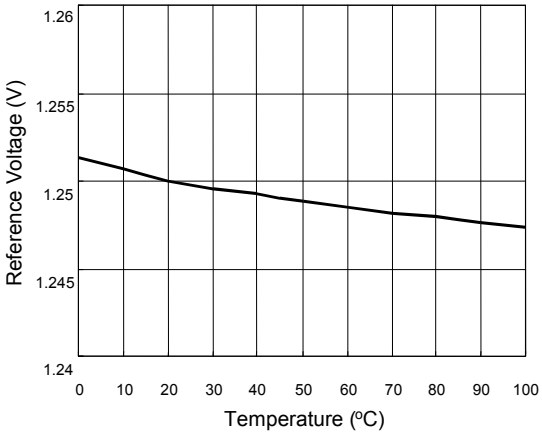


Figure 3. Current Limit Sense Voltage versus Temperature

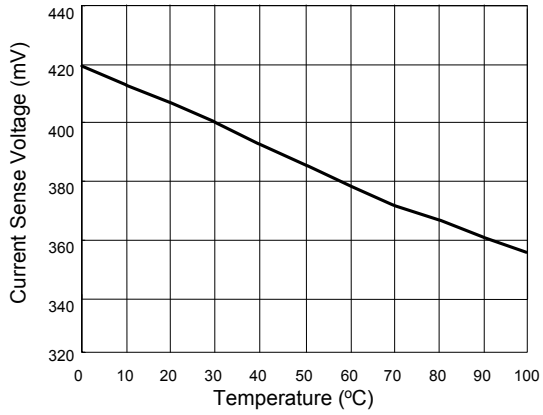


Figure 4. Standby Supply Current versus Supply Voltage

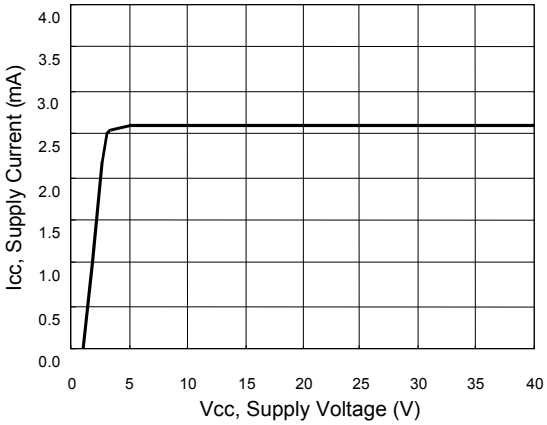


Figure 5. Emitter Follower Configuration Output Saturation Voltage vs. Emitter Current

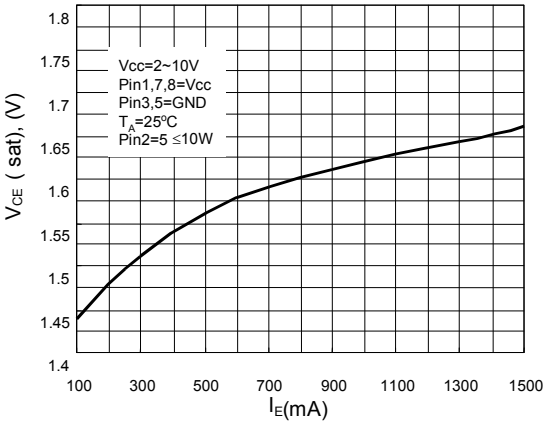
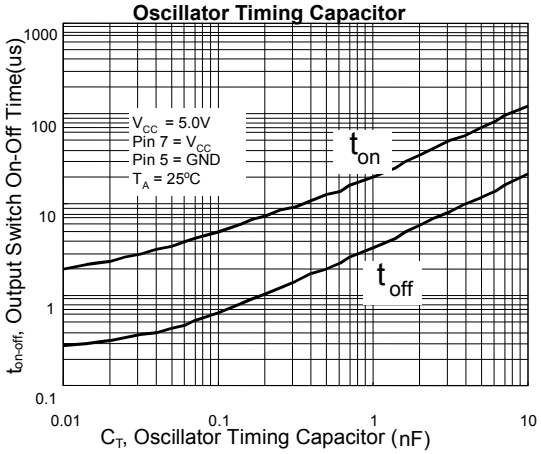


Figure 6.Output Switch On-Off Time versus Oscillator Timing Capacitor

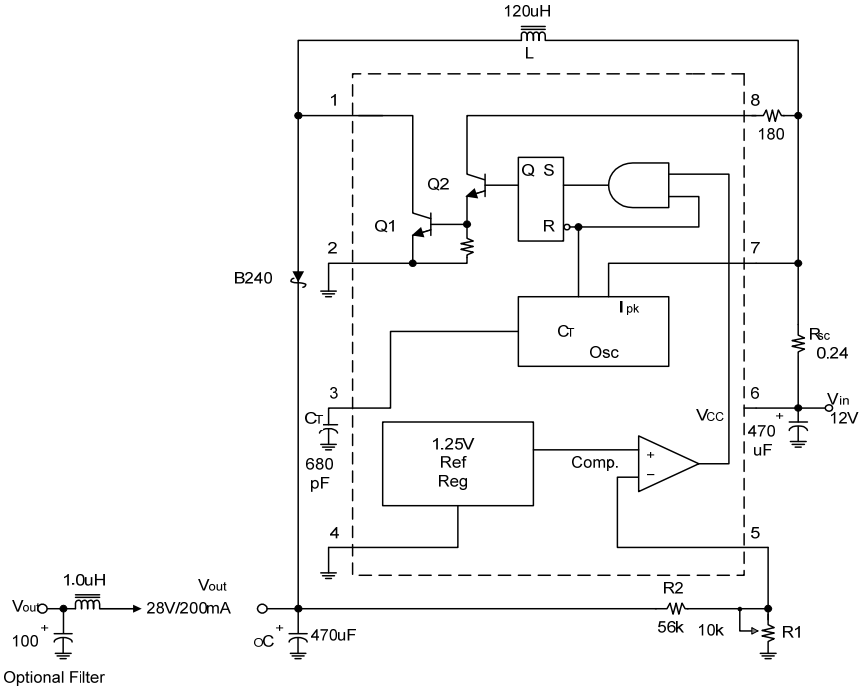


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Application Circuit

(1) Boost Converter

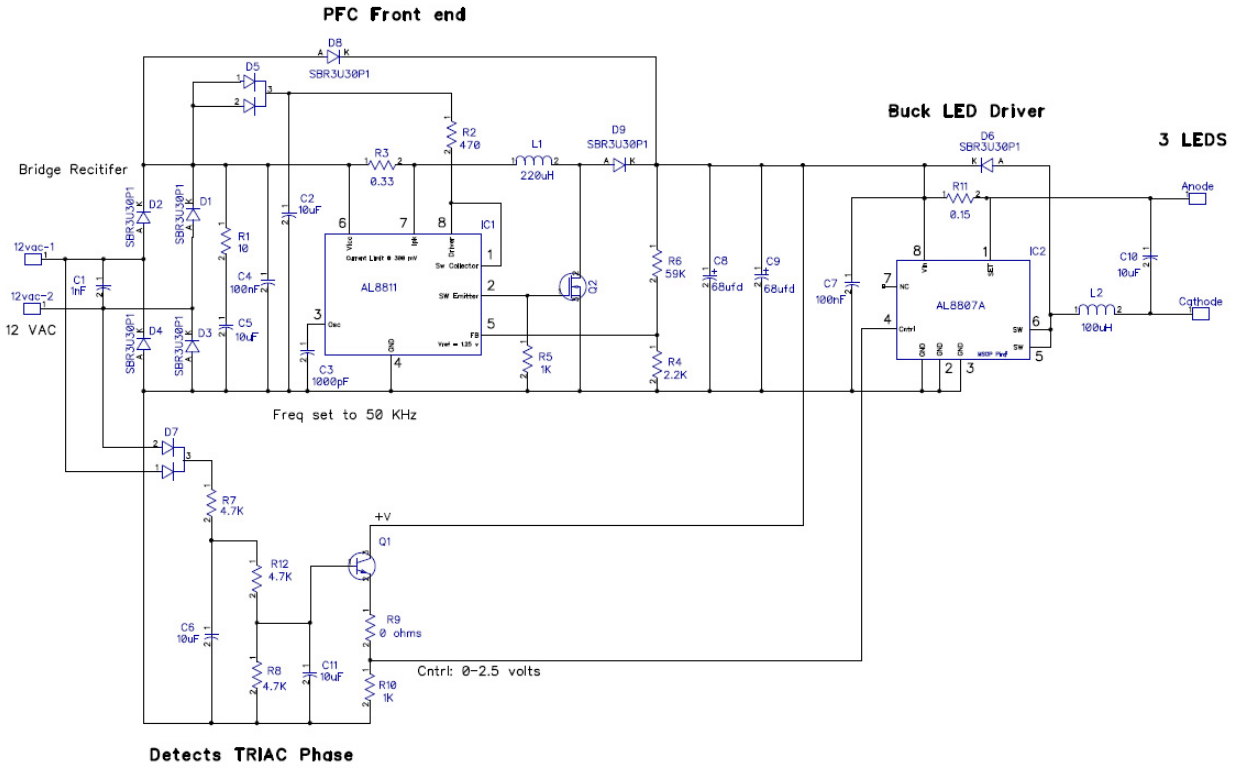
Test	Conditions	Results
Line Regulation	V_{IN} = 9V to 12V, I_O = 200mA	20mV = ±0.035%
Load Regulation	V_{IN} = 12V, I_O = 50mA to 200mA	15mV = ±0.035%
Output Ripple	V_{IN} = 12V, I_O = 200mA	500mV_{PP}
Efficiency	V_{IN} = 12V, I_O = 200mA	80%



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Application Circuit (cont.)

(2) Electronic Transformer compatible triac dimmable MR16/GU5.3 lamp for 120Vac



Circuit Description

This design consists of three sections:

1) The input PFC circuit converts the $12V_{AC}$ input voltage to a DC voltage around 30V (AL8811).

2) The output Buck LED Driver drives the three LEDs in series at a fixed current (AL8807A).

3) Finally, the phase-detect circuit generates a voltage proportional to the phase of the incoming AC voltage (when triac dimming is used).

PFC Circuit

The AL8811 Boost converter is a simple “Constant ON time controller”. By keeping the same ON time throughout the AC cycle, the circuit will draw a current that will closely match the voltage and result in a constant input current. This eliminates the classic peak current problem with a bridge rectifier and a large input filter capacitor.

The PFC circuit includes the input bridge rectifier, EMI filter (if needed) and the AL8811 Boost converter. The AC input voltage is rectified by the bridge circuit and filtered by C1, R1, C4, and C5. This first filter removes the high frequency that is generated by the Electronic Transformer in the range of 20-30 KHz. An additional diode rectifier circuit (D5, C2) is used to generate a voltage that is used to power the circuit that will turn on/off the external MOSFET of the Boost converter. This circuit is very important as the gate drive of the MOSFET has to be greater than 3-4 volts throughout the AC cycle. The external MOSFET is used to reduce the heat dissipation in the AL8811.

The AL8811 has a current limit resistor R3 which sets the maximum current allowed through the inductor L1. The output voltage is set by the divider R6, R5 to an output of around 35 volts. The output voltage is filtered by the two capacitors C8 and C9. These two capacitors store energy that will be used when the input voltage is low during the AC cycle.

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Application Circuit (cont.)

Buck LED Driver

The AL8807A is a step-down DC-DC converter designed to drive LEDs with a constant current. The current through the LED is controlled by R11. In the present Evaluation board, the current is set to around 660mA based on a resistor value of 0.15Ω. The current is set using the "CTRL" input pin which in this new version of the IC can vary from 0 to 2.5V, controlling the current from 0mA to the maximum current at 2.5V. This control input pin is used to lower the LED current as the TRIAC dims the LED. In this way, the energy stored in the two output capacitors of the PFC circuit will be able to provide current throughout the AC cycle.

TRIAC Phase Detection Circuit

The phase of the TRIAC is detected by using an additional rectifier circuit that generates a voltage in proportional to the phase of the TRIAC Driver. This is done by rectifying the input AC voltage and averaging the energy using a resistor to charge a capacitor. Two additional resistors in series, R12 and R8, slowly discharge this circuit so it will follow the input phase change. The two resistors, R12 and R8, are used to scale the voltage so the range is from 0 to 2.6V to the Buck LED driver control pin.

A simple transistor emitter follower circuit is used to drive a 1KΩ resistor in the emitter circuit. This low resistance is needed to drive the input control pin of the AL8807A LED driver because the pin outputs a small current of 50uA, which limits the lowest control voltage to around 50 mV.

Setting the LED output current (AL8807A):

The LED output current is set using resister R11 and the formula:

$I_{LED} = V_{TH} / R11$ where V_{TH} is equal to 0.1V

For a current of 660mA, R11 is about 0.15Ω.

Setting the PFC Variables (AL8811)

The choice for the size of the boost converter inductor selected in this design is based on a compromise which it is able to support a peak current to around 1.5A since the average input voltage will be around 12-14V.

The boost converter (AL8811) includes a current limit resistor R3 which will limit the current through the inductor and thus the power delivered to the output load. The formula for the resistor is:

$I_{PK(switch)} = 0.33V / R3$

For a current limit of 1A, R3 is 0.33Ω.

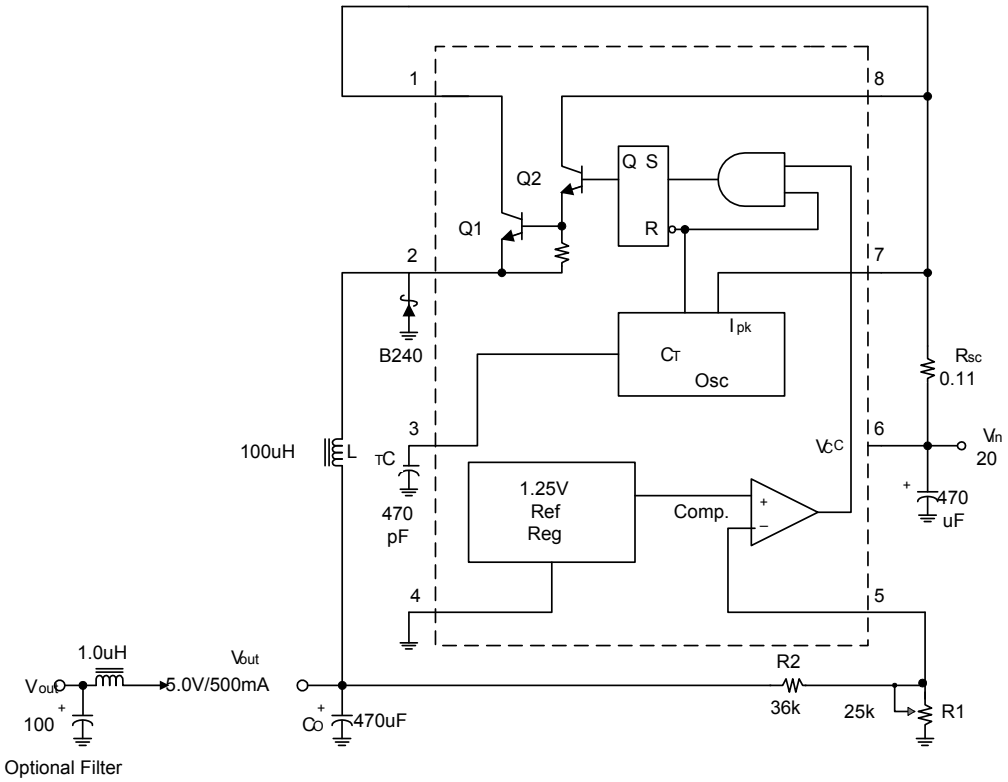
In this evaluation design, this value was selected based on having three LEDs in series drawing about 660mA. It was found that two 68µF capacitors mounted in parallel would just fit into the cavity of the MR16 bulb. The important design goal is to have the PFC circuit, which is used to always draw current from the Electronic Transformer.

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Application Circuit (cont.)

(3) Buck Converter

Test	Conditions	Results
Line Regulation	V_{IN} = 12V to 20V, I_O = 500mA	20mV = ±0.2%
Load Regulation	V_{IN} = 20V, I_O = 50mA to 500mA	5mV = ±0.05%
Output Ripple	V_{IN} = 20V, I_O = 500mA	160mV_{PP}
Efficiency	V_{IN} = 20V, I_O = 500mA	82%

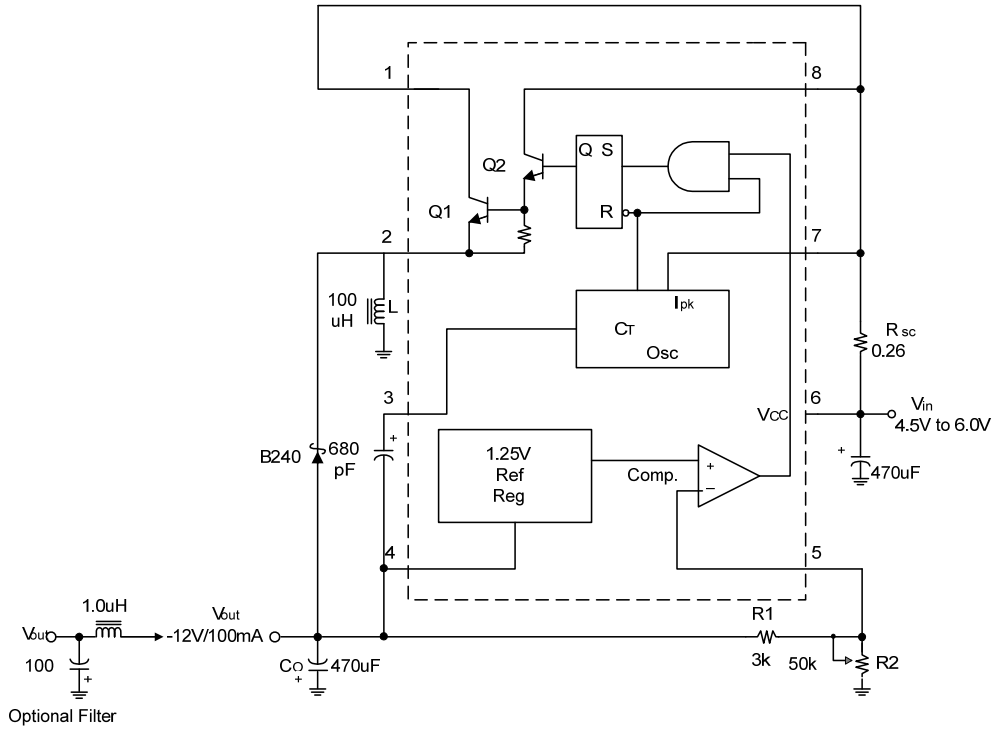


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Application Circuit (cont.)

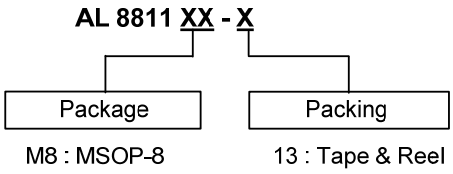
(4) Voltage Inverting Converter

Test	Conditions	Results
Line Regulation	V_{in} = 4.5V to 6.0V, I_O = 100mA	20mV = ±0.08%
Load Regulation	V_{in} = 5.0V, I_O = 20mA to 100mA	30mV = ±0.12%
Output Ripple	V_{in} = 5.0V, I_O = 100mA	500mV_{PP}
Efficiency	V_{in} = 5.0V, I_O = 100mA	60%



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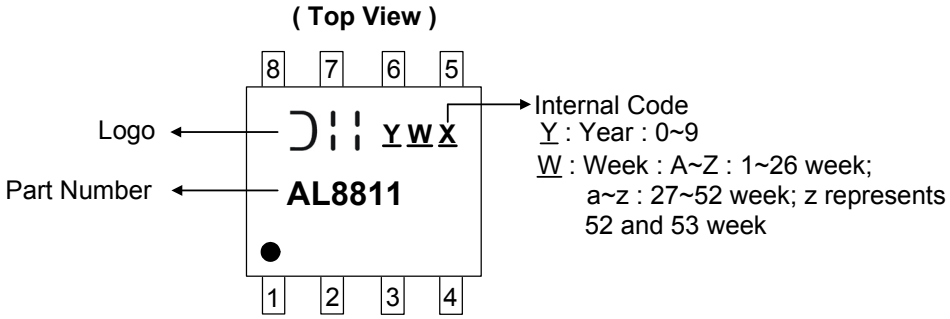
Ordering Information



Part Number	Package Code	Packaging	Tube		13" Tape and Reel	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix
AL8811M8-13	M8	MSOP-8	NA	NA	2500/Tape & Reel	-13

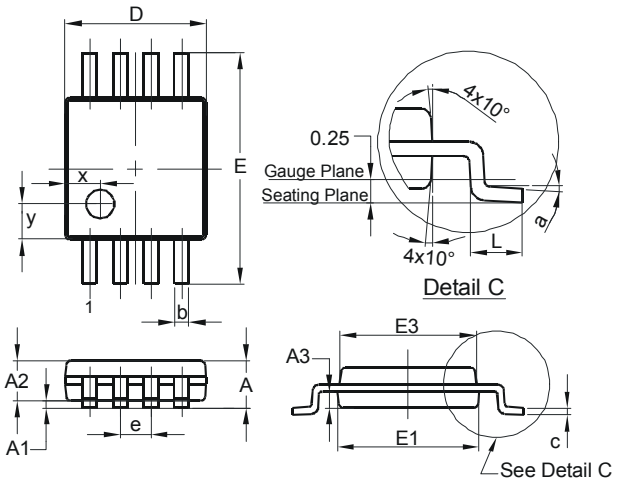
Marking Information

(1) MSOP-8



Package Outline Dimensions (All dimensions in mm.)

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

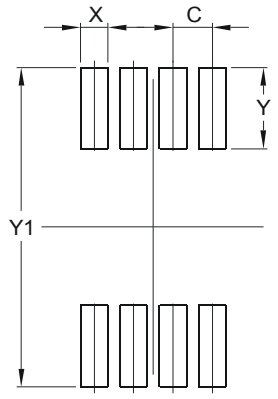


MSOP-8			
Dim	Min	Max	Typ
A	-	1.10	-
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E3	2.85	3.05	2.95
e	-	-	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	-	-	0.750
y	-	-	0.750
All Dimensions in mm			

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Suggested Pad Layout

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



Dimensions	Value (in mm)
C	0.650
X	0.450
Y	1.350
Y1	5.300

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