AP8801EV1 USER GUIDE

DESCRIPTION

The AP8801EV1, Figure 1, is a PCB constructed using an FR4 base for evaluating the AP8801 LED driver with internal switch in SOP-8L package. The evaluation board can be used to drive an external choice of LEDs; the total forward voltage across the LEDs depending on the number and type connected. [1]

The suggested operating voltage for the evaluation board ranges from 8V to 45V maximum. Higher voltage means lower supply current.

The nominal current for the evaluation board is set at 460mA with a 0R43 sense resistor, R1.

Test point CTRL provides a connection point for DC or PWM dimming and shutdown.

Note: The evaluation board does not have reverse polarity protection

Warning: with 500mA output, the connected LED will be hot and very bright

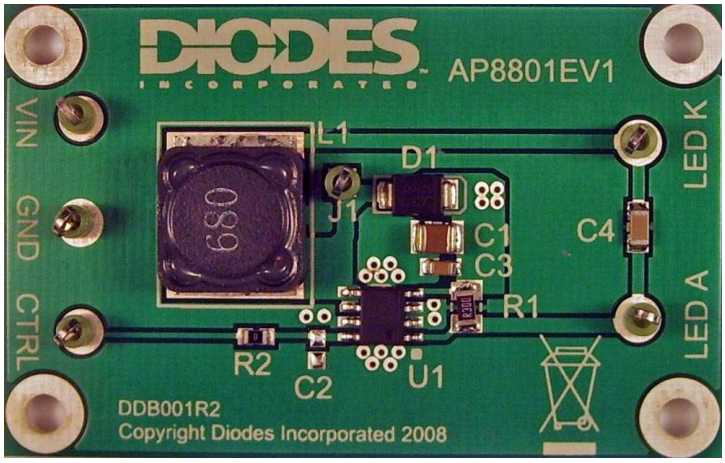


Figure 1: AP8801EV1 Evaluation Board

AP8801 DEVICE DESCRIPTION

The AP8801 is a step-down DC/DC converter designed to drive LEDs with a constant current. The device can drive up to thirteen LEDs, depending largely on the forward voltage of the LEDs, in series from a voltage source of 8V to 48V. Series connection of the LEDs provides identical LED currents resulting in uniform brightness and eliminates the need for ballast resistors. The AP8801 switches at frequencies up to 500kHz. This allows the use of small size external components, hence minimizing the PCB area needed.

Maximum output current of AP8801 is set via an external resistor connected between the V_{IN} and SET input pins. Dimming is achieved by applying either a DC voltage or a PWM signal at the CTRL input pin. An input voltage of 0.2V or lower at CTRL shuts down the output at SW and puts the device into a low-current standby state.

The device includes the output switch and a current sense circuit, which requires an external sense resistor to set the nominal current up to 500mA.

© Diodes Incorporated, 2009

AP8801 DEVICE FEATURES

- LED driving current up to 500mA
- Input voltage from 8V to 48V
- High efficiency up to 92%
- High switching frequency up to 500KHz minimum
- PWM/DC input for dimming control
- Built-in soft-start function
- Built-in output open-circuit protection
- SOP-8L, MSOP-8L are available in "Green" Molding Compound (No Br, Sb)
- Lead Free Finish/RoHS Compliant (Note 1)

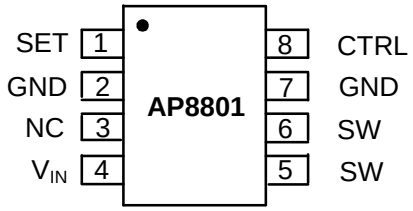
DEVICE APPLICATIONS

- Commercial & industrial lighting
- Small LCD panel backlighting
- Appliance interior lighting
- Architecture detail lighting

AP8801 Device Packages, Pin and Definitions

(1) SOP-8L

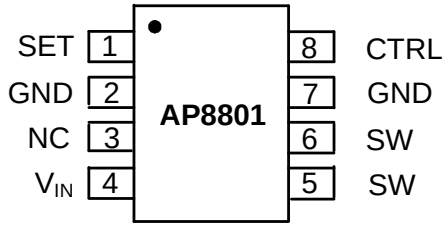
(Top View)



SOP-8L

(2) MSOP-8L

(Top View)



MSOP-8L

Pin Description

Name	Description
SW	Switch Pin. Connect inductor/freewheeling diode here. Minimize trace area at this pin to reduce EMI.
GND	GND pin
SET	Set Nominal Output Current Pin. Configure the output current of the device.
CTRL	Dimming and On/Off Control Input. Input voltage of 0.2V or lower forces the device into low current standby mode and shut off the output. A PWM signal allows the output current to be adjusted above or below the level set by the resistor connected to SET input pin. The input impedance is about 50kΩ, and if the pin is left open $V_{CTRL} = V_{REF}$
V_{IN}	Input Supply Pin. Must be locally bypassed with a capacitor.
NC	No connection

ORDERING INFORMATION

EVALBOARD ORDER NUMBER
AP8801EV1

Please note: Evaluation boards are subject to availability and qualified leads.

DEVICE ORDER NUMBER		
Device	**Package**	Tape & Reel
AP8801	S (SOP8L)	-13
	M8 (MSOP-8L)	-13

© Diodes Incorporated 2009

AP8801EV1 EVALUATION BOARD
REFERENCE DESIGN

The AP8801EV1 is an evaluation board configured to be used with the AP8801 in SOP-8L package. The target application is a driver for one or more series-connected LEDs for luminaires in both commercial and automotive applications.

The suggested maximum operating voltage for the evaluation board is 45V, and a 0R43 sense resistor R1 sets the nominal current at 460mA.

An accurate way of determining the current, avoiding the need to insert an ammeter in the current path, is to measure the voltage on the sense resistor. A 10K resistor and a 1uF capacitor can be used to form a low pass filter and the voltage across the capacitor represents a more stable dc reading of current. Using this method, 200mV represents 0.46 Amp when using a 0R43 sense resistor.

The CTRL pin connects to a low pass filter within the AP8801 chip to provide some decoupling, but the external capacitor C2 (100nF) is used to provide additional decoupling to reduce any high frequency noise as well as providing soft start function.

Both DC and PWM dimming can be achieved by driving the CTRL pin. For DC dimming, the CTRL pin may be driven between 0.3V and 1.25V. Driving the CTRL pin below 0.2V will shut down the output current. For PWM dimming, an external open-collector NPN transistor or open-drain N-channel MOSFET can be used to drive the CTRL pin. The PWM frequency can be around 100Hz to 1kHz.
For better resolution, PWM capacitor C2 should be removed on the evaluation board, to give a more accurate duty cycle.

Shorting R2 will connect the test pin CTRL to device pin CTRL if needed. The external capacitor C2 on the CTRL pin sets the soft start time. The amount of soft start time achievable is approximately 0.2ms/nF.
For other reference designs or further applications information, please refer to the AP8801 datasheet.

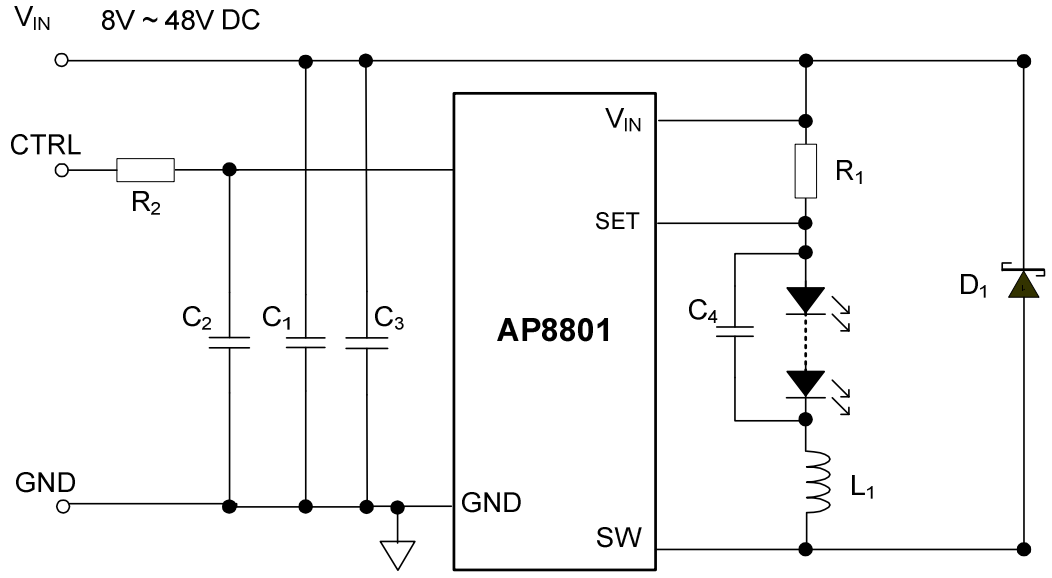


Figure 2: Schematic of the Evaluation Board

© Diodes Incorporated 2009

AP8801 OPERATION

In normal operation, when voltage is applied at V_{IN}, the AP8801's internal NDMOS switch is turned on. Current starts to flow through sense resistor R1, inductor L1, and the LED(s). The current ramps up linearly. The ramp rate is determined by the input voltage V_{IN} and inductor L1. This rising current produces a voltage ramp across R1. The internal circuit of the AP8801 senses this voltage and applies a proportional voltage to the input of the internal comparator. When this voltage reaches an internally set upper threshold, the NDMOS switch is turned off. The inductor current continues to flow through R1, L1, LED(s), Schottky diode D1, and back to the supply rail. The current decays, with the rate of decay determined by the forward voltage drop of the LEDs and the Schottky diode. This decaying current produces a falling voltage at R1 which is sensed by the AP8801. A voltage proportional to the sense voltage across R1 is applied at the input of the internal comparator. When this voltage falls to the internally set lower threshold, the NDMOS switch is turned on again. This switch-on-and-off cycle continues to provide an average current (set by the sense resistor R1) to the LEDs. Please refer to the datasheet for the threshold limits, AP8801 internal circuits, electrical characteristics and parameters.

AP8801EV1 Evaluation Board - BOM

Ref	Value	Package	Part Number	Manufacturer	Notes
U1	**AP8801**	**SOP-8L**	**AP8801SG**	**DIODES inc**	**DC-DC converter**
D1	**100V, 2A**	**SMB**	**B2100**	**DIODES inc**	**Schottky diode**
R1	0R43	1206	SR732BTTDR430F Generic	KOA	+/-1%, +/-100ppm
R2	0R0	0805	Generic	-	+/-1%
C1	4.7uF 50V	1210	C1210C475K5RAC GRM32ER71H475K	Kemet Murata	+/-10%
C2	-	-	Not fitted	--	-
C3	100nF, 100V	0805	C0805C104K1RAC NMC0805X7R104K100	Kemet NIC	+/-10%
C4	100nF, 100V	1206	C1206C104K1RAC GRM319R72A104K NMC1206X7R104K100	Kemet Murata NIC	+/-10%
L1	68uH	-	MSS1038-683ML NPIS104F680MTRF NPIS24H680MTRF	Coilcraft NIC NIC	68uH

The FR4 PCB design, with adequate copper top and bottom and plated through vias for thermal coupling, guarantees a good thermal dissipation for the AP8801 device. Other sources of heat are the Schottky diode, the inductor and the sense resistor, therefore care must be taken in their placement.

Warning: At 45V operation with 500mA output, the board temperature rises by around 60C from ambient after 30 minutes of operation.

© Diodes Incorporated 2009

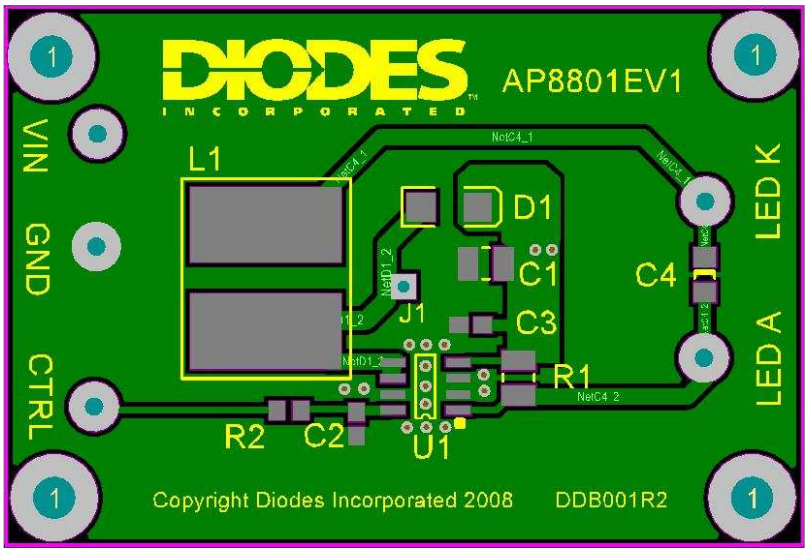


Figure 3: Component layout and circuit board view

AP8801EV1 Connection Point Definition	
Name	**Description**
VIN	Positive supply voltage.
GND	Supply Ground (0V).
CTRL	Internal voltage ref. pin (1.25V). This pin can be used to achieve dimming and soft-start, and for switching the output current off. • Leave floating for normal operation. • See 'Circuit Features' section to achieve dimming, soft-start and for switching the output current off.
LED A	LED A connects to the external LED anode
LED K	LED K connects to the external LED cathode

AP8801EV1 BASIC OPERATION AT FULL VOLTAGE

1. Connect external LEDs across test pins 'LED A' (anode) and 'LED K' (cathode). The number of external LEDs that can be connected depends on their operating power and forward voltage drop, but typically 12 x 3.2V LEDs can be connected using a 45V rail. For an external load other than LEDs, the positive terminal of the load should be connected to the anode and the negative to the cathode.

2. Connect VIN and GND.

   Warning: The board does not have reverse battery/supply protection.

3. Set the PSU to the desired input voltage (usually between 12V and 45V)

4. Turn on the PSU. The external LEDs will illuminate and the current should be approximately 500mA

5. The switching waveform on the SW pin can be acquired using the test point J1

   Warning: Do not stare at the LEDs directly.

© Diodes Incorporated 2009

CIRCUIT FEATURES

N.B. Remove power whilst changing components!

Soft-start

1. The AP8801 has a in-built soft start function. A capacitor, C2 may be fitted to the evaluation board to increase the soft start time by slowing the rise time of the adjust pin at start-up at the rate of 0.2ms/nF. The board is supplied with a zero-ohm resistor in position R2. Please see the data sheet for further details.

PWM

1. Remove the soft start capacitor C2

2. Refer to the datasheet for instructions on how to perform PWM

Switching off the output current

3. Shorting the CTRL pin to GND will cause the LED current to go to zero. Releasing this pin will switch on the system (creating a soft-start power up sequence if the C2 capacitor is used).

Changing the LED current

1. refer to the datasheet for the derating curve and the power dissipation capability of the package
2. Remove R1
3. Calculate and fit a new sense resistor, R1, the value of which is based on the required LED current without dimming. R1 can be calculated using following equation :

$R1 = 0.2V / I_{LED}$ where I_{LED} = the LED current.
R1 = the sense resistors value in ohms.
0.2V is the nominal sense voltage with CTRL open circuit or set to 1.25V.

PERFORMANCE

The system efficiency depends on the sense resistor, supply voltage, switching inductor, and the number of LEDs.

With a 45V supply and 12 LEDs, the switching frequency is typically 320 kHz and efficiency levels >90% are achievable.

Visit our website www.diodes.com to find useful tools for circuit design and simulation.

REFERENCE

[1] AP8801 Datasheet – www.diodes.com

© Diodes Incorporated 2009

INTENTIONALLY BLANK

© Diodes Incorporated 2009

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARD TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channels. Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or

2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably be expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2009, Diodes Incorporated

www.diodes.com

Sales offices

The Americas
3050 E. Hillcrest Drive
Westlake Village,
CA 91362-3154
Tel: (+1) 805 446 4800
Fax: (+1) 805 446 4850

Europe
Kustermannpark
Balanstraße 59,
D-81541 München
Germany
Tel: (+49) 894 549 490
Fax: (+49) 894 549 4949

Taiwan
7F, No. 50,
Min Chuan Road
Hsin-Tien
Taipei, Taiwan
Tel: (+886) 289 146 000
Fax: (+886) 289 146 639

Shanghai
Rm. 606, No.1158
Changning Road
Shanghai, China
Tel: (+86) 215 241 4882
Fax (+86) 215 241 4891

Shenzhen
Room A1103-04,
ANLIAN Plaza, #4018
Jintian Road
Futian CBD,
Shenzhen, China
Tel: (+86) 755 882 849 88
Fax: (+86) 755 882 849 99

Korea
6 Floor, Changhwa B/D,
1005-5 Yeongtong-dong,
Yeongtong-gu, Suwon-si,
Gyeonggi-do, Korea 443-813
Tel: (+82) 312 731 884
Fax: (+82) 312 731 885

© Diodes Incorporated 2009