

AP8802HEV2 USER GUIDE

DESCRIPTION

The AP8802HEV2, Figure 1, is a PCB constructed using an FR4 base for evaluating the AP8802H LED driver with internal switch in the SOP-8L-EP 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 60V maximum. Higher voltage means lower supply current.

The nominal current for the evaluation board is set at 1A with a 0R2 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 1A output, the connected LEDs will be hot and very bright

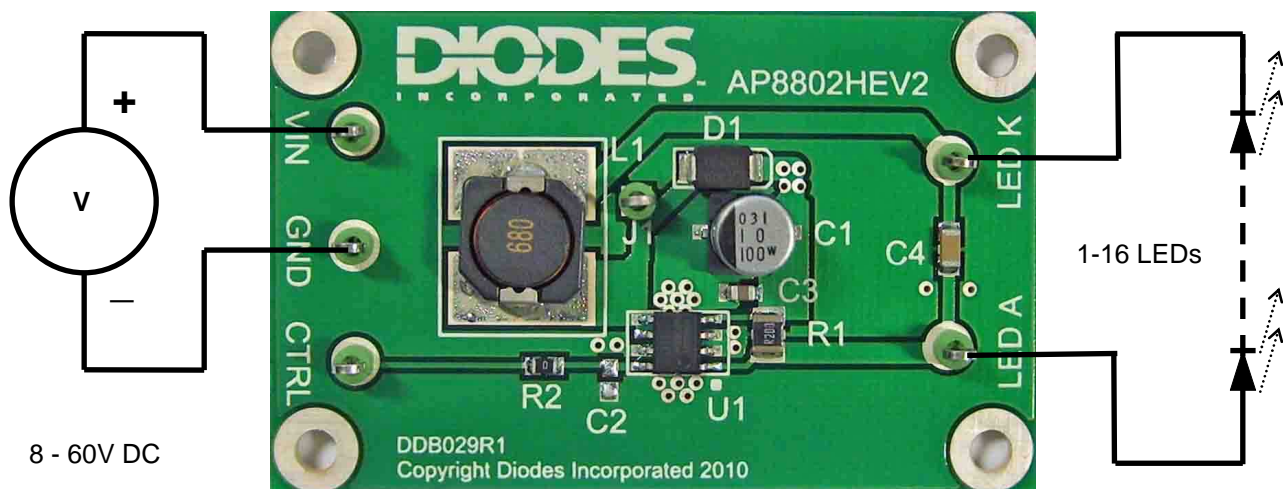


Figure 1: AP8802HEV2 evaluation board and connection diagram

AP8802H DEVICE DESCRIPTION

The AP8802H is a step-down DC/DC converter designed to drive LEDs with a constant current. The device can drive up to seventeen LEDs, in series, depending largely on their forward voltage, from a source of between 8V and 60V. Series connection of the LEDs provides identical LED currents, resulting in uniform brightness and eliminates the need for ballast resistors. The AP8802H switches at frequencies up to 500KHz. This allows the use of small size external components, hence minimizing the PCB area needed.

The maximum output current of the AP8802H 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.

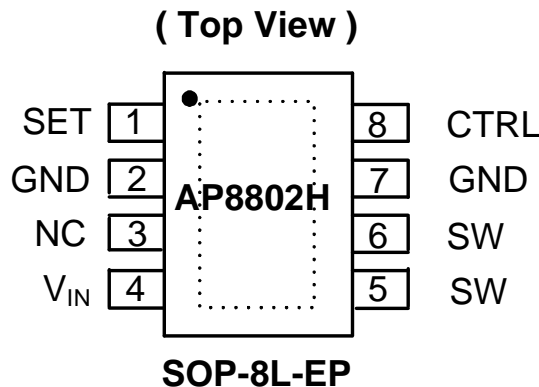
The device includes the output switch and a current sense circuit, which requires an external sense resistor to set the nominal current up to 1A.

AP8802H DEVICE FEATURES

- LED driving current up to 1A
- Input voltage from 8V to 60V
- 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, in environmentally “Green” Molding Compound (No Br, Sb)
- Lead Free Finish/RoHS Compliant

DEVICE APPLICATIONS

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



ORDERING INFORMATION

EVALBOARD ORDER NUMBER
AP8802HEV2

DEVICE ORDER NUMBER		
Device	Package	Tape & Reel
AP8802H	SP (SOP-8L-EP)	-13

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

AP8802HEV2 EVALUATION BOARD REFERENCE DESIGN

The AP8802HEV2 is an evaluation board configured to be used with the AP8802H in SOP-8L-EP package. The target application is a driver for one or more series-connected LEDs for luminaires in both commercial and automotive applications.

The maximum operating voltage for the evaluation board is 60V, and a 0R2 sense resistor R1 sets the nominal current at 1A.

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 1 Amp when using a 0R2 sense resistor.

The CTRL pin connects to a low pass filter within the AP8802H chip to provide some decoupling, but the external capacitor C2 (100nF) can be used to provide additional decoupling to reduce any high frequency noise as well as providing the soft start function.

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 50k, 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

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 1 kHz. For better resolution, PWM capacitor C2 should be removed from 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 AP8802H datasheet.

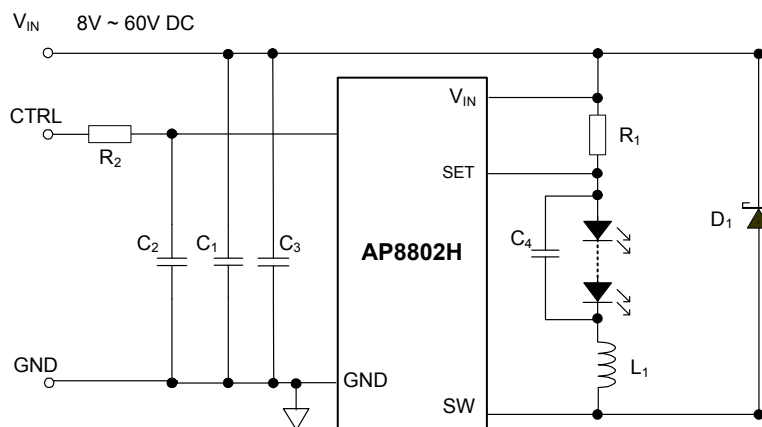


Figure 2: Schematic of the Evaluation Board

AP8802H OPERATION

In normal operation, when voltage is applied at V_{IN} , the AP8802H's internal NDMOS switch is turned on. Current starts to flow through sense resistor R_1 , inductor L_1 , and the LED(s). The current ramps up linearly, the rate being determined by the input voltage V_{IN} and inductor L_1 . This rising current produces a voltage ramp across R_1 . The internal circuit of the AP8802H 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 R_1 , L_1 , the LED(s), Schottky diode D_1 , 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 R_1 which is sensed by the AP8802H. A voltage proportional to the sense voltage across R_1 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 R_1) to the LEDs. Please refer to the datasheet for the threshold limits, AP8802H internal circuits, electrical characteristics and parameters.

AP8802HEV2 EVALUATION BOARD - BILL OF MATERIALS

Ref	Value	Package	Part Number	Manufacturer	Notes
U1	AP8802H	SOP8LEP	AP8802HSPG	DIODES inc	DC-DC converter
D1	100V, 2A	SMB	B2100	DIODES inc	Schottky diode
R1	0R2	1210	Generic	-	+/-1%, +/-100ppm
R2	0R0	0805	Generic	-	
C1	10uF 100V		generic NACE100M100V6.3x8	NIC Components	6.3mm x 8mm SMD electrolytic 85C
C2	-	-	Not Fitted	-	-
C3	100nF, 100V	0805	Generic NMC0805X7R104K100	NIC Components	X7R +/-20%
C4	100nF 100V	1206	Generic NMC1206X7R104K100	NIC Components	X7R +/-20%
L1	68uH	-	MSS1038-683ML NPIS104F680MTRF NPIS24H680MTRF	Coilcraft NIC Comps. NIC Comps.	68uH, ~0.2R, ~1.5A

Note: if not available, components shown above may be changed without notice.

The FR4 PCB design, with adequate copper top and bottom and plated through vias for thermal coupling, guarantees a good thermal dissipation for the AP8802H 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 60V operation with 1A output, the board will become hot !

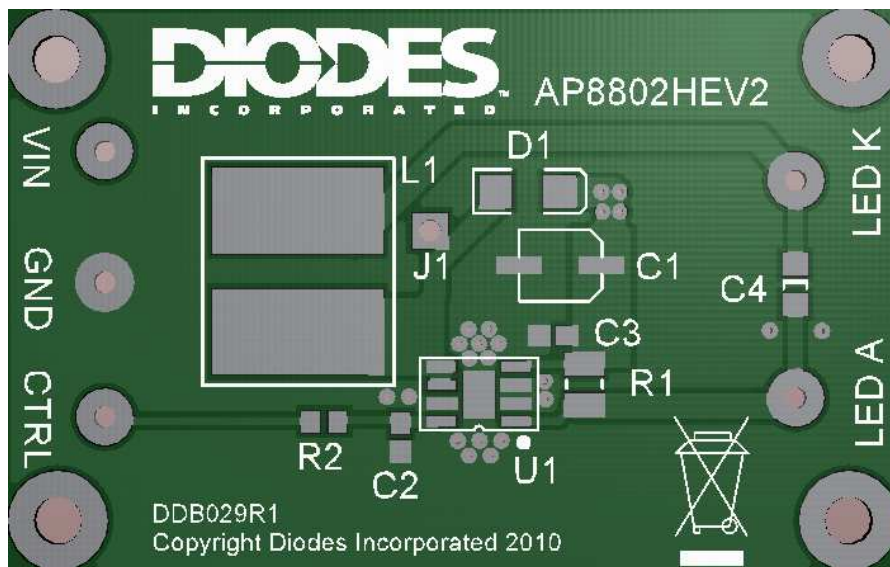


Figure 3: Component layout and circuit board view

AP8802HEV2 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. <ul style="list-style-type: none"> • 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

AP8802HEV2 BASIC OPERATION AT FULL VOLTAGE

1. Connect external LEDs across the 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 16 x 3.2V LEDs can be connected using a 60V 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 (60V max.)
 4. Turn on the PSU. The external LEDs will illuminate and the current should be approximately 1A
 5. The switching waveform on the SW pin can be acquired using the test point J1

Warning: Do not stare at the LEDs directly.

CIRCUIT FEATURES

N.B. Remove power whilst changing components!

Soft-start

1. The AP8802H 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 (if it has been added by the user)
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 :

$$R1 = 0.2V / I_{LED} \text{ where } I_{LED} = \text{the LED current.}$$

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 60V supply and 16 LEDs, the switching frequency is typically 200kHz and efficiency levels >90% are achievable.

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

REFERENCE

[1] AP8802H Datasheet – www.diodes.com

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