

Description

The AP8803 is a step-down DC/DC converter designed to drive LEDs with a constant current. The device can drive up to 7 LEDs, depending on the forward voltage of the LEDs, in series from a voltage source of 8V to 30V. Series connection of the LEDs provides identical LED currents resulting in uniform brightness and eliminating the need for ballast resistors. The AP8803 switches at frequency up to 700kHz. This allows the use of small size external components, hence minimizing the PCB area needed.

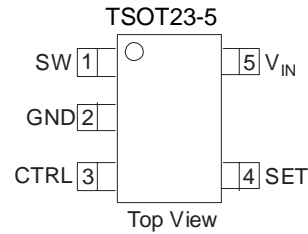
Maximum output current of AP8803 is set via an external resistor connected between the V_{IN} and SET input pins. Dimming is achieved by applying either a DC voltage or a PWM signal at the CTRL input pin. An input voltage of 0.2V or lower at CTRL shuts down the output at SW and puts the device into a low-current standby state.

Features

- LED driving current up to 1A
- High efficiency up to 92%
- Operating input voltage up to 30V
- High switching frequency up to 700kHz
- PWM/DC input for dimming control
- Built-in output open-circuit protection
- TSOT23-5 is available in "Green" Mold Compound
- (No Br, Sb) and lead Free Finish/RoHS Compliant (Note 1)

Notes: 1. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at http://www.diodes.com/products/lead_free.html.

Pin Assignments



Typical Application Circuit

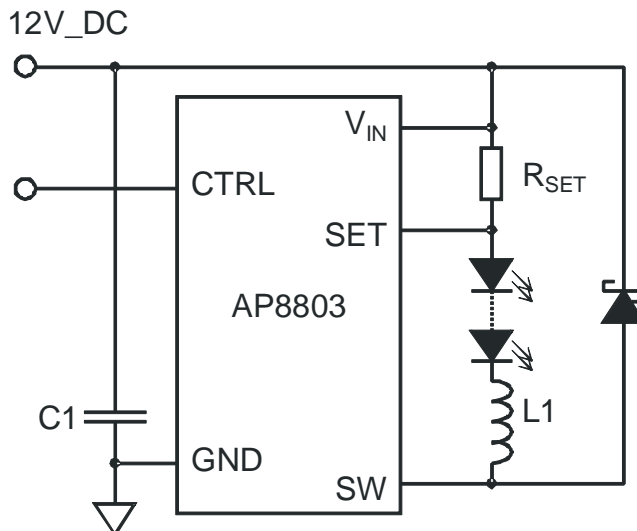


Figure 1. Typical Application Circuit

Pin Descriptions

| Pin Name | Description |
|-----------------|--|
| SW | Switch Pin. Connect inductor/freewheeling diode here, minimizing track length 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. <ul style="list-style-type: none"> Leave floating for normal operation. ($V_{CTRL} = V_{REF} = 1.25V$ giving nominal average output current $I_{OUTnom} = 0.1/R_S$) Drive to voltage below 0.2V to turn off output current Drive with DC voltage ($0.3V < V_{CTRL} < 1.25V$) to adjust output current from 25% to 100% of I_{OUTnom} Input voltage of 0.2V or lower forces the device into low current standby mode and shuts 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. |
| V _{IN} | Input Supply Pin. Must be locally decoupled to GND with $\geq 2.2\mu F$ X7R ceramic capacitor. |

Absolute Maximum Ratings

| Symbol | Parameter | Rating | Unit |
|-------------------|--|-------------|------|
| V _{IN} | Continuous V _{IN} pin voltage | -0.3~30 | V |
| | Transient (t < 0.5s) | 40 | |
| V _{SW} | SW voltage | -0.3~30 | V |
| | Transient (t < 0.5s) | 40 | |
| V _{CTRL} | CTRL pin input voltage | -0.3 ~ 6 | V |
| I _{SW} | Switch current | 1.25 | A |
| T _J | Junction Temperature | 150 | °C |
| T _{LEAD} | Lead Temperature Soldering | 300 | °C |
| T _{ST} | Storage Temperature Range | -65 to +150 | °C |

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any condition.
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 _{IN} | Operating Input Voltage | 8.0 | 30 | V |
| V _{CTRLH} | Voltage High | 0.3 | 2.5 | V |
| V _{CTRLL} | Voltage Low | | 0.25 | V |
| I _{SW} | Continuous switch current (Note 3) | | 1 | A |
| T _A | Ambient Temperature Range | -40 | 125 | °C |
| Duty Cycle | Using Inductor $\geq 100\mu H$ (Note 2) | 0.1 | 0.95 | |

Notes: 2. For most applications the LED current will be within 8% over the duty cycle range specified. Duty cycle accuracy is also dependent on propagation delay. Smaller size inductors can be used but LED current accuracy may be greater than 8% at extremes of duty cycle. This is most noticeable at low duty cycles (less than 0.1) or when the input voltage is high and only one LED is being driven.
3. Refer to figure 4 for the device derating curve.

Electrical Characteristics ($V_{IN} = 12V$, $T_A = 25^\circ C$, unless otherwise specified.)

| Symbol | Parameter | Conditions | Min | Typ. | Max | Unit |
|-------------------|--|--------------------------------|-----|------|-----|--------------|
| V_{INSU} | Internal regulator start up threshold | V_{IN} rising | | 5.65 | | V |
| V_{INSD} | Internal regulator shutdown threshold | V_{IN} falling | | 5.55 | | V |
| I_Q | Quiescent Current | CTRL pin floating $f = 250kHz$ | | 1.8 | 5 | mA |
| V_{THD} | Internal Threshold Voltage | | 92 | 100 | 108 | mV |
| I_{SET} | SET pin input current | $V_{SET} = V_{IN} - 0.1$ | | 1.25 | 10 | μA |
| V_{REF} | Internal Reference Voltage | | | 1.25 | | V |
| $R_{DS(on)}$ | On Resistance of MOSFET | $I_{SW} = 1A$ | | 0.5 | 1 | Ω |
| I_{SW} | Continuous switch current | (Note 3) | | | 1 | A |
| $I_{SW_Leakage}$ | Switch leakage current | | | | 8 | μA |
| f_{OSC} | Switching Frequency | | | | 0.7 | MHz |
| θ_{JA} | Thermal Resistance Junction-to-Ambient | TSOT23-5 (Note 4) | | 125 | | $^\circ C/W$ |

- Notes:
3. Refer to figure 4 for the device derating curve.
 4. Test condition for TSOT23-5: Device mounted on FR-4 PCB, 25mm x 25mm, 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.

Applications Information

LED Current Control

The LED current is controlled by the resistor R_{SET} in Figure 1.

Connected between V_{IN} and SET the nominal average output current in the LED(s) is defined as:

$$I_{LED} = \frac{V_{THD}}{R_{SET}}$$

If the CTRL pin is driven by an external voltage (lower than 2.5V), the average LED current is:

$$I_{LED} = \frac{V_{CTRL}}{V_{REF}} \frac{V_{THD}}{R_{SET}}$$

The graph in figure 2 gives values of nominal average output current for several values of current setting resistor (RSET) in the typical application circuit shown on Figure 1, for different voltages applied on the CTRL pin. It can be used to determine the RSET value based on the desired LED current and the condition of the CTRL pin (floating or driven with an external DC voltage lower than 2.5V and higher than 0.2V).

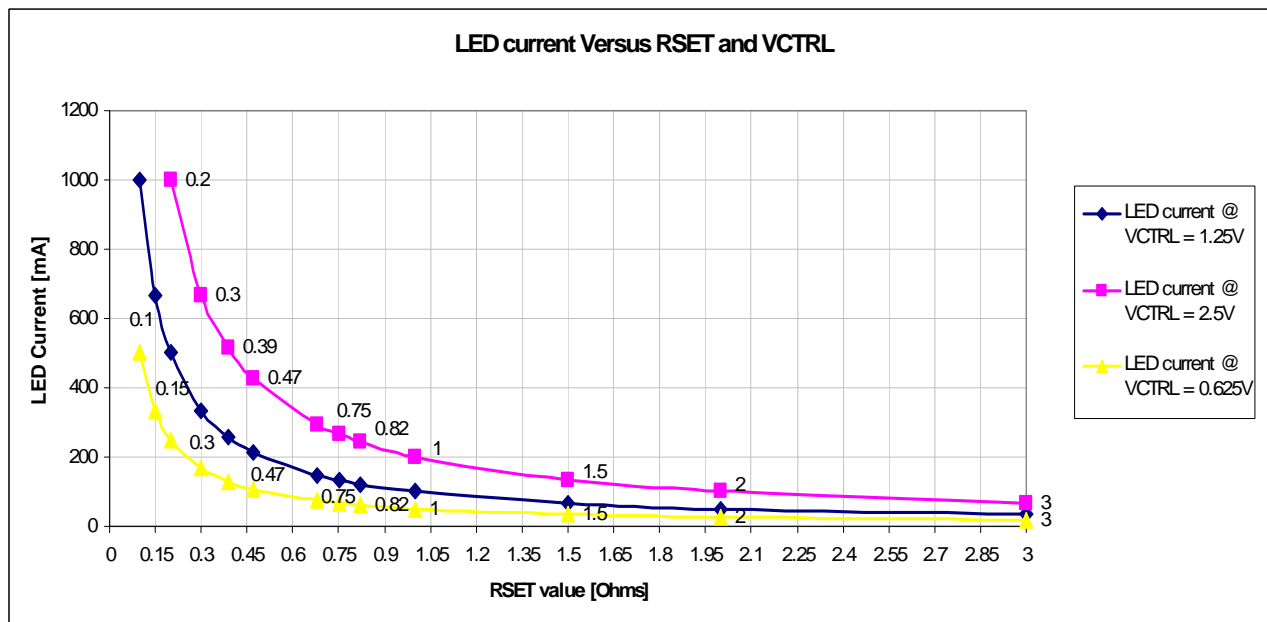


Figure 2. LED Current setting Vs RSET and VCTRL

Inductor Selection

A 33μH inductor (or higher) is recommended for most AP8803 applications with input voltage at 24V.

Figure 3 displays the resulting switching frequency varying the main circuit parameters: Supply voltage, inductor value and number of LEDs to be driven.

In particular, the graph in figure 3 gives values of nominal switching frequency for several values of inductors (L1) in the typical application circuit shown on Figure 1, for different input voltages and load condition. It can be used to determine the inductor value based on the desired switching frequency and the input and load conditions.

Applications Information (Continued)

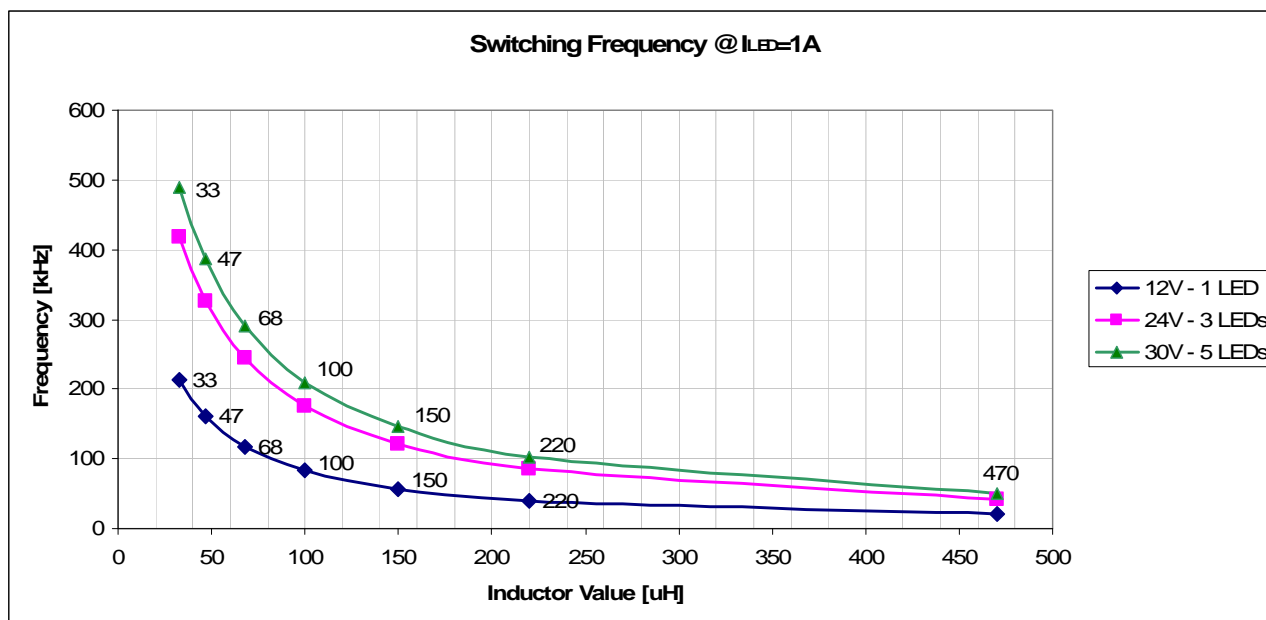


Figure 3. Switching Frequency vs. Supply voltage, Inductor, and number of LEDs

Capacitor Selection

The small size of ceramic capacitors makes them ideal for AP8803 applications. X5R and X7R types are recommended because they retain their capacitance over wider voltage and temperature ranges than other types such as Z5U. A 2.2µF input capacitor is sufficient for most intended applications of AP8803.

Diode Selection

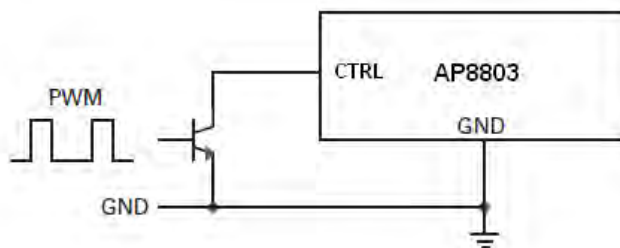
Schottky diodes, e.g. B240 or DFSL240L in the proprietary PowerDI®123 package, with their low forward voltage drop and fast reverse recovery, are the ideal choice for AP8803 applications.

In addition, Super Barrier Rectifier devices (as SBR2A40P1) can be used for their enhanced thermal performances.

PWM Dimming

A Pulse Width Modulated (PWM) signal with a max resolution of 8-bit, can be applied to the CTRL pin to change the output current to a value above or below the nominal average value set by resistor R_{SET}. To achieve this resolution the PWM frequency has to be lower than 500Hz.

The recommended method of driving the CTRL pin and controlling the amplitude of the PWM waveform is to use a small NPN switching transistor as shown below:



This scheme uses the internal 200kΩ resistor between the CTRL pin and the internal voltage reference as a pull-up resistor for the external transistor eg MMBT3904.

Applications Information (Continued)

Thermal Considerations

The graph below in figure 4, gives details for power dissipation derating. This assumes the device to be mounted on a 25x25mm PCB with 1oz copper standing in still air.

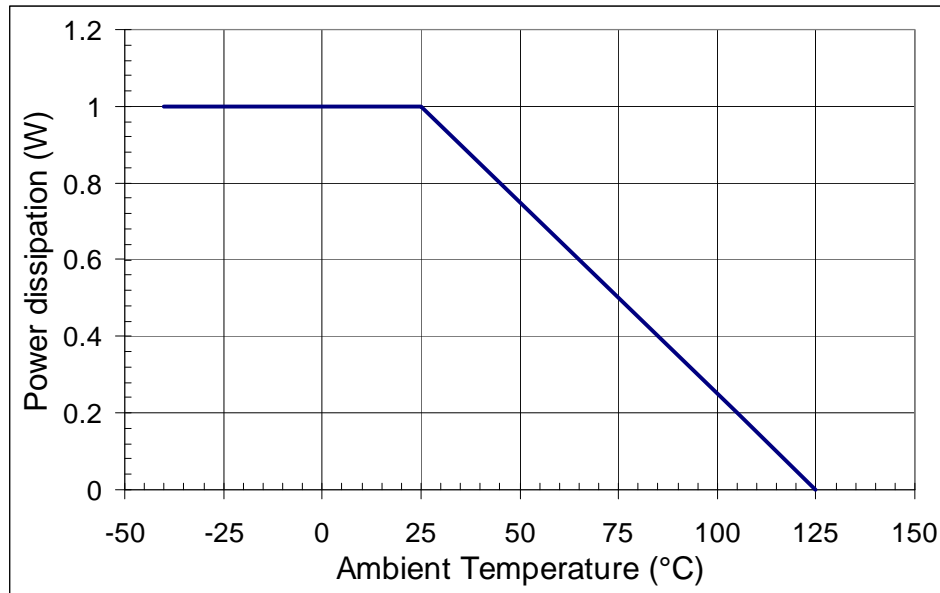
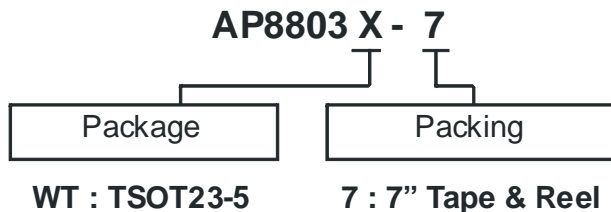


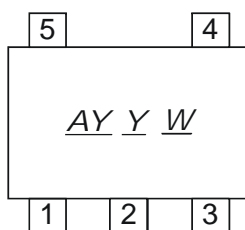
Figure 4. Power dissipation derating curve

Ordering Information



| Device | Package Code | Packaging (Note 2) | 7" Tape and Reel | |
|-------------|--------------|--------------------|------------------|--------------------|
| | | | Quantity | Part Number Suffix |
| AP8803WTG-7 | WT | TSOT23-5 | 3000/Tape & Reel | -7 |

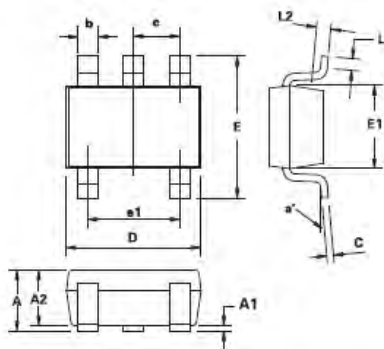
Marking Information



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

Package Outline Dimensions

TSOT23-5



| DIM | Millimeters | | Inches | |
|-----|-------------|------|------------|--------|
| | Min. | Max. | Min. | Max. |
| A | - | 1.00 | - | 0.0393 |
| A1 | 0.01 | 0.10 | 0.0003 | 0.0039 |
| A2 | 0.84 | 0.90 | 0.0330 | 0.0354 |
| b | 0.30 | 0.45 | 0.0118 | 0.0177 |
| c | 0.12 | 0.20 | 0.0047 | 0.0078 |
| D | 2.90 BSC | | 0.114 BSC | |
| E | 2.80 BSC | | 0.110 BSC | |
| E1 | 1.60 BSC | | 0.062 BSC | |
| e | 0.95 BSC | | 0.0374 BSC | |
| e1 | 1.90 BSC | | 0.0748 BSC | |
| L | 0.30 | 0.50 | 0.0118 | 0.0196 |
| L2 | 0.25 BSC | | 0.010 BSC | |
| a° | 4° | 12° | 4° | 12° |

Note: Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

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