

Features

- LED Power Efficiency: up to 90%
- LED Current Accuracy: $\pm 3\%$ ($V_{IN}=3.2V$ to $1.1V$ @ $V_F=3.4V$)
- Low Start-Up Voltage: $0.9V$ ($I_{LED}=243mA$)
- Low Hold Voltage: $0.65V$ ($I_{LED}=95mA$)
- Internal 2A MOSFET Switch
- 1.0MHz Switching Frequency
- Small, Low Profile External Components
- Low $R_{DS(ON)}$: $100m\Omega$ (TYP.)
- Open LED Protection
- Over Temperature Protection
- Low Profile SOT-23 Package
- Pb-Free Package

Applications

- White LED Torch (Flashlight)
- White LED Camera Flash
- DSC (Digital Still Camera) Flash
- Cellular Camera Phone Flash
- PDA Camera Flash
- Camcorder Torch (Flashlight) Lamp

General Description

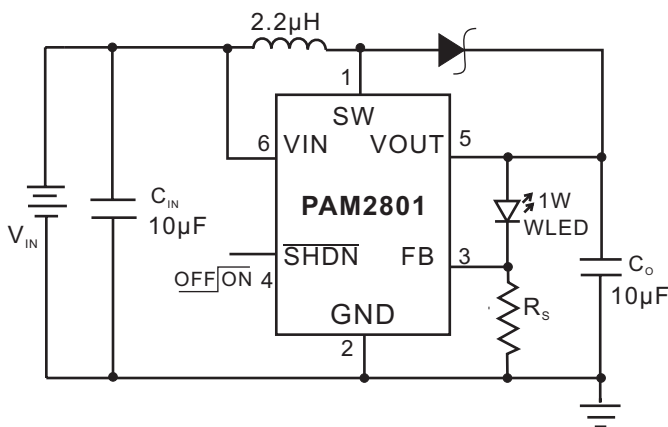
The PAM2801 is a step-up DC-DC converter that delivers a regulated output current. The device switches at a 1.0MHz constant frequency, allowing for the use of small value external inductor and ceramic capacitors.

The PAM2801 is targeted to be used for driving 1W white LED from 0.9V to 3.2V input. The LED current can be programmed by an external current sense resistor, R_s , connected between the feedback pin (FB) and ground. A 95mV feedback voltage reduces the power loss in the R_s for better efficiency. With its internal 2A 100m Ω NMOS switch, the device can provide high efficiency even at heavy load.

LED dimming can be done by applying a DC voltage on the FB pin and a pulse width modulation (PWM) signal on the FB pin or SHDN pin. In shutdown mode, the feedback resistor R_s and the load are completely disconnected and the current consumption is reduced to less than 1 μA .

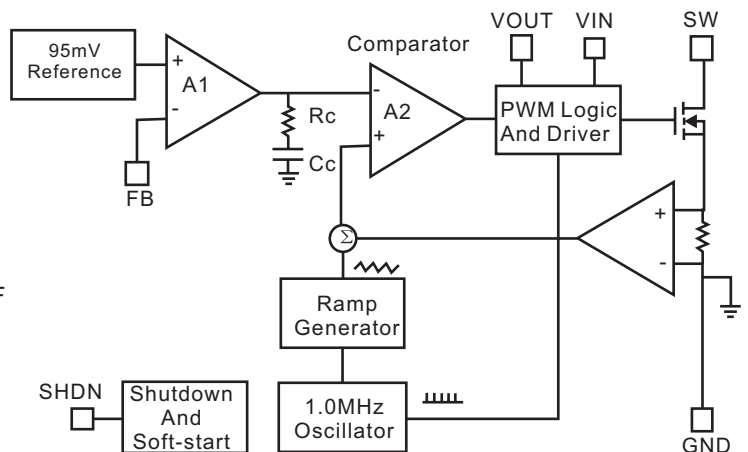
The PAM2801 is available in 6-lead SOT23-6 package.

Typical Application

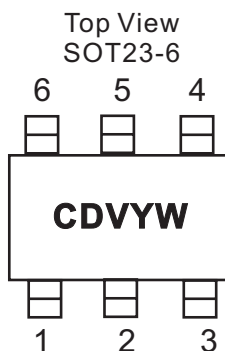


$I_{LED}=350mA, R_s=0.27\Omega$

Block Diagram



Pin Configuration & Marking Information



CD: Product Code
V: Voltage Code
Y: Year
W: Week

Pin Number	Name	Function
1	SW	Switch
2	GND	Ground
3	FB	Feedback
4	SHDN	Shut Down
5	VOUT	Output
6	VIN	Input

Absolute Maximum Ratings

These are stress ratings only and functional operation is not implied. Exposure to absolute maximum ratings for prolonged time period may affect device reliability. All voltages are with respect to ground.

Input Pin Voltage.....	-0.3V to 6V	Maximum Junction Temperature	150°C
SW Pin Voltage.....	-0.3V to 6V	Storage Temperature Range.....	-65°C to 150°C
SHDN, FB Pin Voltage.....	-0.3V to 6V	Lead Temperature (Soldering, 5 sec)	300°C

Recommended Operating Conditions

Junction Temperature.....	-40°C to 125°C	Ambient Temperature.....	-40°C to 85°C
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Thermal Information

Parameter	Package	Symbol	Maximum	Unit
Thermal Resistance (Junction to Case)	SOT23-6	θ_{JC}	130	°C/W
Thermal Resistance (Junction to Ambient)	SOT23-6	θ_{JA}	250	
Internal Power Dissipation	SOT23-6	P_D	400	mW



PAM2801

1W High Power White LED Driver

Electrical Characteristic

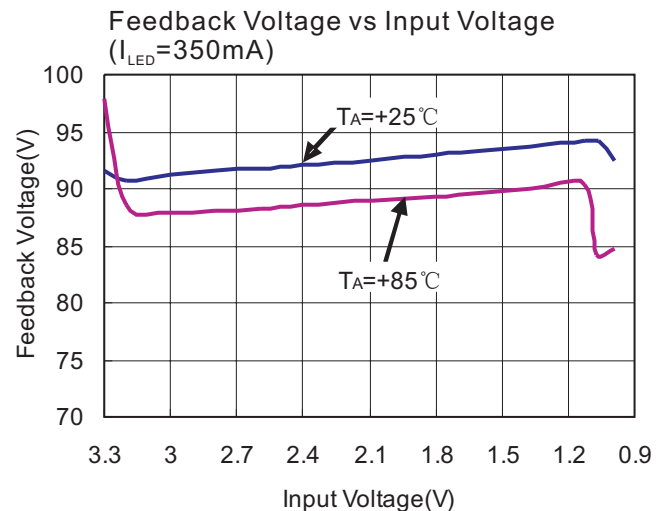
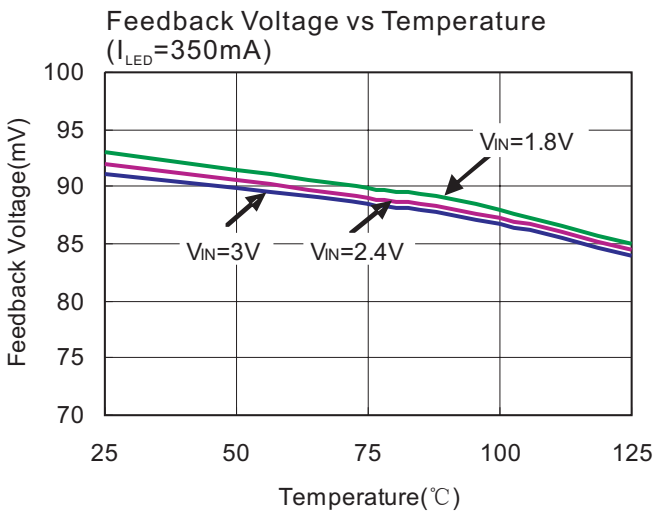
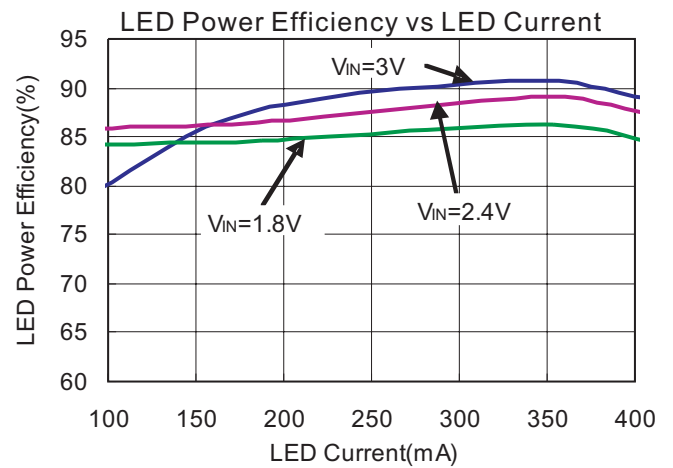
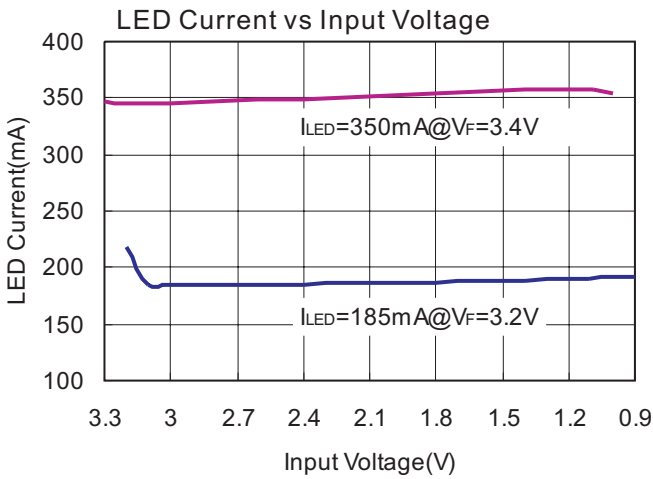
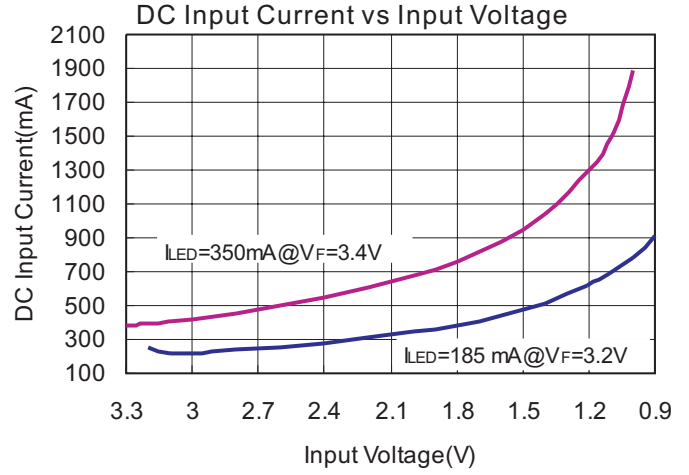
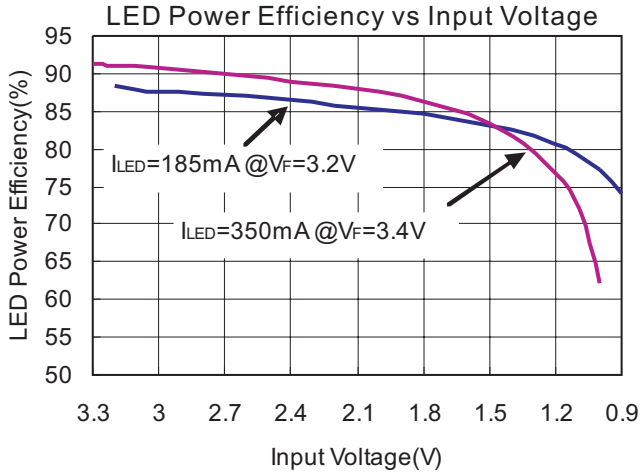
$T_A=25^{\circ}\text{C}$, $V_{IN}=2.4\text{V}$, $I_{LED}=350\text{mA}$, $V_{SHDN}=V_{IN}$, $L=2.2\mu\text{H}$, $C_{IN}=10\mu\text{F}$, $C_O=10\mu\text{F}$, unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		0.9		$V_F-0.2$ (Note)	V
Feedback Voltage	V_{FB}		90	95	100	mV
Start-up Voltage	V_{START}	$I_{LED}=243\text{mA}$ ($R_S=0.39\Omega$), $V_{IN}: 0\text{V} - 2.4\text{V}$		0.9		V
Hold Voltage	V_{HOLD}	$I_{LED}=95\text{mA}$ ($R_S=1\Omega$), $V_{IN}: 2.4\text{V} - 0\text{V}$		0.65		V
Oscillator Frequency	F_{OSC}		0.85	1.0	1.15	MHz
SHDN Input High	V_{SH}	$V_{IN}=1.8\text{V}$	1.0			V
SHDN Input Low	V_{SL}	$V_{IN}=1.8\text{V}$			0.4	V
Over Temperature Shutdown	OTS			150		$^{\circ}\text{C}$
Over Temperature Hysteresis	OTH			15		$^{\circ}\text{C}$
Maximum Output Current Range	$I_{O(MAX)}$		350			mA
Quiescent Current	I_Q	$I_{LED}=0\text{mA}$, $V_O=3.4\text{V}$, Device Switching at 1MHz		1	3	mA
Shutdown Current	I_{SD}	Shutdown mode			1	μA
Switch on Resistance	R_{DSON}	$V_O=3.4\text{V}$		0.1		Ω
Current Limit	I_{LIM}	$V_O=3.4\text{V}$	2			A
Efficiency	η	$I_{LED}=350\text{mA}$		90		%

Note: V_F - LED Forward Voltage

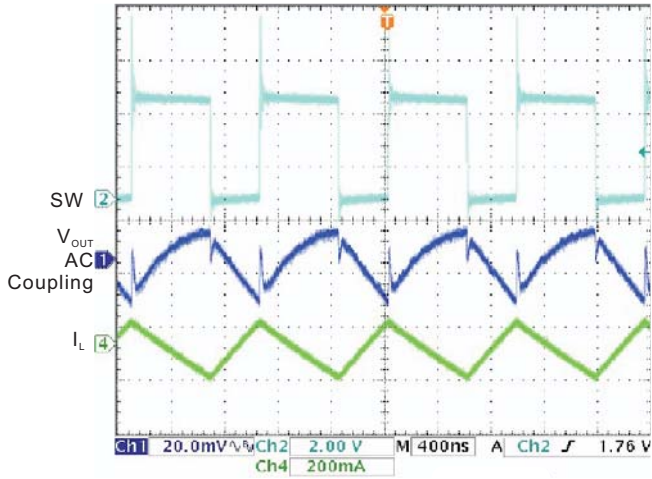
Typical Performance Characteristics

$T_A=25^\circ\text{C}$, $L=2.2\mu\text{H}$, $C_{IN}=10\mu\text{F}$, $C_O=10\mu\text{F}$, unless otherwise noted.

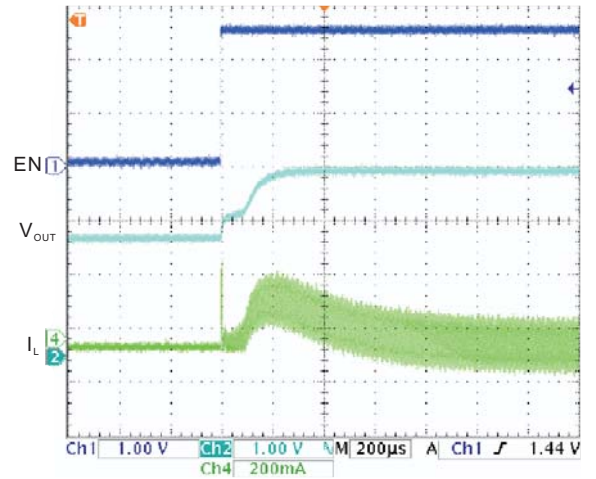


Typical Performance Characteristics (continued)

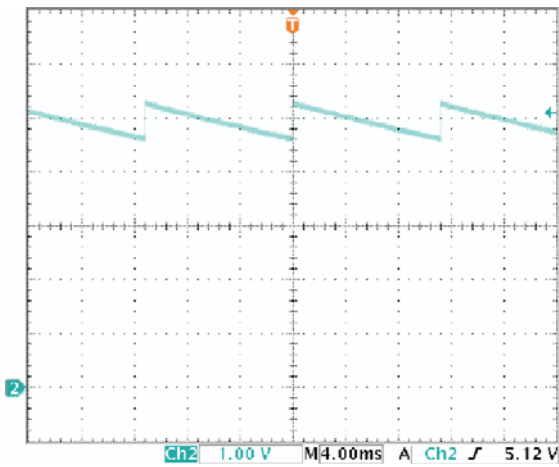
Switching Waveform



Start-Up Waveform



Overvoltage Protection



Application Information

Inductor Selection

The PAM2801 can use a small value inductor because of its 1MHz switching frequency. The value of inductor focuses in the range of 1.5μH to 4.7μH for most PAM2801 applications. In typical high current white LED applications, it is recommended to use a 4.7μH inductor. The inductor should have low DCR (DC resistance) to minimize the I^2R power loss, and a current rating of 2A to handle the peak inductor current without saturating.

Capacitor Selection

An input capacitor is required to reduce the input ripple and noise for proper operation of the PAM2801. For good input decoupling, Low ESR (equivalent series resistance) capacitors should be used at the input. At least a 2.2μF input capacitor is recommended for most applications.

A minimum 4.7μF output capacitor is recommended under normal operating conditions, while a 10μF-22μF capacitor may be required for higher power LED current. A reasonable value of the output capacitor depends on the LED current. The ESR of the output capacitor is the important parameter to determine the output voltage ripple of the converter, so low ESR capacitors should be used at the output to reduce the output voltage ripple.

The small-size ceramic capacitors are good choice for PAM2801 applications. The X5R and X7R types are preferred because they maintain capacitance over wide voltage and temperature ranges.

Diode Selection

It is indispensable to use a Schottky diode rated at 2A with the PAM2801. Using a Schottky diode with a lower forward voltage drop will improve the power LED efficiency. The voltage rating of the diode should be greater than the output voltage. In application, the ON Semiconductor MBRA210LT3G is recommended.

LED Current Setting

The LED current is set by the single external R_s resistor connected to the FB pin as shown in the typical application circuit. The typical FB

reference is internally regulated to 95mV. The LED current is $95mV/R_s$. It is recommended to use a 1% or better precision resistor for the better LED current accuracy. The formula and table 1 for R_s selection are shown as follows:

$$R_s = 95mV / I_{LED}$$

Table 1. R_s Resistor Value Selection

Standard Value(Ω)	$I_{LED}(mA)$
1	95
0.47	202
0.39	243
0.33	288
0.27	352
0.24	396

LED Dimming Control

Dimming Control with DC Voltage on FB Pin

One method for dimming the LEDs is to apply a variable DC voltage through a resistor to the FB pin of the PAM2801. The dimming control with a DC voltage is shown in the Figure1. The DC voltage raises the FB pin voltage, the voltage across R_2 increases and the voltage across R_s decreases, thus lowering the LED current. The values of resistor R_1 and R_2 should be large enough to make the current from the DC source much smaller than the LED current while much larger than the FB leakage current. When V_{DC} ranges from 0V to 2V, the resistors in the Figure will set the LED current from 0mA to 350mA.

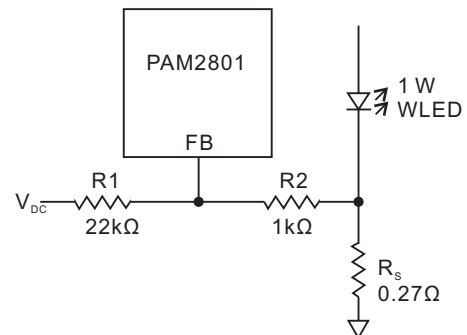


Figure 1. Dimming Control Using a DC Voltage to FB Pin

Dimming Control with PWM Signal on FB Pin

By using the PWM signal to FB pin as shown in Figure 2, the LED is turned on or off and its current operates at either 0mA or the set maximum current. The PWM signal can be considered as an adjustable DC voltage. When the PWM duty cycle increases, the LED current decreases. Typically, the PWM frequency ranges from 5kHz to 40kHz.

Dimming Control with PWM Signal on SHDN Pin

With the PWM signal applied to the SHDN pin of the PAM2801, the LED can be turned on or off. When the SHDN pin is high, the LED is turned on and its current is at the maximum set current; when SHDN low, the LED off and its current 0mA. The average LED current increase proportionally with the PWM duty cycle. A 0% duty cycle corresponds to 0mA of LED current; a 100% duty cycle to the maximum set current. The magnitude of the PWM signal should be higher than the SHDN input high (V_{SH}). The typical frequency of

the PWM signal ranges from 100Hz to 1kHz. Figure 4 shows the LED current with 50% PWM duty cycle and 100Hz and 1kHz PWM frequency respectively. Figure 3 shows the LED current versus the PWM duty cycle with 100Hz PWM frequency.

PCB Layout Guidelines

For all switching power supplies, the layout and components placement of the PAM2801 is an important step in the design, especially at high peak currents and high switching frequencies.

The input capacitor and output capacitor should be respectively placed as close as possible to the input pin and output pin of the IC, the inductor and schottky diode should be placed as close as possible to the switch pin by using wide and short traces as main current path, and the current sense resistor should be placed as close as possible between the ground pin and feedback pin.

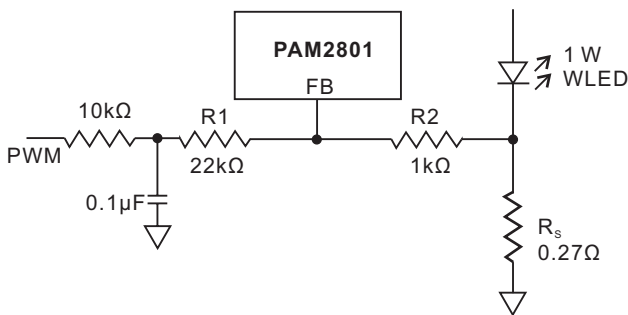


Figure 2. Dimming Control with PWM Signal on FB Pin

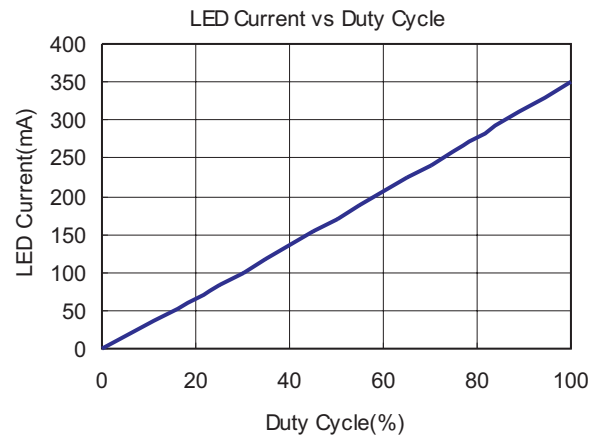
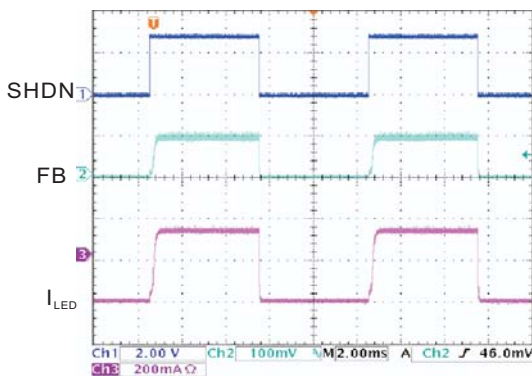
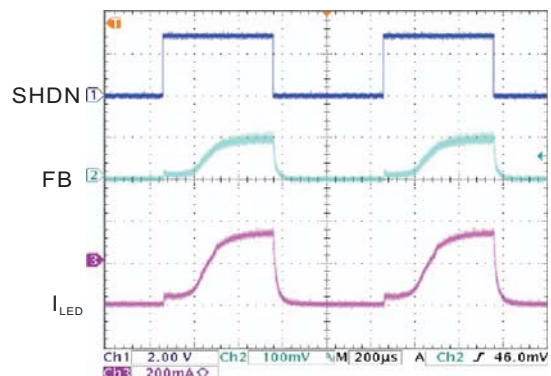


Figure 3. LED Current vs Duty Cycle



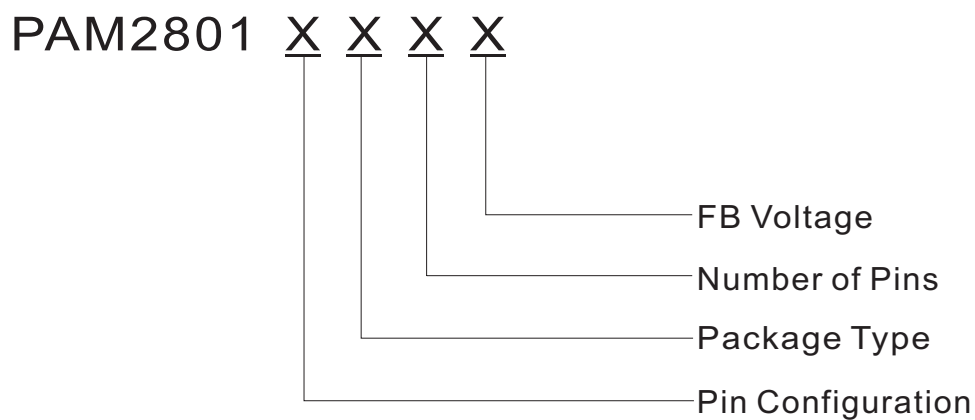
(4a) $f_{PWM}=100\text{Hz}$



(4b) $f_{PWM}=1\text{ kHz}$

Figure 4. Dimming Control with PWM Signal on SHDN Pin

Ordering Information

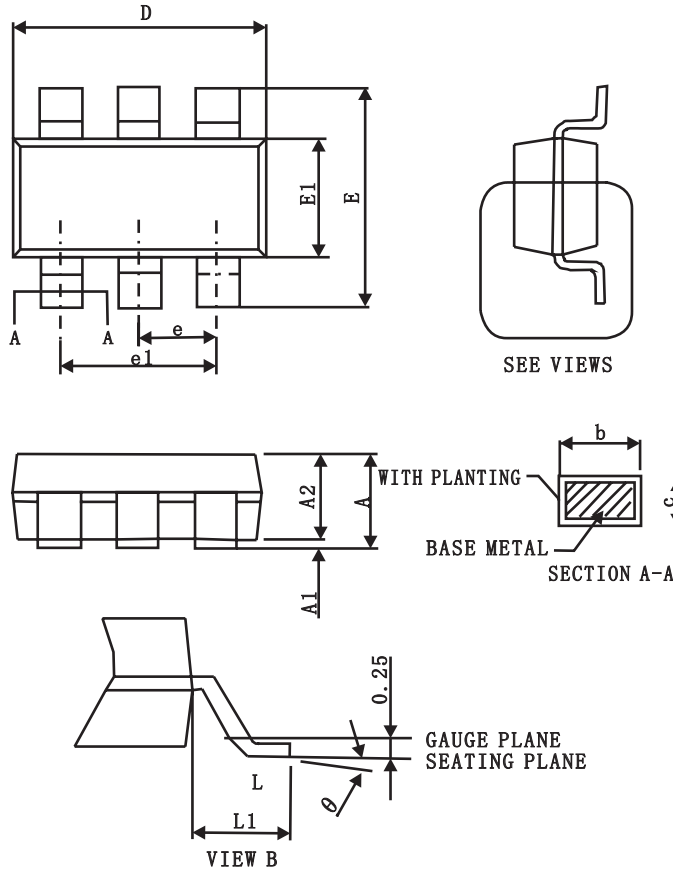


Pin Configuration	Package Type	Number of Pins	FB Voltage
A Type 1. SW 2. GND 3. FB 4. SHDN 5. VOUT 6. VIN	A: SOT23-6	F: 6	095: 95mV

Part Number	Marking	Package Type	Shipping Package
PAM2801AAF095	CDAYW	SOT23-6	3,000 Units/Tape & Reel

Outline Dimension

SOT23-6



Symbol	A	A1	A2	b	c	D	E
Spec	1.20±0.25	0.10±0.05	1.10±0.2	0.40±0.1	0.15±0.07	2.90±0.1	2.80±0.2
Symbol	E1	e	e 1	L	L1	θ	
Spec	1.60±0.1	0.95BSC	1.90BSC	0.55±0.25	0.60REF	4°±4°	

Unit: Millimeter