PAM2862

1.4A LED Driver with Internal Switch

Features

- Simple low parts count
- Internal 24V NDMOS switch
- 1.4A output current
- Single pin on/off and brightness control Using DC voltage or PWM
- Internal PWM filter
- Soft-start
- High efficiency (up to 95%)
- Wide input voltage range: 6V to 24V
- Output shutdown
- Up to 1MHz switching frequency
- Inherent open-circuit LED protection
- Typical 4% output current accuracy
- Pb-free SOT23-5 and MSOP-8 Packages

Applications

- Low voltage halogen replacement LEDs
- Low voltage industrial lighting
- LED back-up lighting
- Illuminated signs

Description

The PAM2862 is a continuous mode inductive step-down converter, designed for driving single or multiple series connected LEDs efficiently from a voltage source higher than the LED voltage. The device operates from an input supply between 6V and 24V and provides an externally adjustable output current of up to 1.4A. Depending upon supply voltage and external components, this can provide up to 20 watts of output power.

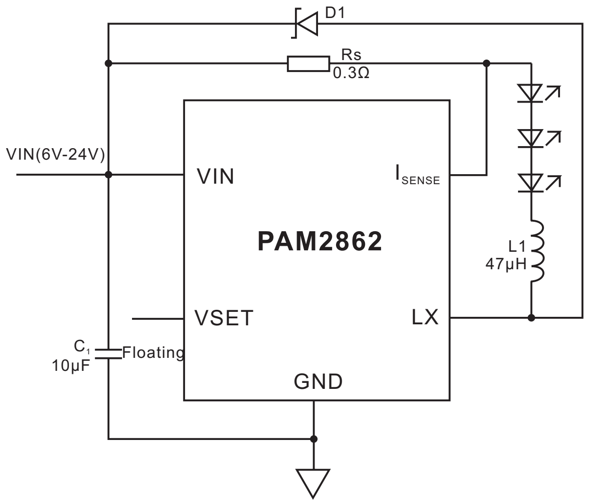
The PAM2862 includes the output switch and a high-side output current sensing circuit, which uses an external resistor to set the nominal average output current.

Output current can be adjusted below the set value, by applying an external control signal to the VSET pin.

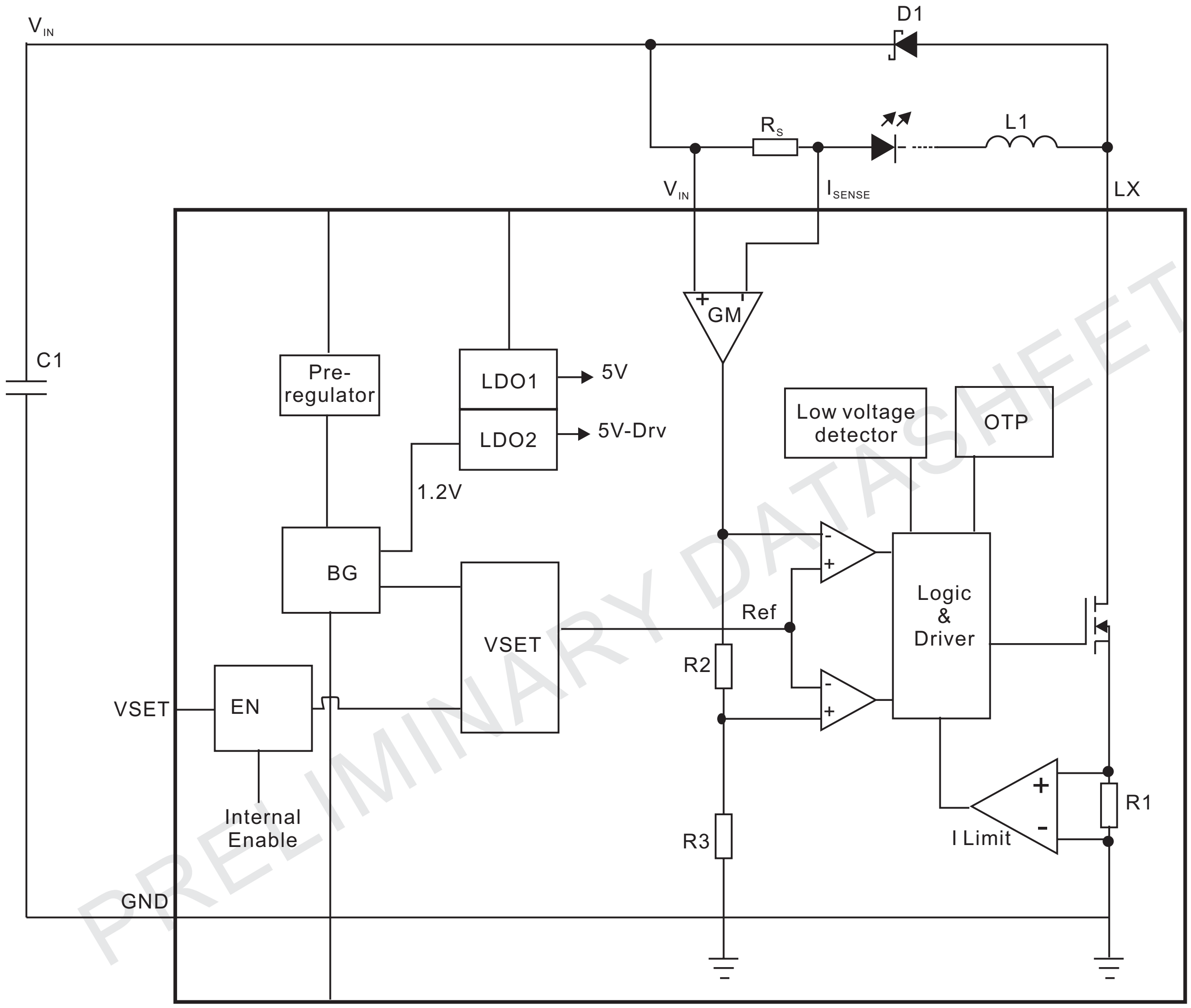
The VSET pin will accept either a DC voltage or a PWM waveform.

The PWM filter provides a soft-start feature by controlling the rise of input/output current. The soft-start time can be increased using an external capacitor from the VSET pin to ground. Applying a voltage of 0.38V or lower to the VSET pin turns the output off and switches the device into a low current standby state.

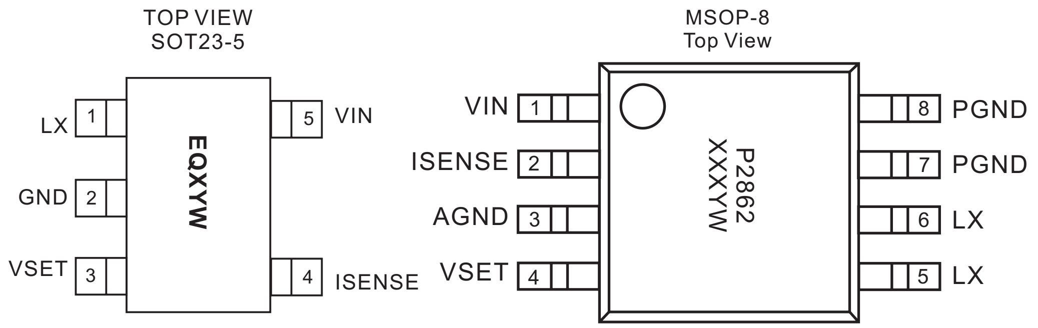
Typical Application



Block Diagram



Pin Configuration



EQ: Product Code of PAM2862
X: Internal Code
Y: Year
W: Week

Pin Descriptions

Pin Number		Name	Description
SOT23-5	**MSOP-8**		
1	5, 6	LX	Drain of NDMOS switch.
2		GND	Ground (0V)
	3	AGND	Analog Ground
	7, 8	PGND	Power Ground
3	4	VSET	Multi-function On/Off and brightness control pin: • Leave floating for normal operation. • Drive to voltage below 0.1V to turn off output current • Drive with DC voltage (0.4V < VSET< 2.4V) to adjust output current from 16% to 100% of I_{OUT}nom • Drive with PWM signal from open-collector or open-drain transistor, to adjust output current. Adjustment range 1% to 100% of I_{OUT}nom for f < 500Hz • Connect a capacitor from this pin to ground to increase soft-start time. (Default soft-start time = 0.1ms. Additional soft-start time is approx.1.5ms/10nF)
4	2	ISENSE	Connect resistor R_S from this pin to VIN to define nominal average output current I_{OUT}nom = 0.1/Rs
5	1	VIN	Input voltage (6V to 24V). Decouple to ground with 4.7µF or higher X7R ceramic capacitor close to device.

Absolute Maximum Ratings

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

Input Voltage Range..........................-0.3V to 26V
LX, ISENSE Pin voltage.....................-0.3V to 26V
ENPin voltage....................................-0.3V to 6V
Maximum Junction Temperature.................150℃

Operation Junction Temperature......-40℃ to 125℃
Storage Temperature......................-65℃ to 150℃
Soldering Temperature........................300℃,5sec

Recommended Operating Conditions

Input Voltage Range............................6V to 24V

Operation Temperature Range.........-40℃to 105℃

Thermal Information

Parameter	Package	Symbol	Maximum	Unit
Thermal Resistance (Junction to Ambient)	SOT23-5	θjA	250	℃/W
	MSOP-8		180	
Thermal Resistance (Junction to Case)	SOT23-5	θjC	130	
	MSOP-8		75	

Electrical Characteristic

T_A=25°C, V_{IN}=16V, unless otherwise noted.

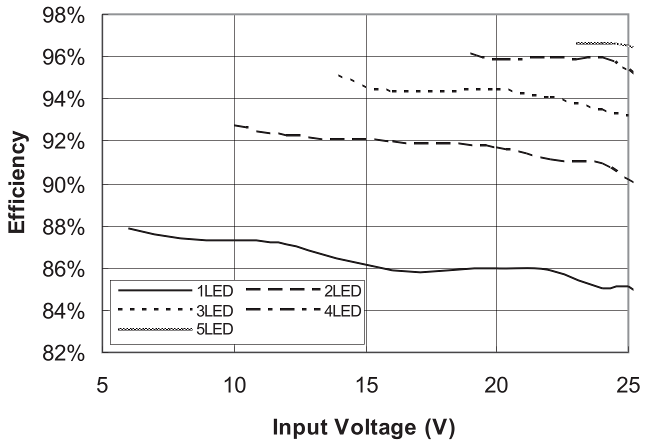
Parameter	Symbol	Condition	Min	Typ	Max	Units
Input voltage	Vin		6	16	24	V
Output current	I_{LED}	R_S=0.3Ω		333		mA
		R_S=0.1Ω		1		A
Shutdown current	I_{SD}	VSET pin grounded		10	20	μA
Quiescent current without switching	I_Q	VSET pin floating		280		μA
Mean current sense threshold voltage	Vsense	Measured on Isense pin with respect to VIN	95	100	105	mV
Sense threshold hysteresis	Vsense_hys		10	15	25	%
Isense pin input current	Isense	Vsense = Vin – 0.1		3.5		μA
Vset range on VSET pin	Ven	For DC dimming	0.4		2.4	V
DC voltage on VSET pin to enable	Venon	Ven rising	0.4			V
DC voltage on VSET pin to disable	venoff	Ven falling			0.38	V
LX switch on resistance	R_{LX}	@I_{LX}=100mA		0.3		Ω
LX switch leakage current	$I_{LX(leak)}$				5	μA
Soft start time	Tss	Vin=16V, Cen = 10nF		1.5		ms
Operating frequency	F_{LX}	Vi=16V, Vo=9.6V (3 LEDS), L=47μH, ΔI=0.25A (I_{LED}=1A)		233		kHz
Recommended minimum switch ON time	Ton_rec	For 4% accuracy		500		ns
Recommended maximum switch frequency	F_{LXmax}				1.0	MHz
Max duty circle					100	%
Recommended duty cycle range	D_{LX}		25		75	%
Internal comparator propagation delay	T_{PD}*			45		ns
Over temperature protection	T_{OTP}			165		°C
Temp protection hysteresis	T_{OTP_hys}			40		°C
Current limit	I_{XLmax}	Peak inductor current		1.7		A

*parameters are not tested at production, but guaranteed by design.

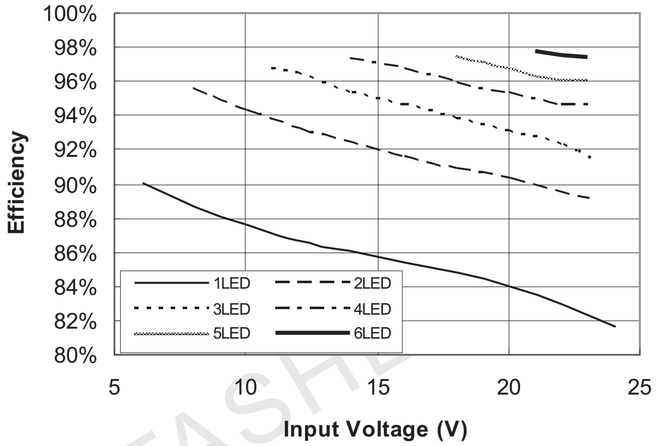
Typical Operating Characteristics

T_A=25°C,V_{DD}=16V, unless otherwise noted.

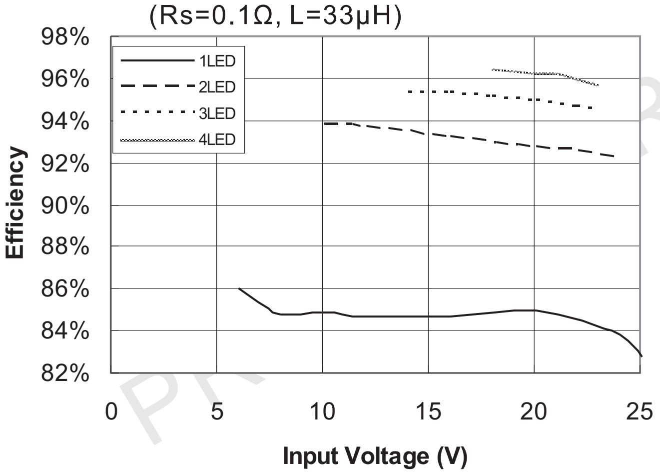
1. Efficiency vs Input Voltage (Rs=0.1Ω, L=47μH)



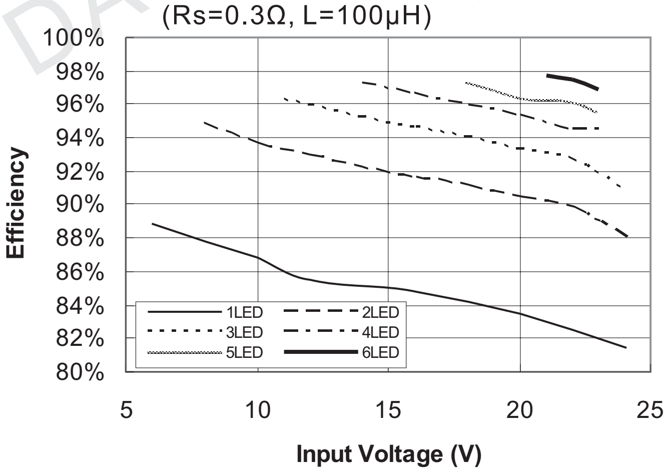
2. Efficiency vs Input Voltage (Rs=0.3Ω, L=47μH)



3. Efficiency vs Input Voltage (Rs=0.1Ω, L=33μH)



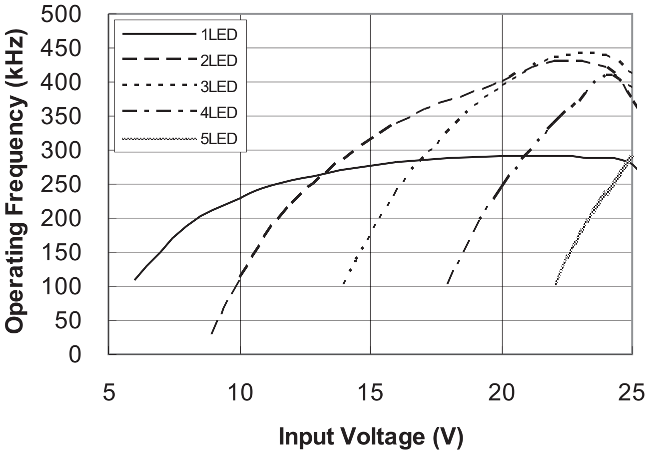
4. Efficiency vs Input Voltage (Rs=0.3Ω, L=100μH)



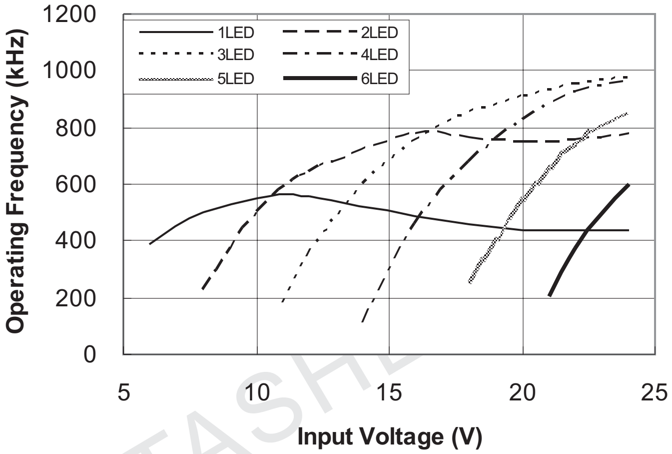
Typical Operating Characteristics

$T_A=25°C, V_{DD}=16V$, unless otherwise noted.

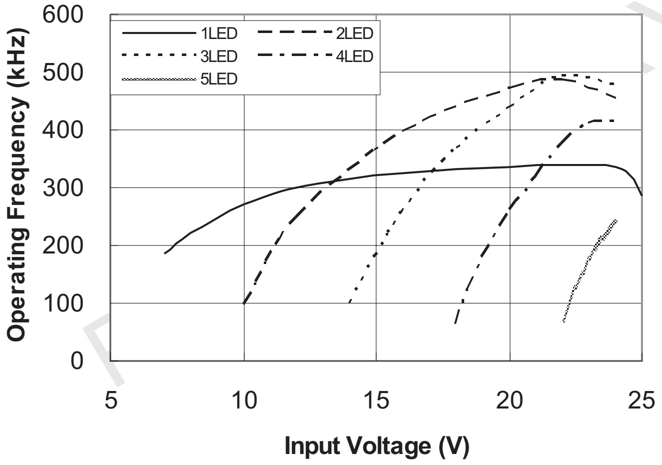
5. Operating Frequency vs Input Voltage (Rs=0.1Ω, L=47μH)



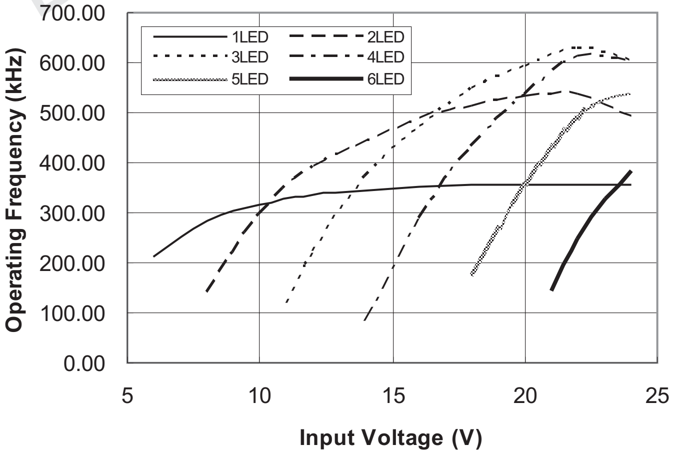
6. Operating Frequency vs Input Voltage (Rs=0.3Ω, L=47μH)



7. Operating Frequency vs Input Voltage (Rs=0.1Ω, L=33μH)



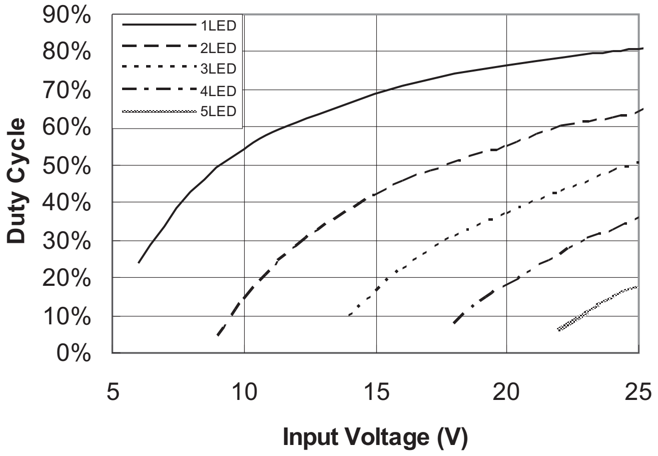
8. Operating Frequency vs Input Voltage (Rs=0.3Ω, L=100μH)



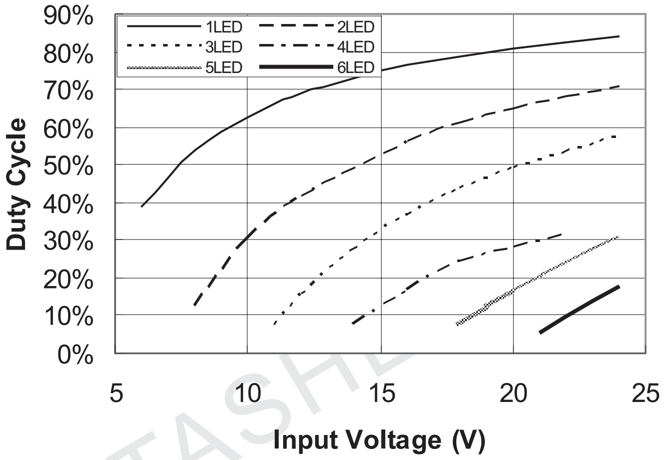
Typical Operating Characteristics

T_A=25°C,V_{DD}=16V, unless otherwise noted.

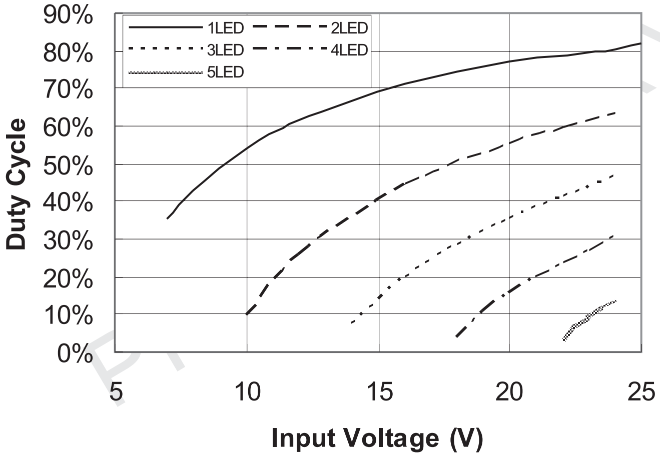
9. Duty Cycle vs Input Voltage
(Rs=0.1Ω, L=47μH)



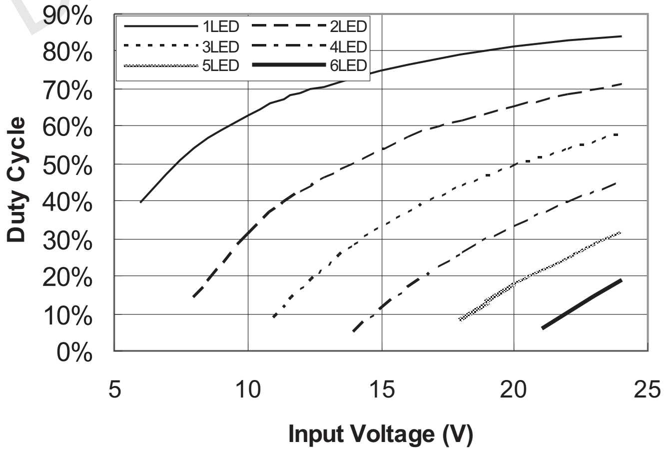
10. Duty Cycle vs Input Voltage
(Rs=0.3Ω, L=47μH)



11. Duty Cycle vs Input Voltage
(Rs=0.1Ω, L=33μH)



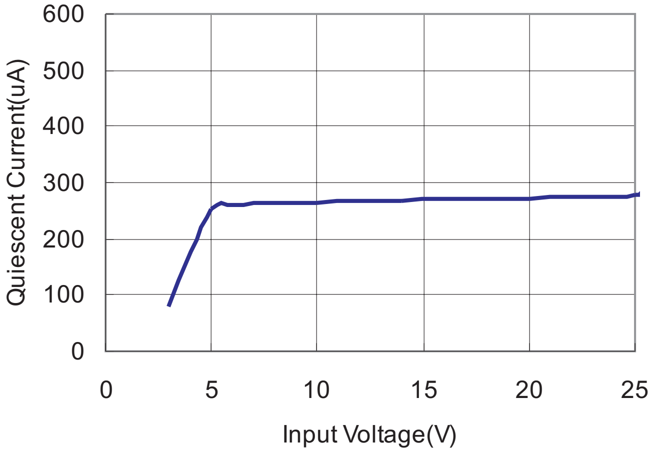
12. Duty Cycle vs Input Voltage
(Rs=0.3Ω, L=100μH)



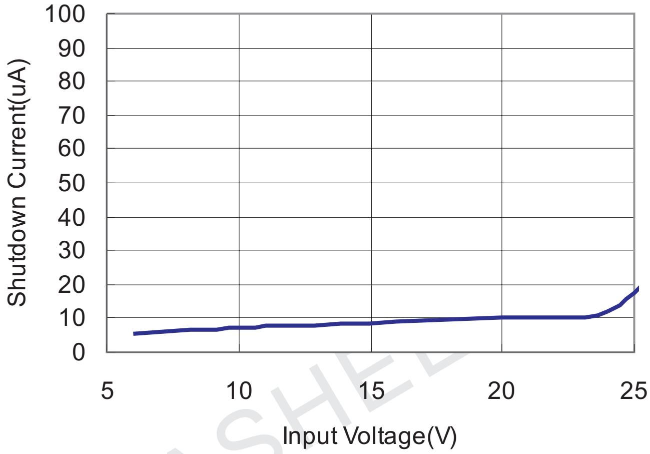
Typical Operating Characteristics

T_A=25°C,V_{DD}=16V, unless otherwise noted.

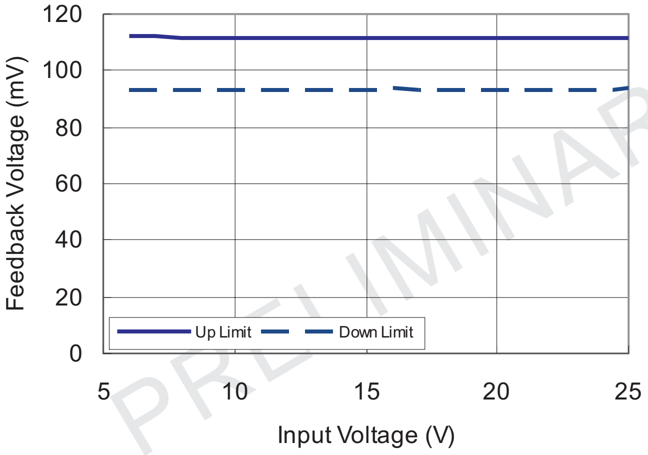
13. Quiescent Current VS. Input Voltage



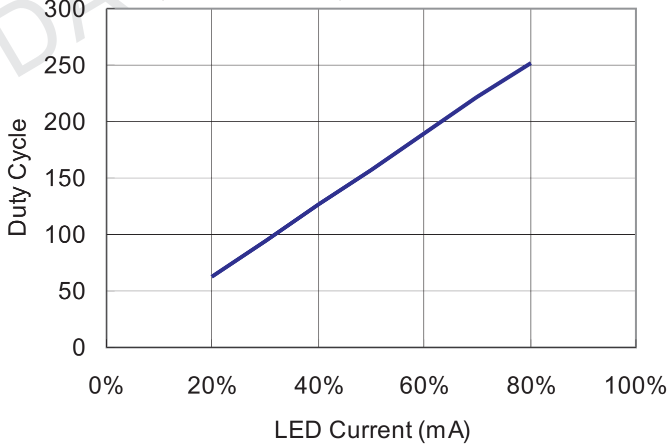
14. Shutdown Current VS. Input Voltage



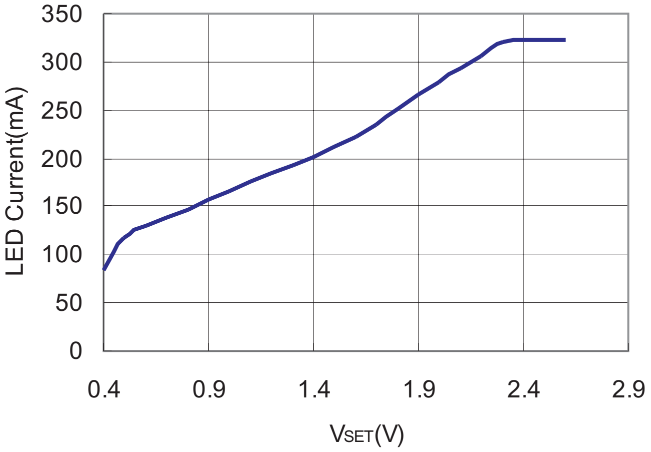
15. Feedback Voltage VS Vin



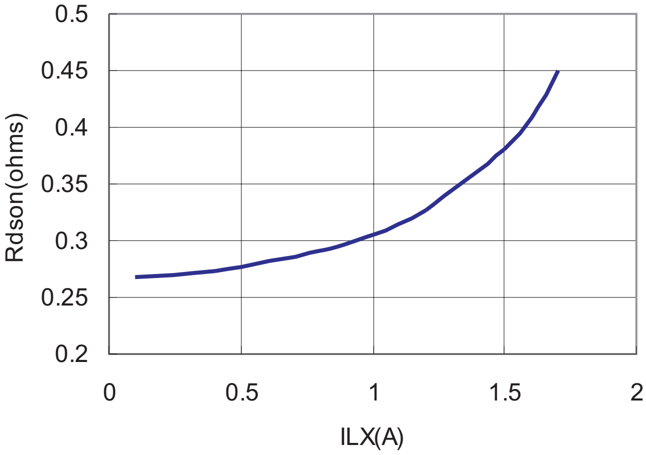
16. Duty Cycle VS LED Current
(PWM=200Hz)



17. I_{LED} vs V_{SET}
(V_{IN}=16V, 3 LEDs, 47μH, Rs=0.3Ω)



18. R_{DSON} vs I_{LX}

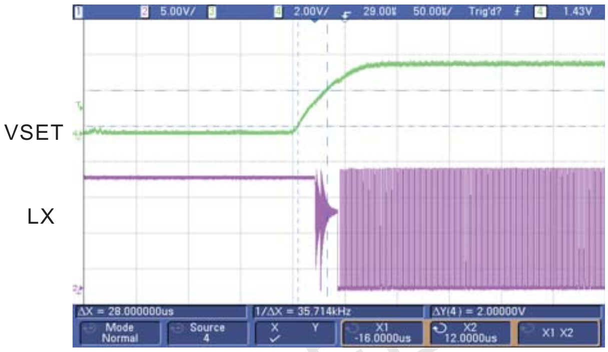


Typical Operating Characteristics

T_A=25°C,V_{DD}=16V, unless otherwise noted.

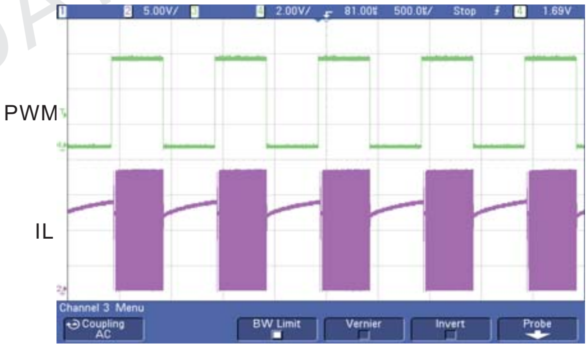
19. Steady State Waveforms

20. Start up Waveforms



21. Dimming Waveform (PWM=20%)

22. Dimming Waveforms (PWM=50%)



23. Dimming Waveforms (PWM=80%)

Application Information

Setting nominal average output current with external resistor R_S

The nominal average output current in the LED(s) is determined by the value of the external current sense resistor (R_S) connected between VIN and ISENSE and is given by:

$$I_{OUTnom} = \frac{0.1}{R_S}$$

The table below gives values of nominal average output current for several preferred values of current setting resistor (R_S) in the typical application circuit shown on page 1.

R_S (Ω)	Nominal average output current (mA)
0.1	1000
0.13	760
0.15	667
0.3	333

The above values assume that the VSET pin is floating and at a nominal voltage of VREF (1.25V). Note that R_S = 0.1Ω is the minimum allowed value of sense resistor under these conditions to maintain switch current below the specified maximum value. It is possible to use different values of R_S if the VSET pin is driven from an external voltage.

Capacitor selection

A low ESR capacitor should be used for input decoupling, as the ESR of this capacitor appears in series with the supply source impedance and lowers overall efficiency. This capacitor has to supply the relatively high peak current to the coil and smooth the current ripple on the input supply. A minimum value of 4.7µF is acceptable if the input source is close to the device, but higher values will improve performance at lower input voltages, especially when the source impedance is high. The input capacitor should be placed as close as possible to the IC.

For maximum stability over temperature and voltage, capacitors with X7R, X5R, or better dielectric are recommended. Capacitors with Y5V dielectric are not suitable for decoupling in this application and should NOT be used.

Inductor selection

Recommended inductor values for the PAM2862 are in the range 33µH to 100µH. Higher values of inductance are recommended at higher supply voltages in order to minimize errors due to switching delays, which result in increased ripple and lower efficiency. Higher values of inductance also result in a smaller change in output current over the supply voltage range. The inductor should be mounted as close to the device as possible with low resistance connections to the LX and VIN pins. The chosen coil should have a saturation current higher than the peak output current and a continuous current rating above the required mean output current.

The inductor value should be chosen to maintain operating duty cycle and switch 'on'/'off' times within the specified limits over the supply voltage and load current range. The following equations can be used as a guide.

LX Switch 'On' time

$$T_{ON} = \frac{L\Delta I}{V_{IN} - V_{LED} - I_{LED}(R_S + R_L + R_{LX})}$$

LX Switch 'Off' time

$$T_{OFF} = \frac{L\Delta I}{V_{LED} + V_D + I_{LED}(R_S + R_L)}$$

Where: L is the coil inductance; R_L is the coil resistance ; R_S is the current sense resistance I_{LED} is the required LED current; ΔI is the coil peak-peak ripple current (Internally set to 0.25 x I_{LED}); V_{IN} is the supply voltage; V_{LED} is the total LED forward voltage; R_{LX} is the switch resistance (0.3Ω nominal); V_D is the diode forward voltage at the required load current.

Diode selection

For maximum efficiency and performance, the rectifier (D1) should be a fast low capacitance Schottky diode with low reverse leakage at the maximum operating voltage and temperature. They also provide better efficiency than silicon diodes, due to a combination of lower forward voltage and reduced recovery time.

It is important to select parts with a peak current rating above the peak coil current and a continuous current rating higher than the maximum output load current. It is very important to consider the reverse leakage of the diode when operating above 85°C. Excess leakage will increase the power dissipation in the device and if close to the load may create a thermal runaway condition.

The higher forward voltage and overshoot due to reverse recovery time in silicon diodes will increase the peak voltage on the LX output. If a silicon diode is used, care should be taken to ensure that the total voltage appearing on the LX pin including supply ripple, does not exceed the specified maximum value.

Ordering Information

PAM 2862 X X X

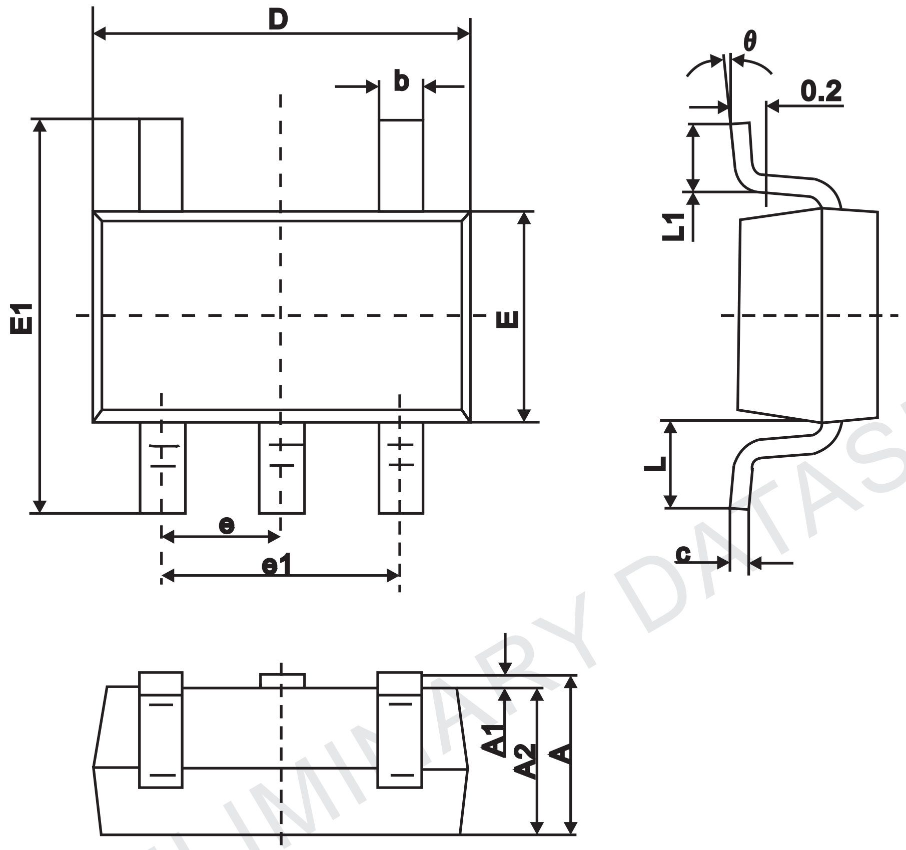
Shipping Packing
Number of Pins
Package Type

Package Type	Number of pins
A: SOT23 S: MSOP	B: 5 C: 8

Part Number	Marking	Package Type	MOQ/ Packing
PAM2862ABR	EQXYW	SOT23-5	3,000 Units/ Tape & Reel
PAM2862SCR	P2862 XXXYW	MSOP-8	2,500 Units/ Tape & Reel

Outline Dimensions

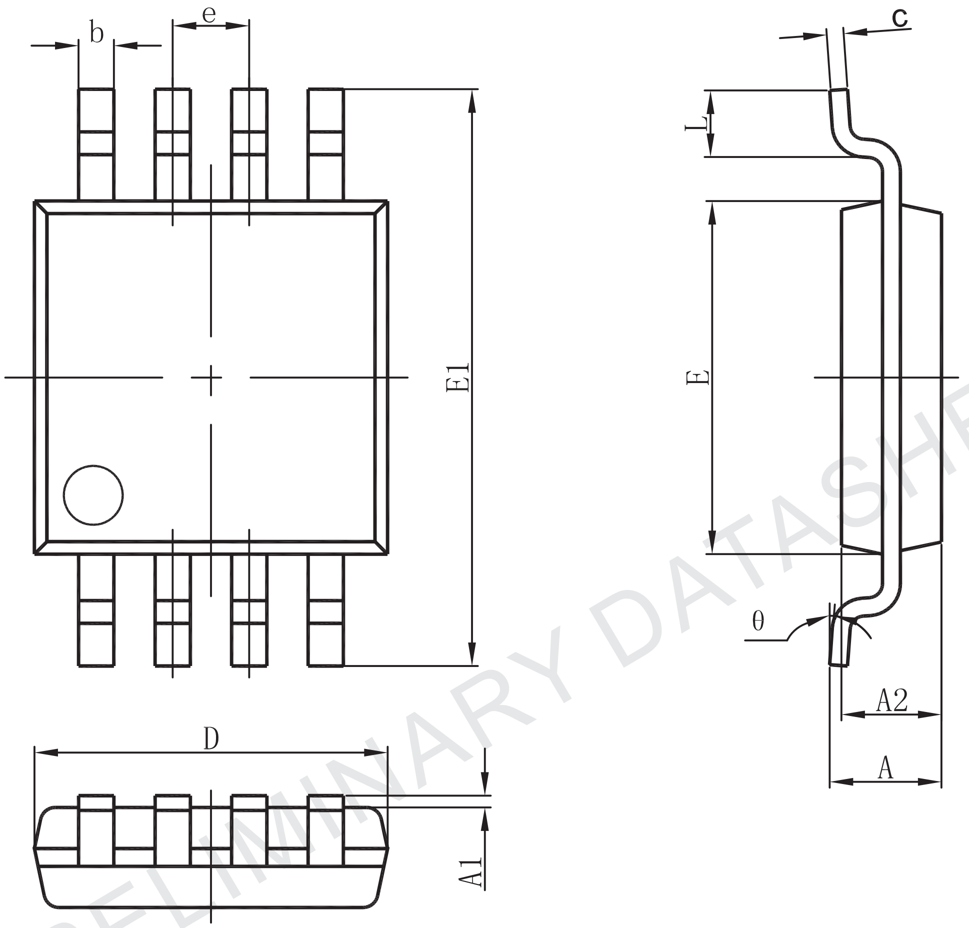
SOT23-5



Symbol	A	A1	A2	b	c	D	E
Spec	1.15±0.1	0.05±0.05	1.10±0.05	0.35±0.05	0.15±0.05	2.92±0.1	1.6±0.1
Symbol	E1	e	e 1	L	L1	θ	
Spec	2.8±0.15	0.950TYP	1.90±0.1	0.70REF	0.45±0.15	4°±4°	

Outline Dimensions

MSOP8



REF	Millimeter	
	Min	Max
A	--	1.10
A1	0.05	0.15
A2	0.78	0.94
b	0.22	0.38
c	0.08	0.23
D	2.90	3.10
E	2.90	3.10
E1	4.75	5.05
e	0.65BSC	
L	0.40	0.70