内置功率开关的滞回式降压型高亮度LED驱动器

UM1360Y *SOT89-5*

描述

UM1360是一款内置功率开关的PWM降压型转换器，专为高效驱动单个或多个串联LED设计，适用于输入电压高于LED电压的场景，最多可驱动10个串联LED。该器件输入电压范围为6V至40V，采用带有高压侧电流采样电阻的滞回式控制调节恒流输出电流，最高可达1A。该器件非常适合宽输入范围的应用。高压侧电流采样和集成电流采样电路最大限度地减少了外部元件的数量，并能保证精确的输出平均电流。该器件可根据电源电压和外部元件的不同，提供高达30W的输出功率。

通过向VSET引脚施加外部控制信号，可将输出电流调整到低于设定值。VSET引脚输入可以是直流电压或PWM波形，特定的PWM波形输入可实现宽亮度范围的LED调光。其滞回式控制可确保出色的输入电源抑制以及负载瞬变和PWM调光时的快速响应。

当VSET引脚的电压小于或等于0.2V时，功率开关关断，UM1360进入极低电流的待机状态。其采用扩频技术，可大幅降低对系统其他部分的干扰。

UM1360采用SOT89-5封装，是工业和普通照明应用的理想之选。

应用

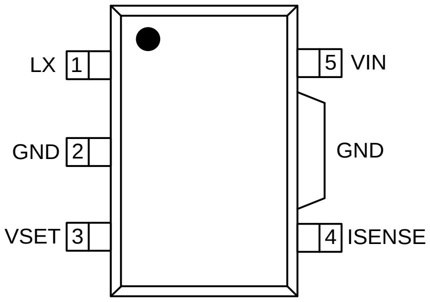
- 低压 LED 灯代替卤素灯
- 低压工业照明
- LED 背光照明
- LED 信号灯
- 用作 DC/DC 或 AC/DC 模式的 LED 驱动器
- 通用、恒定电流源

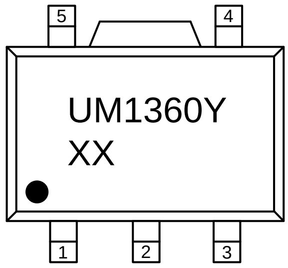
特性

- 具有高压侧电流采样功能的滞回式控制装置
- 集成 40V 0.5Ω NDMOS
- 效率高达 98%
- 宽输入电压范围：6V 至 40V
- 50V 瞬态耐压能力
- ±5% LED 电流精度
- LED 恒定电流可调
- 调节直流电压或 PWM 来进行单引脚开/关和亮度控制
- 扩频驱动器
- LED 电路过温、开路保护
- 开关频率高达 1MHz
- 无铅 SOT89-5 封装

Pin Configurations

Top View





XX: Week Code
UM1360Y
SOT89-5

Ordering Information

Part Number	Packaging Type	Marking Code	Shipping Qty
UM1360Y	SOT89-5	UM1360Y	1000pcs/7Inch Tape & Reel

Pin Description

Pin Number	Symbol	Function
1	LX	Drain of NDMOS switch.
2	GND	Ground (0V).
3	VSET	Multi-function On/Off and brightness control pin: • Leave floating for normal operation. • Drive to voltage below 0.2V to turn off output current. • Drive with DC voltage (0.3V<V_{SET}<2.5V) to adjust output current from 12% to 100% of I_{OUT}nom. • Drive with PWM signal to adjust output current. Adjustment range 1% to 100% of I_{OUT}nom for f≤1kHz.
4	ISENSE	Connect resistor R_S from this pin to VIN to define nominal average output current I_{OUT}nom=0.1/R_S.
5	VIN	Input voltage (6V to 40V). Decouple to ground with 10µF or higher X7R ceramic capacitor close to device.

Absolute Maximum Ratings

Over operating free-air temperature (unless otherwise noted) (Note 1)

Symbol	Parameter	Value	Unit
V_{IN}	Input Voltage Range	-0.3 to +40	V
V_{LX}, V_{ISENSE}	Voltages on LX, ISENSE	-0.3 to +40	V
V_{SET}	VSET Pin Voltage	-0.3 to +6	V
θ_{JA}	Thermal Resistance (Junction to Ambient)	100	℃/W
T_J	Maximum Junction Temperature	+150	℃
T_{STG}	Storage Temperature Range	-55 to +150	℃
T_L	Maximum Lead Temperature for Soldering 5 Seconds	+300	℃

Note 1: 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 voltage values are with respect to network ground terminal.

Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range	6.0		40	V
T_A	Operating Ambient Temperature	-40		85	℃
T_J	Operating Junction Temperature	-40		150	℃

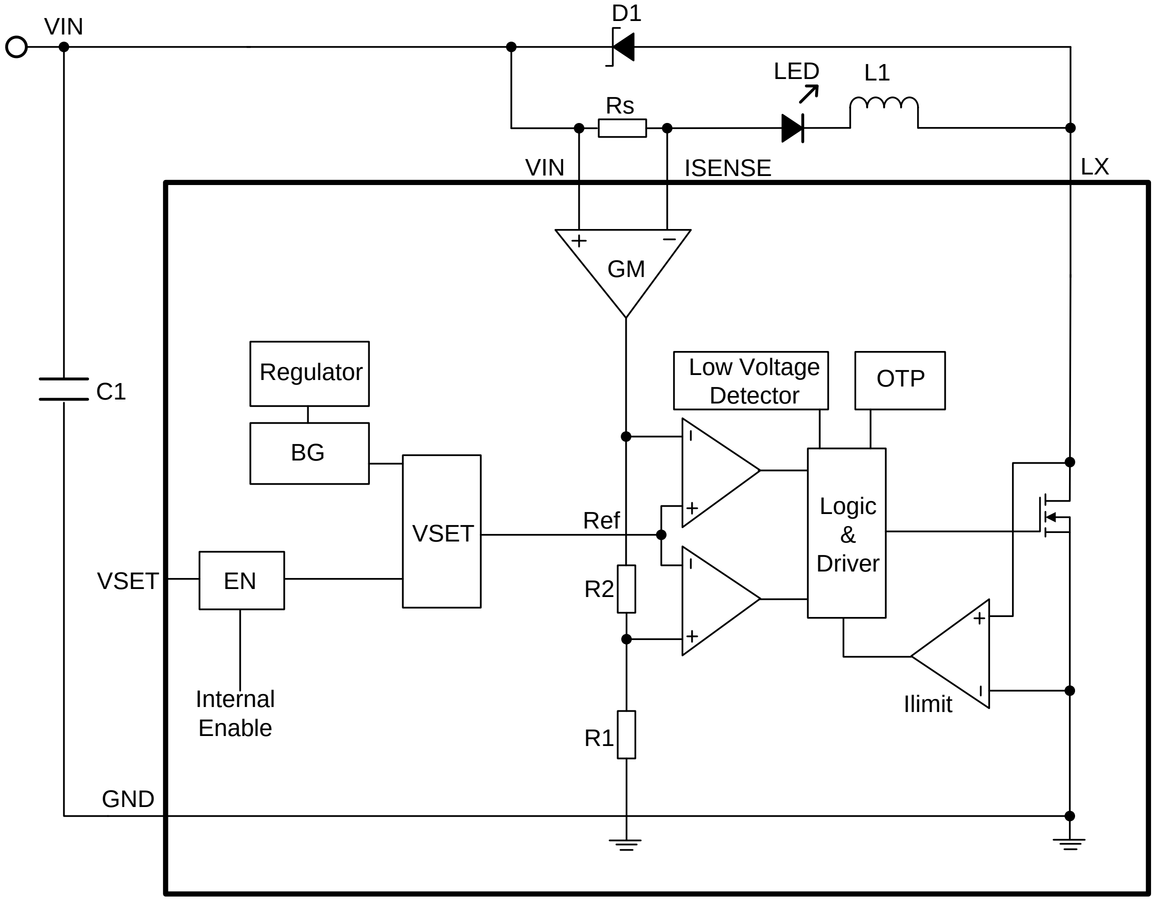
Electrical Characteristics

(V_{IN}=16V, T_A=25℃, unless otherwise noted)

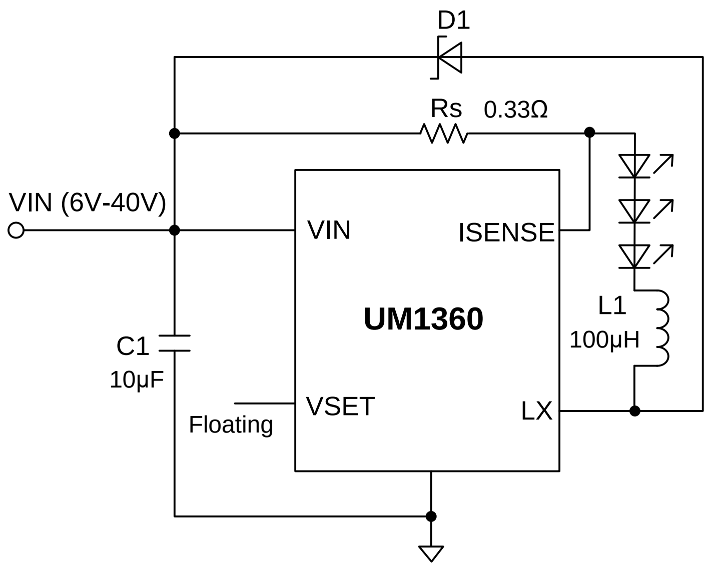
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range		6		40	V
I_{LED}	Output Current	R_S=0.33Ω		303		mA
		R_S=0.1Ω		1000		
I_Q	Quiescent Current without Switching	VSET Pin Floating, V_{IN}=16V		430		µA
I_{SD}	Shutdown Current	VSET=GND, V_{IN}=16V		35	70	µA
V_{SENSE}	Mean Current Sense Threshold Voltage	Measured on ISENSE Pin with Respect to VIN	95	100	105	mV
V_{SENSE_HYS}	Sense Threshold Hysteresis			±15		%
I_{SENSE}	ISENSE Pin Input Current	V_{SENSE}=V_{IN}-0.1		20		µA
V_{EN}	V_{SET} Range on VSET Pin	For DC Dimming	0.3		2.5	V
V_{ENON}	DC Voltage on VSET Pin to Enable	V_{EN} Rising		0.25		V
V_{ENOFF}	DC Voltage on VSET Pin to Disable	V_{EN} Falling		0.2		V
R_{LX}	LX Switch on Resistance	I_{LX}=1000mA		0.5		Ω
$I_{LX(leak)}$	LX Switch Leakage Current				5	µA
F_{LX}	Operating Frequency	V_{IN}=16V, L1=47µH, V_{OUT}=9.6V (3 LEDs), R_S=0.1Ω		230		kHz
F_{LXmax}	Recommended Maximum Switch Frequency			1.0		MHz
T_{on_rec} (Note 2)	Recommended Minimum Switch ON Time	For 4% Accuracy		500		ns
	Max Duty Cycle			100		%
D_{LX}	Recommended Duty Cycle Range		25		75	%
T_{PD} (Note 2)	Internal Comparator Propagation Delay			500		ns
T_{OTP}	Over Temperature Protection			150		℃
T_{OTP_HYS}	Temperature Protection Hysteresis			40		℃
I_{LXmax}	Peak Switch Current		1.5			A
I_{LXmean}	Continuous Switch Current				1.0	A

Note 2: Parameters are not tested at production, but guaranteed by design.

Function Block Diagram

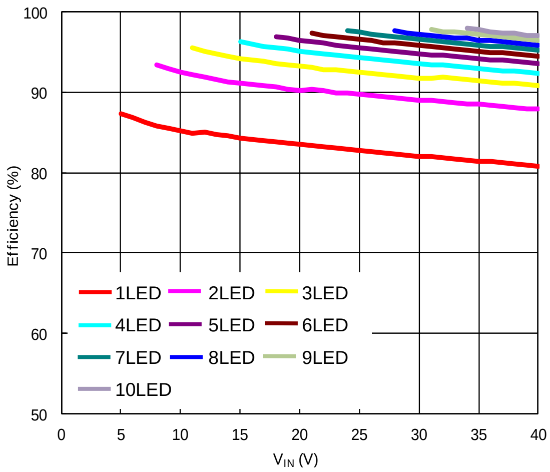


Typical Application Circuit

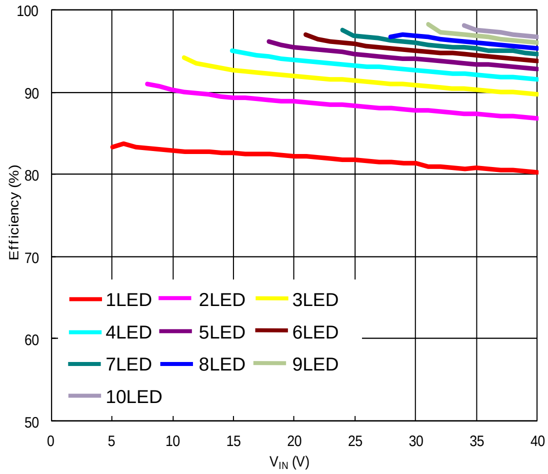


Typical Operating Characteristics

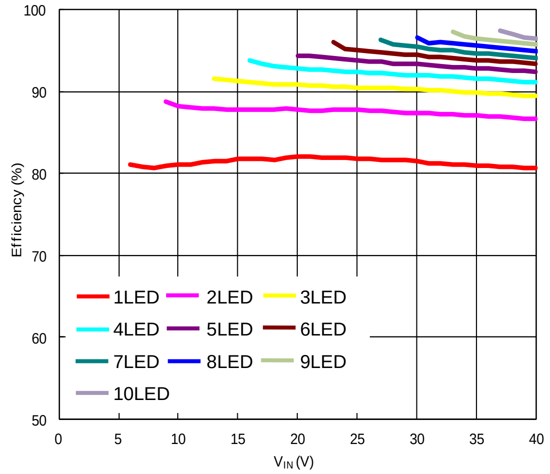
Efficiency vs. V_{IN} (L1=100μH, Rs=0.33Ω)



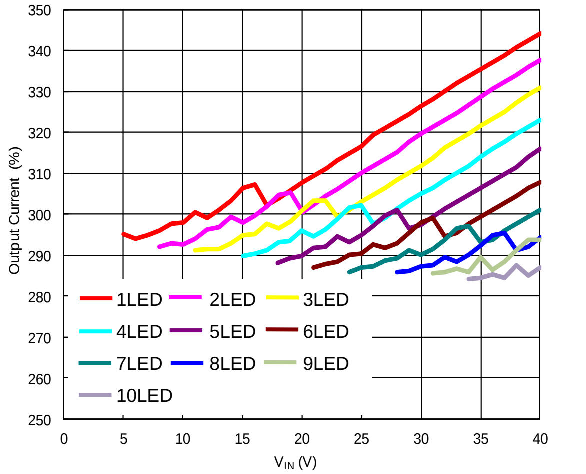
Efficiency vs. V_{IN} (L1=47μH, Rs=0.15Ω)



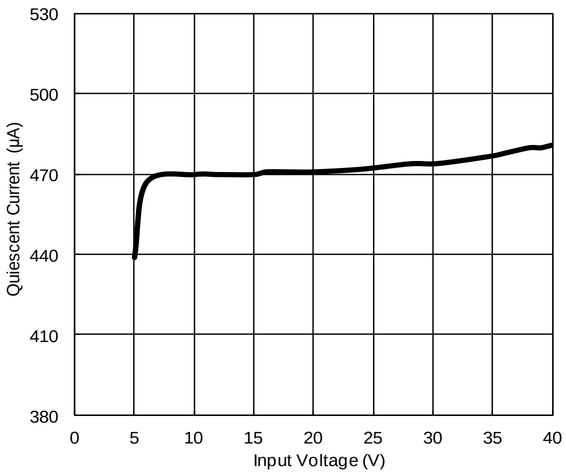
Efficiency vs. V_{IN} (L1=33μH, Rs=0.1Ω)



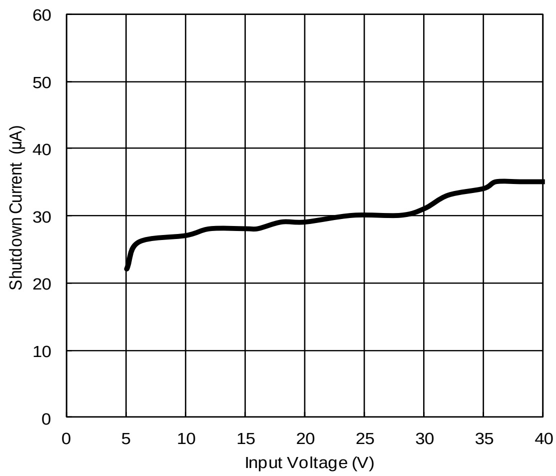
Output Current vs. V_{IN} (L1=100μH, Rs=0.33Ω)



Quiescent Current vs. Input Voltage

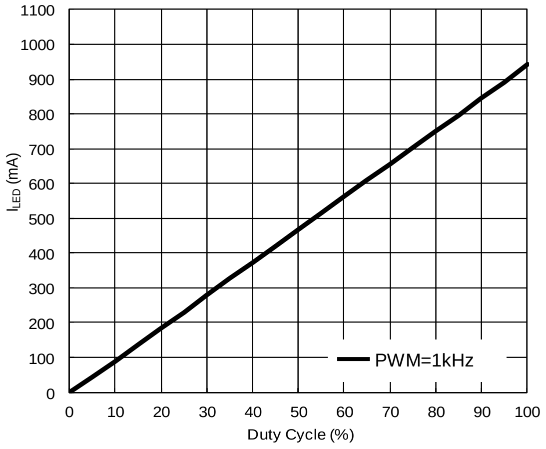


Shutdown Current vs. Input Voltage

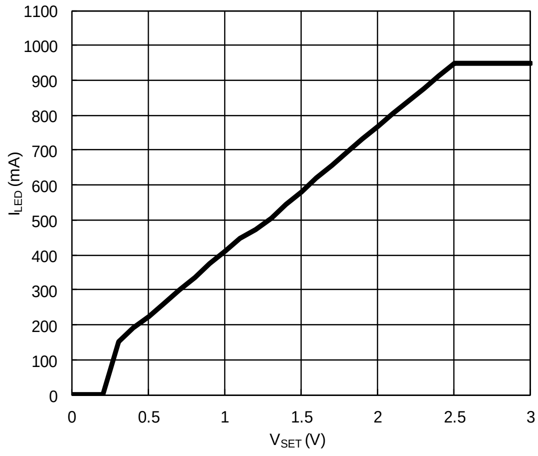


Typical Operating Characteristics (Continued)

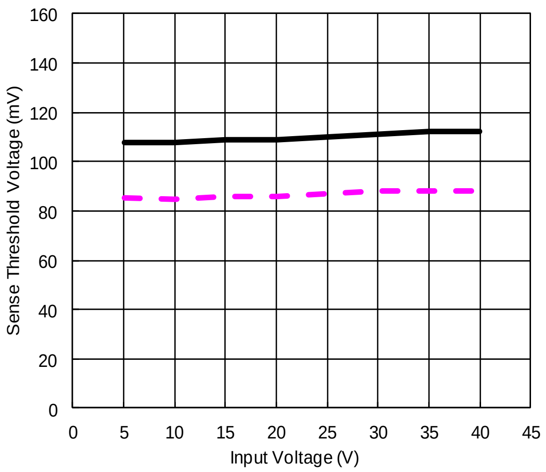
LED Current vs. V_{SET} Duty Cycle (V_{IN}=16V, 3 LEDs, L1=33μH, Rs=0.1Ω)



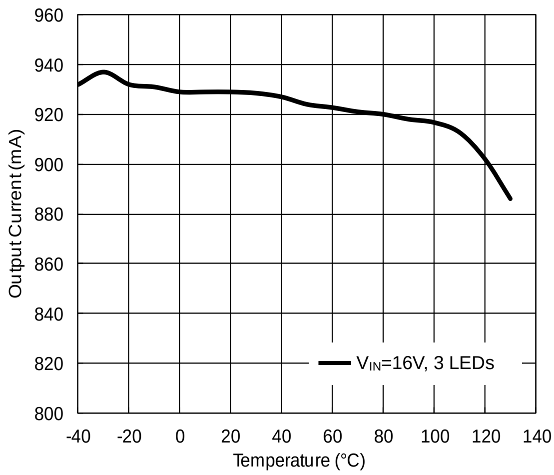
LED Current vs. V_{SET} (V_{IN}=16V, 3 LEDs, L1=33μH, Rs=0.1Ω)



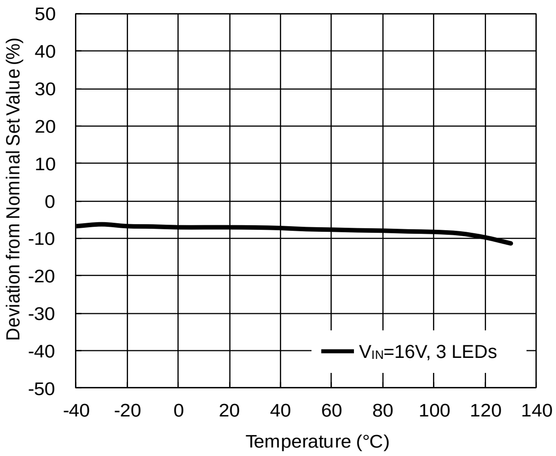
Feedback Voltage vs. V_{IN}



Output Current vs. Temperature (L1=33μH, Rs=0.1Ω)

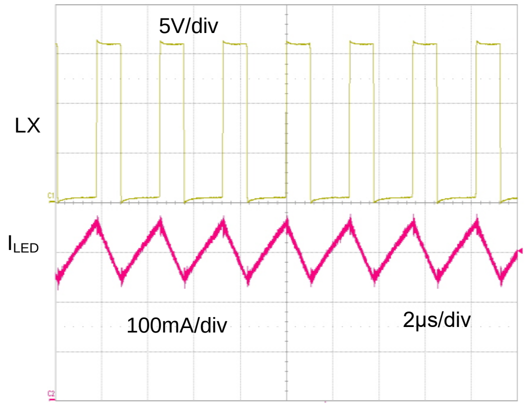


Output Current Change vs. Temperature (L1=47μH, Rs=0.33Ω)

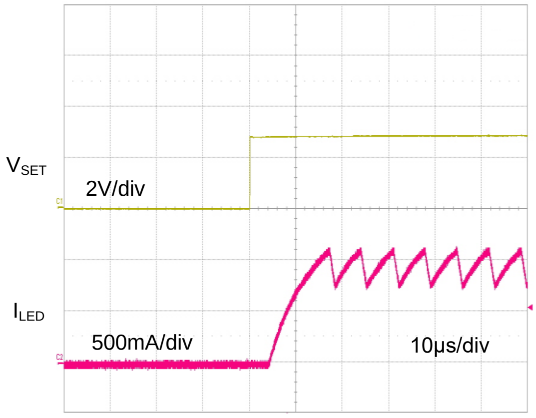


Typical Operating Characteristics (Continued)

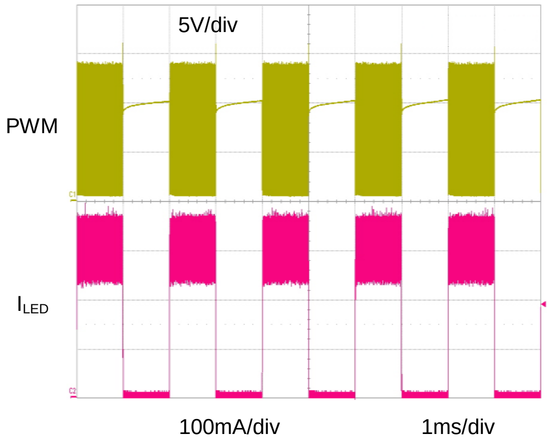
Steady State Waveforms
(V_{IN}=16V, 3 LEDs, L1=100μH, Rs=0.33Ω)



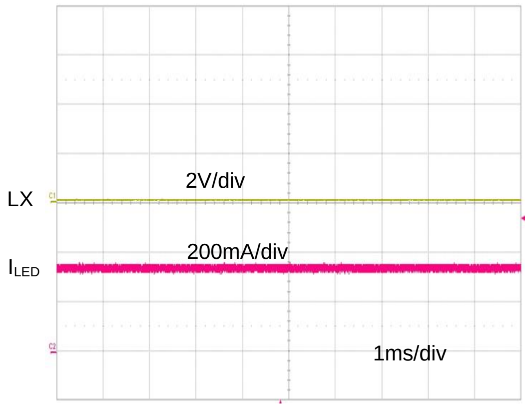
Start Up Waveforms



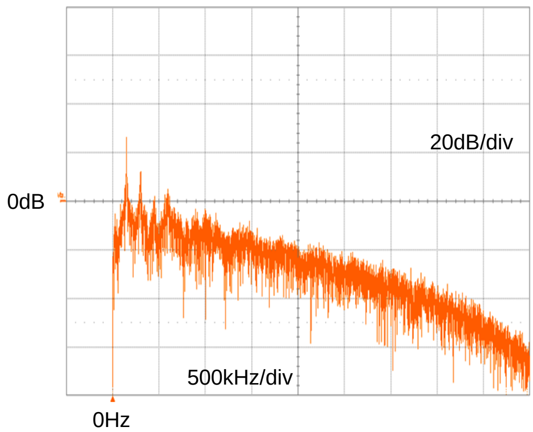
Dimming Waveforms
(PWM=50%, V_{IN}=16V, 3 LEDs, L1=100μH, Rs=0.33Ω)



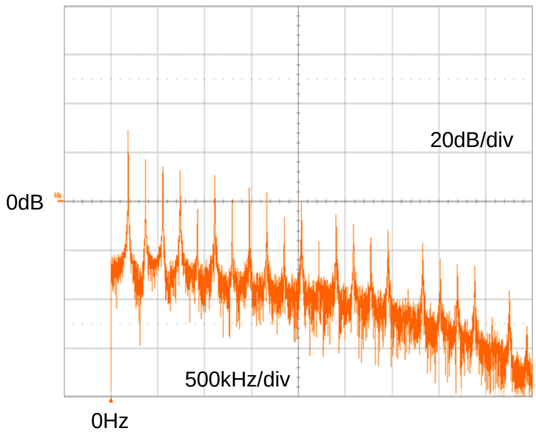
100% Duty Cycle Mode
(V_{IN}=10V, 3 LEDs, L1=100μH, Rs=0.33Ω)



Hopping Switching Frequency Waveform
Spectrum of the UM1360
(V_{IN}=16V, 3 LEDs, L1=100μH, I_{OUT}=1A)



Fixed Switching Frequency
Waveform Spectrum of Competitor
(V_{IN}=16V, 3 LEDs, L1=100μH, I_{OUT}=1A)



Applications 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:

$I_{OUTnom}=0.1/R_S$ [for $R_S \geq 0.1\Omega$]

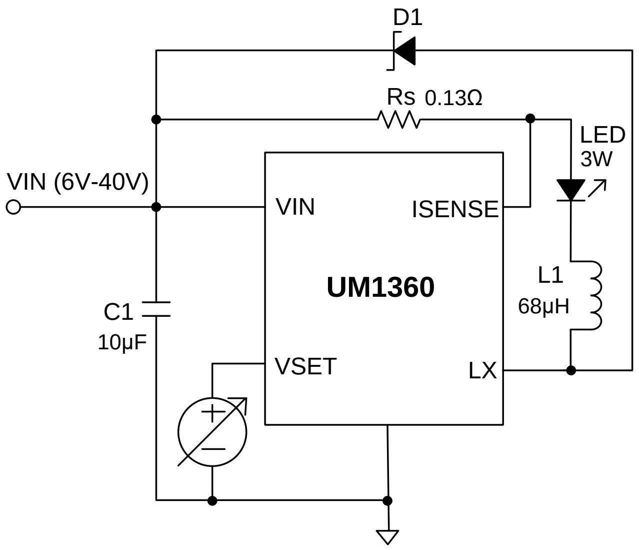
The table below gives values of nominal average output current for several preferred values of current setting resistor (Rs) in the typical application circuit as shown on page 5.

Rs (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 or applied with a voltage higher than 2.5V (must be less than 5V). Note that Rs=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 Rs if the VSET pin is driven from an external voltage. (See next section).

Output Current Adjustment by External DC Control Voltage

The VSET pin can be driven by an external DC voltage (V_{EN}), as shown, to adjust the output current to a value below the nominal average value defined by Rs.



The average output current is given by:

$I_{OUT}=(0.1*V_{EN})/(2.5*Rs)$ [for $0.3V<V_{EN}<2.5V$]

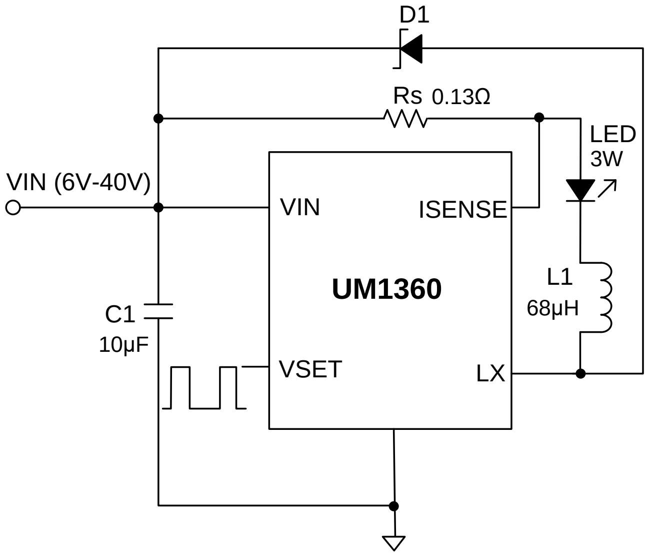
Note that 100% brightness setting corresponds to:

($2.5V \leq V_{EN} \leq 5V$)

Output Current Adjustment by PWM Control

A Pulse Width Modulated (PWM) signal with duty cycle PWM can be applied to the VSET pin, as shown below, to adjust the output current to a value below the nominal average value set by resistor Rs:

I_{OUT}=(0.1*D)/R_S (0≤D≤100%, 2.5V<V_{pulse}<5V)
I_{OUT}=(V_{pulse}*0.1*D)/(2.5*R_S) (0≤D≤100%, 0.5V<V_{pulse}<2.5V)



PWM dimming provides reduced brightness by modulating the LED's forward current between 0% and 100%. The LED brightness is controlled by adjusting the relative ratios of the on time to the off time. A 25% brightness level is achieved by turning the LED on at full current for 25% of one cycle. To ensure this switching process between on and off state is invisible by human eyes, the switching frequency must be greater than 100Hz. When above 100Hz, the human eyes average the on and off times, seeing only an effective brightness that is proportional to the LED's on-time duty cycle. The advantage of PWM dimming is that the forward current is always constant, therefore the LED color does not vary with brightness as it does with analog dimming. Pulsing the current provides precise brightness control while preserving the color purity.

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 UM1360 are in the range 27μH to 220μH. 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. Suitable coils for the UM1360 are listed in the table below:

Load Current	Inductor	Saturation Current
I_{OUT}>1A	27-47μH	1.3-1.5 Times of Load Current
0.8A<I_{OUT}≤1A	33-82μH	
0.4A<I_{OUT}≤0.8A	47-100μH	
I_{OUT}≤0.4A	68-220μH	

Order Code	L(μH)	Size	DCR (mΩ)	Saturation Current (mA)	Manufacturer
744066330	33	1038	92	1800	Würth Elektronik www.we-online.com
7447714470	47	1050	82.5	2.5	
7447714680	68	1050	110	2200	
7447714101	100	1050	165	1800	

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

$T_{ON}=(L1*\Delta I)/(V_{IN}-V_{LED}-I_{LED}*(R_S+R_L+R_{LX}))$

LX Switch 'Off' time

$T_{OFF}=(L1*\Delta I)/(V_{LED}+V_D+I_{LED}*(R_S+R_L))$

Where:

L1 is the coil inductance (H).

R_L is the coil resistance (Ω).

R_S is the current sense resistance (Ω).

I_{LED} is the required LED current (A).

ΔI is the coil peak-peak ripple current (A) {internally set to $0.3\times I_{LED}$}.

V_{IN} is the supply voltage (V).

V_{LED} is the total LED forward voltage (V).

R_{LX} is the switch resistance (Ω) {=0.5Ω nominal}.

V_D is the diode forward voltage at the required load current (V).

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℃. 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.

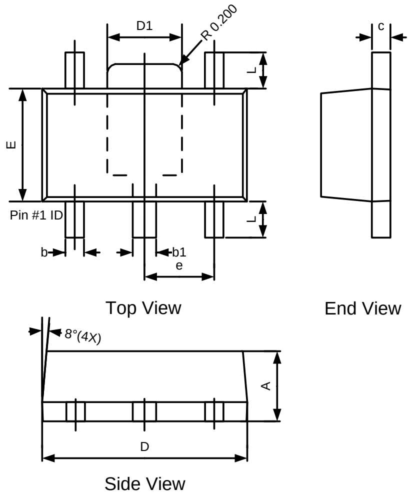
PCB Layout Guidelines

Careful PCB layout is critical to achieve low switching losses and stable operation. Minimize ground noise by connecting high current ground returns, the input bypass capacitor ground lead, and the output filter ground lead to a single point. Place Rs as close as possible to the ISENSE and VIN. For better noise immunity, a Kelvin connection is strongly recommended between ISENSE and Rs.

Package Information

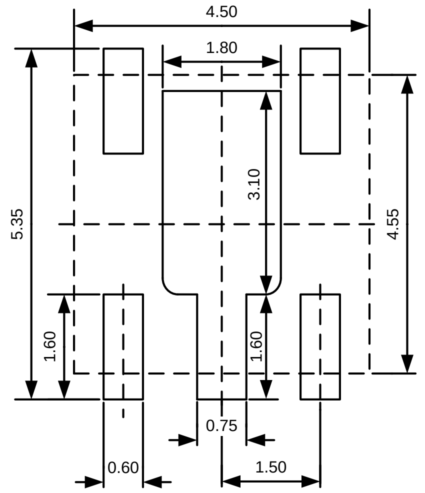
UM1360Y SOT89-5

Outline Drawing



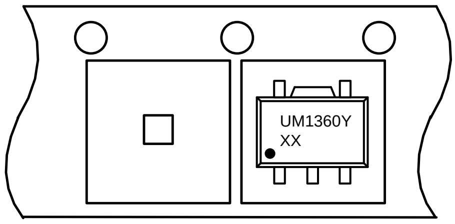
DIMENSIONS						
Symbol	MILLIMETERS			INCHES		
	Min	Typ	Max	Min	Typ	Max
A	1.40	1.50	1.60	0.055	0.059	0.063
b	0.32	-	0.54	0.013	-	0.021
b1	0.38	-	0.62	0.015	-	0.024
c	0.35	-	0.44	0.014	-	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.40	-	1.83	0.055	-	0.072
E	2.30	2.50	2.60	0.091	0.098	0.102
e	1.50TYP			0.059TYP		
L	0.65	-	1.20	0.026	-	0.047

Land Pattern



NOTES:
1. Compound dimension: 4.50×2.50;
2. Unit: mm;
3. General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

Tape and Reel Orientation



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