JW1123

2A, 28V Synchronous Buck LED Driver

DESCRIPTION

The JW®1123 is a current mode monolithic buck LED driver. Operating with an input range of 4.5V-28V, JW1123 delivers 2A of continuous output current with two integrated N-Channel MOSFETs. The internal synchronous power switches provide high efficiency without the use of an external Schottky diode. It integrates PWM signal to analogy dimming mode to achieve dimmable LED lighting application.

The JW1123 guarantees robustness with LED short protection, thermal protection, start-up current run-away protection, input under voltage lockout.

The JW1123 is available in 6-pin SOT23 packages, which provide a compact solution with minimal external components.

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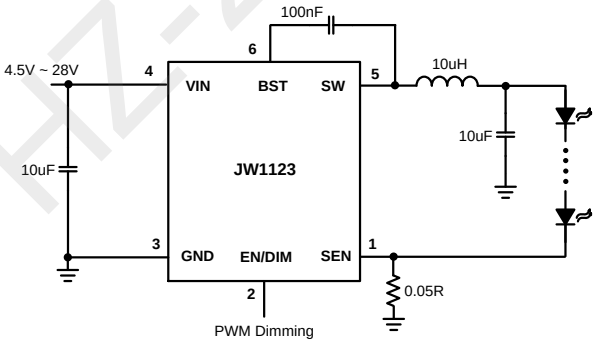
FEATURES

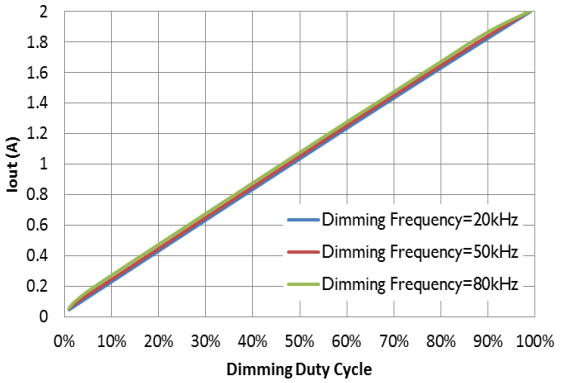
- 4.5V to 28V Operating Input Range
  2A Output Current
- Up to 94% Efficiency
  @ Vin=12V, Vout=6V, ILED=2A
- 600kHz Switching Frequency
- Input Under Voltage Lockout
- Start-up Current Run-away Protection
- LED Short Protection
- Thermal Protection
- Available in SOT23-6 Package

APPLICATIONS

- IP camera and CCD camera
- Flash light
- Display cabinet lamp
- General LED lighting

TYPICAL APPLICATION





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ORDER INFORMATION

DEVICE[1)]	PACKAGE	TOP MARKING[2)]
JW1123SOTB#TRPBF	SOT23-6	JWDR□ YW□□□

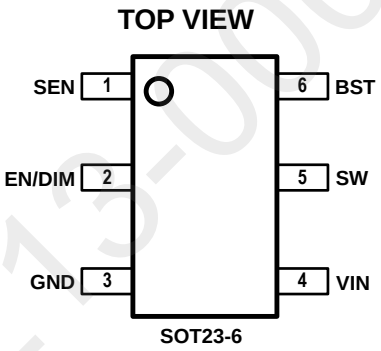
Note：

1) JW□□ # TRPBF
- PB Free
- Tape and Reel(If" TR" is not shown, it means tube)
- Package Code
- Part No.

2) Line1: JW□□□
- Internal control code
- Product code
- Joulwatt LOGO

Line2: YW□□□
- Lot number
- Week code
- Year code

PIN CONFIGURATION



ABSOLUTE MAXIMUM RATING[1)]

VIN Pin .....-0.3V to 30V
SW Pin .....-0.3V (-4.5V for 10ns) to 30V (32V for 10ns)
BST Pin..... SW-0.3V to SW+5V
All other Pins ..... -0.3V to 6V
Junction Temperature[2)] 150ºC
Lead Temperature 260ºC
Storage Temperature ..... -65 ºC to +150ºC

RECOMMENDED OPERATING CONDITIONS

Input Voltage VIN .....4.5V to 28V
Operating Junction Temperature.....-40ºC to 125ºC

THERMAL PERFORMANCE[3)]

	θ_{JA}	θ_{Jc}
SOT23-6	220	130ºC/W

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Note：

1) Exceeding these ratings may damage the device. These stress ratings do not imply function operation of the device at any other conditions beyond those indicated under RECOMMENDED OPERATING CONDITIONS.

2) The JW1123 includes thermal protection that is intended to protect the device in overload conditions. Continuous operation over the specified absolute maximum operating junction temperature may damage the device.

3) Measured on JESD51-7, 4-layer PCB

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ELECTRICAL CHARACTERISTICS

VIN=12V, T_A=25℃，Unless otherwise stated

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
V_{IN} Under Voltage Lock-out Threshold	V_{IN_MIN}	V_{IN} rising	3.5	3.8	4.1	V
V_{IN} Under Voltage Lockout Hysteresis	$V_{IN\_MIN\_HYST}$			200		mV
Shutdown Supply Current	I_{SD}	V_{EN}=0V			10	μA
Feedback Reference Voltage	V_{SEN}	D_{DIM}=100%	96	100	104	mV
Feedback Minimum Reference Voltage	V_{SEN_MIN}	D_{DIM}=1%	1	3	5	mV
Top Switch Resistance[4)]	$R_{DS(ON)T}$			85		mΩ
Bottom Switch Resistance[4)]	$R_{DS(ON)B}$			85		mΩ
Top Switch Leakage Current	I_{LEAK_TOP}	V_{IN}=28V, V_{EN}=0V, V_{SW}=0V			1	μA
Bottom Switch Leakage Current	I_{LEAK_BOT}	V_{IN}=28V, V_{EN}=0V, V_{SW}=28V			1	μA
Top Switch Current Limit[4)]	I_{LIM_TOP}		2.8	3.5	4.2	A
Bottom Switch Current Limit[4)]	I_{LIM_BOT}		1.8	2.2	2.6	A
Switching Frequency	F_{SW}	Tj=-40℃~125℃	480	600	700	kHz
EN/DIM High Input Threshold	V_{ENH}	V_{EN} rising, D_{DIM}≥5%	1.5			V
EN/DIM Low Input Threshold	V_{ENL}	V_{EN} falling			0.5	V
PWM Dimming Duty Range[4)]	D_{DIM}		1%		100%	
Minimum On-Time	T_{ON-MIN}	measured at 15% to 15%,Tj=-40℃~125℃		90	135	ns
Minimum Off-Time	$T_{OFF-MIN}$			120		ns
Maximum Duty Cycle	D_{MAX}		90	93		%
Thermal Shutdown[4)]	T_{TSD}			160		°C
Thermal Shutdown Hysteresis[4)]	T_{TSD_HYST}			30		°C

Note：

4) Guaranteed by design.

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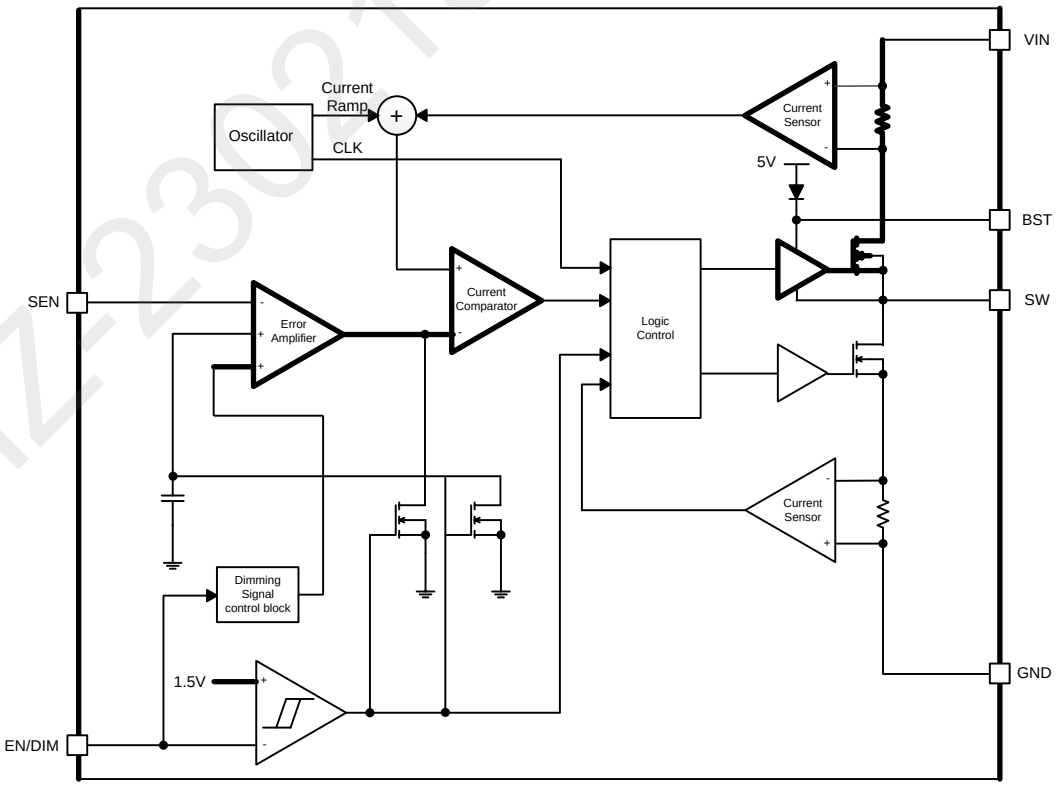
PIN DESCRIPTION

Pin SOT23-6	Name	Description
1	SEN	LED current sense pin.
2	EN/DIM	Drive the high level voltage of EN/DIM pin above 1.5V to enable the LED driver when dimming frequency is 50kHz and duty cycle≥5%. The recommended lowest value of V_{ENH} under different dimming frequency and duty cycle is shown in Figure 4 and 5. When a 20kHz ~ 80kHz is applied to EN/DIM pin, the internal feedback reference is proportional to the PWM input duty cycle.
3	GND	Ground.
4	VIN	Input voltage pin. VIN supplies power to the IC. Connect a 4.5V to 28V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
5	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
6	BST	Bootstrap pin for top switch. A 0.1μF or larger capacitor should be connected between this pin and the SW pin to supply current to the top switch and top switch driver.

BLOCK DIAGRAM



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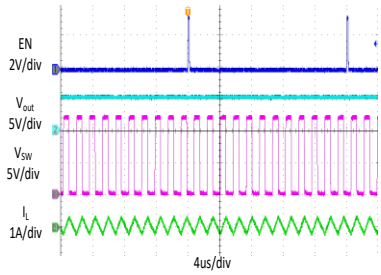
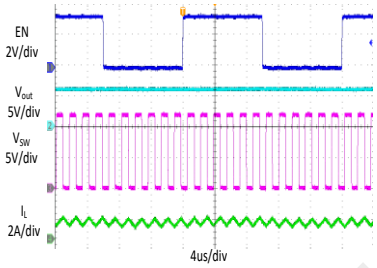
TYPICAL PERFORMANCE CHARACTERISTICS

Vin = 12V, Vout = 2#LED, L = 10μH, Cout = 10μF, TA = +25°C, unless otherwise noted

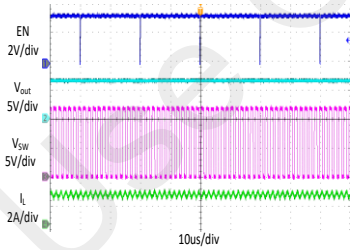
Steady State Test
VIN=12V, Vout=2#LED
PWM=50kHz, 1%



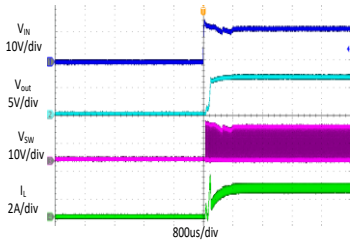
Steady State Test
VIN=12V, Vout=2#LED
PWM=50kHz, 50%



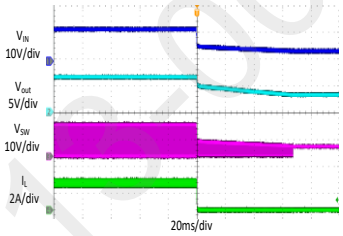
Steady State Test
VIN=12V, Vout=2#LED
PWM=50kHz, 99%



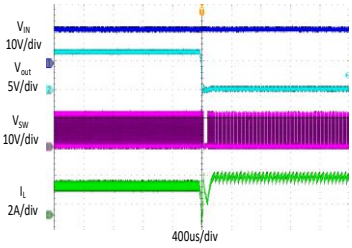
Startup through Vin
VIN=12V, Vout=2#LED
PWM=50kHz, 99%



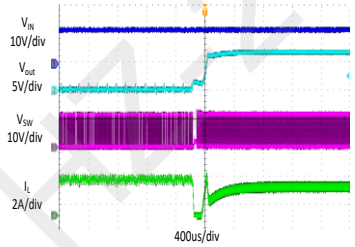
Shutdown through Vin
VIN=12V, Vout=2#LED
PWM=50kHz, 99%



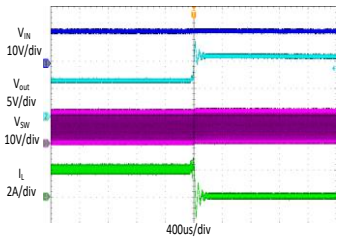
Short LED+ to LED- Protection
VIN=12V, Vout=2#LED
PWM=50kHz, 99%- Short



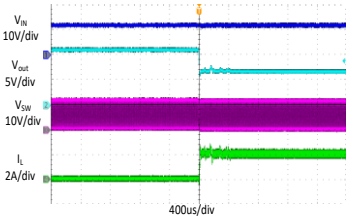
Short LED+ to LED- Recovery
VIN=12V, Vout=2#LED
Recovery



Open LED Load Protection
VIN=12V, Vout=2#LED
PWM=50kHz, 99%- open



Open LED Load Recovery
VIN=12V, Vout=2#LED
Recovery



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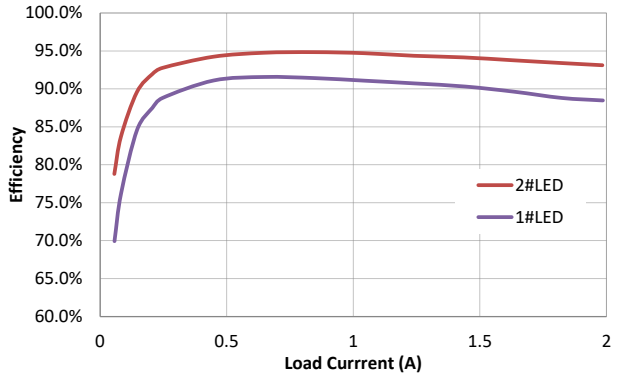

Figure 1. Efficiency vs. Load Current (L=10μH)

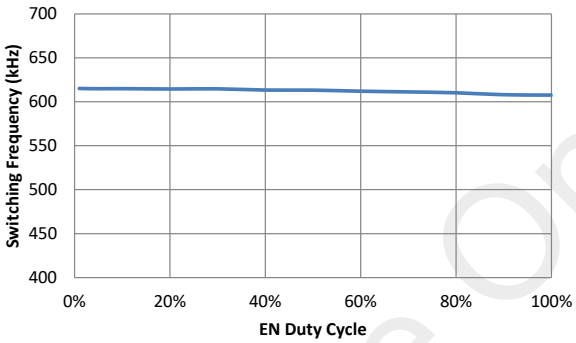

Figure 2. Frequency vs. EN/DIM Duty Cycle

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FUNCTIONAL DESCRIPTION

The JW1123 is a synchronous, current-mode buck LED driver capable of supplying up to 2A of load current.

Power Switch

N-Channel MOSFET switches are integrated on the JW1123 to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage great than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 5V rail when SW is low.

Current-Mode Control

The JW1123 utilizes current-mode control to regulate the SEN pin voltage. Voltage between SEN pin and GND pin is regulated at 0.1V so that by connecting a resistor between SEN pin and GND pin, maximum current through the LED string can be accurately controlled.

FCCM Operation

JW1123 operates in FCCM mode, so its frequency keeps constant at all load range for low output current ripple.

Shut-Down Mode

The JW1123 operates in shut-down mode when voltage at EN pin is driven below 0.5V for 10ms or longer. In shut-down mode, the entire regulator is off and the supply current consumed by the JW1123 drops below 10μA.

PWM Dimming Mode

Once a PWM signal is applied to EN/DIM pin, the internal voltage reference will be proportional to PWM duty cycle as shown as figure 3. LED current is continuous, and the current magnitude can be adjusted by changing PWM duty cycle. Since the internal voltage reference is filtered from PWM signal, too low PWM frequency may cause a little big ripple at voltage reference. To minimize this ripple, PWM signal frequency is recommended to be higher than 20kHz, such as 50kHz.

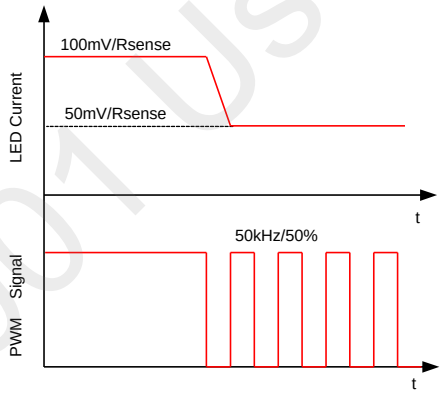

Figure 3. PWM Dimming Mode Operation

Output Current Run-Away Protection

At start-up, due to the high voltage at input and low voltage at output, current inertia of the output inductor can be easily built up, resulting in a large start-up output current. A valley current limit is designed in the JW1123 so that only when output current drops below the valley current limit can the bottom power switch be turned off. By such control mechanism, the output current at start-up is well controlled.

Sense Pin Short Protection

When the sense resistor is shorted, the SENSE voltage is low, and the internal COMP voltage is clamped to a max value. When the COMP voltage is clamped for 768 cycles and the maximum duty cycle is not triggered, the devices stop switching. The devices then

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automatically start a new start-up after 3840 cycles. The devices repeat this mode until the short condition is removed.

LED+ and LED- Short Protection

When the LED load is shorted, the SENSE voltage is higher than internal reference voltage, and the internal COMP voltage is driven low and clamped, and the high-side MOSFET is commanded on for a minimum on-time each cycle. In this condition, if the output voltage is too low, the inductor current may not be able to balance in a cycle, causing current runaway. Finally, the inductor current is clamped at the low-side MOSFET sourcing-current limit, which is much higher than target LED current.

LED+ and GND Short Protection

When LED+ is shorted to GND, the SENSE voltage is low, and the internal COMP voltage is clamped to a max value. When the COMP voltage is clamped for 768 cycles and the maximum duty cycle is not triggered, the devices stop switching. The devices then automatically start a new start-up after 3840 cycles. The devices repeat this mode until the short condition is removed.

Open Circuit Protection

Once the LED load is open, the SENSE voltage is low, and the internal COMP voltage is driven high and clamped. This action charges the output capacitor to a voltage as high as VIN and the devices operate in maximum duty cycle status. Only when the open circuit condition is removed, the output voltage becomes normal.

Thermal Protection

When the temperature of the JW1123 rises above 160°C, it is forced into thermal shut-down. Only when core temperature drops below 130°C can the regulator becomes active again.

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APPLICATION INFORMATION

External Bootstrap Capacitor

The bootstrap capacitor is required to supply voltage to the top switch driver. A 0.1μF low ESR ceramic capacitor is recommended to connected to the BST pin and SW pin.

EN/DIM Pin High Input Threshold

When the dimming frequency is high and the dimming duty cycle is small, the period of high level voltage is quite short. As the PWM signal at EN/DIM pin will be filtered in the chip, narrower pulse needs higher level amplitude to guarantee the high level voltage. The recommended lowest value of EN/DIM high input threshold can be calculated as below:

$$V_{ENH} = \frac{1.3}{1 - e^{-\frac{3.57\times10^6 D_{DIM}}{f_{DIM}}}}$$

where D_{DIM} is dimming duty cycle and f_{DIM} is dimming frequency.

Figure. 4 and 5 show the value of V_{ENH} under different dimming frequency and duty cycle.

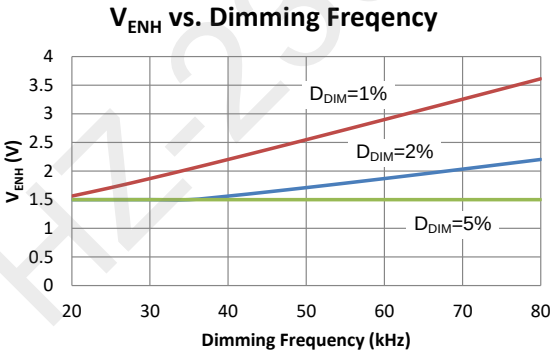

Figure 4. V_{ENH} vs. Dimming Frequency

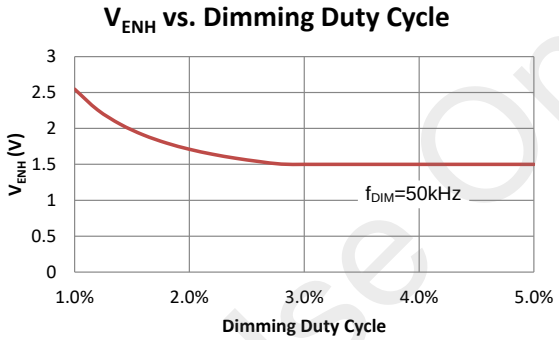

Figure 5. V_{ENH} vs. Dimming Duty Cycle

SEN Positive Spike Protection Circuit

In some application failure scenarios， such as LED+ short to LED-，the sudden failure might cause abnormally high positive spike on SEN pin which can create false actions or damage.

To protect SEN suffer from high positive spikes，it is recommended to add a diode (e.g. IN4007) between SEN and GND, as shown in Figure 6.

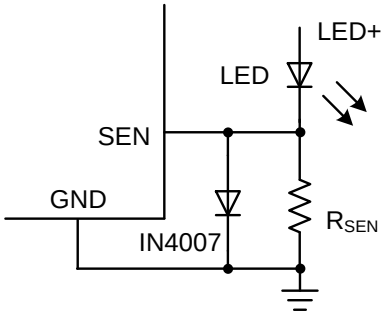

Figure 6. SEN Protection Circuit

Cout in Parallel with LED

The output capacitor can be connected in parallel with the LED in application, as shown in Figure 7.

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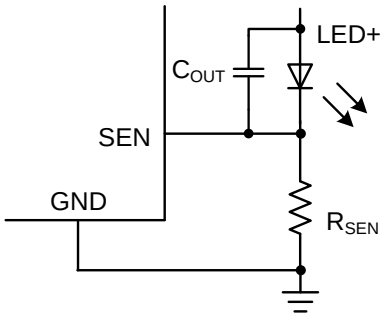


Figure 7. Cout in Parallel with LED

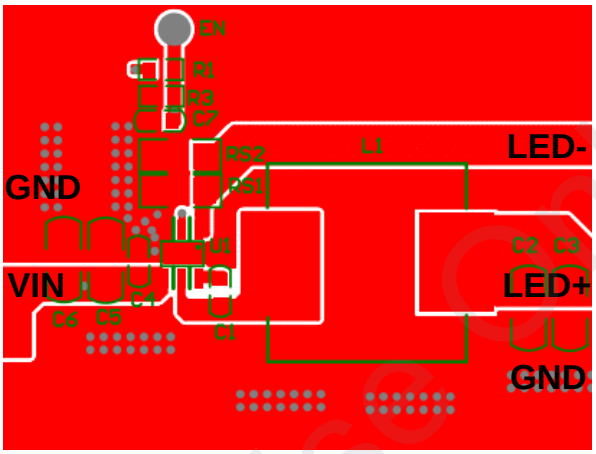
The current ripple of inductor will generate a voltage ripple on R_{SEN}. To prevent the voltage ripple ΔV_{SEN} affects the dimming linearity, the suitable inductor L and sense resistor R_{SEN} can be calculated as below to make sure ΔV_{SEN}< 0.2V.

$$\Delta V_{SEN} = \frac{Vo}{L \cdot fs}\left(1 - \frac{Vo}{Vin}\right) \cdot R_{SEN}$$

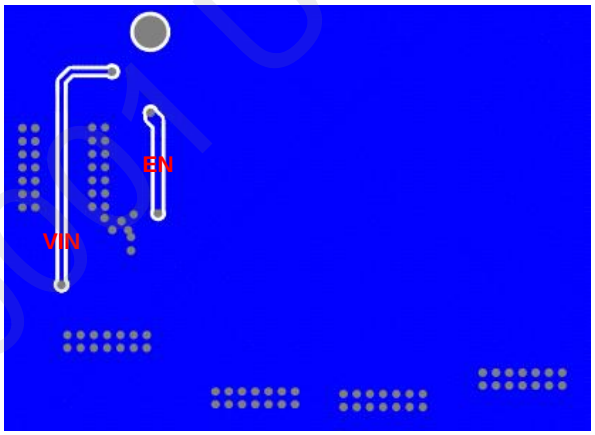
PCB Layout Note

For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

1. Place the input decoupling capacitor as close to JW1123 (VIN pin and GND pin) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized.
2. Put the sensing resistors as close to SEN pin and GND pin as possible.
3. The ground plane on the PCB should be as large as possible for better heat dissipation.



Top Layer



Bottom Layer

Figure 8. PCB Layout Recommendation

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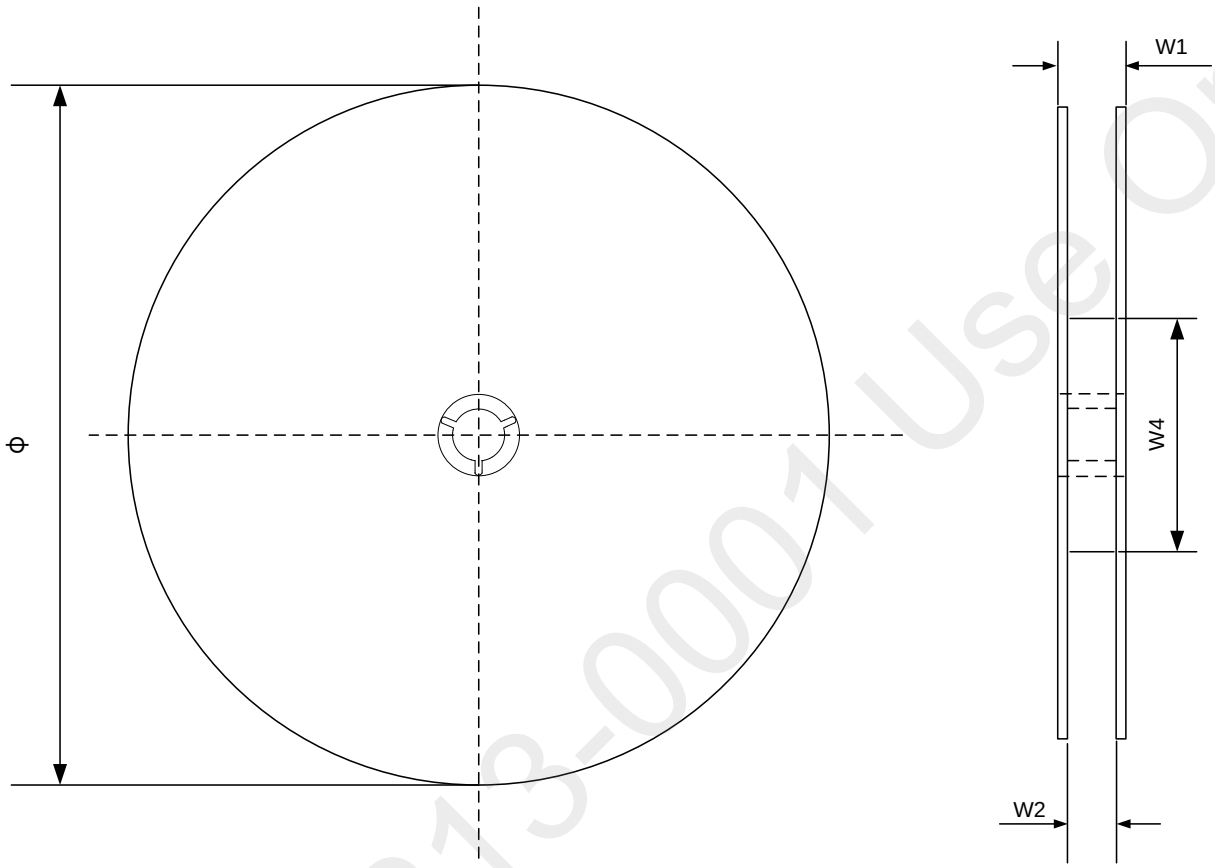
TAPE AND REEL INFORMATION

Reel UNIT: mm



Package	Diameter Φ	Thickness W1	Width W2	W4
SOT23-6	178±2	12.30±2	9.5±2	58±4

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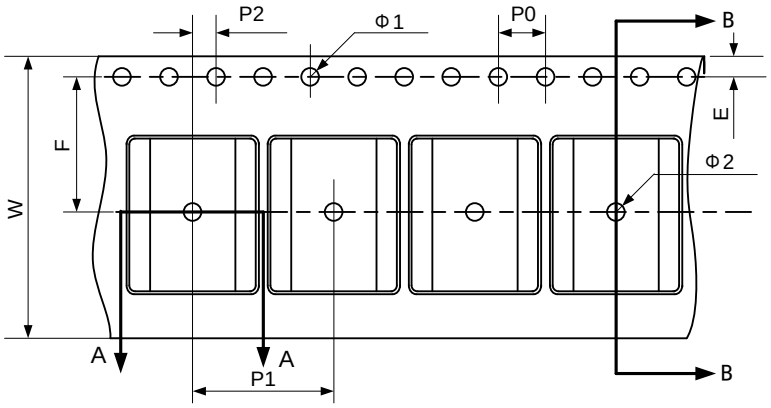
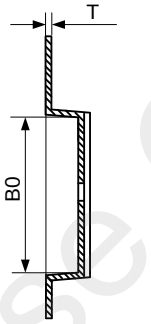
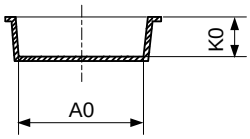
Carrier Tape UNIT: mm





SECTION B-B



SECTION A-A

Note :

1) The carrier type is black, and colorless transparent.
2) Carrier camber is within 1mm in 100mm.
3) 10 pocket hole pitch cumulative tolerance:±0.20.
4) All dimensions are in mm.

Package	Tape dimensions（mm）											
	P0	P2	P1	A0	B0	W	T	K0	Φ1	Φ2	E	F
SOT23-6	4.0±0.1	2.0±0.1	4.0±0.1	3.23±0.2	3.13±0.3	8.0±0.3	0.25±0.2	1.37±0.2	1.55±0.15	1.00min	1.75±0.1	3.50±0.1

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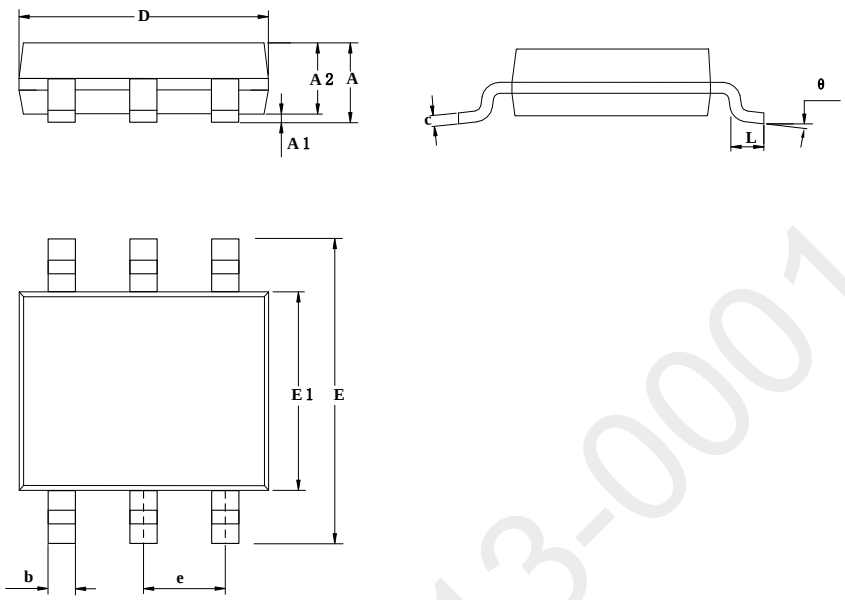
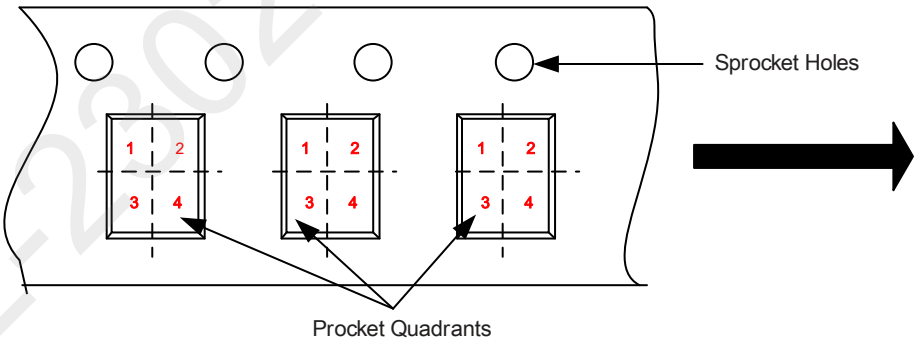
PACKAGE OUTLINE

SOT23-6 UNIT: mm



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.05	1.15	1.25
A1	0	0.05	0.15
A2	0.95	1.10	1.20
b	0.20	0.40	0.60
c	0.05	—	0.21
D	2.72	2.92	3.12
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	0.95（BSC)		
L	0.30	0.45	0.60
θ	0°	—	8°

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPAE



Package Type	Pin1 Quadrant
SOT23-6	3

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