Application Note: AN_SY8750

High Efficiency, 5-80V Input, 500kHz White LED Driver

Preliminary Specification

General Description

SY8750 is a high efficiency, 5V-80V wide input voltage range DC/DC regulator targeting at LED applications. The device integrates the low $R_{DS(ON)}$ MOSFET and internal compensation.SY8750 supports analog dimming with PWM signal/Analog signal.

Features

- Wide input range: 5-80 V
- 500kHz switching frequency
- Integrated low $R_{DS(ON)}$ FET: 200m Ω
- Analog dimming with PWM signal/Analog signal
- Maximum output LED current 2A
- Compact package: SO8E

Ordering Information

SY8750 □(□□)□
- Temperature Code
- Package Code
- Optional Spec Code

Ordering Number	Package type	Note
SY8750FCC	SO8E	----

Applications

- LED lighting

Typical Applications

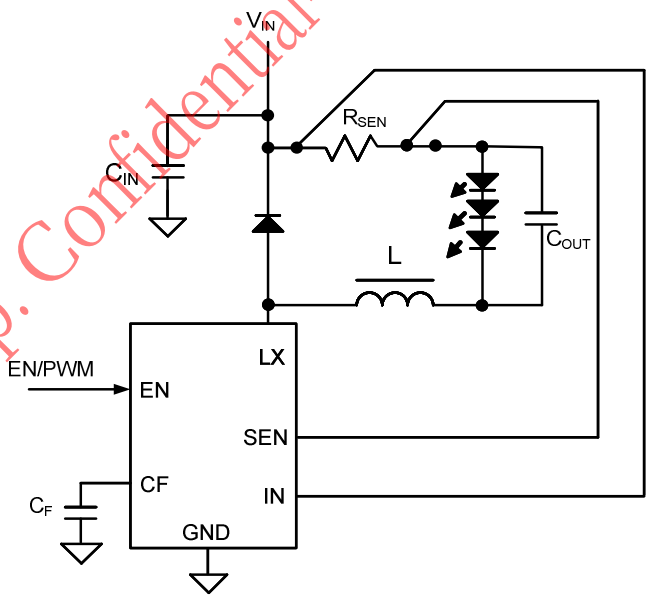
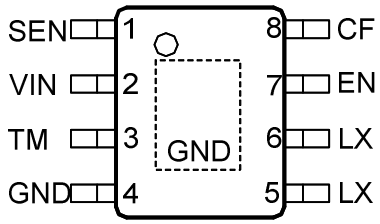


Figure 1. Schematic diagram

Pinout (top view)



SO8E

Top Mark: AQW*xyz* (device code: AQW, ***x=year code, y=week code, z= lot number code***)

Pin Name	S08E	Pin Description
SEN	1	Negative Current Sense Pin.
IN	2	Input pin. Decouple this pin to GND pin with 1uF ceramic cap. Also used as the positive current sense pin.
TM	3	Connect to GND
GND	4	Ground pin
LX	5,6	Inductor node. Connect an inductor between V_{IN} and LX pin.
EN	7	Enable pin and PWM dimming input pin.
C_F	8	Connect a capacitor from this pin to ground to filter out the AC ripple on reference voltage. Or add 0~1.1V on this pin directly to realize linear dimming.

Absolute Maximum Ratings

LX, IN, EN---------- 90V
SEN ---------- V_{IN} ± 0.6V
All other pins---------- ---------- 4V
Power Dissipation, PD @ T_A = 25°C SO8E, ----------3.3W
Package Thermal Resistance (Note 2)
θ_{JA}----------30°C/W
θ_{JC} ----------10°C/W
Junction Temperature Range ---------- -40°C to125°C
Lead Temperature (Soldering, 10 sec.) ---------- 260°C
Storage Temperature Range ---------- -65°C to 150°C

Recommended Operating Conditions

IN, LX,EN ----------5V to 80V
SEN ---------- V_{IN} ± 0.4V
All other pins ---------- 0-3.6V
Junction Temperature Range ---------- -40°C to 125°C

Electrical Characteristics

(V_{IN} =80V, V_{OUT}=70V, I_{OUT}=0.6A, TA = 25°C unless otherwise specified)

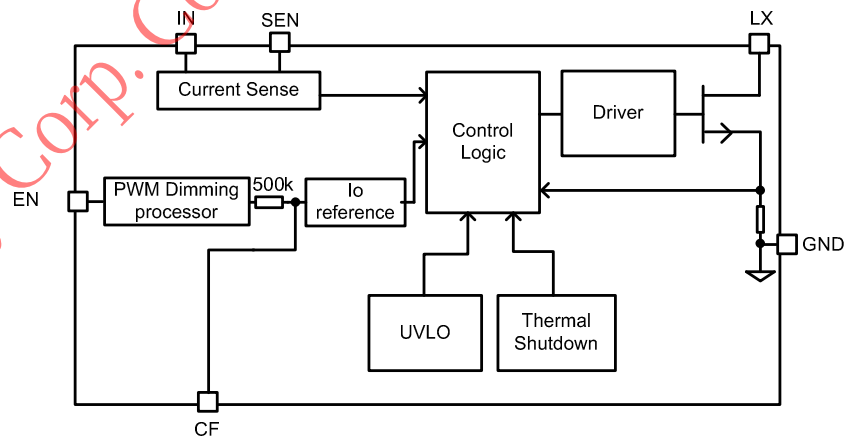
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		5		90	V
Shutdown Current	I_{SHDN}	EN=0		10		μA
Main FET R_{ON}	$R_{DS(ON)}$			200		mΩ
Main FET Current Limit	I_{LIM}			2.6		A
Switching Frequency	F_{SW}			500		kHz
Current Sense Limit	V_{IN-SEN}		196	200	204	mV
EN Rising Threshold	V_{ENH}			1.05		V
EN Falling Threshold	V_{ENL}			0.95		V
IN UVLO Rising Threshold	$V_{IN,UVLO}$			4.1		V
UVLO Hysteresis	$U_{VLO,HYS}$			0.8		V
Dimming section:						
Analog dimming range on CF	V_{CF}	I_{LED} is 5.7% of full load		62.5		mV
		I_{LED} is 100% of full load		1.1		V
Thermal Shutdown Temperature	T_{SD}			150		°C
Thermal Hysteresis	Hyst			15		°C

Note 1: Stresses beyond the "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

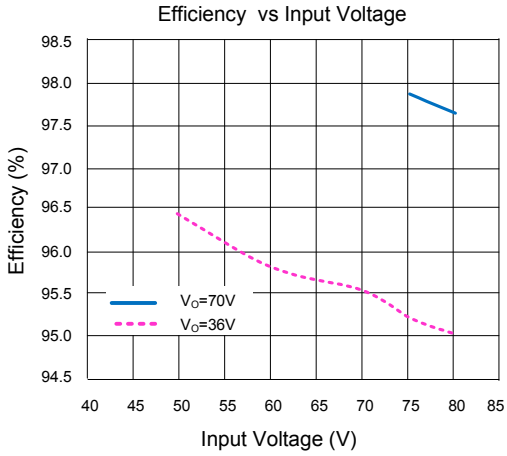
Note 2: θ_{JA} is measured in the natural convection at T_A = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

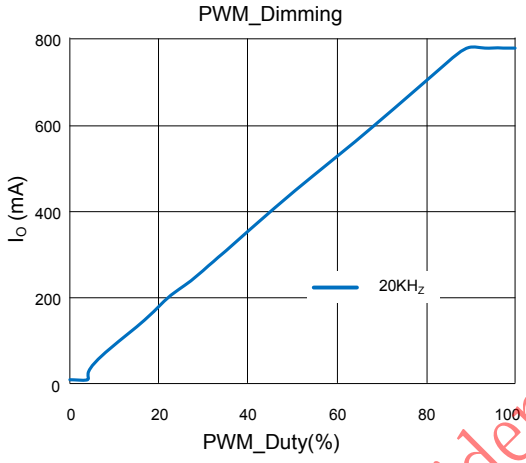
Note 3. The device is not guaranteed to function outside its operating conditions

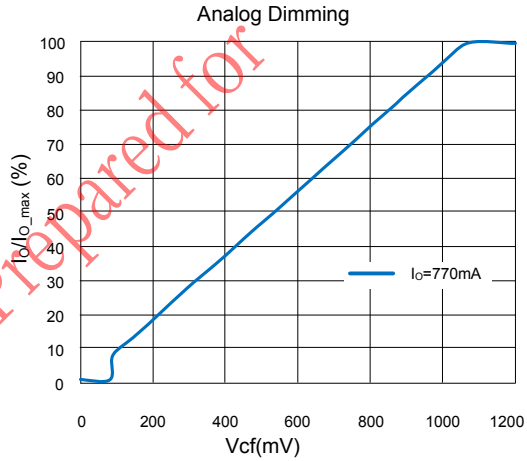
Block Diagram

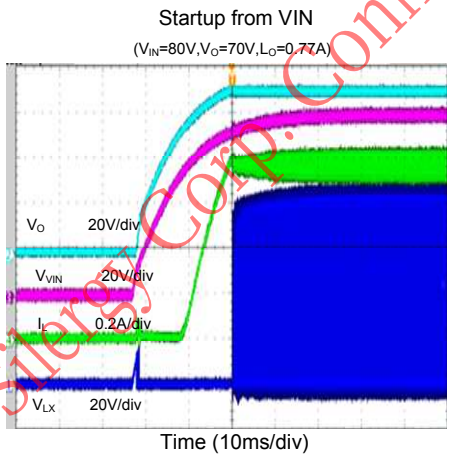


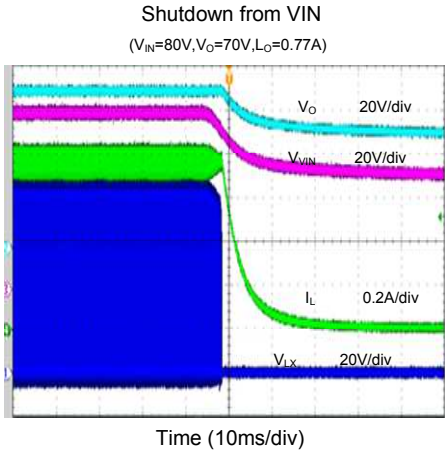
Typical Performance Characteristics





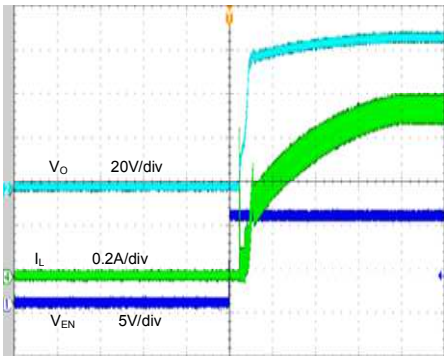






Startup from Enable

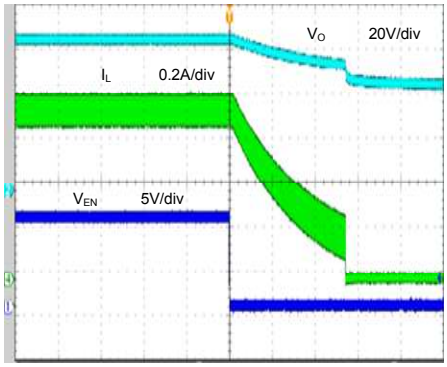
(V_{IN}=80V,V_O=70V,L_O=0.77A)



Time (4ms/div)

Shutdown from Enable

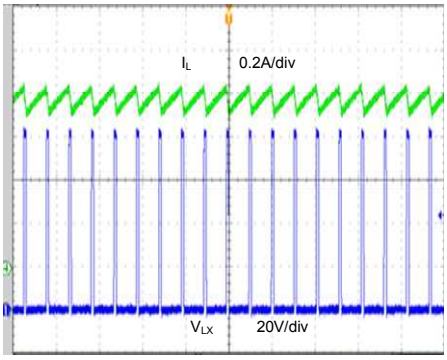
(V_{IN}=80V,V_O=70V,L_O=0.77A)



Time (4ms/div)

Steady State

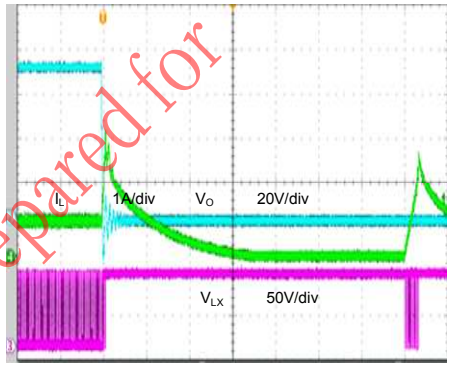
(V_{IN}=80V,V_O=70V,L_O=0.77A)



Time (4us/div)

Short Circuit Protection

(V_{IN}=80V,V_O=70V,L_O=0.77A)



Time (100us/div)

Operation

SY8750 is a grounded-switch buck regulator IC that integrates the PWM control, power MOSFET on the same die. With ultra low $R_{DS(ON)}$ power switches and proprietary PWM control, this regulator IC can achieve the high efficiency. SY8750 also supports analog dimming function with both PWM and analog dimming signal.

Applications Information

Because of the high integration in the SY8750 IC , the application circuit based on this regulator IC is rather simple. Only input capacitor C_{IN}, output capacitor C_{OUT}, output inductor L and current sense resistor R_{SEN} need to be selected for the targeted applications specifications.

Current sense resistor R_{SEN}:

Choose R_{SEN} to program the proper output Current:

$$I_{LED}(A) = \frac{0.2(V)}{R_{SEN}(\Omega)}$$

Input capacitor C_{IN}:

The ripple current through input capacitor is calculated as:

$$I_{CIN\_RMS} = I_{OUT} \cdot \sqrt{D(1-D)}$$

A typical X7R or better grade ceramic capacitor with suitable capacitance should be chosen to handle this ripple current well. To minimize the potential noise problem, this ceramic capacitor should be placed really close to IN and GND. The loop area, formed by C_{IN}, and IN/GND pins, should be minimized to achieve better EMI performance.

Output capacitor C_{OUT}:

The output capacitor is selected to handle the output current ripple. For the best performance, it is recommended to use X7R or better grade ceramic capacitor greater than 1uF capacitance.

Output inductor L:

There are several considerations in choosing this inductor.

1) Choose the inductance to provide the desired ripple current. It is suggested to choose the ripple current to be about 40% of the maximum output current. The inductance is calculated as:

$$L = \frac{V_{OUT}(1 - V_{OUT}/V_{IN,MAX})}{F_{SW} \times I_{OUT,MAX} \times 40\%}$$

where Fsw is the switching frequency and $I_{OUT,MAX}$ is the LED current.

The SY8750 regulator IC is quite tolerant of different ripple current amplitude. Consequently, the final choice of inductance can be slightly off the calculation value without significantly impacting the performance.

2) The saturation current rating of the inductor must be selected to be greater than the peak inductor current under full load conditions.

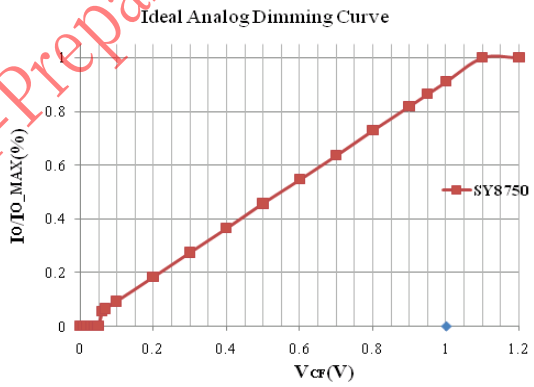
$$I_{SAT,MIN} > I_{OUT,MAX} + \frac{V_{OUT}(1-V_{OUT}/V_{IN,MAX})}{2 \cdot F_{SW} \cdot L}$$

Dimming Operation:

It is compatible with two dimming signals: PWM signal and analog signal.

Applied with PWM signal, the PWM is connected to EN pin, the dimming frequency is limited to larger than 20kHz. If the dimming frequency is lower than 20kHz, an external capacitor is needed to bypass CF pin.

Applied with analog dimming, EN pin is pulled up to high, and the analog signal 0-1.1V is connected to CF pin.



Soft Start:

Add a ceramic capacitor C_F on CF to achieve soft start, the soft start time can be adjusted by C_F.

SCP:

If V_{VIN}-V_{SEN}>=0.6V, the output is disabled

EN OFF:

If VEN is lower than VENL, IC will shut down after 11ms.

Layout Design:

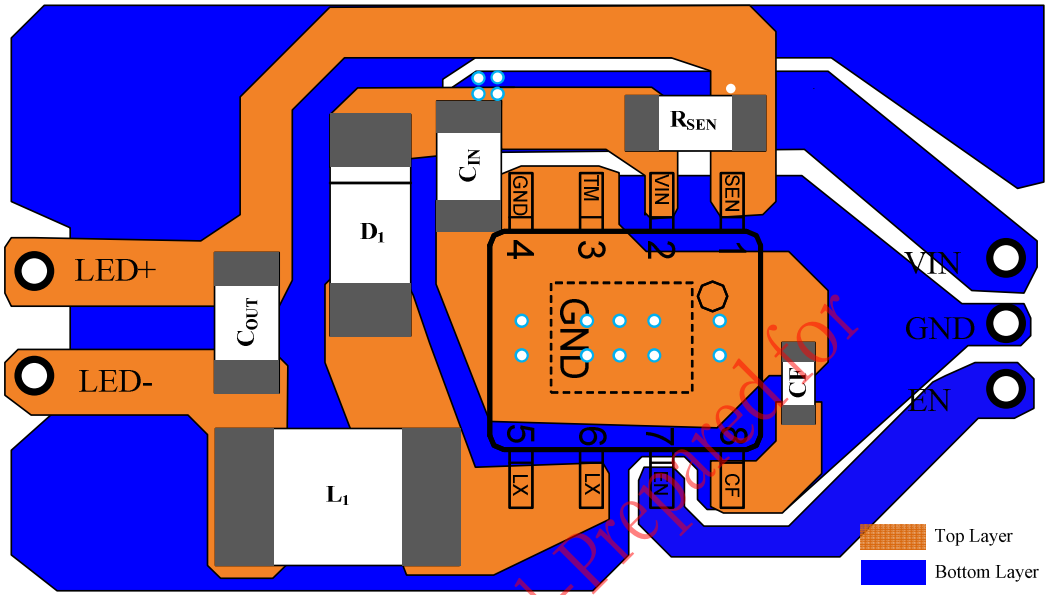
The layout design of SY8750 regulator is relatively simple. For the best efficiency and minimum noise problems, we should place the following components close to the IC: C_{IN}, L, C_{OUT}, C_F and R_{SEN}.

1) It is desirable to maximize the PCB copper area connecting to GND pin to achieve the best thermal and noise performance. If the board space allowed, a ground plane is highly desirable.

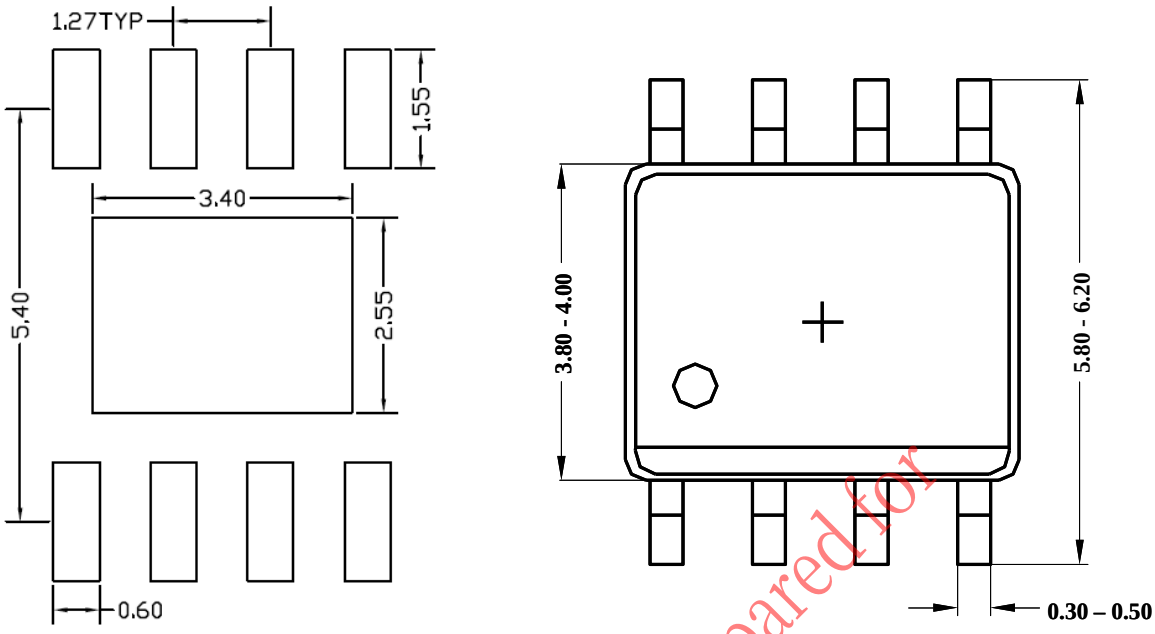
2) C_{IN} must be close to Pins IN and GND. The loop area formed by C_{IN} and GND must be minimized.

3) The PCB copper area associated with LX pin must be minimized to avoid the potential noise problem.

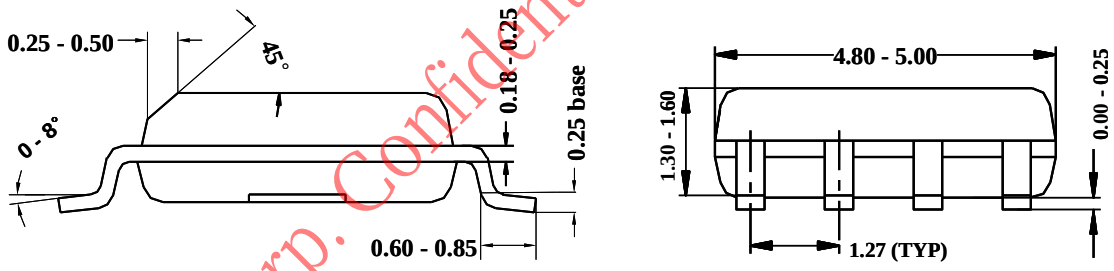
PCB Layout Suggestion



SO8E Package outline & PCB layout design



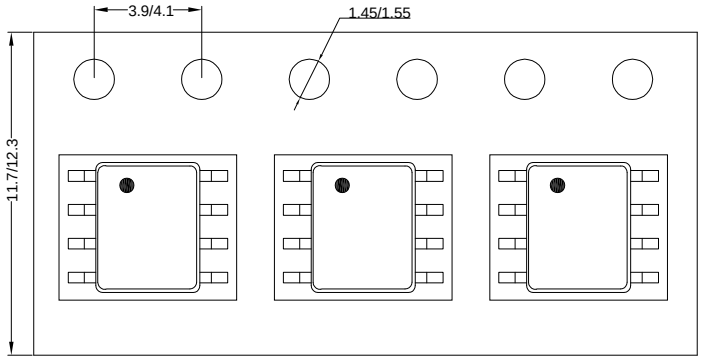
Recommended Pad Layout



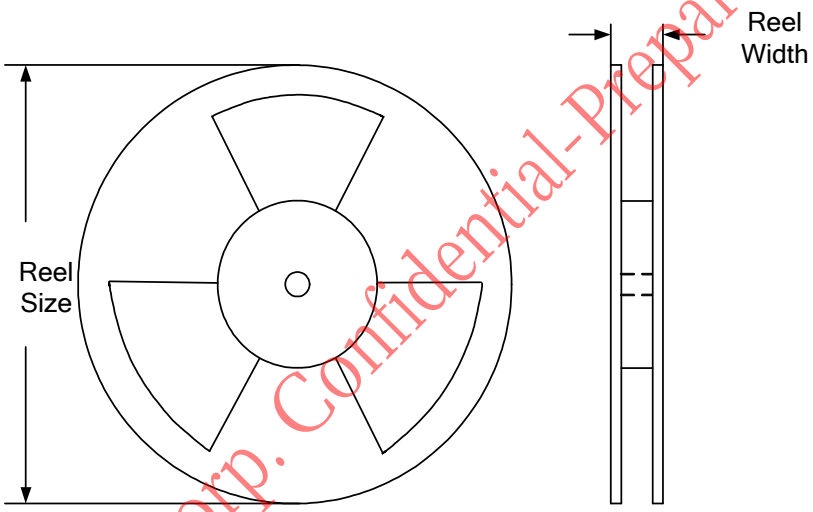
Notes: **All dimension in MM**
All dimension don't not include mold flash & metal burr

Taping & Reel Specification

1. SOP8-EP



2. Carrier Tape & Reel specification for packages



Package types	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Reel width(mm)	Trailer length(mm)	Leader length (mm)	Qty per reel
SOP8-EP	12	8	13"	12.4	400	400	2500

3. Others: NA