

General Description

The SY22728H1 is a high efficiency synchronous step-down LED regulator that can deliver up to 2.0A output current. It operates at 1MHz and integrates two very low $R_{DS(ON)}$ power switches to minimize losses and reduce the external components.

The LED intensity can be changed by an external PWM. Using a PWM signal with a duty cycle between 1% and 100%, the LED current can be adjusted on a linear scale between 0.6% and 100%.

Features

- Wide input voltage range: 4V-23V
- Up to 2.0A Output Current Capability
- Low $R_{DS(ON)}$ for Internal Switches
High Side/Low Side: 125m Ω /75m Ω
- Fixed 1MHz Switching Frequency
- Cycle by Cycle 3.5A Peak Current Limit for High Side and 2.5A Valley Current Limit for Low Side
- High Accuracy at low duty cycle operation
- Enables dimming down to 1% of the maximum LED programmed current
- Over Temperature Protection
- RoHS Compliant and Halogen Free
- Compact package: TSOT23-6

Applications

- IR LED driving for DVR /NVR Camera Systems
- 12VDC Lighting

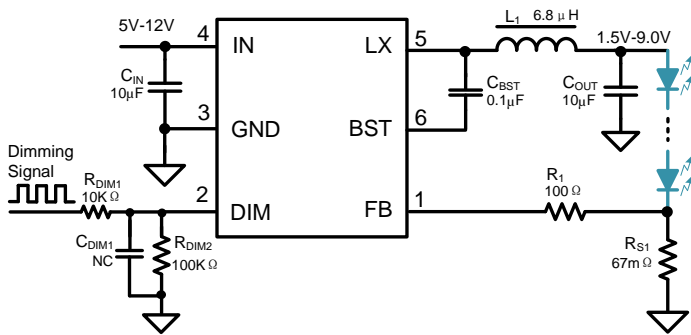


Figure 1. Schematic

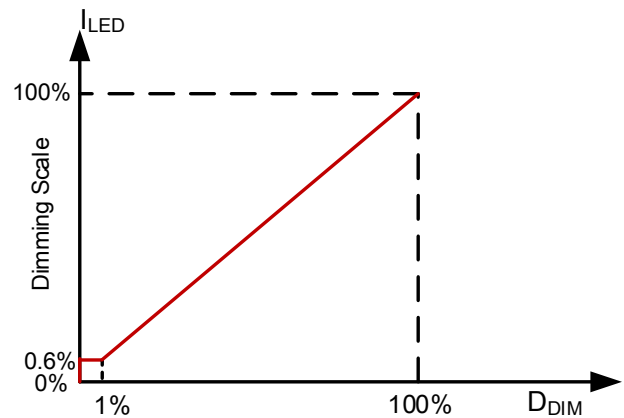


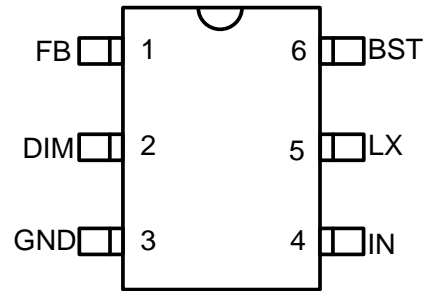
Figure 2. Ideal Dimming Curve Of SY22728H1

Ordering Information

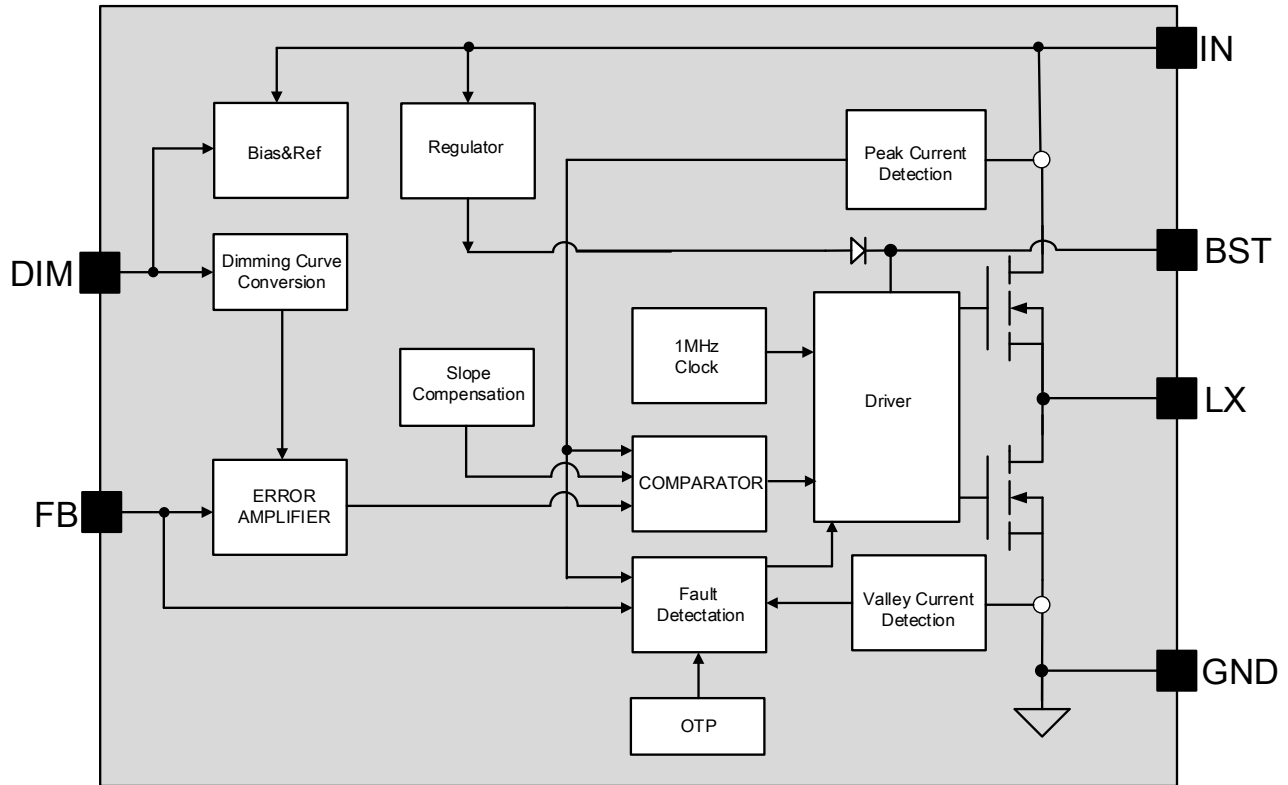
Ordering Part Number	Package type	Top Mark
SY22728H1ADC	TSOT23-6 RoHS Compliant and Halogen Free	6D .xyz

x=year code, y=week code, z= lot number code

Pinout (top view)



Pin No	Pin Name	Pin Description
1	FB	Output current feedback pin. The output current: $I_{OUT} = 0.1V / R_s$
2	DIM	Dimming signal input. Ensure the PWM high time be longer than 100ns and PWM duty be larger than 2% to light the LED on
3	GND	Ground pin
4	IN	Input supply pin. Decouple this pin to GND pin with a 1 μ F ceramic cap
5	LX	Switching node pin. Connect this pin to the inductor
6	BST	Boot-strap pin. Supply for high side gate driver. Connect this pin to LX using a 0.1 μ F ceramic cap

Block Diagram

Figure 3. Functional Block Diagram

Absolute Maximum Ratings (1)	Min	Max	Unit
IN IN, DIM, FB	-0.3	25	V
LX	-0.3	25	
BST-LX	-0.3	4	
Power Dissipation, PD @ TA = 25°C TSOT23-6		1.5	W

Package Thermal Information (2)	Min	Max	Unit
θ_{JA} Junction-to-ambient Thermal Resistance		66	°C/W
θ_{JC} Junction-to-case Thermal Resistance		15	
Junction Temperature Range	-40	150	°C
Lead Temperature (Soldering, 10 sec.)		260	
Storage Temperature Range	-65	150	

Recommended Operating Conditions (3)	Min	Max	Unit
Supply Voltage IN	4	23	V
Junction Temperature Range	-40	125	°C

Electrical Characteristics $V_{IN} = 12V$, $V_{OUT} = 1.5V$ $T_A = 25^\circ C$, unless otherwise specified							
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit	
IN Pin	Input Voltage Range	V_{IN}	4.0		23.0	V	
	IN UVLO Rising Threshold	V_{UVLO}	3.5		4.0	V	
	UVLO Hysteresis	V_{UVLO_HYS}		0.2		V	
	Quiescent Current	I_Q	$V_{DIM}=2V$, $V_{FB}=0.105V$		2.5	mA	
FB Pin	Feedback Reference Voltage	V_{FB}	$D_{DIM}=100\%$, $V_{IN}=12V$, $V_{OUT}=2.0V$, $I_{OUT}=1.0A$	96	99	102	mV
			$D_{DIM}=100\%$, $V_{IN}=12V$, $V_{OUT}=8.0V$, $I_{OUT}=1.0A$	98	101	104	mV
	Min Feedback Reference Voltage	V_{FB_MIN}	$D_{DIM}=0.5\%$		0.6		mV
Integrated Power Switches	High Side FET $R_{DS(ON)}$	$R_{DS(ON)1}$		125		m Ω	
	High Side FET Peak Current Limit	I_{LIM_HIGH}	$T_{ON} < 300ns$		3.5	A	
	Low Side FET $R_{DS(ON)}$	$R_{DS(ON)2}$		75		m Ω	
	Low Side FET Valley Current Limit	I_{LIM_LOW}			2.5	A	
DIM Pin	PWM Dimming Duty Range	D_{DIM}	0%		100%		
	Dimming ON Threshold	V_{DIM_ON}			1.5	V	
	Dimming OFF Threshold	V_{DIM_OFF}	0.4			V	
BST Pin	Bias Voltage for High FET Driver	V_{BST_LX}	$4V \leq V_{IN} \leq 23V$		3	V	
	Operating Frequency	F_S	0.8	1.0	1.2	MHz	
	Min ON Time	T_{ON_MIN}		80		ns	
	Max Duty Cycle	D_{MAX}	89%	92%			
Thermal Shut Down	Thermal Shutdown Temperature	T_{SD}		150		$^\circ C$	
	Thermal Shutdown Hysteresis	T_{HYS}		15		$^\circ C$	

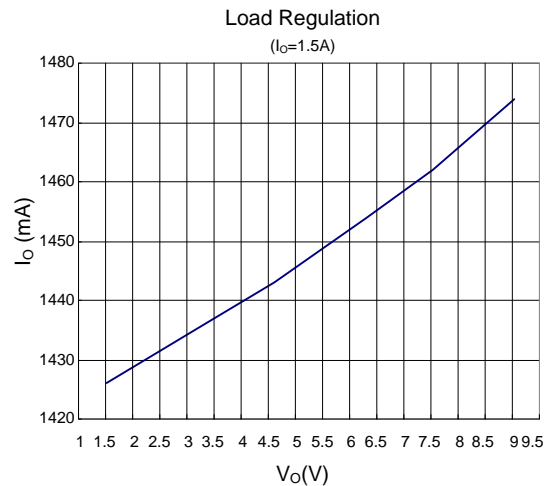
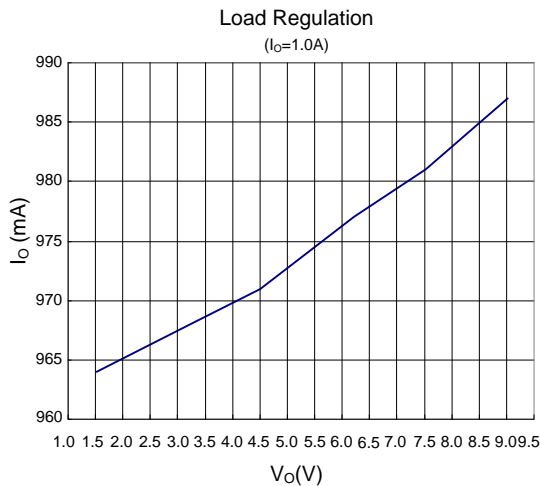
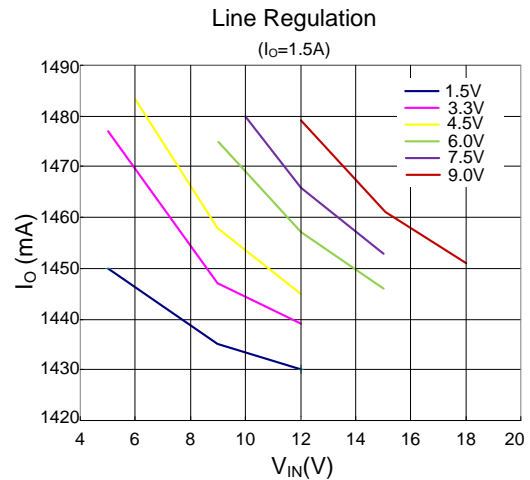
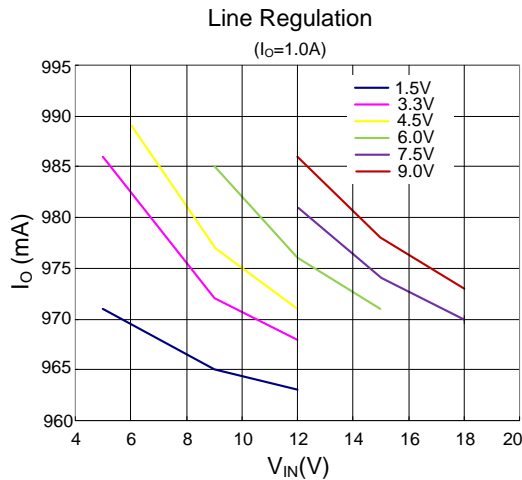
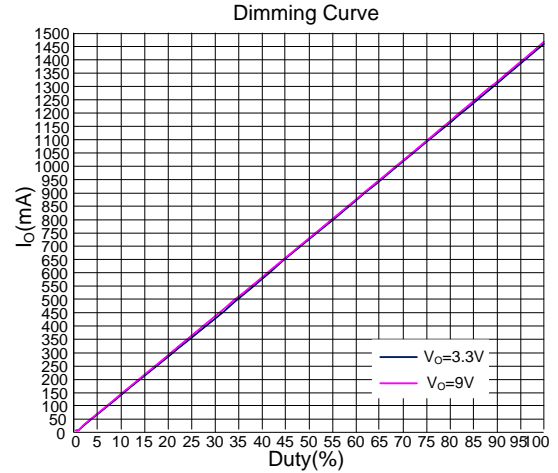
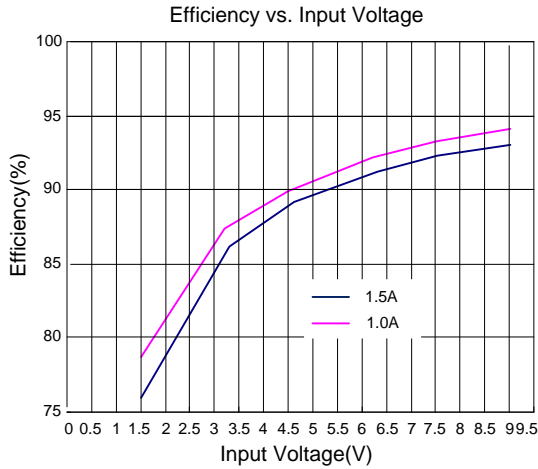
Note 1: Stresses beyond the “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute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

Note 2: θ_{JA} is measured in the natural convection at $T_A = 25^\circ C$ on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard. Test condition: Device mounted on 2” x 2” FR-4 substrate PCB, 2oz copper, with minimum recommended pad on top layer and thermal vias to bottom layer ground plane.

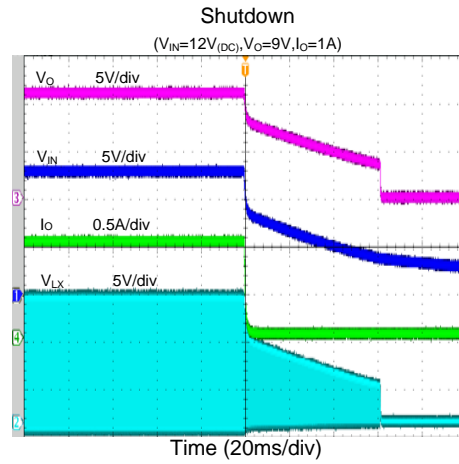
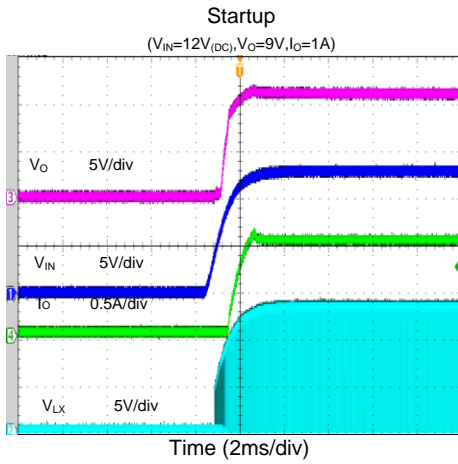
Note 3: The device is not guaranteed to function outside its operating conditions.

Typical Operation Characteristics

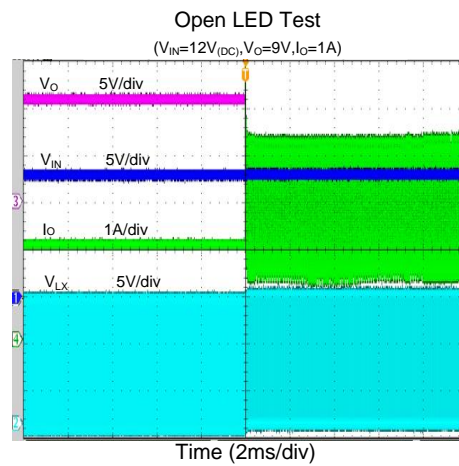
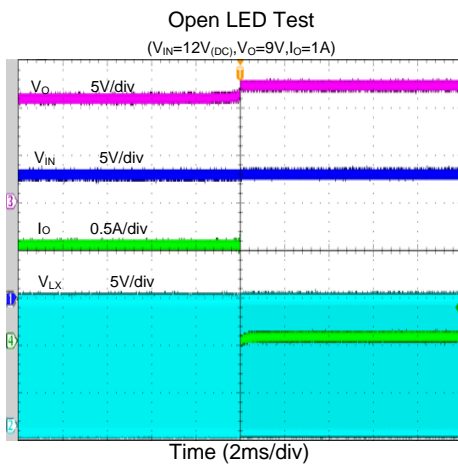
($V_{IN} = 12V$, $V_{OUT}=1.5V$ $T_A = 25^\circ C$ unless otherwise specified)



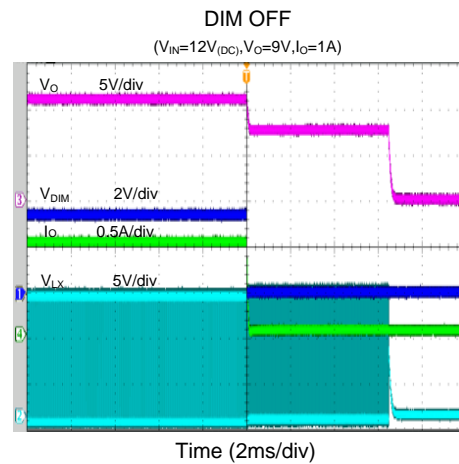
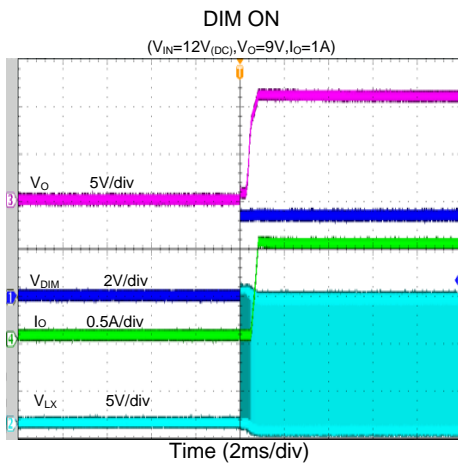
Start Up and Shut Down



Open LED Protection and Short LED Protection



DIM ON&OFF





Operation

The SY22728H1 is a 23V and up to 2A constant output current capability synchronous buck regulator IC. It integrates two very low $R_{DS(ON)}$ power switches to minimize the switching and conduction losses. The high switching frequency is used to minimize the external inductor and capacitor sizes.

The device supports PWM dimming, using duty cycles from 1% to 100% for controlling the LED current on a linear scale.

Application Information

The steps required for calculating and selecting the external components are shown below:

Current Sensing Resistor R_{S1}

Choose the proper R_{S1} to program the output current I_{OUT}

$$R_{S1} = \frac{0.1V}{I_{OUT}}$$

To prevent the FB pin from being damaged in the event of a short circuit on the output, connecting a resistor (R_1) with a value of 100 Ω is recommended.

Input Capacitor C_{IN}

The ripple current through input capacitor is calculated as:

$$I_{CIN_RMS} = I_{OUT} \times \sqrt{D \times (1-D)}$$

A typical X7R or better dielectric grade ceramic capacitor with suitable capacitance should be chosen to handle this ripple current well. To minimize the potential noise problem, place this ceramic capacitor really close to the IN and GND pins of the device. Caution should be taken to minimize the loop area formed by C_{IN} and IN/GND pin.

Output Capacitor C_{OUT}

The output capacitor is selected to improve the loop stability and handling of the output current ripple. For best performance, it is recommended using a X7R or better capacitor, with a capacitance greater than 10uF.

Inductor L_1

There are several considerations in choosing optimal inductor.

- 1) Select the proper inductance to ensure the loop stability.
- 2) Choose the ripple current to be about 40% of the maximum output current as long as the loop stability allows it. The inductance is calculated using the formula:

$$L_1 = \frac{V_{OUT} \times (1 - \frac{V_{OUT}}{V_{IN,MAX}})}{F_s \times I_{OUT,MAX} \times 40\%}$$

Where F_s is the switching frequency and $I_{OUT,MAX}$ is the full scale LED current.

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

$$I_{SAT,MIN} > I_{OUT,MAX} + \frac{V_{OUT} \times (1 - \frac{V_{OUT}}{V_{IN,MAX}})}{2 \times F_s \times L_1}$$

Bootstrap Capacitor C_{BST}

This capacitor provides the gate driver voltage for internal high side MOSEFET. A low ESR, 100nF ceramic capacitor connected between BST pin and LX pin is recommended.

Dimming Performance

The DIM pin is used to regulate output current using a PWM signal, with a frequency between 20KHz and 500KHz. The logic high voltage is 1.5V and the logic low voltage is 0.4V. For PWM duty cycles from 1% to 100%, the output current will be 0.6%-100% of its programmed value. The dimming curve is shown in Fig.2

Note: Ensure that the PWM duty-cycle >2% and PWM high time > 100ns for proper operation during device start-up.

Layout

To obtain the best efficiency and reduce the possible noise problems consider the following guidelines:

- 1) It is desirable to maximize the PCB copper area connected to the GND pin to achieve the best thermal and noise performance. If the board space allows, a ground plane is highly desirable.
- 2) C_{IN} must be close to the 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 reduce radiated noise.
- 4) The FB pin must not be adjacent to the LX line on the PCB layout to avoid the crosstalk.

The recommended layout for SY22728H1 is shown in figure 4

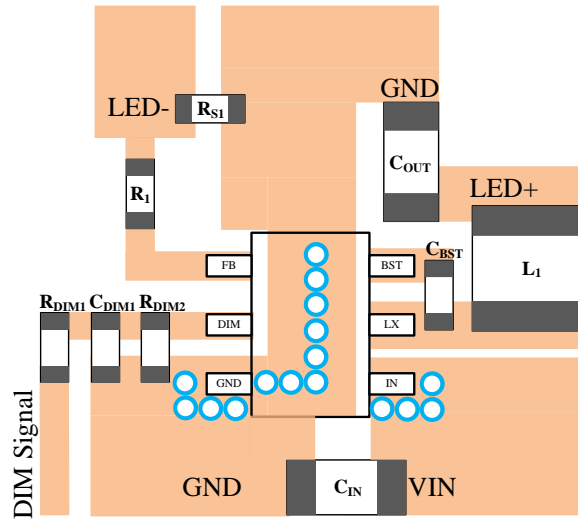
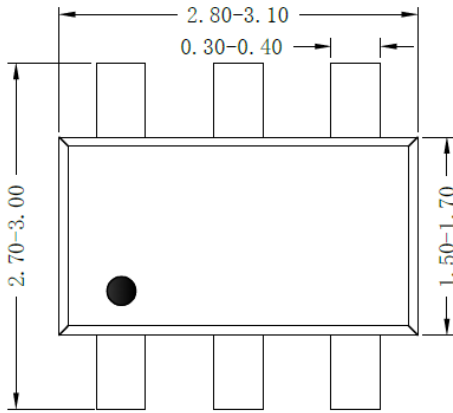
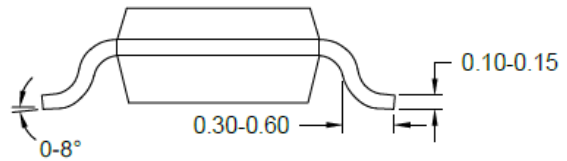


Figure 4. Recommended PCB Layout

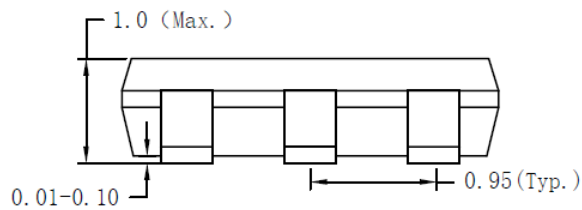
TSOT23-6 Package outline & PCB layout



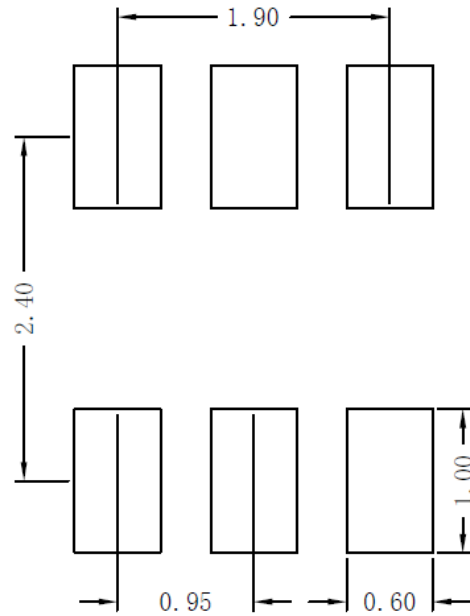
Top view



Side view



Front view

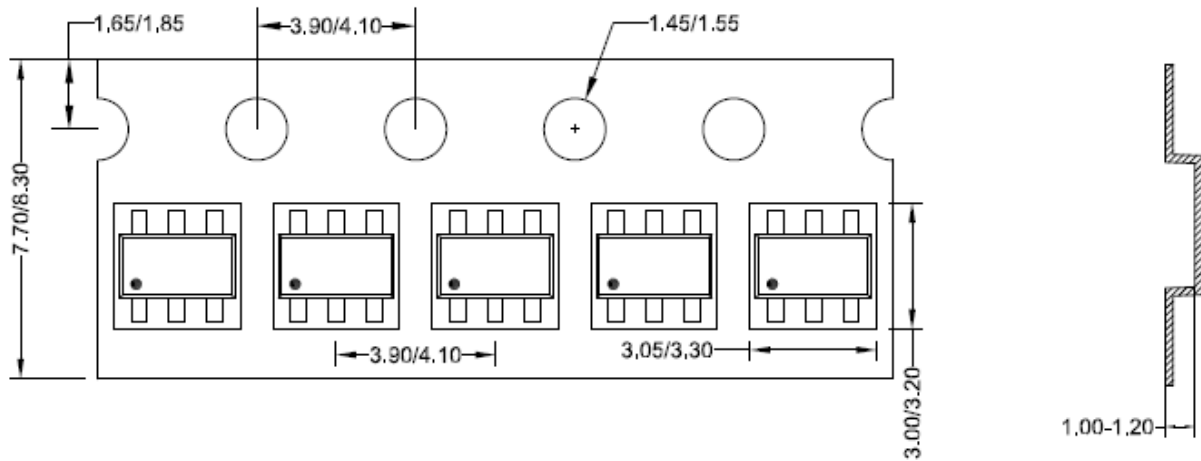


**Recommended Pad Layout
(Reference Only)**

Notes: All dimensions are in millimeter and exclude mold flash & metal burr.

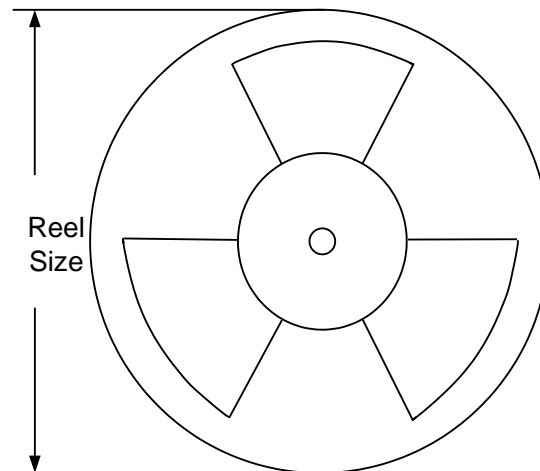
Taping & Reel Specification

1. Taping Orientation



Feeding direction

2. Carrier Tape & Reel specification for packages



Package types	Tape width (mm)	Pocket pitch(mm)	Reel size (Inch)	Trailer length(mm)	Leader length (mm)	Qty per reel
TSOT23-6	8	4	7	400	160	3000

3. Others: NA

Revision History

The revision history provided is for informational purpose only and is believed to be accurate, however, not warranted. Please make sure that you have the latest revision.

Date	Revision	Change
December 30, 2019	Revision 0.9	Initial Release
December 30, 2020	Revision 1.0	Production Release

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