\Application Note: SY6288F1/F2

3A Low Loss Power Distribution Switch

General Description

SY6288F1/F2 is an ultra-low $R_{DS(ON)}$, 3A Low Loss Power Distribution switch with current limit to protect the power source from over current and short circuit conditions. It incorporates over temperature protection and reverse blocking function.

Ordering Information

SY6288 □(□□)□
- Temperature Code
- Package Code
- Optional Spec Code

Ordering Number	Package type	**UL certified**
SY6288F1ABC	SOT23-6	YES
SY6288F2ABC	SOT23-6	YES

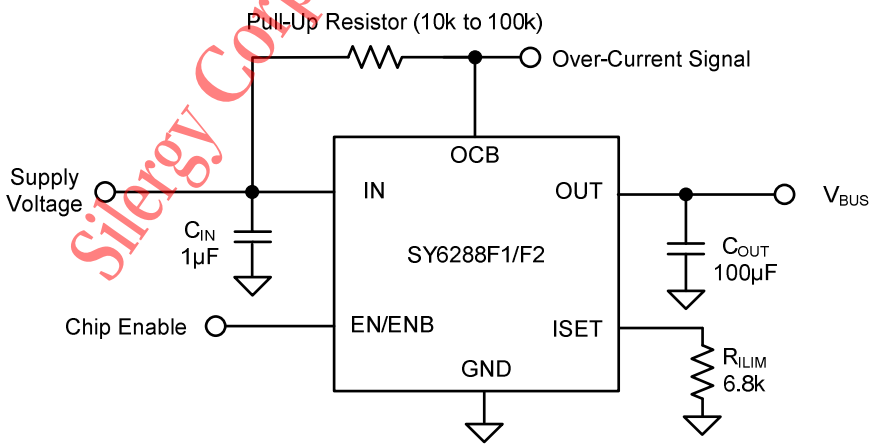
Features

- Input voltage: 2.5V to 5.5V
- Extremely Low Power Path Resistance: 45mΩ (typ.)
- 3A load current capability
- Two Enable polarities:
  - SY6288F1ABC: Active High
  - SY6288F2ABC: Active Low
- Over temperature shutdown and automatic retry
- Reverse blocking (no body diode)
- Fault flag (OCB) output for over current and fault conditions
- Programmable current limitation
- At shutdown, OUT can be forced higher than IN
- Built-in soft-start
- Compact package minimizes the board space: SOT23-6
- RoHS Compliant and Halogen Free
- UL certification NO. 20160229-E333762

Applications

- USB 3.1 Application
- USB 3G Datacard
- USB Dongle
- MiniPCI Accessories
- USB Charger
- Public Place Multi-USB Charger

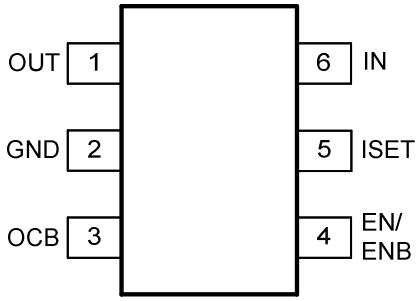
Typical Application Circuit



Note: If 1uF input cap will lead to large Vin voltage spike, it is strongly recommended to add additional 10uF ceramic cap.

Figure 1. Schematic Diagram

Pinout (Top View)

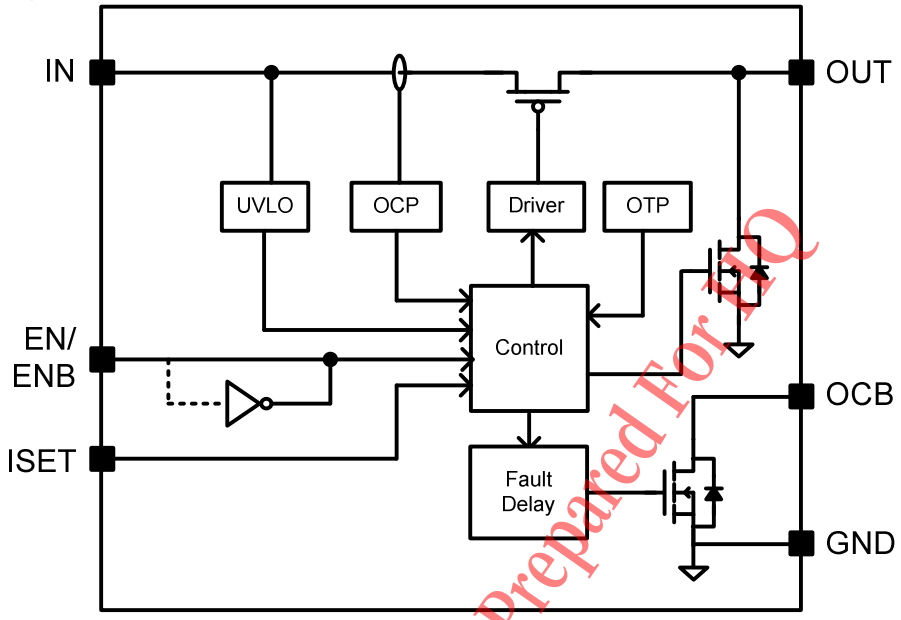


Part Number	Package type	Top Mark①
SY6288F1ABC	SOT23-6	**Kn*xyz***
SY6288F2ABC	SOT23-6	**Nf*xyz***

Note①： ***x=year code, y=week code, z= lot number code.***

Pin Name	Pin number SOT23-6	Pin Description
OUT	1	Output pin, decoupled with a 10μF capacitor to GND.
GND	2	Ground pin.
OCB	3	Open Drain Fault Flag
EN/ENB	4	ON/OFF control. Do not leave it floating. EN: Active high; ENB: Active low.
ISET	5	Current limit programming pin. Connect a resistor R_{SET} from this pin to ground to program the current limit: I_{LIM} (A)=6800/R_{SET} (Ω)
IN	6	Input pin, decoupled with a 10μF capacitor to GND

Block Diagram



Absolute Maximum Ratings (Note 1)

All pins ---------- 6V
Power Dissipation, P_D @ T_A = 25°C SOT23-6 ---------- 1.7W
Package Thermal Resistance (Note 2)
θ_{JA} ---------- 61°C/W
θ_{JC} ---------- 22°C/W
Junction Temperature ---------- 150°C
Lead Temperature (Soldering, 10 sec.) ---------- 260°C
Storage Temperature Range ---------- -65°C to 150°C

Recommended Operating Conditions (Note 3)

IN ---------- 2.5V to 5.5V
All other pins ---------- 0V to 5.5V
Junction Temperature Range ---------- -40°C to 125°C
Ambient Temperature Range ---------- -40°C to 85°C

Electrical Characteristics

(V_{IN} = 5V, C_{OUT}=10μF, T_A = 25°C unless otherwise specified)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range		V_{IN}		2.5		5.5	V
Shutdown Input Current		I_{SHDN}	Open load, switch off		0.1	1	μA
			Output grounded, switch off		0.1	1	μA
Quiescent Supply Current		I_Q	Open load, switch on		35		μA
FET $R_{DS(ON)}$		$R_{DS(ON)}$	V_{IN}=5V I_{OUT}=0.5A	38	45	50	mΩ
Current Limit		I_{LIM}	Rset=6.8k	0.75	1	1.25	A
Fold back Current		I_{FBC}	V_{IN}>3.5V, V_{OUT}<1V		0.6	0.75	A
Programmable current limit range		I_{LIM_RANGE}		0.4		4	A
EN/ENB Threshold	Logic-Low Voltage	V_{IL}				0.5	V
	Logic-High Voltage	V_{IH}		1.0			V
IN UVLO Threshold		$V_{IN,UVLO}$				2.45	V
IN UVLO Hysteresis		$V_{IN,HYS}$			0.1		V
Rise Time		T_{RISE}	V_{IN}=3.3V, R_L=3 Ω, C_L=1uF	1	1.5	2	ms
			V_{IN}=5.0V, R_L=5 Ω, C_L=1uF	1.6	2.3	3	ms
OCB Low Resistance		R_{OCB}			65		Ω
OCB Delay Time		T_{OCB_Delay}			10		ms
OUT Shutdown Discharge Resistance		R_{DIS}	SY6288F1/F2	50	63	76	Ω
Thermal Shutdown Temperature		T_{SD}			150		°C
Thermal Shutdown Hysteresis		T_{HYS}			20		°C

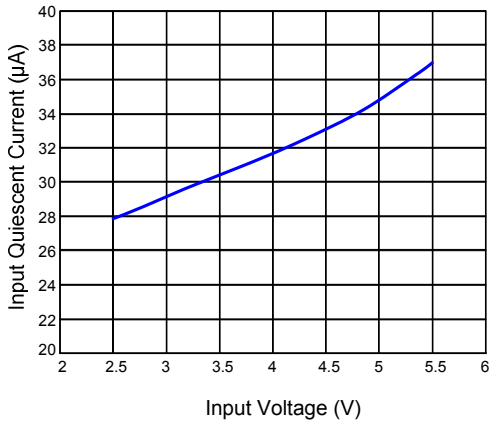
Note 1: Stresses beyond "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute 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 Silergy test board. Pin 2 of SOT23 package is the case position for θ_{JC} measurement.

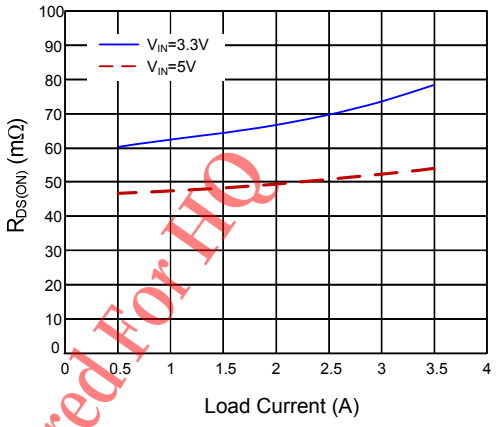
Note 3: The device is not guaranteed to function outside its operating conditions.

Typical Performance Characteristics

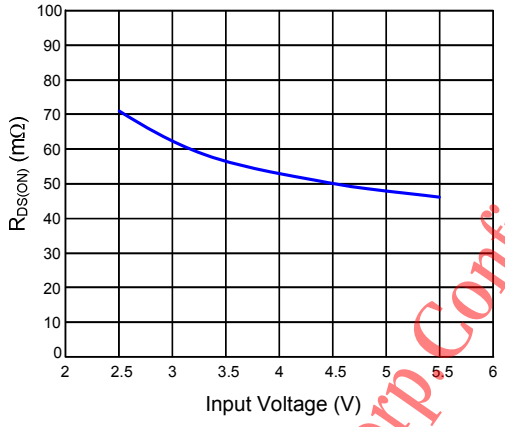
Input Quiescent Current vs. Input Voltage



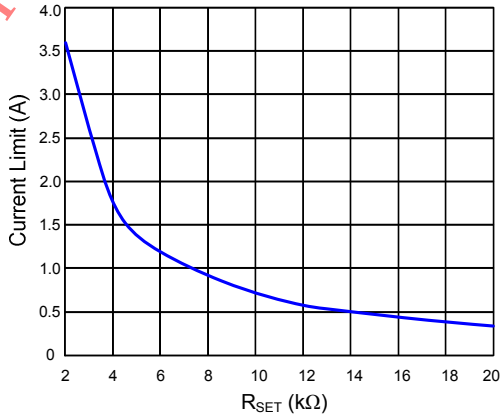
$R_{DS(ON)}$ vs. Load Current



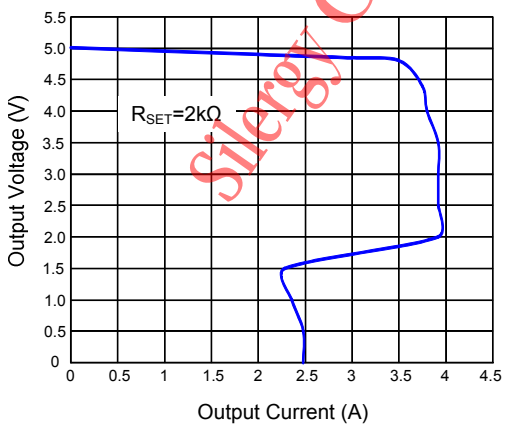
$R_{DS(ON)}$ vs. Input Voltage



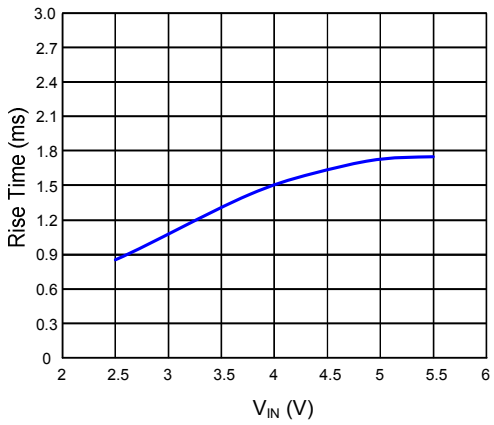
R_{SET} vs. Current Limit



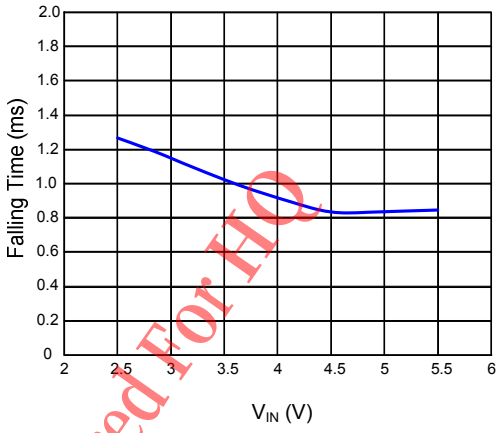
Output Voltage vs. Output Current



Rise Time vs. V_{IN}

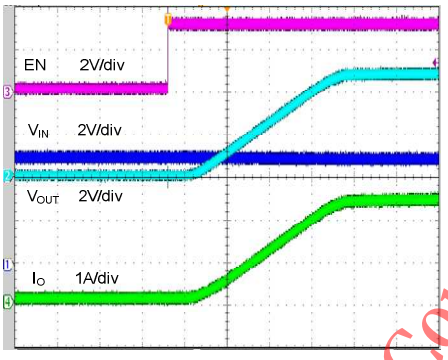


Falling Time vs. V_{IN}



Startup from Enable

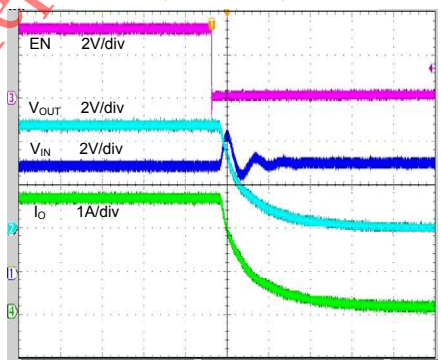
(V_{IN}=5V, I_O=2.5A)



Time (800μs/div)

Shutdown from Enable

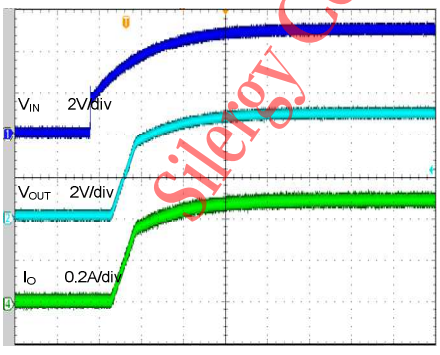
(V_{IN}=5V, I_O=2.5A)



Time (20μs/div)

Startup from V_{IN}

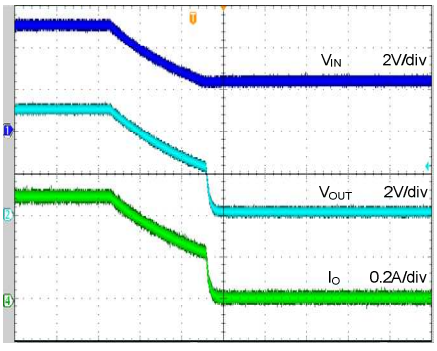
(V_{IN}=5V, I_O=1A)



Time(2ms/div)

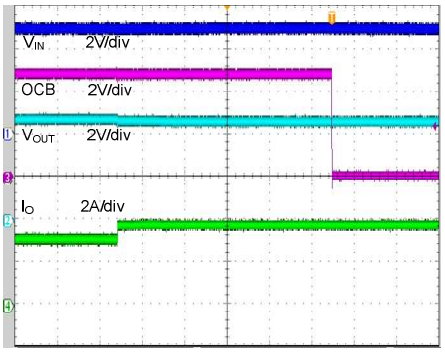
Shutdown from V_{IN}

(V_{IN}=5V, I_O=1A)



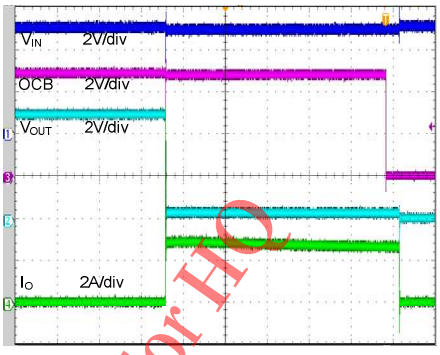
Time (800μs/div)

OCB Response
(OCB Response during Over Load)



Time (2ms/div)

OCB Response
(OCB Response during Short Circuit)



Time (2ms/div)

Applications Information

SY6288F1/F2 is a current limited P-channel MOSFET power switch with over current and over temperature protections. There is no body diode across the drain and the source of the MOSFET. It prevents the current flow from the output to the input after the chip is disabled.

Output Discharge

SY6288F1/F2 integrates a 60Ω pull down resistor for quick output discharge. The resistor is activated when the switch is turned off.

Over-current protection

The SY6288F1/F2 supports Current limit programming. Connect a resistor R_{SET} from ISET pin to ground to program the current limit:

$$I_{LIM}\,(A)=6800/R_{SET}\,(\Omega)$$

The minimum current limit is 0.4A. Current limit beyond 4A is not recommended.

When the over-current condition is sensed, SY6288F1/F2 is modulated to achieve constant output current. Under output short circuit conditions, the normal current limit folded back 50%..

Thermal Shutdown Protection

If the junction temperature of the device exceeds the thermal protection threshold which is typically 150°C, over temperature protection will shut down SY6288F1/F2. Once the chip temperature drops to 130°C, the SY6288F1/F2 will restart.

Fault flag

The OCB pin is an active-low, open drain output. It is high impedance when there's no protection occurring or the device is disable. When the device is enable, the OCB pin goes low whenever over-current protection or thermal shutdown protection occurs.

Input Capacitor

To reduce device inrush current, a 10μF ceramic capacitor, CIN, is recommended. A higher value of CIN can be used to reduce the voltage drop experienced as the switch is turned on into large capacitive load.

To minimize the potential noise problem, place CIN really close to the IN and GND pins.

Output Capacitor

A 10μF ceramic output cap is recommended to prevent parasitic board inductance from forcing VOUT below GND when switching off.

Reverse Block Function:

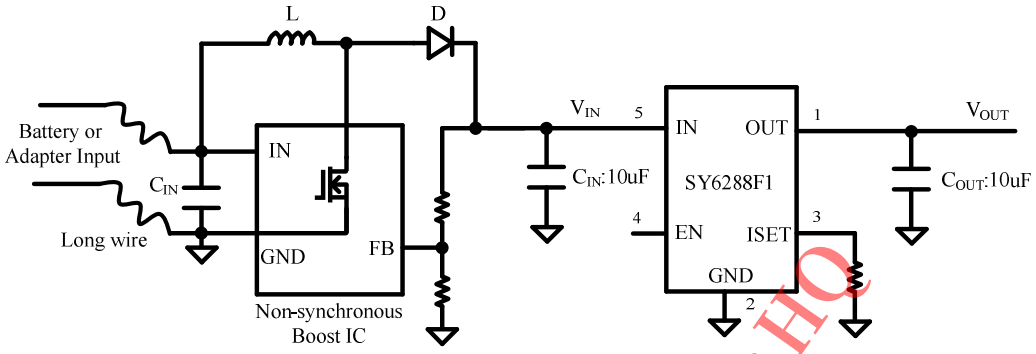
The SY6288F integrates reverse block function. Once the deviation voltage of OUT-IN exceeds 160mV, the reverse block function is triggered. The power FET will be shutdown in 800ns to block the reverse current flow from OUT to IN.

Maximum input voltage consideration:

For any application, input voltage for SY6288F1/F2 should not be allowed to exceed the maximum recommended value (5.5V).

Below is a typical application circuit for SY6288F1/F2. The front stage is a non-synchronous boost stage and the input power supply can be a battery or an adapter.

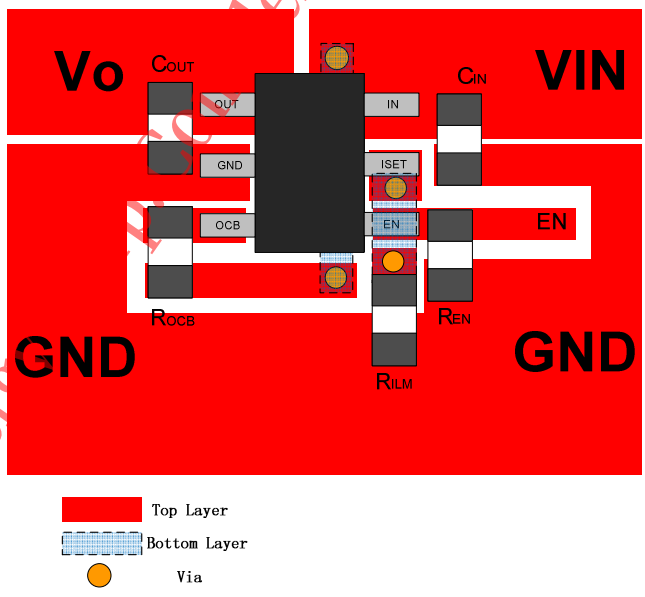
Some adapters may have poor output voltage tolerance, or may have large output voltage overshoot if the adapter is hot plug in directly. The voltage overshoot higher than VIN(5.5V) will significantly reduce the reliability of SY6288F1/F2 and may even lead to IC EOS failure.



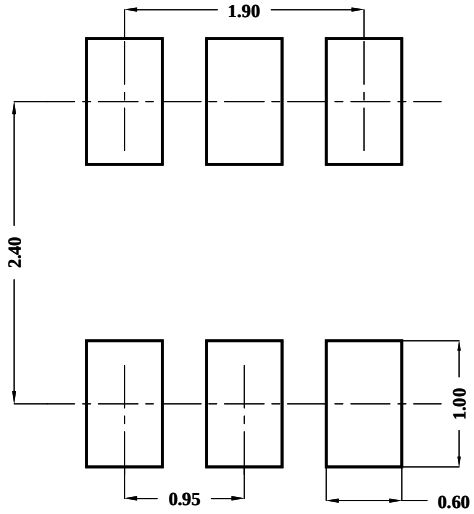
PCB Layout Guide

For best performance of the SY6288F1/F2, the following guidelines must be strictly followed:

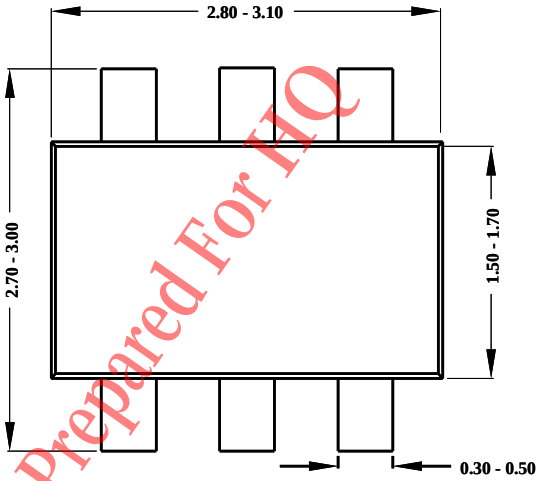
- Keep all power traces as short and wide as possible and use at least 2 ounce copper for all power traces.
- Place a ground plane under all circuitry to lower both resistance and inductance and improve DC and transient performance.
- Input decoupling ceramic capacitor should be placed as close as possible between IN and GND pin to reduce the leakage inductance.
- Output decoupling ceramic capacitor should be placed as close as possible between OUT and GND pin to reduce the leakage inductance.

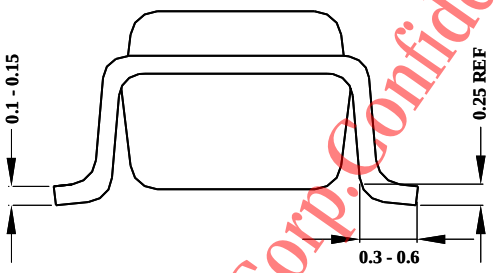


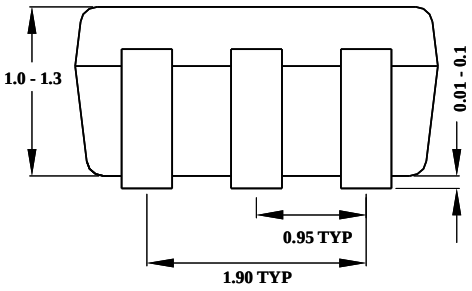
SOT23-6 Package outline & PCB layout design



Recommended Pad Layout





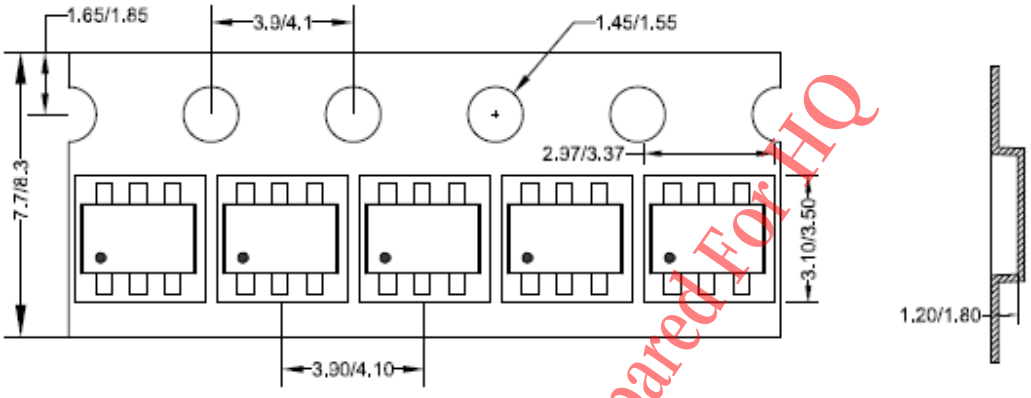


Notes: **All dimensions are in millimeters.**
All dimensions don't include mold flash & metal burr.

Taping & Reel Specification

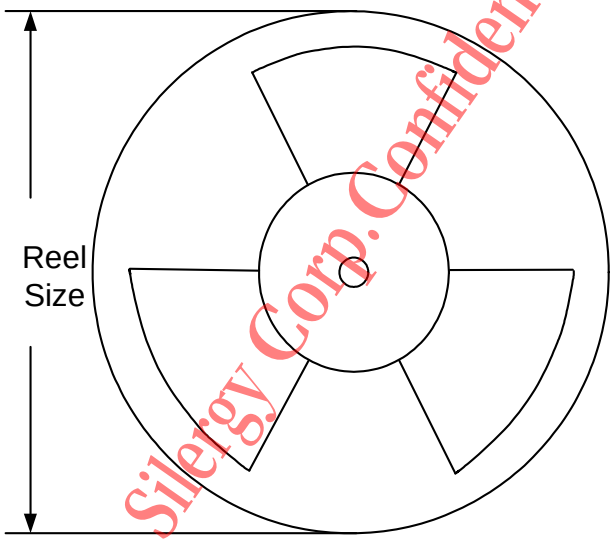
1. Taping orientation

SOT23-6



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
SOT23-6	8	4	7"	280	160	3000

3. Others: NA

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