Application Note: SY6287C

Low Loss Power Distribution Switch with Programmable Current limit

General Description

SY6287C is an ultra-low $R_{DS(ON)}$ 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.

Features

- Input Voltage: 2.5V to 5.5V
- Extremely Low Power Path Resistance: 65mΩ (Typ.)
- Adjustable Current Limit Up to 2.0A
- Over Temperature Shutdown and Automatic Retry
- Reverse Blocking (No Body Diode)
- Fault Flag (OCB) Output for Over Current and Fault Conditions
- Built-in Soft-start
- Compact Package Minimizes the Board Space: SOT23-6/DFN2x2-6

Ordering Information

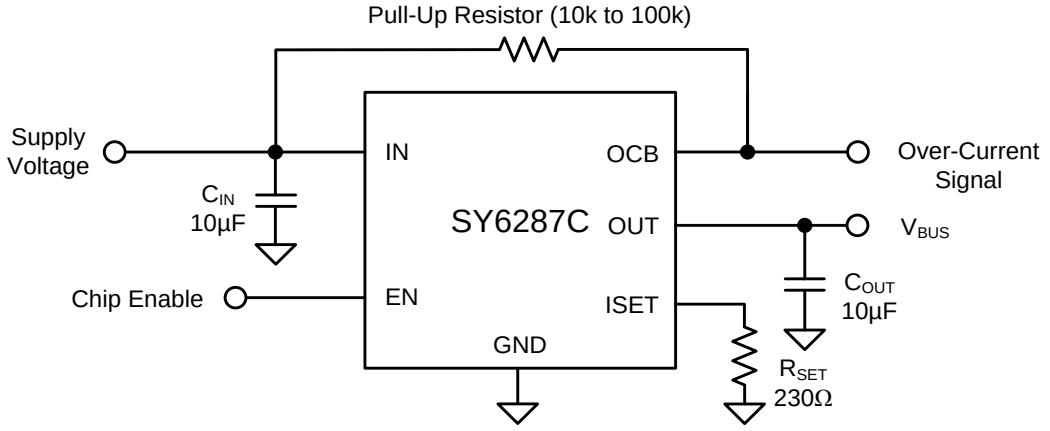
SY6287 □(□□)□
- Temperature Code
- Package Code
- Optional Spec Code

Ordering Number	Package Type	Note
SY6287CABC	SOT23-6	
SY6287CDEC	DFN2x2-6	

Applications

- USB 3.1 Application
- USB 3G Data Card
- USB Dongle
- Mini PCI Accessories
- USB Charger
- Public Place Multi-USB Charger
- PC Card Hot Swap Applications

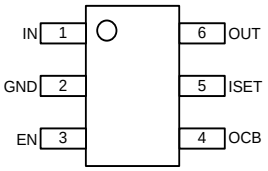
Typical Application Circuit



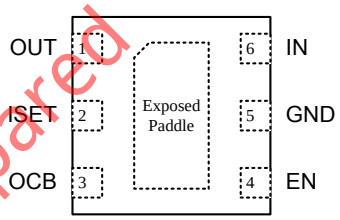
Note: If 1µF input cap will lead to large Vin voltage spike, it is strongly recommended to add additional 10 µF ceramic cap.

Figure1. Schematic Diagram

Pinout (Top view)



SY6287CABC, SOT23-6



SY6287CDEC, DFN2x2-6

Part Number	Package Type	Top Mark①
SY6287CABC	SOT23-6	cL*xyz*
SY6287CDEC	DFN2x2-6	cMxyz

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

Pin Name	Pin Number		Pin Description
	SY6287C SOT23-6	SY6287C DFN2x2-6	
IN	1	6	Input pin, decoupled with a 10μF capacitor to GND.
GND	2	5, Exposed Paddle	Ground pin.
OUT	6	1	Output pin, decoupled with a 10μF capacitor to GND.
EN	3	4	ON/OFF control, active high. Do not leave it floating.
ISET	5	2	Current limit programming pin. Connect a resistor R_{SET} from this pin to ground to program the current limit: I_{LIM} (A)=230/R_{SET} (Ω).
OCB	4	3	Open drain fault flag.

Block Diagram

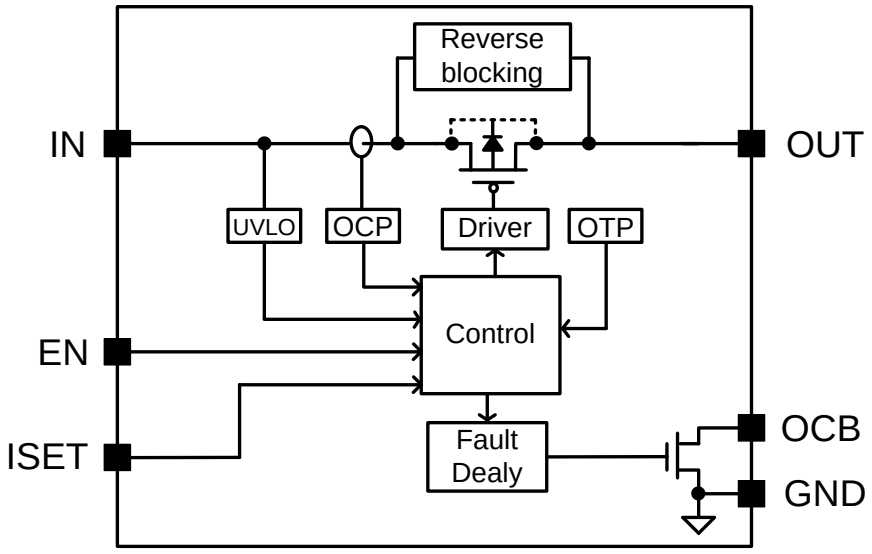


Figure2. Block Diagram

Absolute Maximum Ratings (Note 1)

IN, OUT ---------- 7V
ISET, OCB, EN ---------- 7V
Power Dissipation, P_D @ T_A = 25℃ SOT23-6/DFN2x2-6 ---------- 0.94W/1.53W
Package Thermal Resistance (Note 2)
SOT23-6/DFN2x2-6, θ_{JA} ---------- 106.4℃/W/65.3℃/W
SOT23-6/DFN2x2-6, θ_{JC} ---------- 41.7℃/W/16.2℃/W
Junction Temperature ---------- 150℃
Lead Temperature (Soldering, 10 sec.) ---------- 260℃
Storage Temperature Range ---------- -65℃ to 150℃

Recommended Operating Conditions (Note 3)

IN, OUT ---------- 2.5V to 5.5V
All Other Pins ---------- 0V to 5.5V
Junction Temperature Range ---------- -40℃ to 125℃
Ambient Temperature Range ---------- -40℃ to 85℃

Electrical Characteristics

(V_{IN} = 5V, C_{OUT}=10μF, T_A = 25℃, BOLD values indicate -40℃ to 85℃, unless otherwise specified.)

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range		V_{IN}		2.5		5.5	V
IN UVLO Threshold		$V_{IN,UVLO}$				2.45	V
IN UVLO Hysteresis		$V_{IN,HYS}$			0.1		V
Shutdown Input Current		I_{SHDN}	Open load, switch off		0.1	5	μA
			Output grounded, switch off		0.1	5	μA
Reverse Leakage Current			IN tie to GND, V_{OUT}=5V		0.1	5	μA
Quiescent Supply Current		I_Q	Open load, switch on		45	100	μA
FET $R_{DS(ON)}$		$R_{DS(ON)}$	V_{IN}=5V, I_{OUT}=0.5A		65	100	mΩ
Current Limit Factor			I_{OUT}=0.5A, V_{OUT}= 4V (Note5)	195.5	230	264.5	V
			I_{OUT}=1.5A, V_{OUT}= 4V (Note5)	212	230	248	V
EN/ $\overline{EN}$ Threshold	Logic-low Voltage	V_{IL}				0.4	V
	Logic-high Voltage	V_{IH}		1.0			V
EN Input Cap		C_{EN}	(Note4)		1		pF
Output Turn On Time		t_{ON}	R_L=10Ω, C_L=1μF. Measure from EN ON to V_{OUT} reach V_{IN}×90%	1	2	5	ms
Output Turn On Rise Time		t_R	R_L=10Ω, C_L=1μF. Measure from V_{OUT}=10% of V_{IN} to 90% of V_{IN}	1	2	5	ms
Output Turn Off Time		t_{OFF}	R_L=10Ω, C_L=1μF. Measure from EN OFF to V_{OUT} reach V_{IN}×10%		22		μs
Output Turn Off Fall Time		t_F	R_L=10Ω, C_L=1μF. Measure from V_{OUT}=90% of V_{IN} to 10% of V_{IN}		21		μs
OCB Low Resistance		R_{OCB}	V_{IN}=5V, I_L=10μA		9		Ω
			V_{IN}=3.3V, I_L=10μA		12		Ω

OCB Leakage Current	I_{LKG_OCB}	V_{OCB}=5V		0.01	1	μA
Thermal Shutdown Temperature	T_{SD}			150		℃
Thermal Shutdown Hysteresis	T_{HYS}			20		℃
Current-limit Response Time	t_{OC_res}	V_{OUT}=0V (Note5)		25		μs
Over Current Flag Response Time	t_{OCB}	V_{OUT}=V_{IN}/2 to FLG low	4	8	12	μs

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℃ on a Silergy's test board. Pin 2 of SOT23-6 packages is the case position for θ_{JC} measurement.

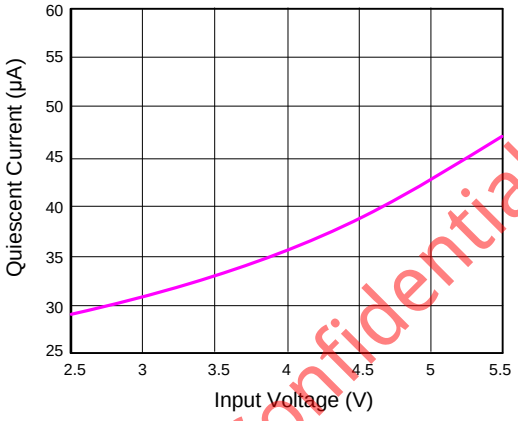
Note 3: The device is not guaranteed to function outside its operating conditions.

Note 4: Guaranteed by design but not production tested.

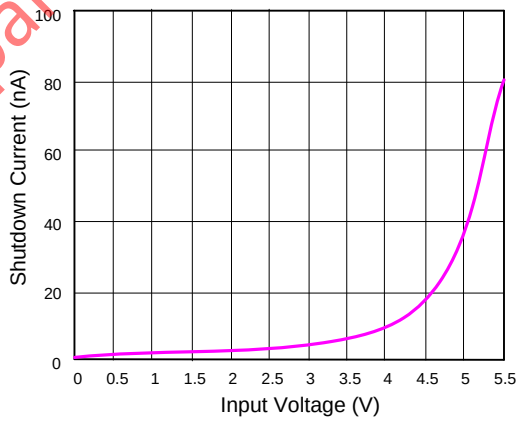
Note5: Current limit threshold is determined by I_{LMT}=230V/R_{SET}, where R_{SET} is in ohms.

Typical Performance Characteristic

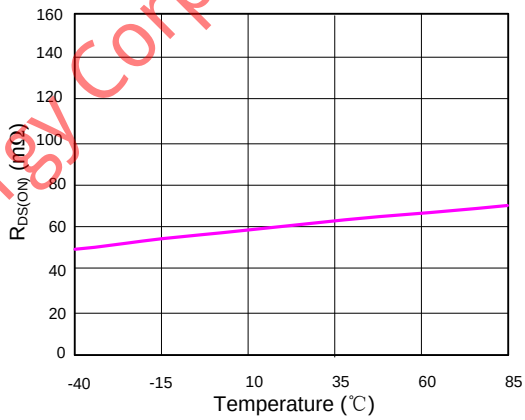
Quiescent Current vs. Input Voltage



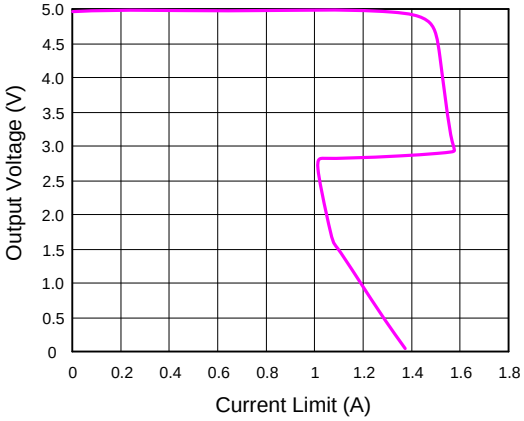
Shutdown Current vs. Input Voltage



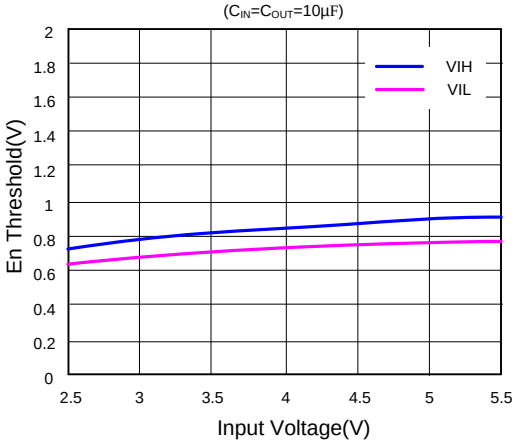
$R_{DS(ON)}$ vs. Temperature
(V_{IN}=5V, I_{OUT}=0.5A)



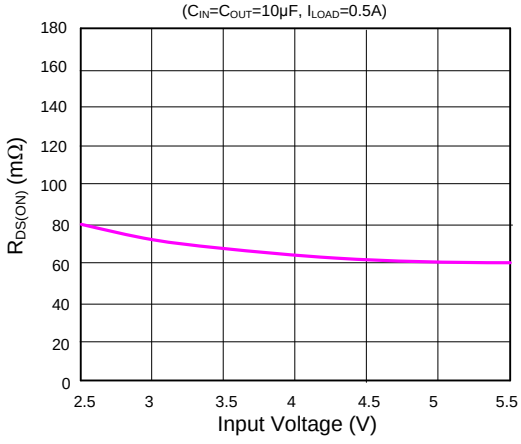
Current Limit vs. Output Voltage
(V_{IN}=5V, R_{SET}=154Ω)



En Threshold vs. Input Voltage
(C_{IN}=C_{OUT}=10μF)

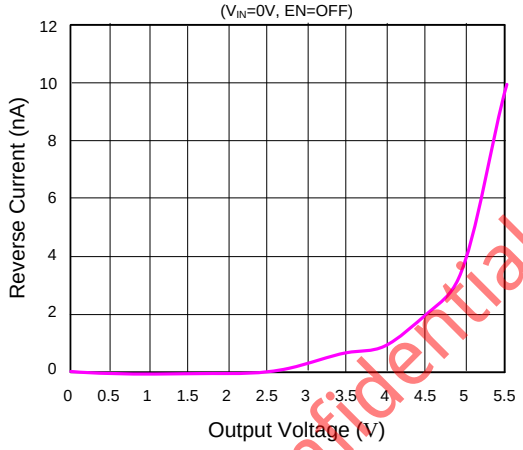


$R_{DS(ON)}$ vs. Input Voltage
(C_{IN}=C_{OUT}=10μF, I_{LOAD}=0.5A)



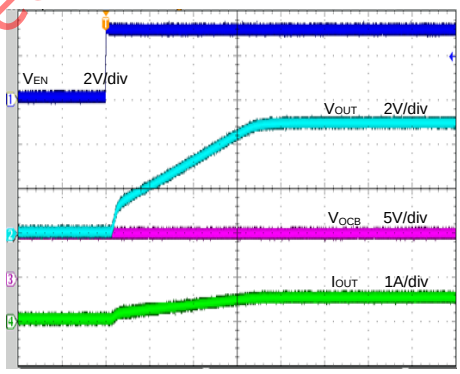
Reverse Current vs. Output Voltage

(V_{IN}=0V, EN=OFF)



Startup From Enable

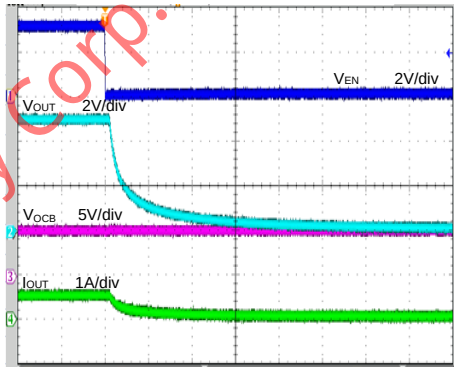
(V_{IN}=5V, C_{IN}= C_{OUT}=10μF, R_{SET}=154Ω, 10Ω Load)



Time (800μs/div)

Shutdown From Enable

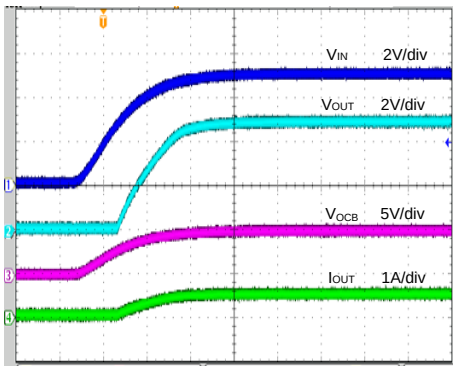
(V_{IN}=5V, C_{IN}= C_{OUT}=10μF, R_{SET}=154Ω, 10Ω Load)



Time (40μs/div)

Startup From V_{IN}

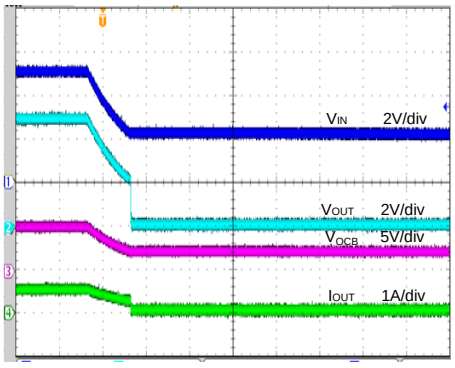
(V_{IN}=5V, C_{IN}= C_{OUT}=10μF, R_{SET}=154Ω, 10Ω Load)



Time (800μs/div)

Shutdown From V_{IN}

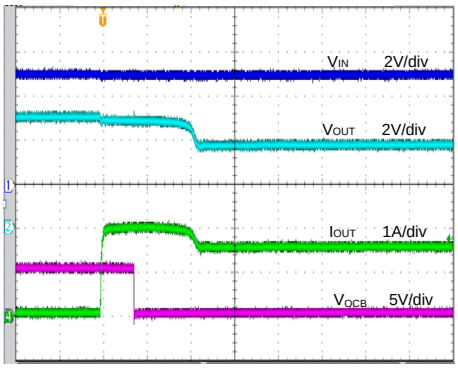
(V_{IN}=5V, C_{IN}= C_{OUT}=10μF, R_{SET}=154Ω, 10Ω Load)



Time (10ms/div)

Over Current Response

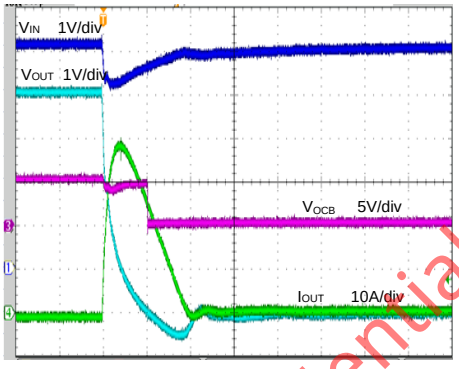
(V_{IN}=5V, C_{IN}= 10μF, C_{OUT}=0μF, R_{SET}=154Ω, 2.5Ω Load)



Time (10μs/div)

Short Circuit Response

(V_{IN}=5V, C_{IN}=C_{OUT}=10μF)



Time (10μs/div)

Operation

The SY6287C is a current limited P-channel MOSFET power switch designed for USB load-switching or hot plug applications. It incorporates the over temperature protection and reverse blocking function, so the IC prevents current flow from OUT to IN when out being externally forced to a higher voltage than IN.

Over Current Protection

The SY6287C supports Current limit programming. Connect a resistor R_{SET} from ISET pin to ground to program the current limit:

$$I_{LIM}(A) = 230 / R_{SET}(\Omega)$$

The minimum current limit is 0.2A. Current limit beyond 2.0A is not recommended.

When the over current condition is sensed, the gate of the pass switch is modulated to achieve constant output current. If the over current condition persists for a long time, the junction temperature may exceed 150 ℃, and over-temperature protection will shut down the part. Once the chip temperature drops below 130 ℃, the part will restart.

Table1. Current Limit vs. R_{SET}

$R_{SET}(\Omega)$	Current Limit Threshold(mA)		
	MIN	TYP	MAX
460.0	425	500	575
153.3	1380	1500	1620

Fault Flag(OCB)

The OCB output is asserted (active low) when Thermal shutdown protection is triggered or over current condition persists for 8μs. The output remains asserted until fault condition is removed. Connecting a heavy capacitance load to an enabled device can cause a momentary over current condition; However, no false reporting on OCB occurs due to 8us deglitch circuit.

Supply Filter Capacitor

In order to prevent the input voltage drooping during hot-plug events, a 10μF ceramic capacitor from VIN to GND is strongly recommended. However, higher capacitor values could reduce the voltage droop on the input further. Furthermore, an output short will cause ringing on the input without the input capacitor. It could destroy the internal circuitry when the input transient exceeds the absolute maximum supply voltage even for a short duration.

Output Filter Capacitor

A 10μF output ceramic capacitor is recommended to be placed close to the IC and output connector to reduce voltage drop during load transient. Higher values of output capacitor can be used to further reduce the drop during high current application.

Reverse Block Function:

The SY6287C integrates reverse block function. Once the deviation voltage of OUT-IN exceeds 100mV, the reverse block function is triggered. The power FET will be shutdown in 700ns block the reverse current flow from OUT to IN.

PCB Layout Guide

For best performance of the SY6287C, the following guidelines must be strictly followed:

1) Keep all VBUS traces as short and wide as possible and use at least 2 ounce copper for all VBUS traces.

2) Locate the output capacitor as close to the connectors as possible to lower impedance (mainly inductance) between the port and the capacitor and improve transient performance.

3) Input and output capacitors should be placed closed to the IC and connected to ground plane to reduce noise coupling.

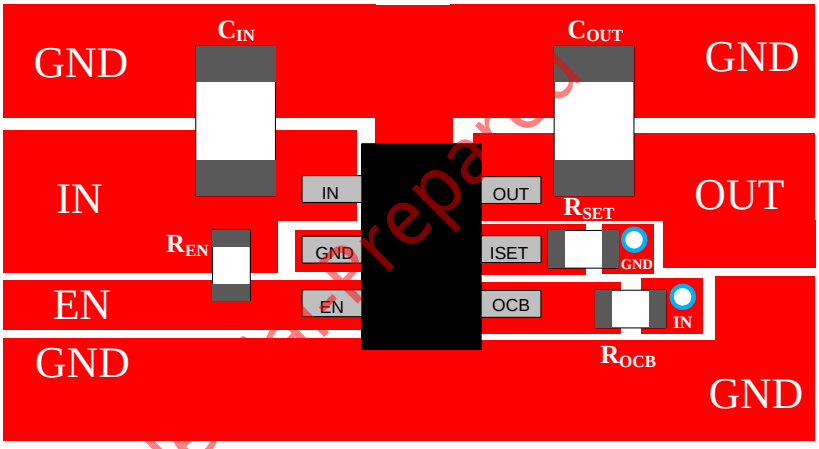


Figure3. SY6287CABC PCB Layout Suggestion

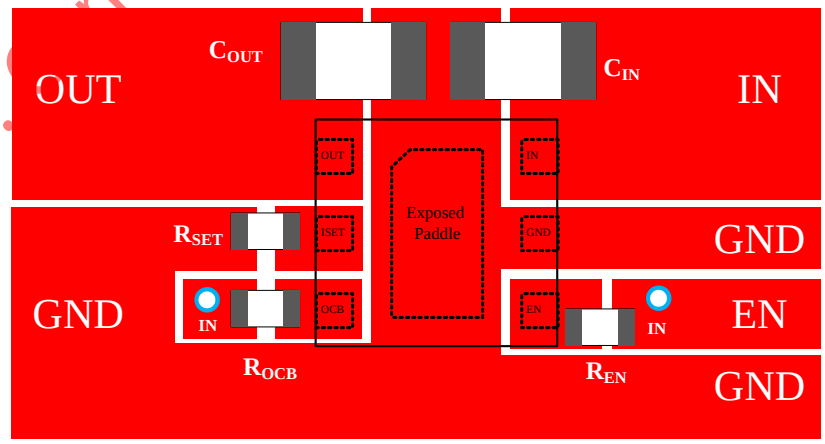
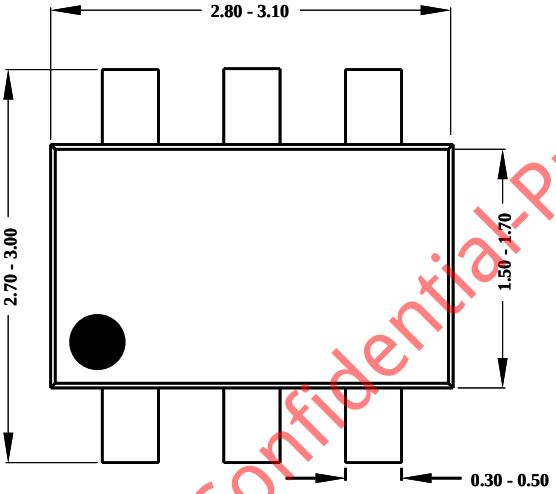
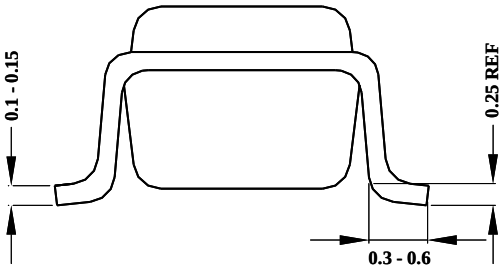


Figure4. SY6287CDEC PCB Layout Suggestion

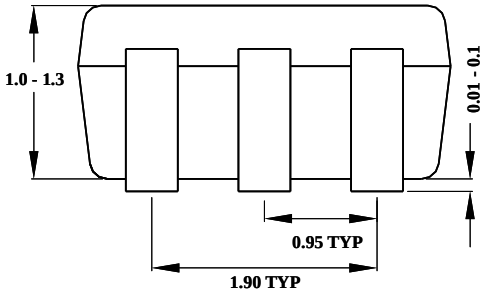
SOT23-6L Package Outline & PCB Layout



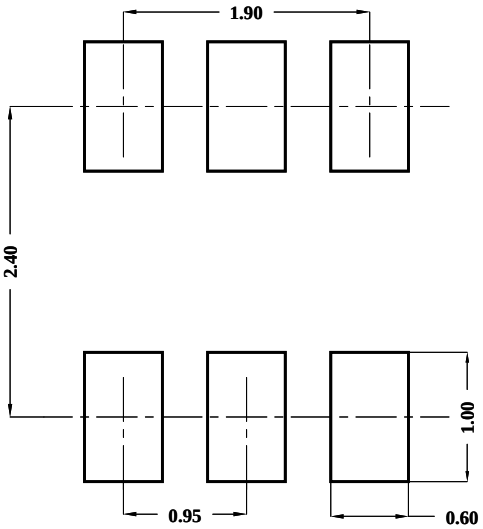
Top View



Side View A



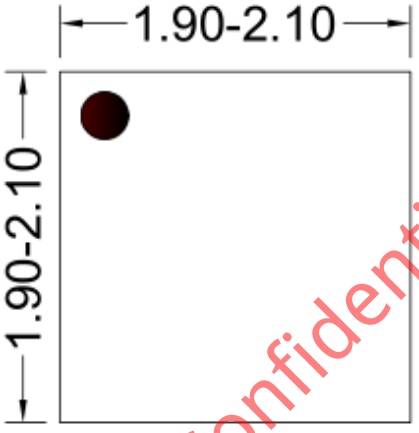
Side View B



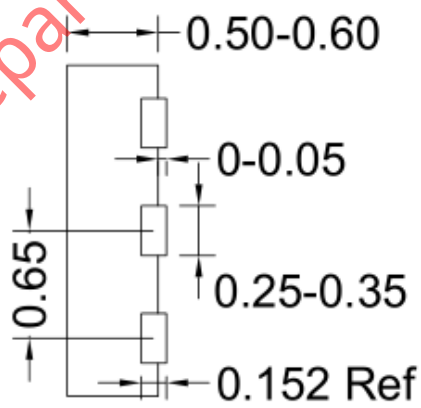
Recommended Pad Layout

Notes: **All dimension in millimeter.**
All dimension don't include mold flash & metal burr.

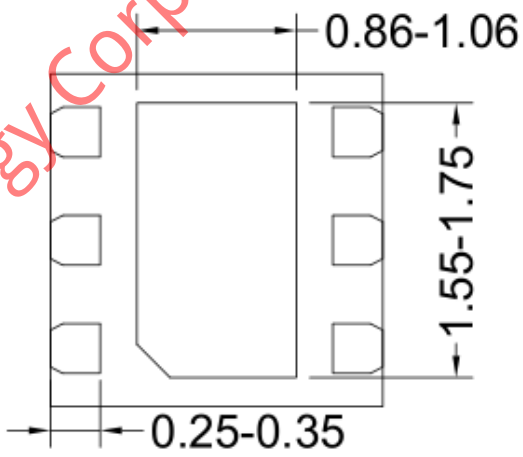
DFN2x2-6 Package Outline



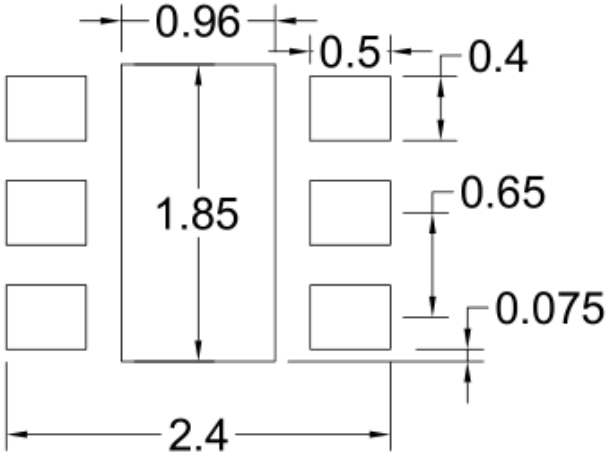
Top View



Side View



Bottom View



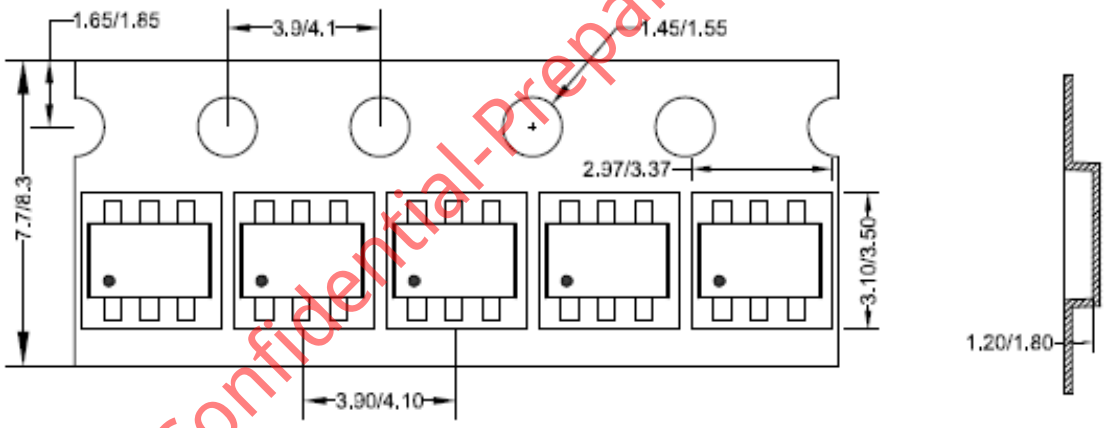
Recommended PCB layout

Notes: All dimension in millimeter and exclude mold flash & metal burr

Taping & Reel Specification

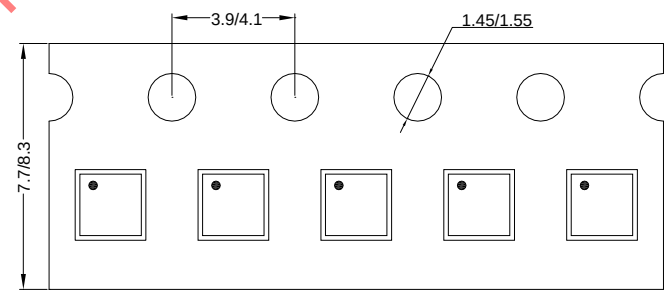
1. Taping Orientation

SOT23-6



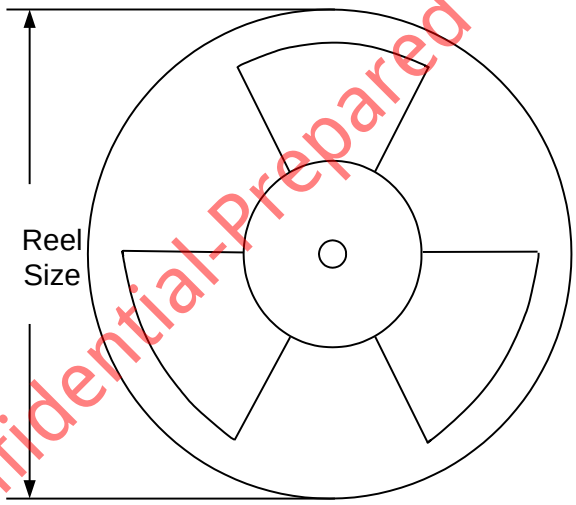
Feeding direction ⟶

DFN2x2 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
SOT23-6	8	4	7"	280	160	3000
DFN2x2	8	4	7"	400	160	3000

3. Others: NA

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