SY6863B3

5.5V, 3A Low Loss Power Distribution Switch with Reverse Block Rating Up to 28V

General Description

SY6863B3 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.

SY6863B3 has over voltage protection and the output pin can withstand 28V. It incorporates the over-temperature protection and reverse blocking functions.

SY6863B3 supports USB PD3.0 fast role swap. The output voltage can recover to USB valid voltage range within 110μs during USB PD fast role swap event.

Ordering Information

SY6863 □(□ □)□
- Temperature Code
- Package Code
- Optional Spec Code

Ordering Number	Package Type	Note
SY6863B3ABC	SOT23-6	Active High

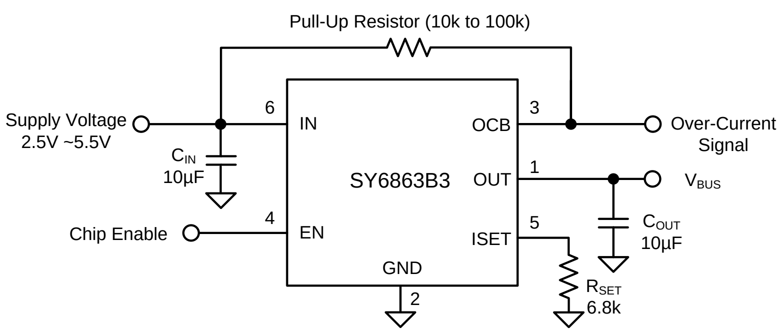
Features

- Input Voltage: 2.5V to 5.5V
- Output Voltage Withstanding 28V
- Extremely Low Power Path Resistance: 45mΩ (typ.)
- 3A Load Current Capability
- Reverse Blocking in Normal Operation or Shutdown
- Fault Flag (OCB) Output For Over Current and Fault Conditions
- Fast Role Swap Support
- Compact Package: SOT23-6
- RoHS Compliant and Halogen Free
- UL Certification NO. E491480-4790781918-1
- CB Certification by IEC 62368-1: 2018

Applications

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

Typical Applications



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

Figure1. Schematic Diagram

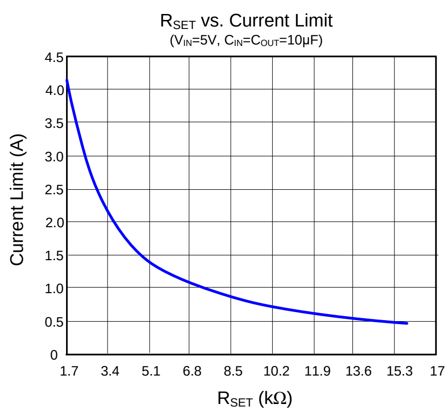
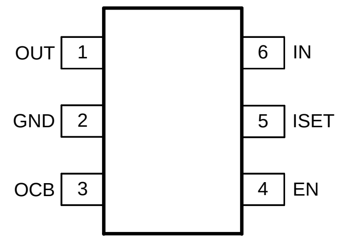


Figure2. R_{SET} vs. Current Limit

Pinout (top view)



(SOT23-6)

Top Mark: **dE*xyz* (**Device code: dE; ***x=year code, y=week code, z= lot number code*)**

Pin Name	Pin number	Pin Description
OUT	1	Output pin.
GND	2	Ground pin.
OCB	3	Fault Flag. Open drain under normal conditions, grounded under fault operation.
EN	4	ON/OFF control. Active high. Do not leave it floating.
ISET	5	Current limit programming pin. Connect a resistor R_{SET} from this pin to ground to program the current limit: I_{LIM} (A)=7100/R_{SET} (Ω)
IN	6	Input pin.

Block Diagram

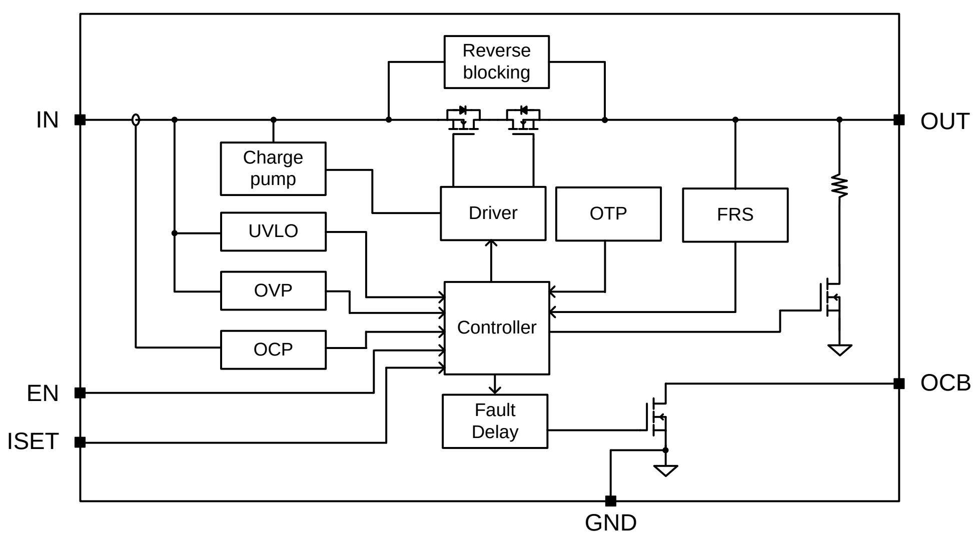


Figure3. Block Diagram

Absolute Maximum Ratings (Note 1)

IN---------- -0.3V to 7V
ISET ---------- -0.3V to 3.6V
OCB, EN, OUT ---------- -0.3V to 28V
Power Dissipation, P_D @ T_A = 25°C SOT23-6---------- 1.2W
Package Thermal Resistance (Note 2)
θ_{JA} ---------- 81°C/W
θ_{JC} ---------- 14°C/W
Junction Temperature Range---------- -40°C to 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
ISET ---------- 0V to 3.3V
OCB, EN, OUT ---------- 0V to 22V
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
Output Over Voltage Protection		V_{OVP}			5.6		V
OVP Hysteresis		V_{OVP_HYS}			0.1		V
Shutdown Input Current		I_{SHDN}	Open load, switch OFF		5	30	µA
			Output grounded, switch OFF		5	30	µA
Quiescent Supply Current		I_Q	Open load, switch ON		150		µA
FET $R_{DS(ON)}$		$R_{DS(ON)}$	V_{IN}=5V, I_{OUT}=2A		45	50	mΩ
Current Limit		I_{LIM}	R_{SET}=1.878k, V_{IN}=5V, V_{OUT}=4.75V	3.47	3.78	4.08	A
Programmable Current Limit Range		I_{LIM_RANGE}		0.4		4	A
EN Threshold	Logic-Low Voltage	V_{IL}				0.4	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=10Ω, C_L=1µF	1.0	1.9	3.0	ms
			V_{IN}=5.0V, R_L=10Ω, C_L=1µF	1.5	3.0	4.5	ms
OCB Low Resistance		R_{OCB}			125		Ω
OCB Delay Time		t_{OCB_Delay}			15		ms
OUT Shutdown Discharge Resistance		R_{DSG}		90	115	140	Ω
Discharge Time		t_{DSG}			130		ms
Fast Role Swap Response		t_{FRS}	From V_{OUT} drops below 4.75V to V_{OUT} back to 4.75V		100		µs
Thermal Shutdown Temperature		T_{SD}			150		°C
Thermal Shutdown Hysteresis		T_{HYS}			20		°C

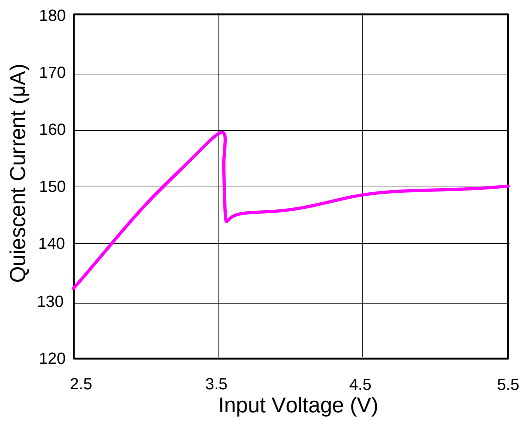
Note 1: Stresses beyond the "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute 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 Silergy's test board. Pin 2 of SOT23-6 package is the case position for θ_{JC} measurement.

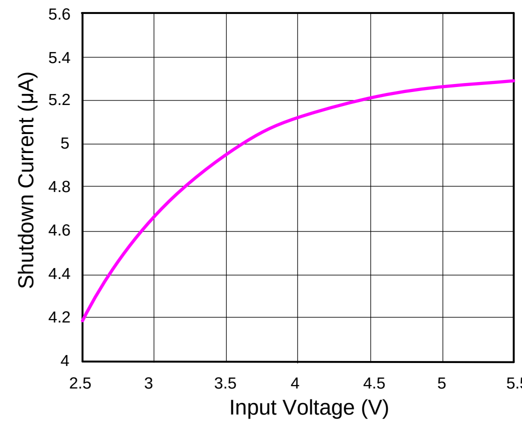
Note 3: The device is not guaranteed to function outside its operating conditions.

Typical Performance Characteristic

Quiescent Current vs. Input Voltage

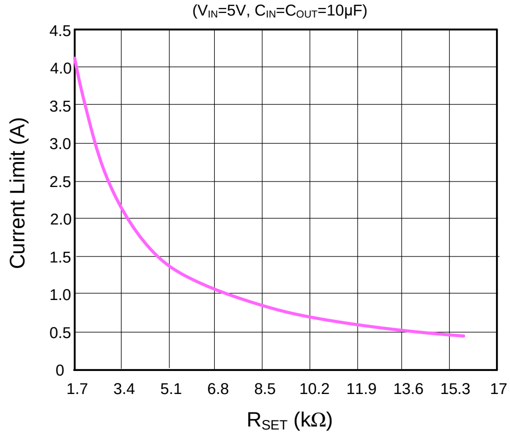


Shutdown Current vs. Input Voltage



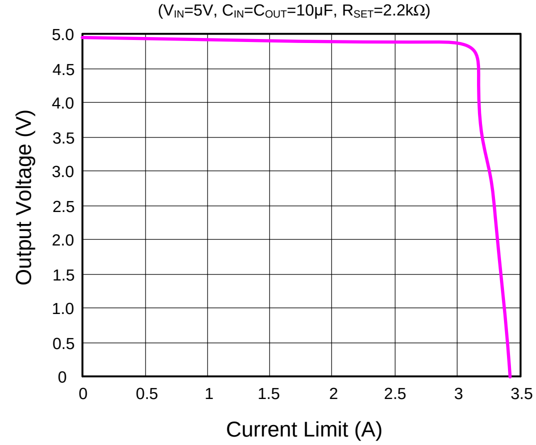
R_{SET} vs. Current Limit

(V_{IN}=5V, C_{IN}=C_{OUT}=10μF)

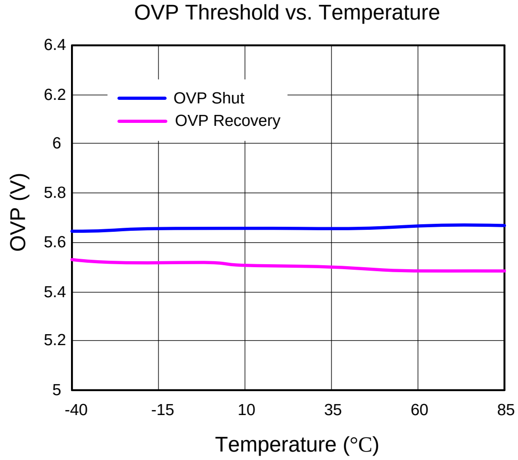


Current Limit vs. Output Voltage

(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, R_{SET}=2.2kΩ)

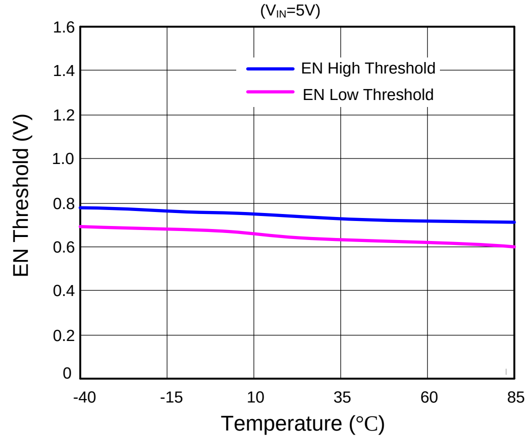


OVP Threshold vs. Temperature

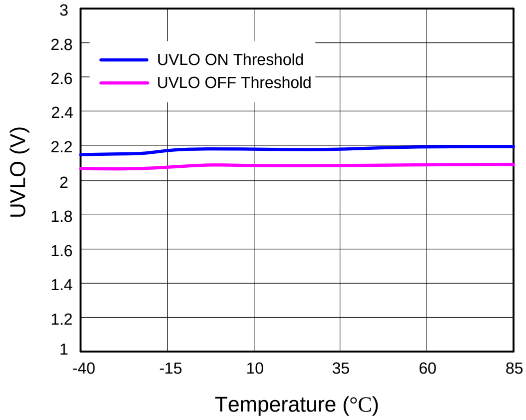


EN Threshold vs. Temperature

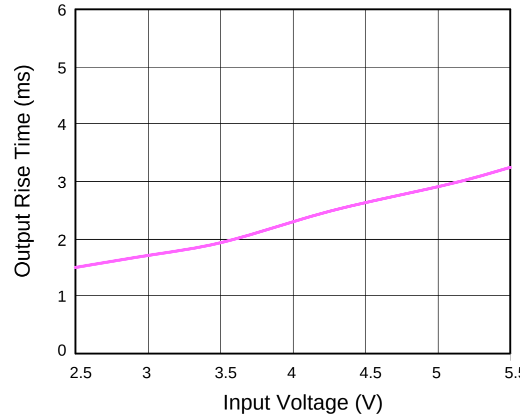
(V_{IN}=5V)



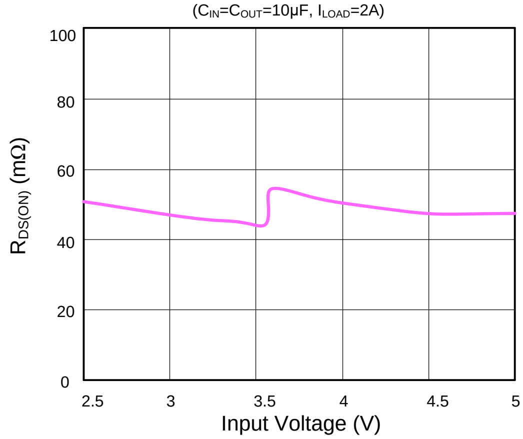
UVLO Threshold vs. Temperature



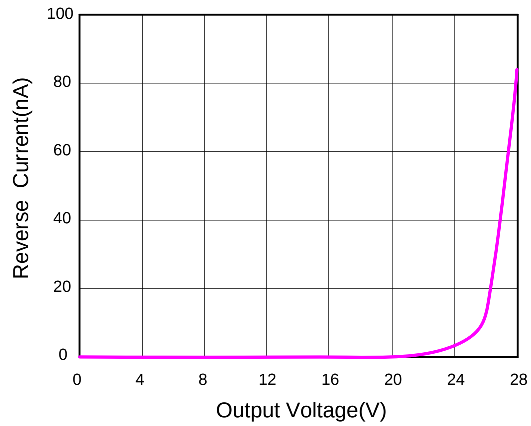
Output Rise Time vs. Input Voltage
(C_{IN}=C_{OUT}=10μF)



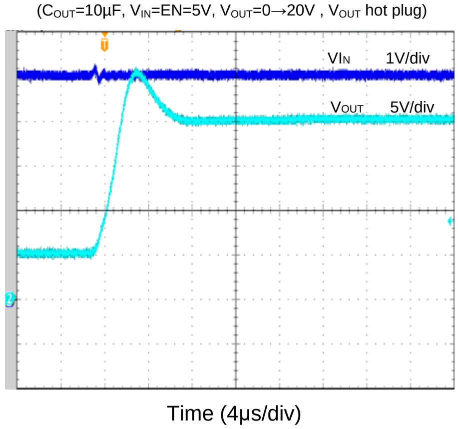
$R_{DS(ON)}$ vs. Input Voltage
(C_{IN}=C_{OUT}=10μF, I_{LOAD}=2A)



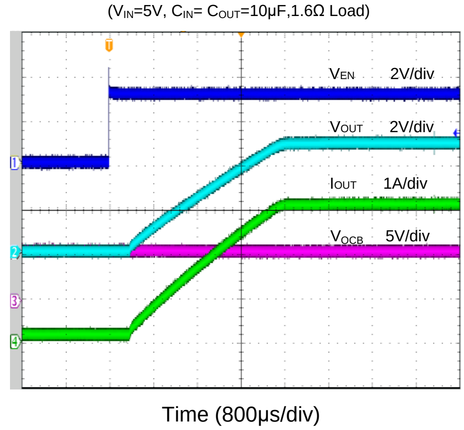
Reverse Current vs. Output Voltage
(V_{IN}=0V, EN=OFF)



Hot Plug Response
(C_{OUT}=10μF, V_{IN}=EN=5V, V_{OUT}=0→20V , V_{OUT} hot plug)

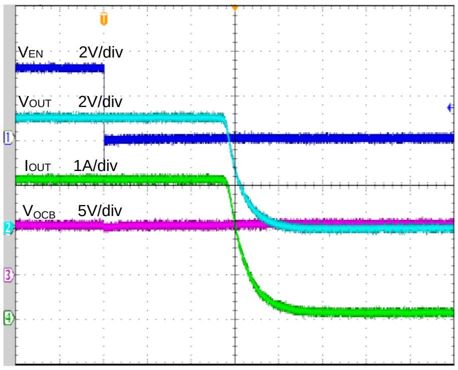


Startup from Enable
(V_{IN}=5V, C_{IN}= C_{OUT}=10μF,1.6Ω Load)



Shutdown from Enable

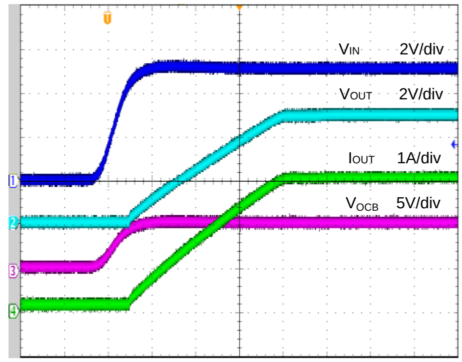
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, 1.6Ω Load)



Time (4μs/div)

Startup from V_{IN}

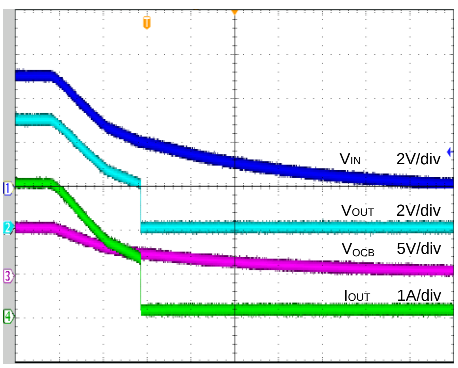
(V_{IN}=5V, C_{IN}= C_{OUT}=10μF, 1.6Ω Load)



Time (800μs/div)

Shutdown from V_{IN}

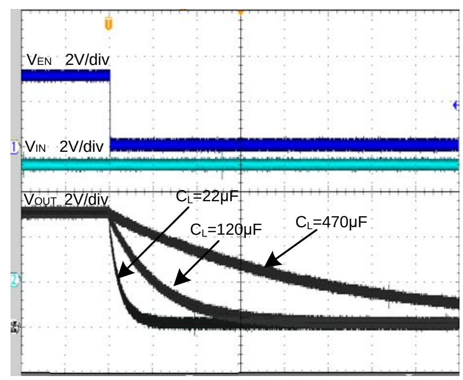
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, 1.6Ω Load)



Time (2ms/div)

Turn off Delay Time and Fall Time

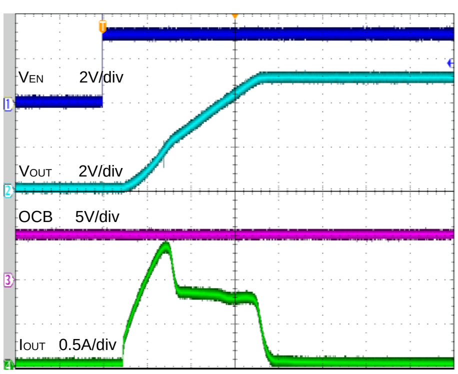
(V_{IN}=5V, R_L=10Ω, C_{IN}=C_{OUT}=10μF)



Time (2ms/div)

Inrush Current with Different Load Capacitance

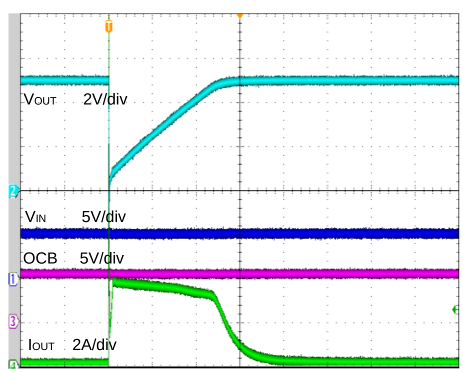
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, C_L=470uF , R_L=10Ω)



Time (800μs/div)

Capacitance Load Inrush Response

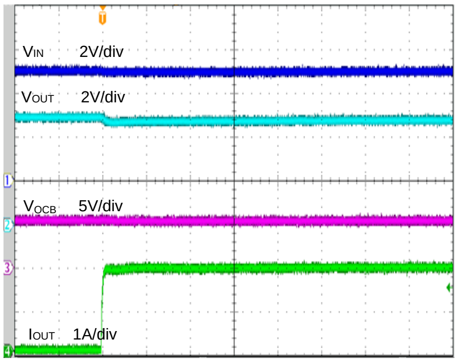
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, R_L=10Ω , 470μF plug in)



Time (200μs/div)

Resistance Load Inrush Response

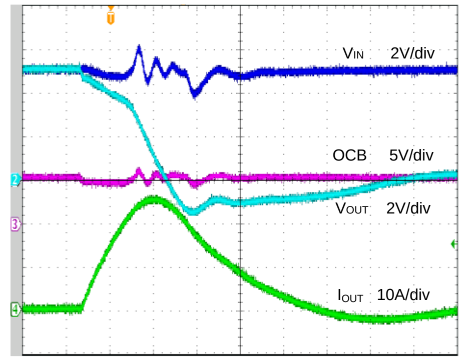
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, R_{LOAD}=2.5Ω)



Time (10μs/div)

Short Circuit Response

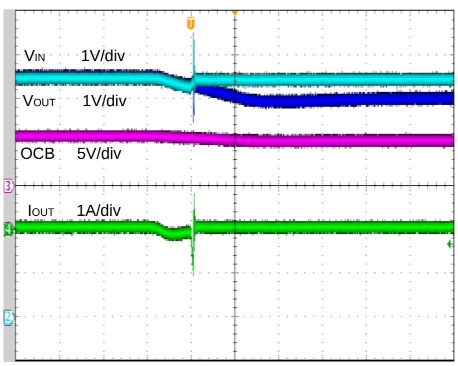
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF)



Time (2μs/div)

Reverse-Voltage Protection Response

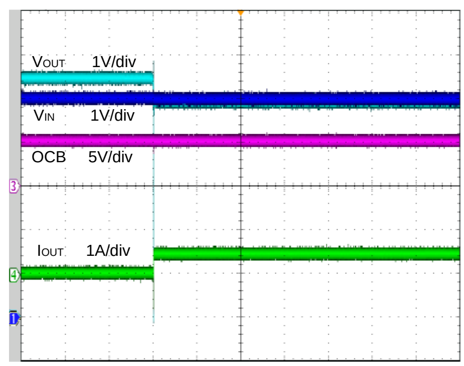
(V_{IN}=5.5V→5V, V_{OUT}=5.5V, C_{IN}=C_{OUT}=10μF)



Time (400μs/div)

Reverse-Voltage Protection Recovery

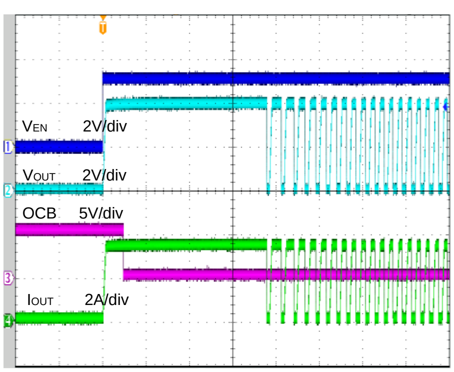
(V_{IN}=5V , C_{IN}=C_{OUT}=10μF, R_L=10Ω, 5.5V V_{OUT} Removed)



Time (200ms/div)

Thermal Shutdown Response

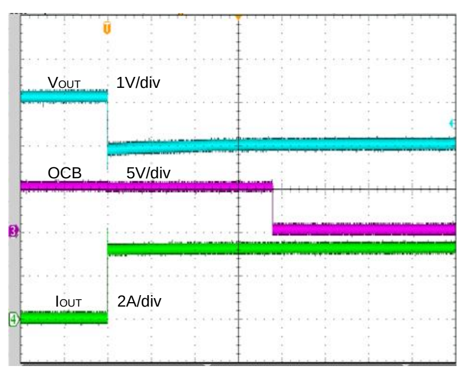
(V_{IN}=5V , C_{IN}=C_{OUT}=10μF, R_L=1.3Ω)



Time (40ms/div)

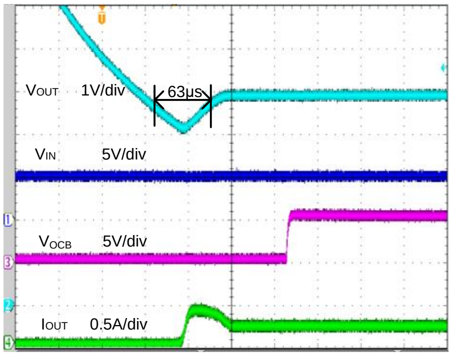
OCB Response During Over Load

(V_{IN}=5.0V, C_{IN}=C_{OUT}=10uF,R_{SET}=2.2k)



Time (4ms/div)

Fast Role Swap Response
(V_{IN}=EN=5V, V_{OUT}=20V plug out , R_{LOAD}=20Ω)



Time (40µs/div)

Operation

The SY6863B3 is a current limited N-channel MOSFET power switch designed for high-side load-switching applications. It incorporates the back to back N-channel MOSFET, so the IC prevents the current-flow from OUT to IN when OUT being externally forced to a higher voltage than IN when the IC is disabled.

Over Current Protection

The SY6863B3 supports current limit programming. Connect a resistor R_{SET} from ISET pin to ground to program the current limit:

$I_{LIM}(A)=7100/R_{SET}(\Omega)$

The minimum current limit is 0.4A. A current limit beyond 4A 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°C, and over-temperature protection will shut down the part. Once the chip temperature drops below 130°C, the part will restart.

Fault Flag(OCB)

The OCB output is asserted (active low) when input OVP or thermal shutdown protection is triggered or over current condition persists for 15ms. 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 15ms deglitch circuit.

Over Voltage Protection

SY6863B3 integrates over voltage protection for the input pin. When the IC is in the ON state and the VIN exceeds 5.6V (typ.), the power FET will be turned off to protect low voltage input stage during the output voltage is higher than 5.6V (typ.). Meanwhile OCB is pulled low to indicate fault condition. Once the output voltage is lower than the input voltage, the power FET will be turned on and OCB is released to high impedance.

Fast Role Swap

SY6863B3 integrates the fast role swap function, which makes V_{OUT} recovery to 4.75V within 110µs during V_{OUT} drops from high voltage to low. When EN is high, V_{IN} is valid and V_{OUT} is higher than V_{IN}, the device works at reverse block mode, power FET is off and standby for FRS. Once V_{OUT} drops lower than V_{IN}, power FET will be turned on in 110µs.

Supply Filter Capacitor

In order to prevent the input voltage drooping during hot-plug events, a 1µF 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. Some illegal USB PD device will provide 20V bus voltage without USB negotiation. Therefore the output capacitor should be larger than 4.7µF to decouple the large spike when unstandardized USB PD device plug in. The SY6863B3 is guaranteed to be safe from damage with OUT voltage up to 28V. Nevertheless, voltage transient above 28V may cause permanent damage. A TVS is recommended to clamp the voltage spike.

Reverse Block Function

The SY6863B3 integrates reverse block function. Once the deviation voltage of OUT-IN exceeds 60mV, the reverse block is triggered. The power FET will be shutdown in 600ns to block the reverse current flow from OUT to IN.

SY6863B3 uses dynamic gate drive control loop to implement reverse block protection. In the light load condition, the gate control loop will reduce the gate driving current to increase $R_{DS(ON)}$ when dropout voltage is below 70mV, so that SY6863B3 could block the reverse current during V_{OUT} hot plug situation.

PCB Layout Guide

For the best performance of the SY6863B3, 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 the impedance (mainly inductance) between the port and the capacitor to improve transient performance.
3. Input and output capacitors should be placed closed to the IC and connected to ground plane to reduce the noise coupling.

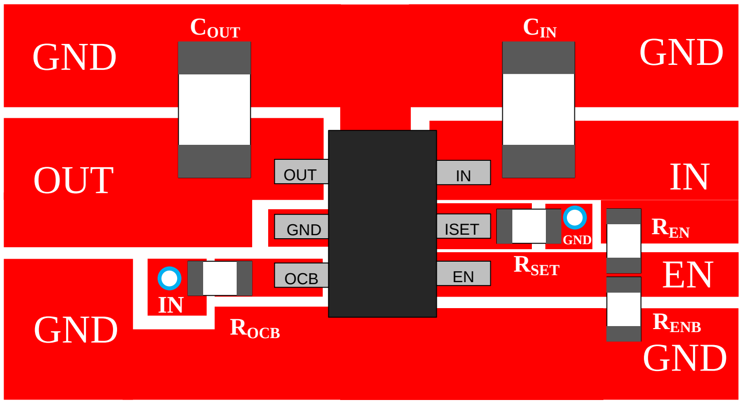
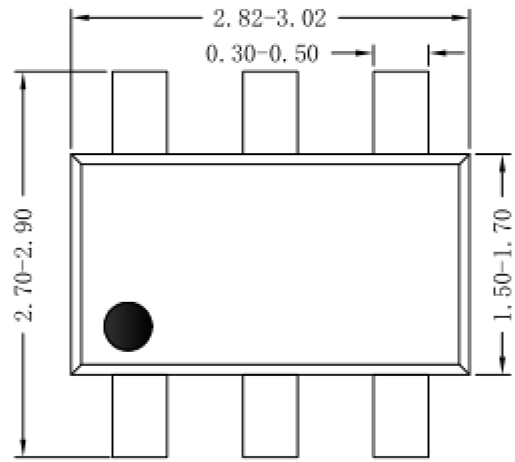
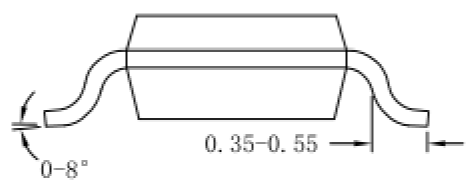


Figure4. PCB Layout Suggestion

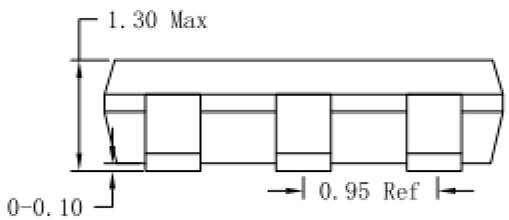
SOT23-6 Package Outline & PCB Layout



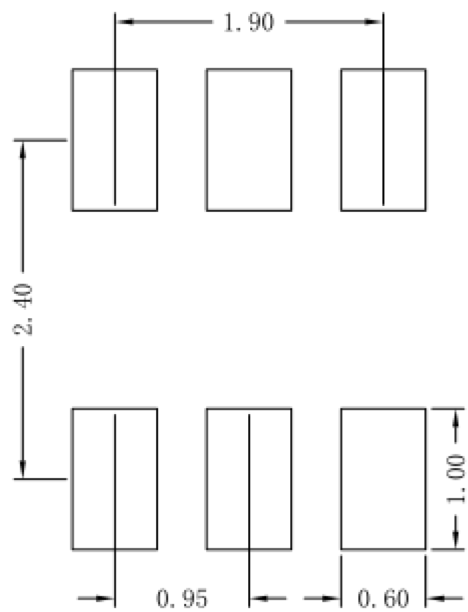
Top View



Side View



Side View



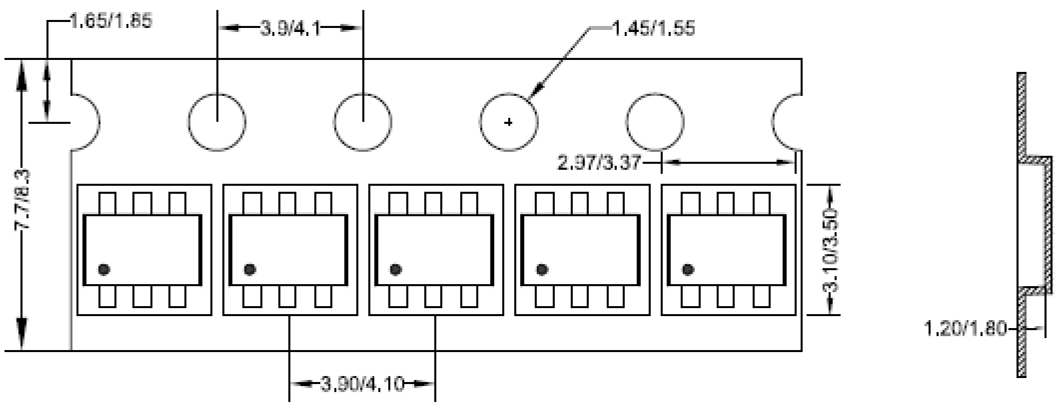
Recommended Pad Layout

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

Taping & Reel Specification

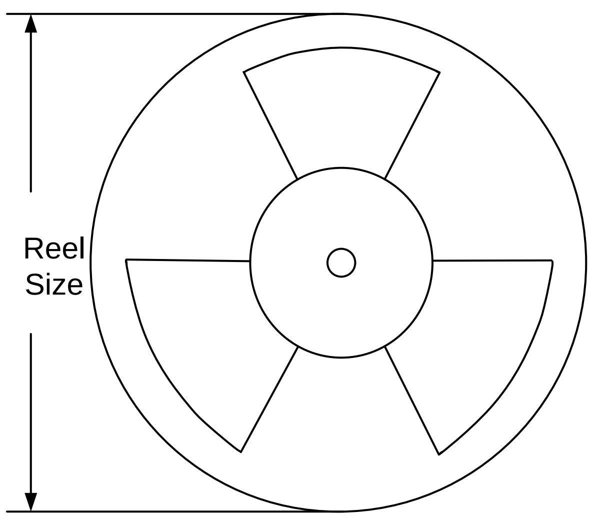
1. Taping orientation

SOT23-6



Feeding direction →

2. Carrier Tape & Reel specification for packages



Package type	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

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
Mar. 10, 2025	Revision 1.0	Initial Production Release
June 28, 2024	Revision 0.9C	Update the CB/UL Certification Information (Page 1)
Aug.20, 2021	Revision 0.9B	Update CB/UL Certification NO.
Jun15, 2018	Revision 0.9A	1. EC table page 4: Change "Current Limit" min value from 3A to 3.47A, typ. Value from 3.62A to 3.78A, max value from 4.16A to 4.08A. 2. Operation page 10: In "Over Current Protection", change the formula from "ILIM(A)=6800/RSET(Ω)" to "ILIM(A)=7100/RSET(Ω)".
Feb 11, 2018	Revision 0.9	Initial Risk Production Release

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