SY20831F

Low Loss Power Distribution Switch With 1.57A Fixed Current Limit

General Description

The SY20831F is an ultra-low $R_{DS(ON)}$ power distribution switch with a 1.57A fixed current limit to protect the power source from over-current and short-circuit conditions. It incorporates overtemperature protection and a reverse blocking function.

The SY20831F is available in a compact SOT23-5 package.

Applications

- USB 3.1 Applications
- USB 3G Data Cards
- USB Dongles
- USB Chargers
- Multi-USB Chargers
- PC Card Hot-Swap Applications

Features

- Input Voltage: 2.5V to 5.5V
- Extremely Low Power Path Resistance: 65mΩ (Typ.)
- 1.57A±10% Current Limit Accuracy
- Reverse Blocking (No Body Diode)
- Fast Reverse Recovery
- Fault Flag (OCB) Output for Over-Current and Fault Conditions
- During Shutdown, OUT Can Be Forced Higher than IN
- Built-In Soft-Start
- RoHS Compliant and Halogen-Free
- Compact Package Minimizes Board Space: SOT23-5

Typical Application

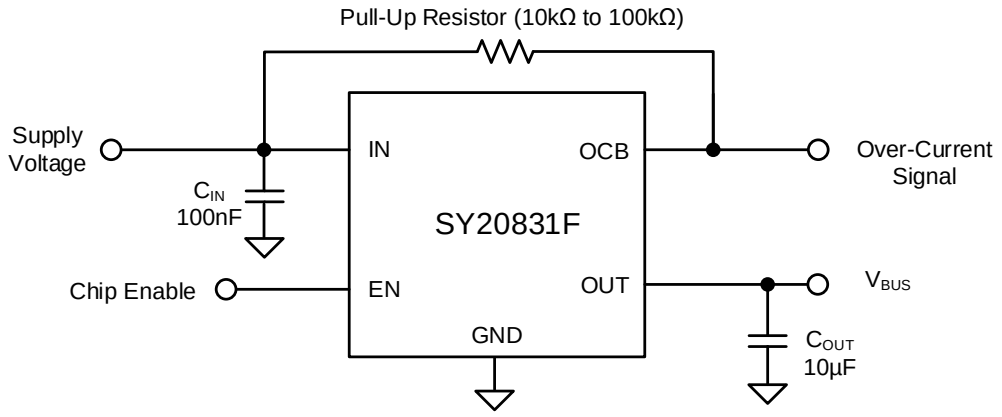


Figure 1. Schematic Diagram

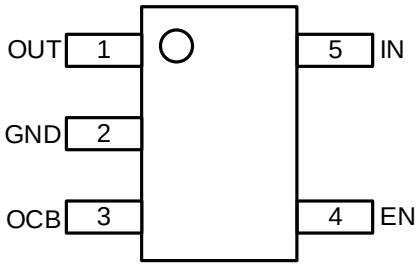
Ordering Information

Ordering Part Number	Package Type	Top Mark
SY20831FAAT	SOT23-5 RoHS Compliant and Halogen Free	**KCYxyz**

Device code: KCY

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

Pinout (Top View)



Pin Description

Pin Name	Pin Number	Pin Description
OUT	1	Output pin, decoupled with a 10μF capacitor from the IN to the GND, as close to the IC as possible.
GND	2	Ground pin.
OCB	3	Active low, open-drain fault flag. Asserted during over-current or over-temperature.
EN	4	ON/OFF control. Do not leave floating. A logic high turns on the power switch.
IN	5	Input pin, decoupled with a 100nF capacitor from the IN to the GND, as close to the IC as possible.

Block Diagram

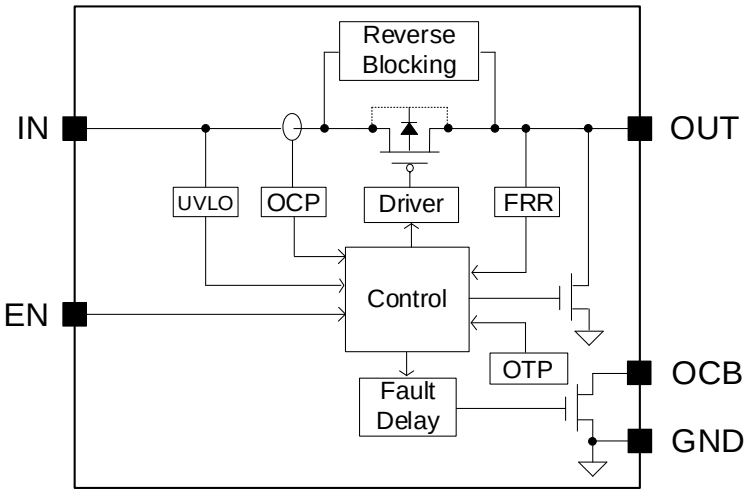


Figure 2. Block Diagram

Absolute Maximum Ratings

Parameter (Note 1)	Min	Max	Unit
IN, OUT, OCB, EN	-0.3	6	V
Lead Temperature (Soldering, 10 sec.)		260	°C
Junction Temperature, Operating	-40	150	
Storage Temperature	-65	150	

Thermal Information

Parameter (Note 2)	Typ	Unit
θ_{JA} Junction-to-ambient Thermal Resistance	89.8	°C/W
θ_{JC} Junction-to-case Thermal Resistance	9.9	
P_D Power Dissipation T_A = 25°C	1.1	W

Recommended Operating Conditions

Parameter (Note 3)	Min	Max	Unit
IN, OUT	2.5	5.5	V
OCB, EN	0	5.5	
Junction Temperature, Operating	-40	125	°C
Ambient Temperature	-40	85	

Electrical Characteristics

(V_{IN} = 5V, C_{OUT} = 10μF, T_J = -40°C to 125°C, typical values are at T_J=25°C unless otherwise specified. (Note 4))

Parameter		Symbol	Test Conditions	Min	Typ	Max	Unit
Input Voltage Range		V_{IN}		2.5		5.5	V
IN UVLO Threshold		$V_{IN,UVLO}$	T_J= -40°C to 85°C			2.45	V
IN UVLO Hysteresis		$V_{IN,HYS}$			0.1		V
Shutdown Input Current		I_{SHDN}	Open load, switch off T_J= -40°C to 85°C		0.1	5	μA
			Output grounded, switch off T_J= -40°C to 85°C		0.1	5	μA
Reverse Leakage Current			IN tie to GND, V_{OUT}=5V T_J= -40°C to 85°C		0.1	5	μA
Reverse Blocking Threshold		V_{RBT}	IN tied to GND, V_{OUT}=5V		100		mV
Reverse Blocking Recovery Threshold		V_{RBT_REC}	V_{OUT}-V_{IN}		-30		mV
Quiescent Supply Current		I_Q	Open load, switch on T_J= -40°C to 85°C		45	100	μA
FET $R_{DS(ON)}$		$R_{DS(ON)}$	V_{IN}=5V, I_{OUT}=0.5A T_J= -40°C to 85°C		65	100	mΩ
Current Limit Threshold		I_{LIM}	Output current increases until OCB low, T_A = 25°C	1420	1570	1720	mA
EN Threshold	Logic-Low Voltage	V_{IL}				0.4	V
	Logic-High Voltage	V_{IH}		1.0			V

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
EN Input Capacitor	C_{EN}	(Note 5)		1		pF
EN Leakage Current	I_{ENLK}				1	μA
Output Turn-On Rise Time	t_R	R_L=100Ω, C_L=1μF. Measure from V_{OUT}=10% of V_{IN} to 90% of V_{IN}		0.55		ms
Output Turn-Off Fall Time	t_F	R_L=100Ω, C_L=1μF. Measure from V_{OUT}=90% of V_{IN} to 10% of V_{IN}		126		μs
OCB Low Resistance	R_{OCB}	V_{IN}=5V, I_L=10μA		9		Ω
		V_{IN}=3.3V, I_L=10μA		12		
OUT Shutdown Discharge Resistance	R_{DSG}	EN=0V, V_{OUT}=0.1V	75	100	145	Ω
OCB Leakage Current	I_{LKG_OCB}	V_{OCB}=5V		0.01	1	μA
Fast Reverse Recovery Time	t_{FRR}	V_{IN}=3.3V, V_{OUT}=3.5V, C_L=1μF, OUT= 100Ω to GND. Remove 3.5V from OUT. Measure time from V_{OUT} thru 2.9V to V_{OUT}=3.2V (Note 5)			50	μs
Current-Limit Response Time	t_{OC_res}	I_{LOAD}=1.2I_{LIMIT} (Note 5)		15		μs
Over-Current Flag Response Time	t_{OCB}	I_{LOAD}=1.2I_{LIMIT}		10		ms
Reverse Blocking Response Time	t_{RBT}	(Note 5)		800		ns
Thermal Shutdown Temperature	T_{SD}	(Note 5)		150		°C
Thermal Shutdown Hysteresis	T_{HYS}	(Note 5)		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 SOT23-5 package is the case position for θ_{JC} measurement.

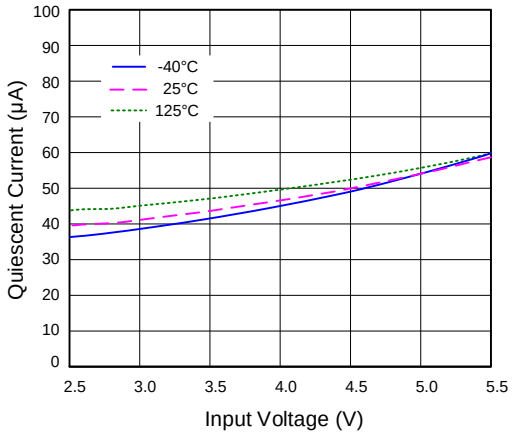
Note 3: The device is not guaranteed to function outside its operating conditions.

Note 4: Unless otherwise stated, limits are 100% production tested under pulsed load conditions such that $T_A \cong T_J$= 25°C. Limits over the operating temperature range (see recommended operating conditions) and relevant voltage range(s) are guaranteed by design, test, or statistical correlation.

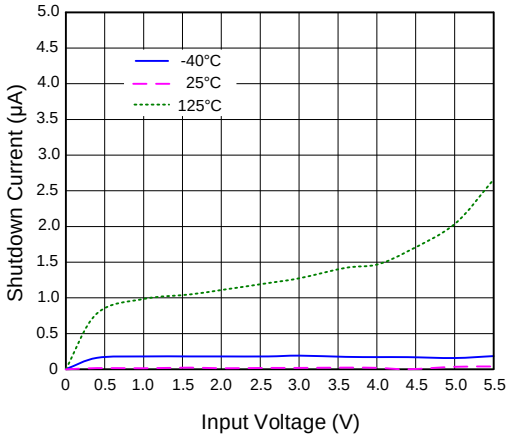
Note 5: Guaranteed by design but not production tested.

Typical Performance Characteristics

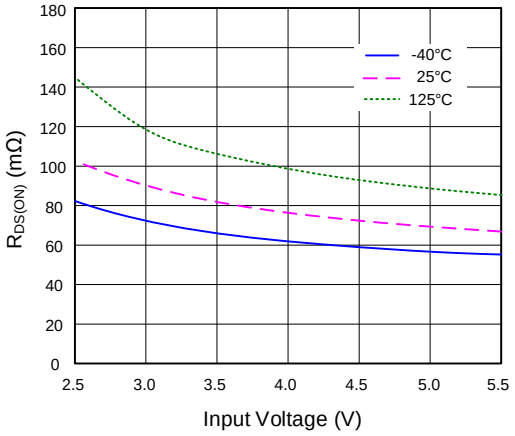
Quiescent Current vs. Input Voltage



Shutdown Current vs. Input Voltage

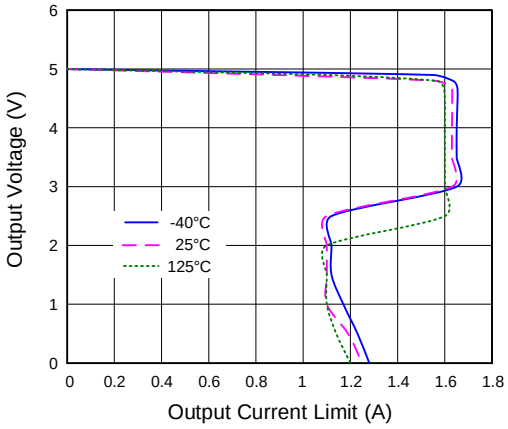


$R_{DS(ON)}$ vs. Input Voltage

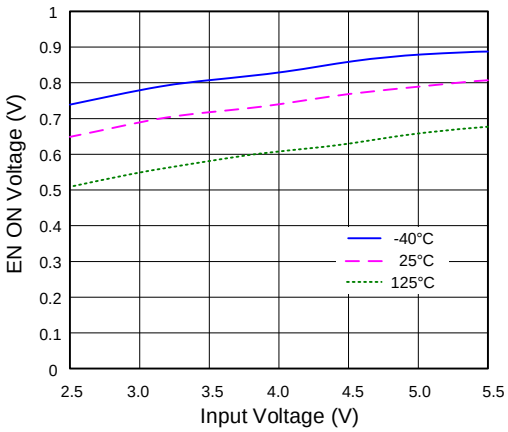


Output Voltage vs. Output Current Limit

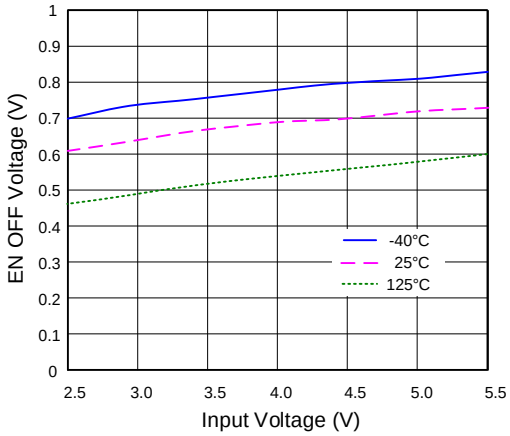
(V_{IN}=EN=5V, CV from 5V to 0V)



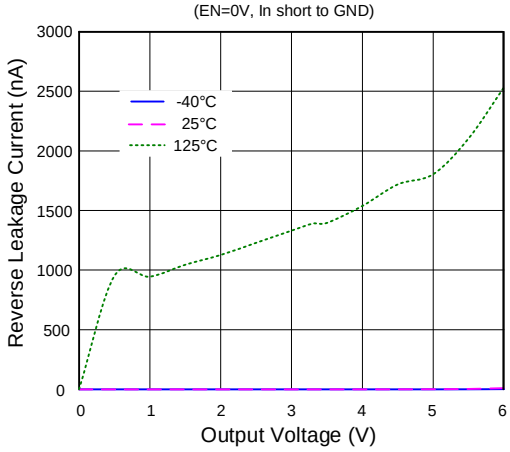
EN ON Voltage vs. Input Voltage



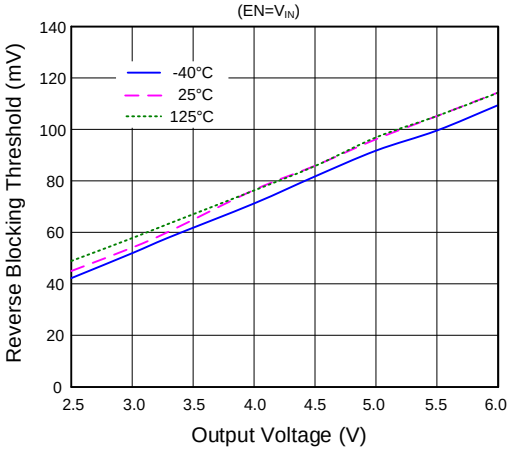
EN OFF Voltage vs. Input Voltage



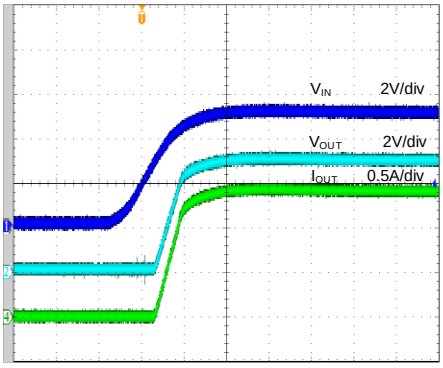
Reverse Leakage Current vs. Output Voltage
(EN=0V, In short to GND)



Reverse Blocking Threshold vs. Output Voltage
(EN=V_{IN})

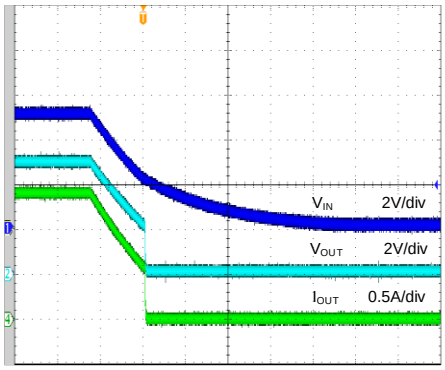


Startup from VIN
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, 1.4A Load)



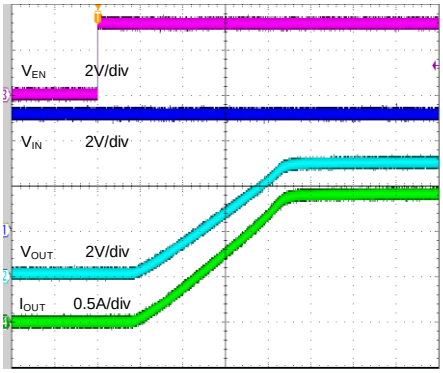
Time (400μs/div)

Shutdown from VIN
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, 1.4A Load)



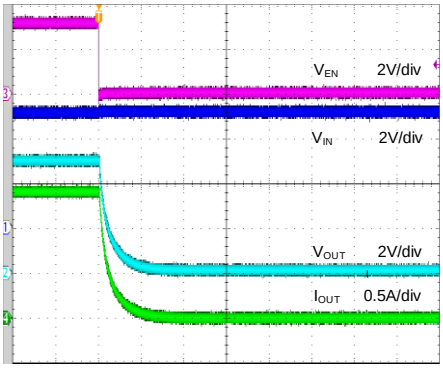
Time (4ms/div)

Startup from Enable
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, 1.4A Load)



Time (200μs/div)

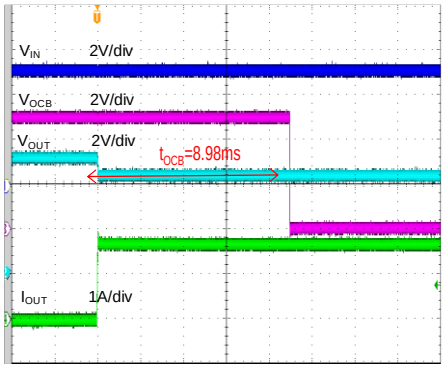
Shutdown from Enable
(V_{IN}=5V, C_{IN}=C_{OUT}=10μF, 1.4A Load)



Time (100μs/div)

Over Current Response

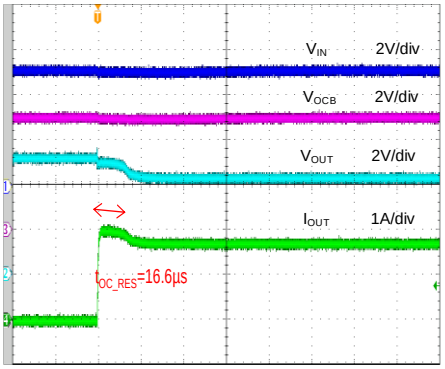
(V_{IN}=5V, C_{IN}=10μF, C_{OUT}=0μF, Null load → 2.5Ω Load)



Time (2ms/div)

Current Limit Response Time

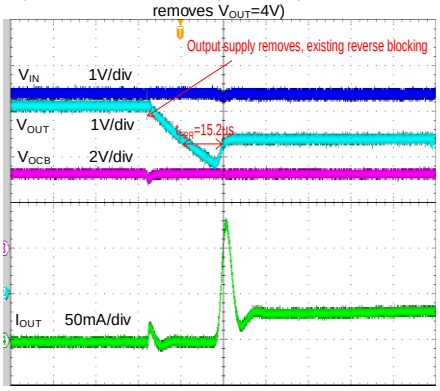
(V_{IN}=5V, C_{IN}=10μF, C_{OUT}=0μF, Null load → 2.5Ω Load)



Time (20μs/div)

Fast Reverse Blocking Recovery Response

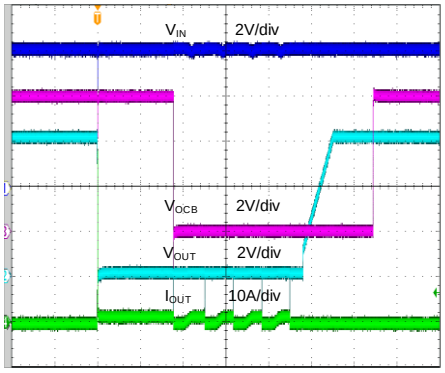
(V_{IN}=3.3V, V_{OUT}=4V, C_{IN}=10μF ,C_{OUT}=1μF, R_{LOAD}=100Ω, removes V_{OUT}=4V)



Time (20μs/div)

Short Circuit

(V_{IN}=EN=6V)



Time (800μs/div)

Operation

The SY20831F is a current limited power switch designed for USB load-switching or hot-plug applications. It incorporates over-temperature protection and reverse blocking function, to prevent current flow from OUT to IN when OUT is externally forced to a higher voltage than IN.

Over Current Protection

The SY20831F integrates a 1.57A fixed current limit to protect the power source from over-current conditions. When an over-current condition is sensed, the gate of the pass MOSFET is modulated to achieve constant output current. If the over-current condition persists for a prolonged period, the junction temperature may exceed 150°C, and the overtemperature protection will shut down the device. Once the chip temperature drops below 130°C, the device will restart.

The current limit of the device is folded back to 67%×I_{LIMIT} to decrease power dissipation when V_{OUT} < 50%×V_{IN}.

Fault Flag (OCB)

The OCB output is asserted (active low) when thermal shutdown protection is triggered or an over-current condition persists for more than 10ms. The output remains asserted until the fault condition is removed. Connecting a heavy capacitance load to an enabled device can cause a momentary over-current condition.

Supply Filter Capacitor

In order to prevent the input voltage droop during hot-plug events, a 100nF ceramic capacitor from VIN to GND is strongly recommended. Higher capacitor values could reduce the voltage droop on the input further. 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 voltage.

Output Filter Capacitor

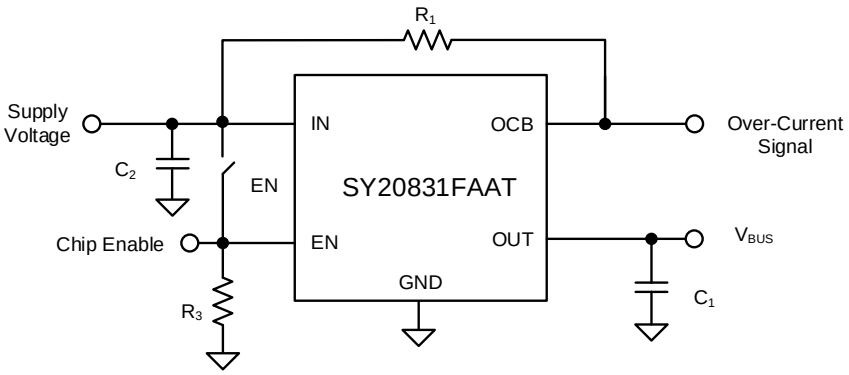
A 10μF output ceramic capacitor should be placed close to the device and output connector to reduce voltage drop during load transient. Higher values of output capacitor can be used to further reduce the droop in high current applications.

Reverse Blocking Function

The SY20831F integrates a reverse block function. When the voltage at the OUT pin exceeds voltage at the IN pin by 100mV, the reverse block function is triggered. The power MOSFET will shut down in 800ns to block the reverse current flow from OUT to IN.

The device integrates a fast reverse recovery function, which enables V_{OUT} recovery to 3.2V within 50μs once V_{OUT} drops lower than V_{IN} after the device is already operating in reverse blocking mode.

Schematic



BOM List

Reference Designator	Description	Part Number	Manufacturer
C_1	10μF/10V, 0805	GRM21BR71A106K	Murata
C_2	100nF/50V，0603	GRM188R61H104K	Murata
R_1	100kΩ, 0603	RC0603FR-07100KL	YAGEO
R_3	1MΩ, 0603	RC0603FR-071ML	YAGEO

PCB Layout Guide

For optimal performance of the SY20831F, the following guidelines must be adhered to:

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

2) Place 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.

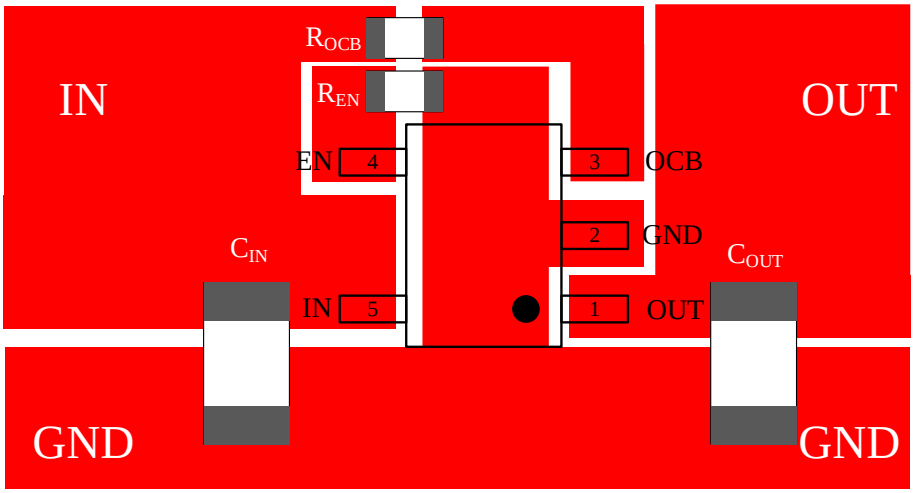
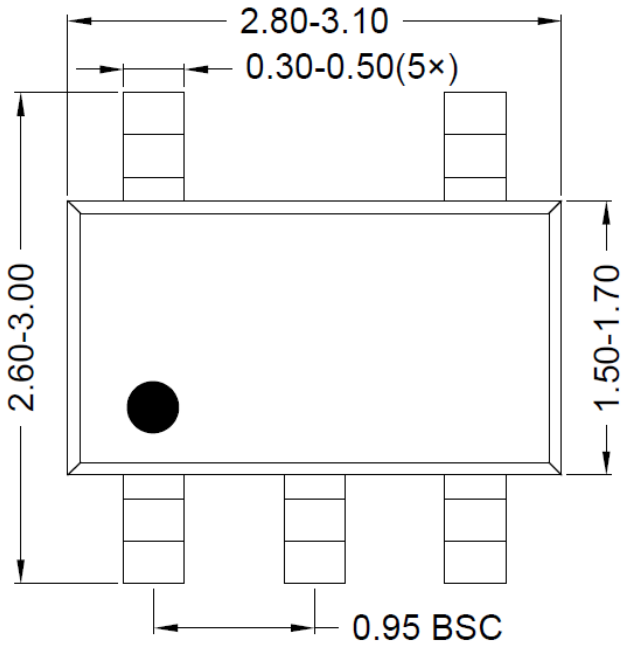
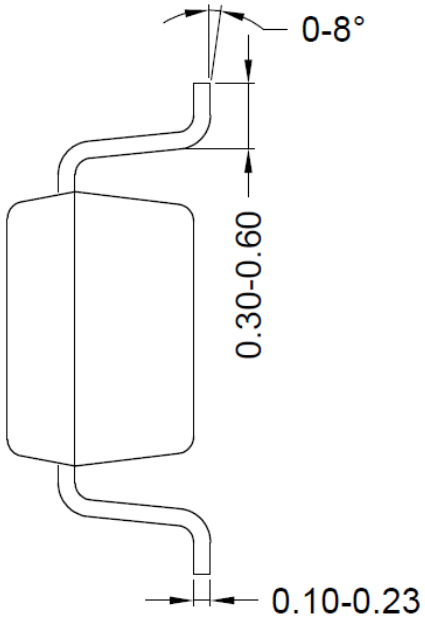


Figure 3. PCB Layout Suggestion

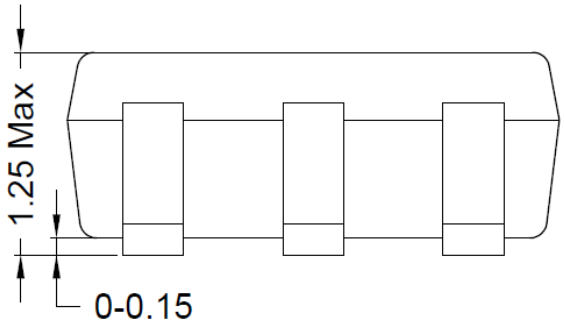
SOT23-5 Package Outline Drawing



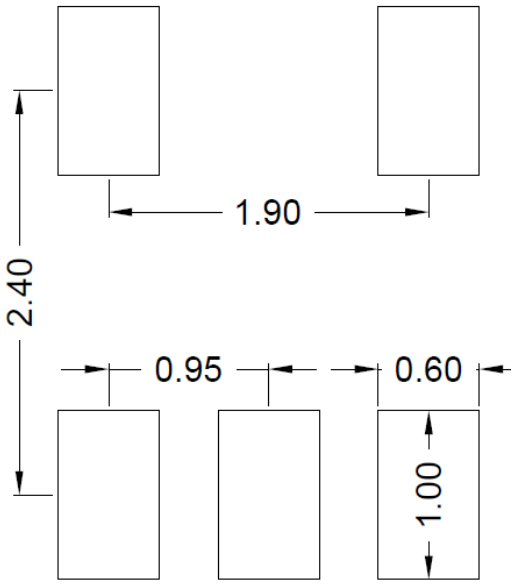
Top View



Side View



Front View



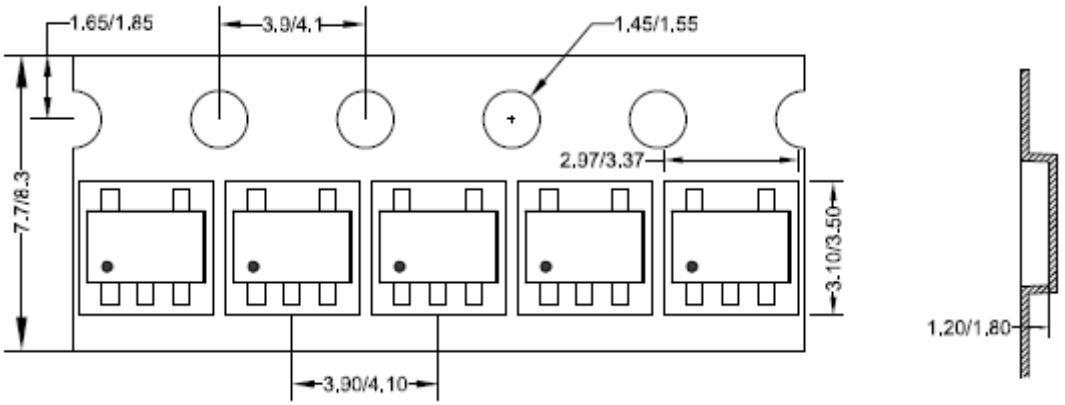
Recommended PCB Pad Layout (Reference Only)

Note: All dimensions in millimeters and exclude mold flash & metal burr.

Tape and Reel Information

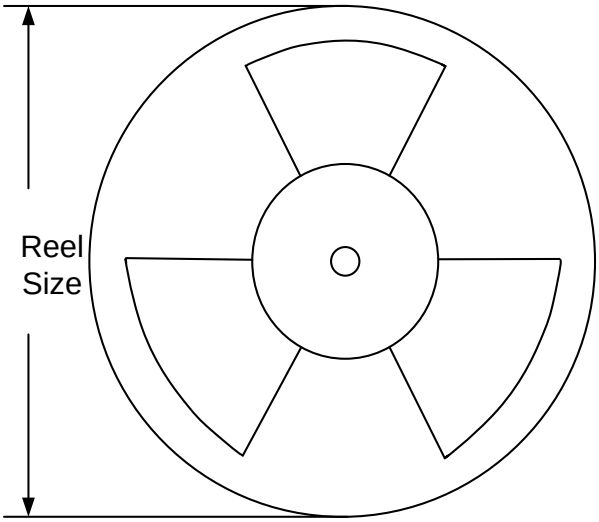
1. Tape Dimensions and Pin1 Orientation

SOT23-5



Feed Direction ⟶

2. Reel Dimensions



Package Type	Tape Width (mm)	Pocket Pitch(mm)	Reel Size (Inch)	Trailer Length(mm)	Leader Length (mm)	Qty Per Reel
SOT23-5	8	4	7"	280	160	3000

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
Dec.25, 2024	Revision 1.0	Initial Release

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