SY20877B

5.5V 10A Load Switch with Ultra Low $R_{DS(ON)}$

General Description

The SY20877B is a 5.3mΩ, single-channel load switch with an N-channel MOSFET that can operate over an input voltage range of 0.285V to 5.5V and can support a maximum continuous current of 10A. The wide input voltage range and high current capability enable the device to be used across multiple designs and end equipment. 5.3mΩ ON resistance minimizes the voltage drop across the load switch and associated power loss.

The controlled rise time for the device greatly reduces inrush current caused by large bulk load capacitances, thereby reducing or eliminating power supply droop.

The SY20877B has an optional 50Ω discharge resistor for quick discharging of the output when the switch is disabled, in order to avoid any unknown state caused by a floating power supply to the downstream load.

The SY20877B is available in a small, space-saving QFN1.5×2 package. The device is designed for operation over the free-air temperature range of –40°C to +105°C.

Features

- Integrated Single Channel Load Switch
- V_{BIAS} Voltage Range: 2.2V to 5.5V
- V_{IN} Voltage Range: 0.285V to V_{BIAS}
- On-Resistance
  - R_{ON} = 5.3mΩ (typical) at V_{IN}=5V (V_{BIAS}=5V)
  - R_{ON} = 5.3mΩ (typical) at V_{IN}=3.3V (V_{BIAS}=3.3V)
- 10A Maximum Continuous Switch Current
- Auto Output Discharge: 50Ω
- RoHS Compliant and Halogen-Free
- Compact Package: QFN1.5×2-10

Applications

- Notebooks
- Desktop PCs
- SSDs
- Servers
- Telecom Systems

Typical Application

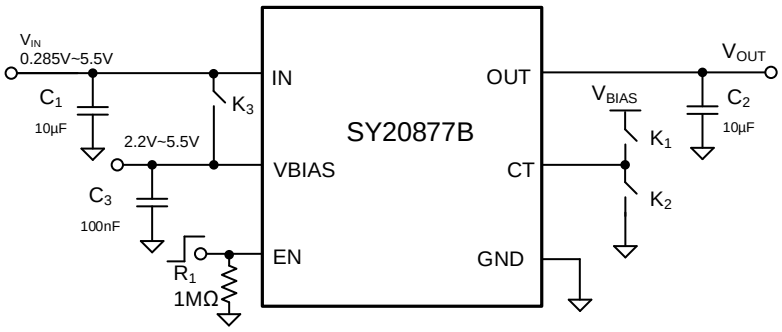


Figure 1. Schematic Diagram

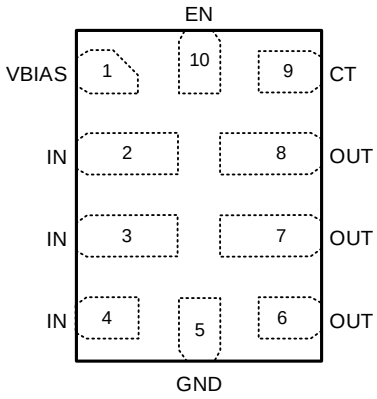
Ordering Information

Ordering Part Number	Package Type	Top Mark
SY20877BWPQ	QFN1.5×2-10 RoHS Compliant and Halogen Free	**KLRxyz**

Device code: KLR

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

Pinout (Top View)



Pin Name	Pin Number	Pin Description
VBIAS	1	Bias pin. Bias supply for overdriving the gate of the pass switch between input and output. The recommended BIAS voltage range is 2.2V to 5.5V.
IN	2,3,4	Switch input. Decouple this pin to GND with a 10μF or larger ceramic capacitor.
GND	5	Ground pin.
OUT	6,7,8	Switch output. Decouple this pin to GND with a 10μF or larger ceramic capacitor.
CT	9	Soft start programmable pin, Tri-state Selection for soft start time without an external capacitor. The pull-up or pull-down resistor should be less than 50kΩ.
EN	10	Enable interface pin. Active high switch control input. Do not leave floating.

Block Diagram

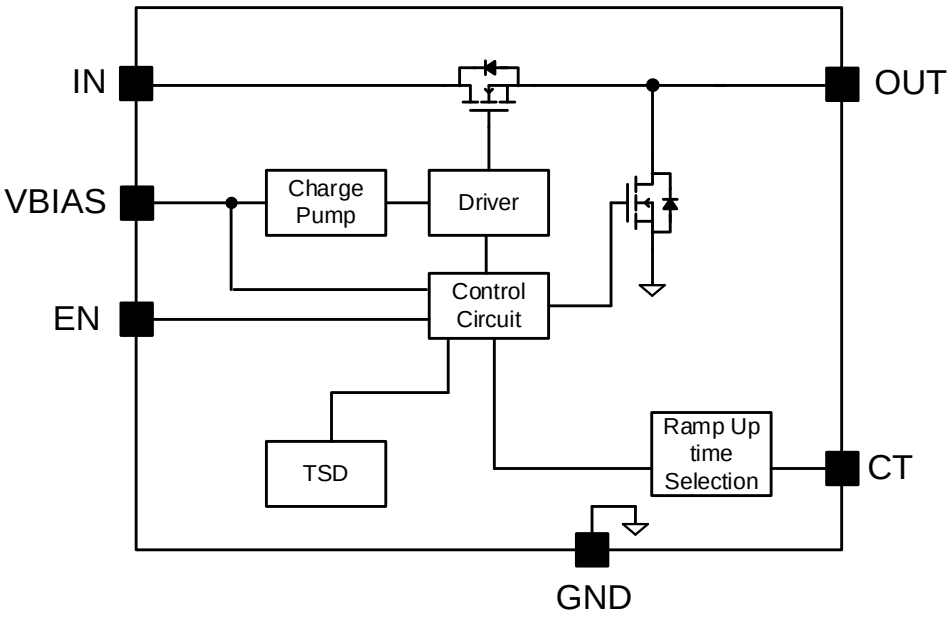


Figure 2. Block Diagram

Absolute Maximum Ratings

Parameter (Note 1)	Min	Max	Unit
IN, VBIAS, OUT, EN	-0.3	6	V
CT	-0.3	V_{BIAS}+0.3	
Lead Temperature (Soldering, 10s)		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	54.5	°C/W
θ_{JC} Junction-to-Case Thermal Resistance	21.5	
P_D Power Dissipation TA = 25°C	1.83	W

Recommended Operating Conditions

Parameter (Note 3)	Min	Max	Unit
IN	0.285	V_{BIAS}	V
VBAIS	2.2	5.5	
CT	0	V_{BIAS}	
OUT	0	V_{IN}	
EN	0	5.5	
Junction Temperature, Operating	-40	125	°C
Ambient Temperature	-40	105	

Electrical Characteristics

(Unless otherwise noted, the specifications in the following table apply to an operating ambient temperature range of 40°C≤T_A≤+105°C and V_{BIAS} = 5V. Typical values are for T_A = 25°C, unless otherwise noted. (Note 4))

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Voltage Range for VIN	V_{IN}		0.285		5.5	V
Voltage Range for V_{BIAS}	V_{BIAS}		2.2		5.5	V
V_{BIAS} UVLO	V_{BIAS_UVLO}				2.1	V
V_{BIAS} UVLO Hysteresis	V_{BIAS_HYS}			0.1		V
V_{BIAS} Quiescent Current	I_{Q_BIAS}	V_{BIAS}=5V, V_{IN}=V_{EN}=5V		40	60	μA
		V_{BIAS}=3.3V, V_{IN}=V_{EN}=3.3V		30	60	μA
V_{BIAS} Shutdown Current	I_{SHDN_BIAS}	V_{BIAS}=5V, V_{IN}=5V, V_{EN}=0V		1	5	μA
		V_{BIAS}=3.3V, V_{IN}=3.3V, V_{EN}=0V		1	5	μA
EN Leakage Current	I_{EN_LKG}	V_{EN}=5.5V			0.1	μA
EN Turn-on Threshold	V_{EN_ON}	V_{BIAS}=3.3V, V_{IN}=3.3V	0.84	0.9	0.96	V
EN Turn-on Threshold Hysteresis	V_{EN_HYS}	V_{BIAS}=3.3V, V_{IN}=3.3V		0.2		V
EN Input Low Level Voltage	V_{EN_OFF}	T_A=25°C			0.2	V
Integrated MOSFET $R_{DS(ON)}$	$R_{DS(ON)}$	V_{BIAS}=V_{EN}=5V, I_{OUT}=1A V_{IN}=2.5V		5.3	7	mΩ
		V_{BIAS}=V_{EN}=5V, I_{OUT}=1A V_{IN}=1.8V		5.3	7	mΩ
		V_{BIAS}=V_{EN}=5V, I_{OUT}=1A V_{IN}=1.1V		5.3	7	mΩ
		V_{BIAS}=V_{EN}=5V, I_{OUT}=1A V_{IN}=0.55V		5.3	7	mΩ

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Output Discharge Resistance	R_{DSG}	V_{BIAS}=V_{IN}=3.3V, V_{EN}=0, V_{OUT}=0.1V I_{OUT}= 0A		50		Ω
		V_{BIAS}=V_{IN}=5V, V_{EN}=0, V_{OUT}=0.1V I_{OUT}= 0A		50		Ω
EN ON Delay Time	t_{d_ON}	R_L=10Ω, C_L=0.1μF, V_{BIAS}=V_{IN}=3.3V, V_{EN}=0V to 3.3V	20	35	50	μs
EN OFF Delay Time	t_{d_OFF}	R_L=10Ω, C_L=0.1μF, V_{BIAS}=V_{IN}=3.3V, V_{EN}=3.3V to 0V,	2	5	8	μs
VOUT Rise Slew Rate	SR	R_L=10Ω, C_L=4.7μF, V_{BIAS}=V_{IN}=3.3V, V_{EN}=0V to 3.3V, CT Floating	13.34	16.67	20	V/ms
		R_L=10Ω, C_L=4.7μF, V_{BIAS}=V_{IN}=3.3V, V_{EN}=0V to 3.3V, CT Pull-up	1.6	2	2.4	V/ms
		R_L=10Ω, C_L=4.7μF, V_{BIAS}=V_{IN}=3.3V, V_{EN}=0V to 3.3V, CT Pull-down	0.8	1	1.2	V/ms
VOUT Fall Time	t_{fall}	R_L=10Ω, C_L=4.7μF, V_{BIAS}=V_{IN}=3.3V, V_{EN}=3.3V to 0V, CT Pull up		117		μs
		R_L=10Ω, C_L=4.7μF, V_{BIAS}=V_{IN}=3.3V, V_{EN}=3.3V to 0V, CT Floating		117		μs
		R_L=10Ω, C_L=4.7μF, V_{BIAS}=V_{IN}=3.3V, V_{EN}=3.3V to 0V, CT Pull low		117		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 natural convection at T_A=25°C on a Silergy evaluation board following JEDEC51-2 thermal measurement standard.

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.

Soft Start Time Program

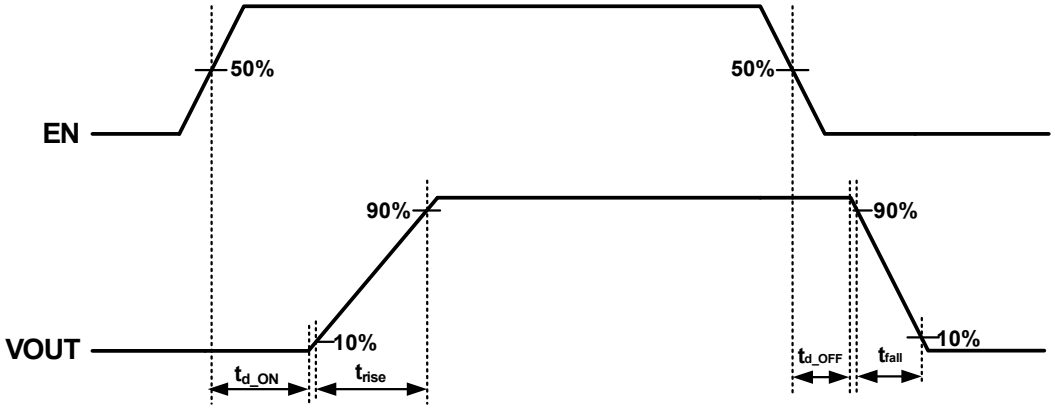
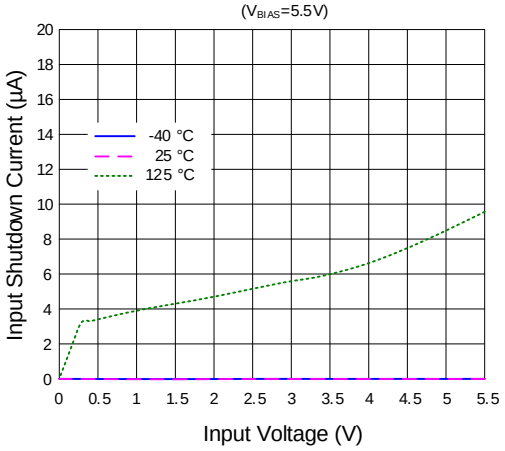


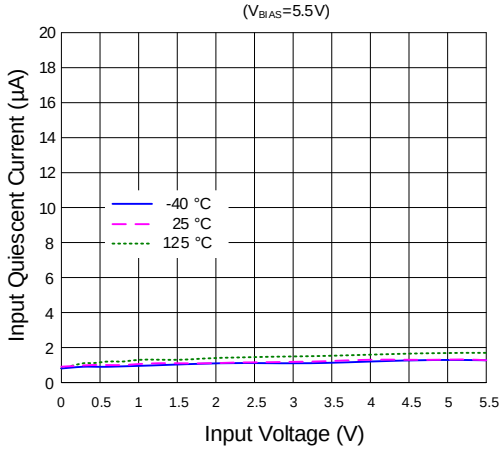
Figure 3. Soft Start Time

Typical Performance Characteristics

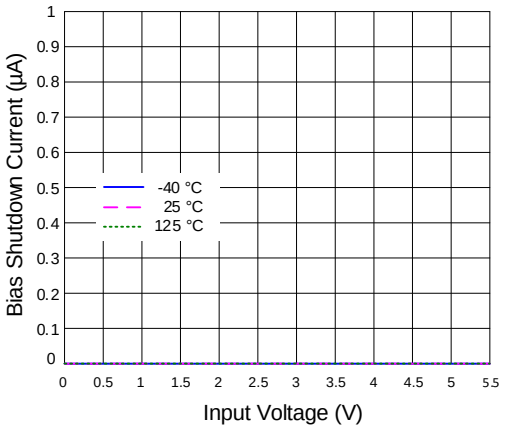
Input Shutdown Current vs. Input Voltage
(V_{BIAS}=5.5V)



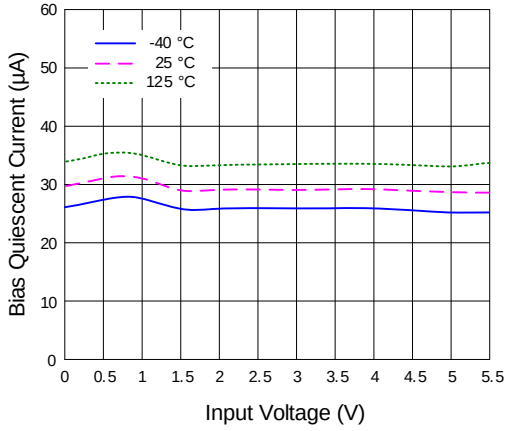
Input Quiescent Current vs. Input Voltage
(V_{BIAS}=5.5V)



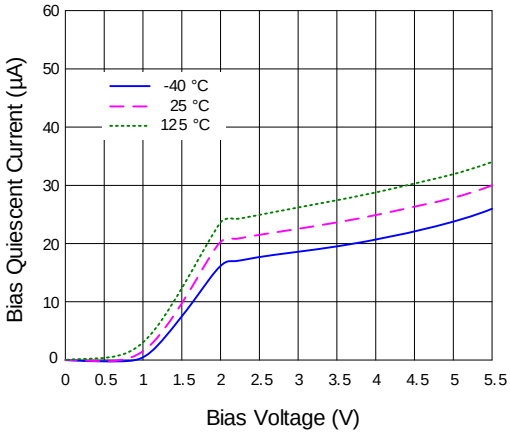
Bias Shutdown Current vs. Input Voltage
(V_{BIAS}=5.5V)



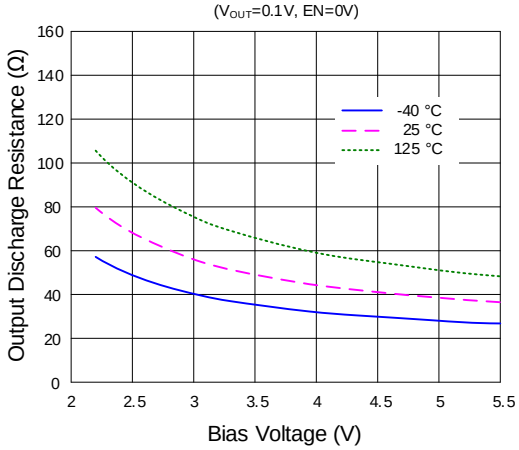
Bias Quiescent Current vs. Input Voltage
(V_{BIAS}=5.5V)



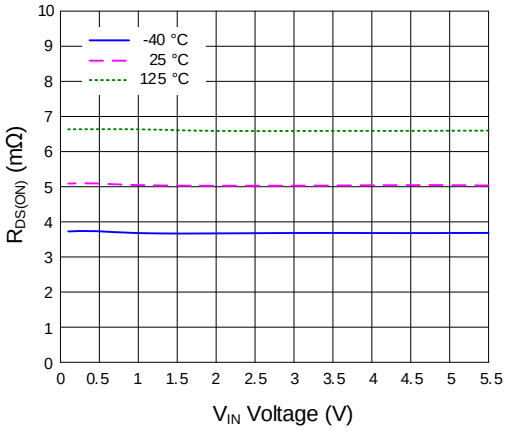
Bias Quiescent Current vs. Bias Voltage



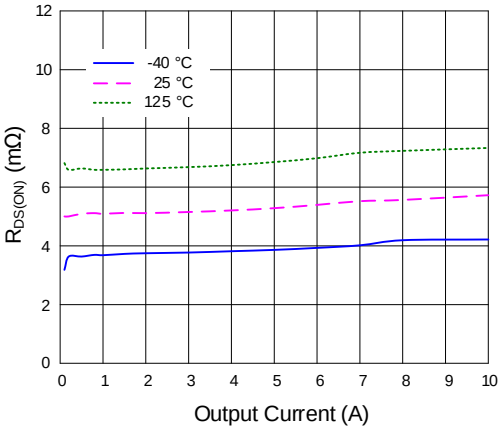
Output Discharge Resistance vs. Bias Voltage
(V_{OUT}=0.1V, EN=0V)



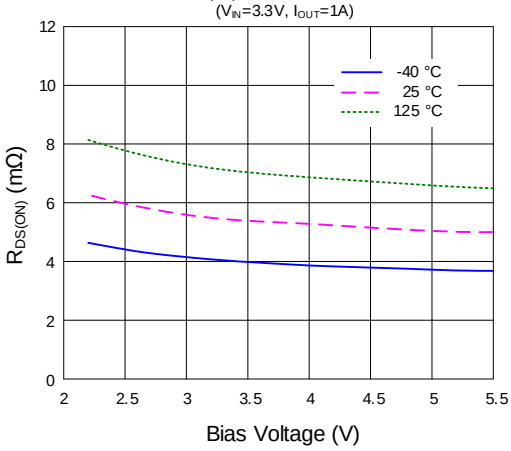
$R_{DS(ON)}$ vs. V_{IN} Voltage
(V_{BIAS}=5.5V)



$R_{DS(ON)}$ vs. Output Current
(V_{BIAS}=5.5V)



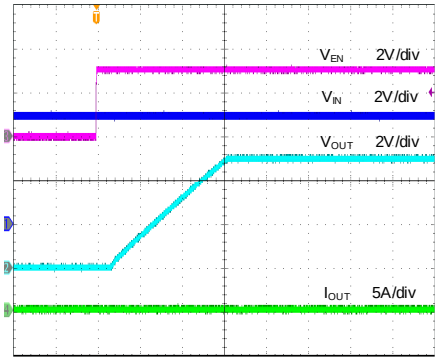
$R_{DS(ON)}$ vs. Bias Voltage
(V_{IN}=3.3V, I_{OUT}=1A)



Typical Performance Characteristics

EN ON

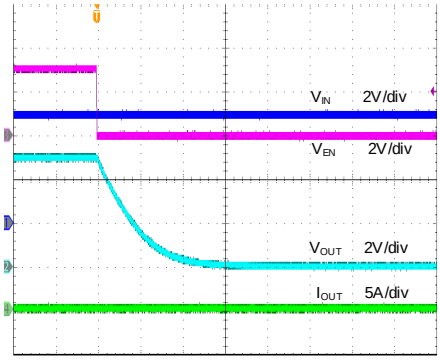
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Floating, Null load)



Time (100μs/div)

EN OFF

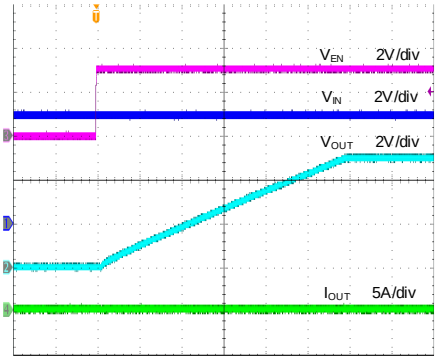
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Floating, Null load)



Time (400μs/div)

EN ON

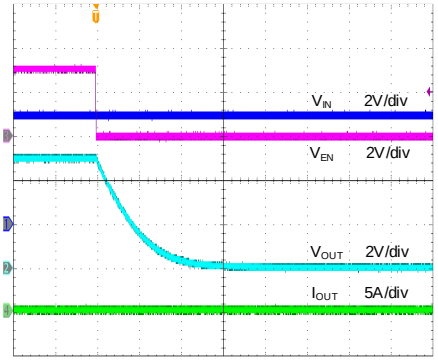
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT High, Null load)



Time (400μs/div)

EN OFF

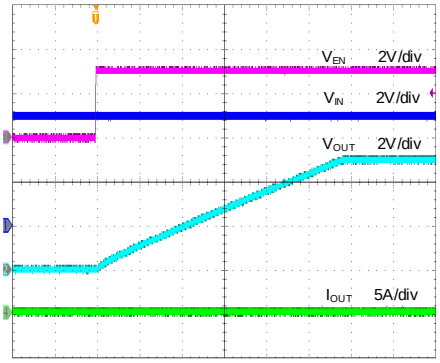
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT High, Null load)



Time (400μs/div)

EN ON

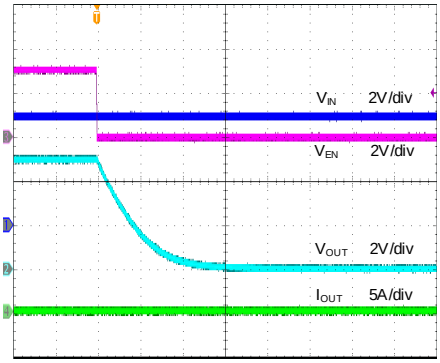
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Low, Null load)



Time (800μs/div)

EN OFF

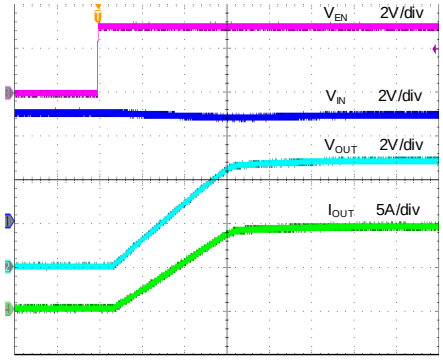
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Low, Null load)



Time (400μs/div)

EN ON

(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Floating, 10A load)



Time (100μs/div)

EN OFF

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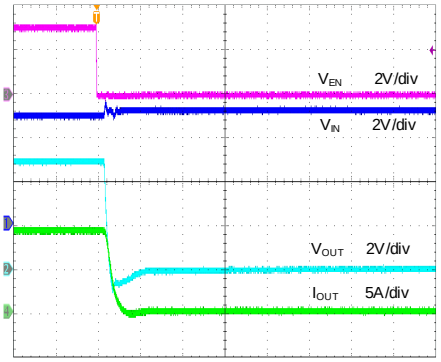
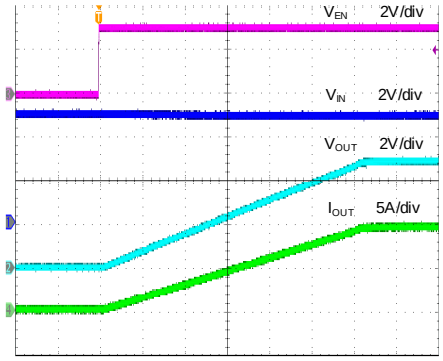


Time (20μs/div)

EN ON

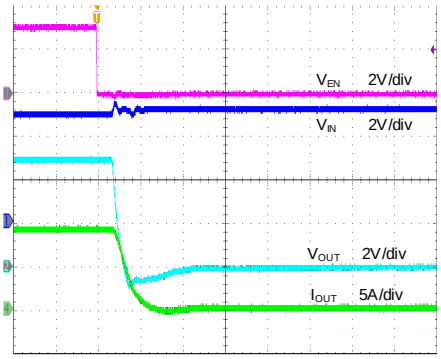
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT High, 10A load)



Time (400μs/div)

EN OFF

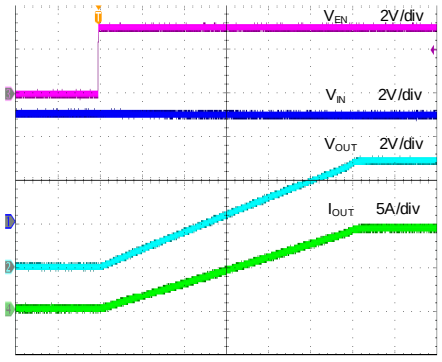
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT High, 10A load)



Time (10μs/div)

EN ON

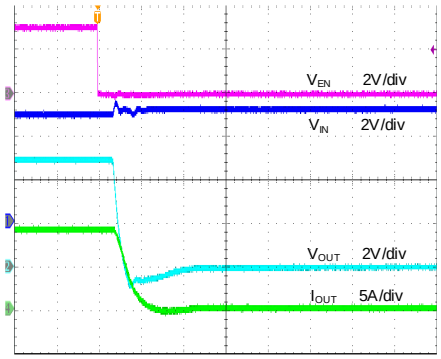
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Low, 10A load)



Time (800μs/div)

EN OFF

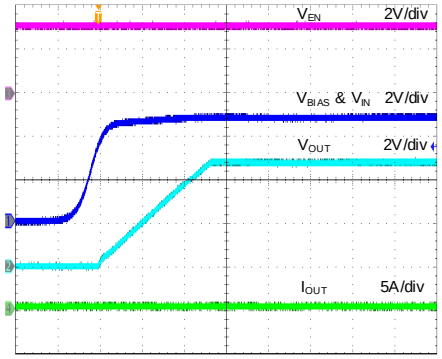
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Low, 10A load)



Time (10μs/div)

V_{BIAS} & V_{IN} ON

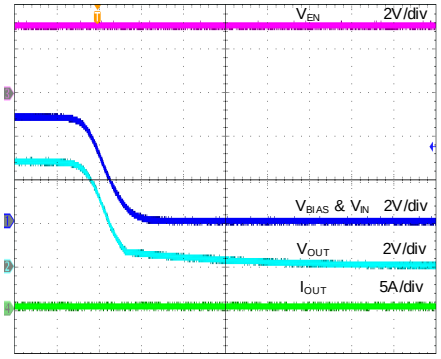
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Floating, Null load)



Time (100μs/div)

V_{BIAS} & V_{IN} OFF

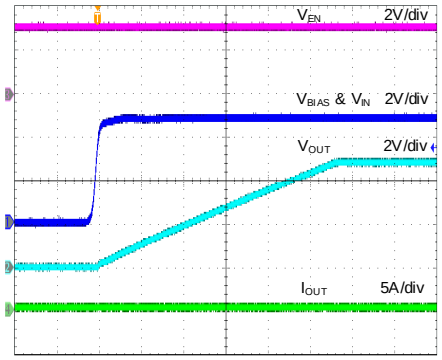
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Floating, Null load)



Time (100μs/div)

V_{BIAS} & V_{IN} ON

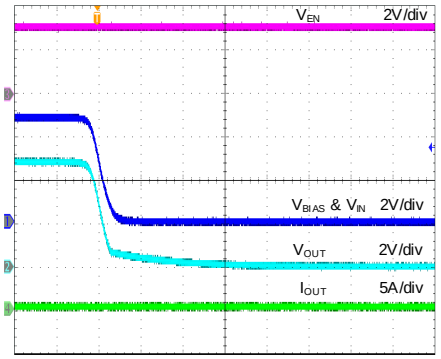
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT High, Null load)



Time (400μs/div)

V_{BIAS} & V_{IN} OFF

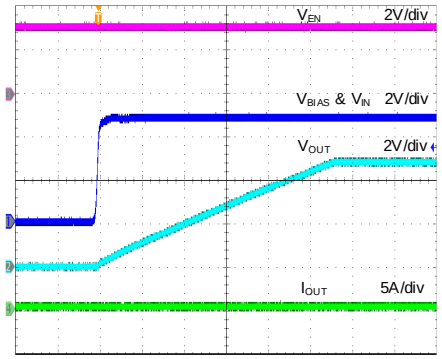
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT High, Null load)



Time (200μs/div)

V_{BIAS} & V_{IN} ON

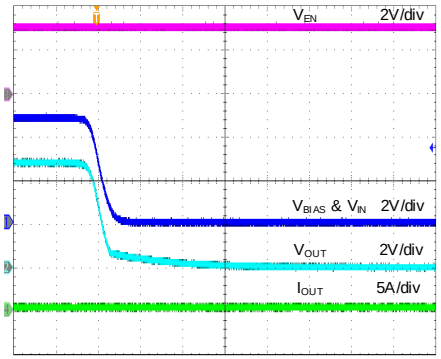
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Low, Null load)



Time (800μs/div)

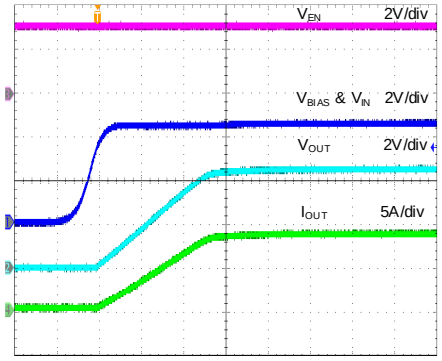
V_{BIAS} & V_{IN} OFF

(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Low, Null load)



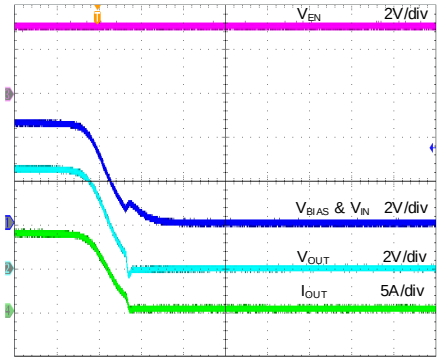
Time (200μs/div)

V_{BIAS} & V_{IN} ON
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Floating, 10A load)



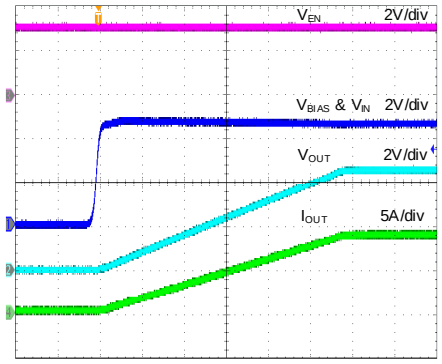
Time (100μs/div)

V_{BIAS} & V_{IN} OFF
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Floating, 10A load)



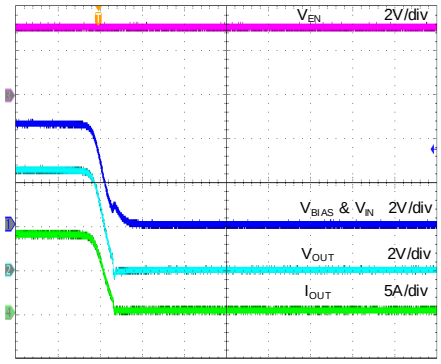
Time (100μs/div)

V_{BIAS} & V_{IN} ON
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT High, 10A load)



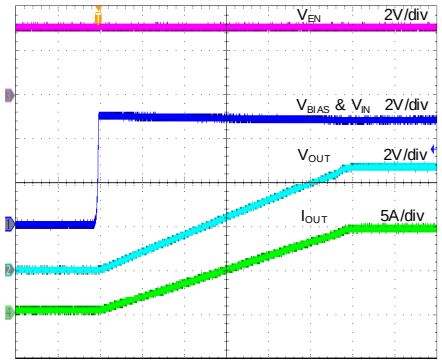
Time (400μs/div)

V_{BIAS} & V_{IN} OFF
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT High, 10A load)



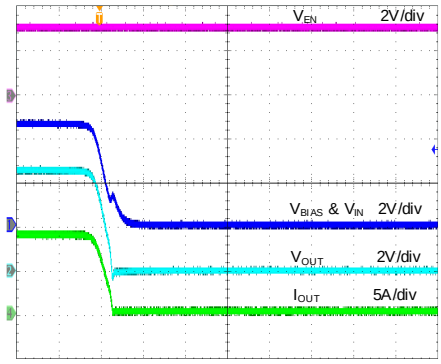
Time (200μs/div)

V_{BIAS} & V_{IN} ON
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Low, 10A load)



Time (800μs/div)

V_{BIAS} & V_{IN} OFF
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Low, 10A load)



Time (200μs/div)

Operation

The SY20877B is a 5.3mΩ, single-channel load switch with an N-channel MOSFET that can operate over an input voltage range of 0.285V to 5.5V and can support a maximum continuous current of 10A. The wide input voltage range and high current capability enable the device to be used across multiple designs and end equipment. 5.3mΩ ON resistance minimizes the voltage drop across the load switch and associated power loss.

The controlled rise time for the device greatly reduces inrush current caused by large bulk load capacitances, thereby reducing or eliminating power supply droop.

Application Information

Input Capacitor C_{IN}:

To reduce device inrush current, a 10μF ceramic capacitor, C_{IN}, is recommended. A higher value of C_{IN} can be used to reduce the voltage drop experienced as the switch is turned on into a large capacitive load. To minimize potential noise, C_{IN} should be placed adjacent to the IN and GND pins.

Output Capacitor C_{OUT}:

A 10μF output ceramic capacitor should be placed close to the device and output connector to reduce voltage drop during load transients. A higher value of C_{OUT} can be used to further reduce the voltage drop in high current applications.

Output Discharge:

The SY20877B integrates a 50Ω pull down resistor for quick output discharge. The resistor is activated when the switch is turned off.

Soft Start Function:

The SY20877B uses a controlled rise time for inrush current control. Tri-state Selection is used for configuring the soft-start time without an external capacitor. The pull-up or pull-down resistor should be less than 50kΩ. Refer to the EC table for timing parameters.

Thermal Considerations:

The SY20877B can deliver a current of up to 10A over the full operating temperature range. However, the maximum output current must be derated at a higher ambient temperatures. For all possible conditions, the junction temperature must be within the range specified under operating conditions. Power dissipation can be calculated based on the output current and the voltage drop across the regulator.

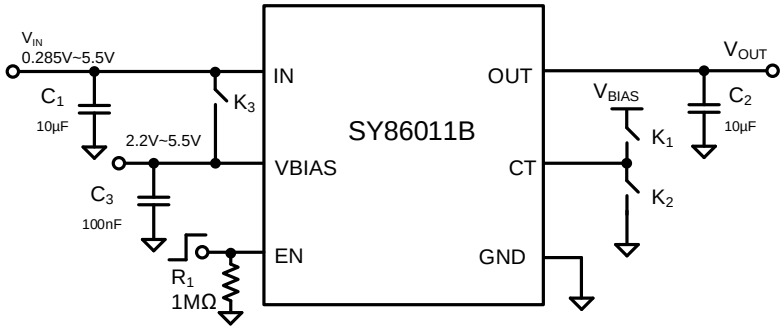
$$P_D=(V_{IN}-V_{OUT})\times I_{OUT}+V_{IN}\times I_{GND}$$

The final operating junction temperature for any set of conditions can be estimated using the following thermal equation:

$$P_{D(MAX)}=(T_{J(MAX)}-T_A)/\theta_{JA}$$

Where $T_{J(MAX)}$ is the maximum junction temperature of the die (125 °C) and T_A is the maximum ambient temperature. The junction to ambient thermal resistance (θ_{JA}) is 54.5°C /W for the QFN package.

Schematic



BOM List

Reference Designator	Description	Part Number	Manufacturer
C_1, C_2	10μF/10V, ±10%, X5R, 0805	GRM21BR71A106K	Muruta
C_3	100nF/50V, ±10%, X7R, 0603	GRM188R61H104K	Muruta
R_1	1MΩ, 1%, 0.1W, 0603	RC0603FR-071ML	YAGEO

PCB Layout Guide

For optimal performance of the SY20877B, the following guidelines must be adhered to:

1) Keep all power traces (VIN / OUT / BIAS/ GND) as short and wide as possible and use 2-ounce copper or better.

2) Place a ground plane under all circuitry to lower both resistance and inductance and improve DC and transient performance.

3) Input and output capacitors should be placed close to the SY20877B and connected to the ground plane to reduce noise coupling.

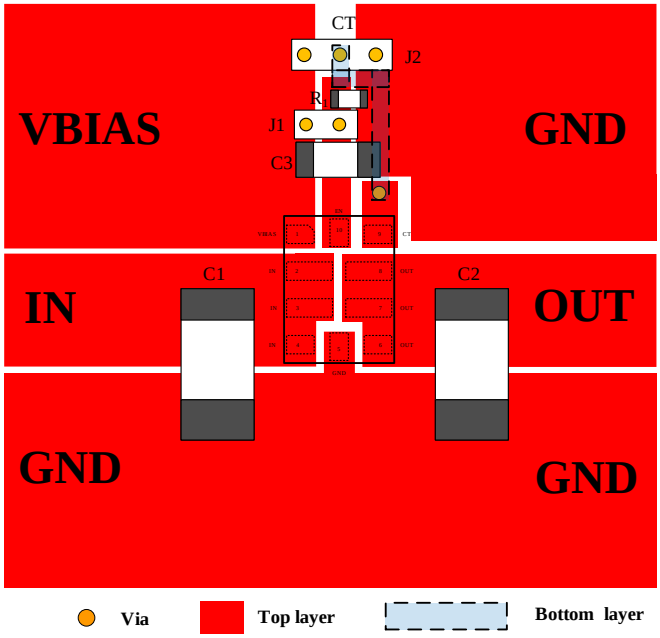
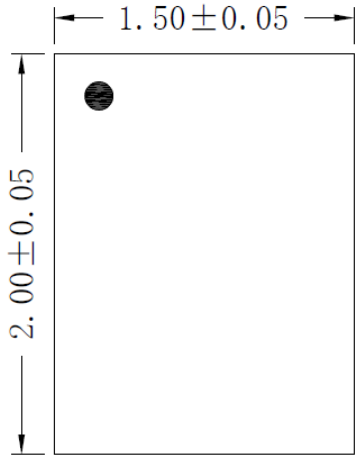
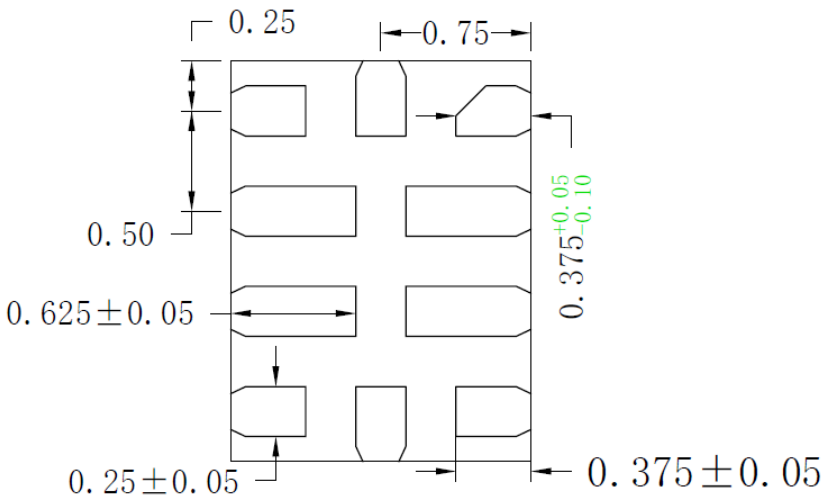


Figure 4. PCB Layout Suggestion

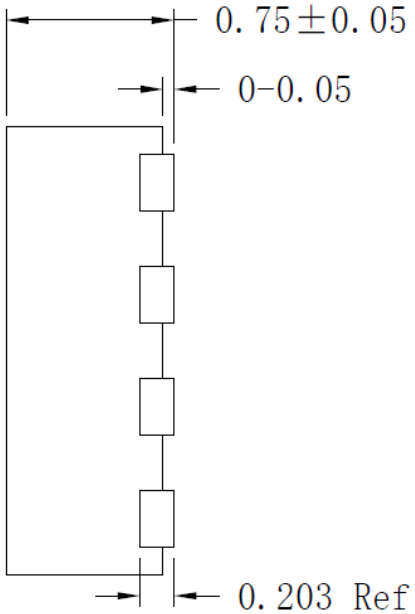
QFN1.5×2-10 Package Outline



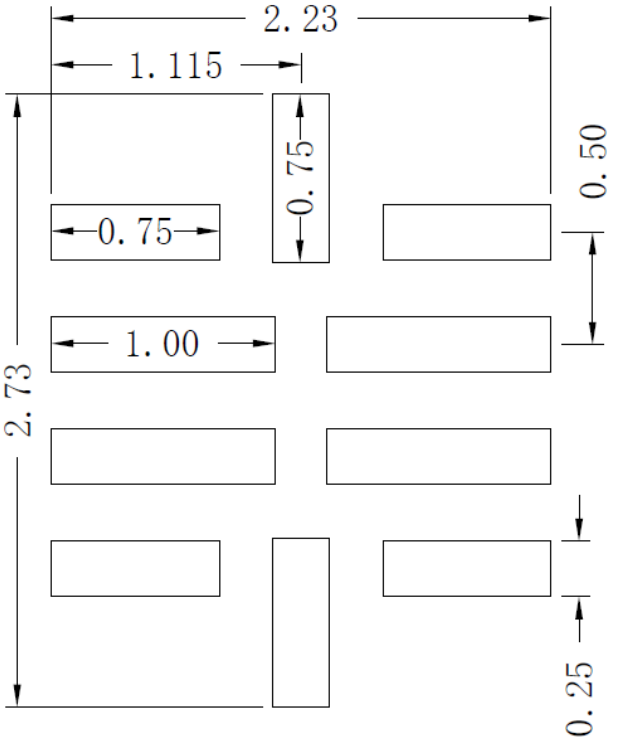
Top View



Bottom View



Side View

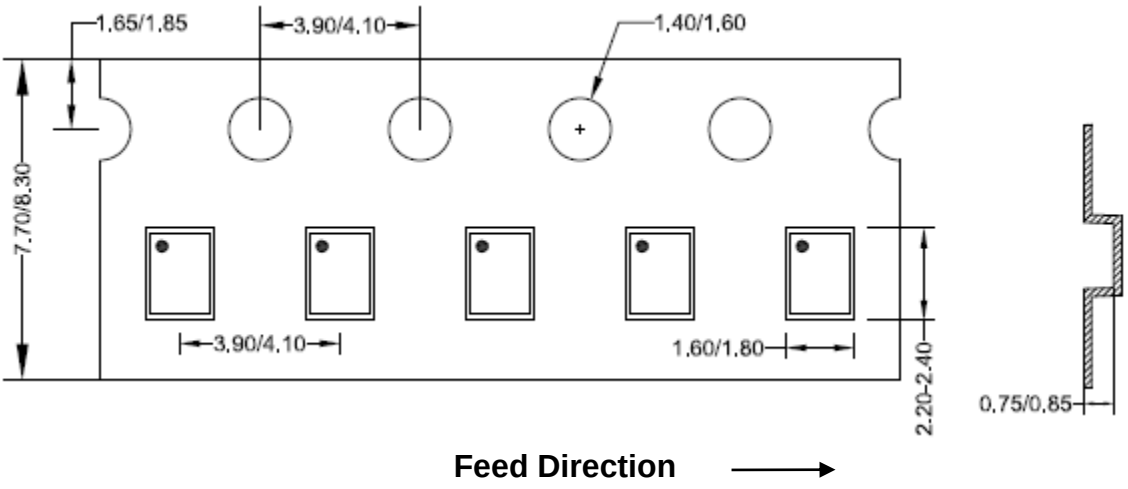


Recommended PCB Layout
(Reference Only)

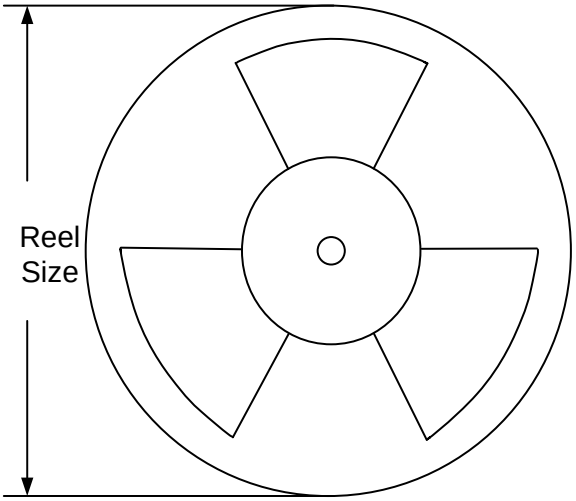
Note: All dimensions in millimeters and exclude mold flash & metal burr.

Tape and Reel Information

1. Tape Dimensions and Pin1 Orientation



2. Reel Dimensions



Package Type	Tape Width (mm)	Pocket Pitch(mm)	Reel Size (Inch)	Trailer Length(mm)	Leader Length (mm)	Qty Per Reel
QFN1.5×2	8	4	7	400	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
Nov. 20, 2024	Revision 1.0	Initial Release

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