

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

General Description

The SY20877B is a 5.3m Ω , 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. 5.3m Ω 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 50 Ω 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 $\times$ 2 package. The device is designed for operation over the free-air temperature range of -40°C to $+105^{\circ}\text{C}$.

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
 - $R_{ON} = 5.3\text{m}\Omega$ (typical) at $V_{IN}=5\text{V}$ ($V_{BIAS}=5\text{V}$)
 - $R_{ON} = 5.3\text{m}\Omega$ (typical) at $V_{IN}=3.3\text{V}$ ($V_{BIAS}=3.3\text{V}$)
- 10A Maximum Continuous Switch Current
- Auto Output Discharge: 50 Ω
- RoHS Compliant and Halogen-Free
- Compact Package: QFN1.5 $\times$ 2-10

Applications

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

Typical Application

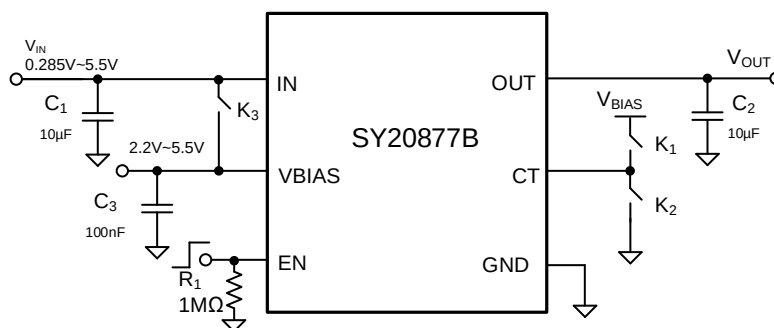


Figure 1. Schematic Diagram

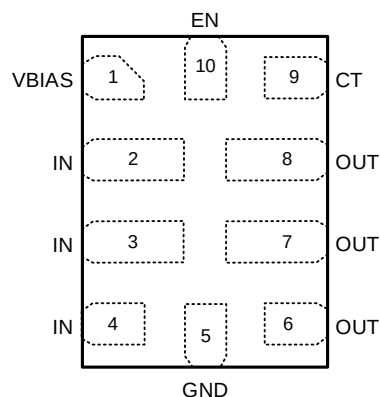
Ordering Information

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

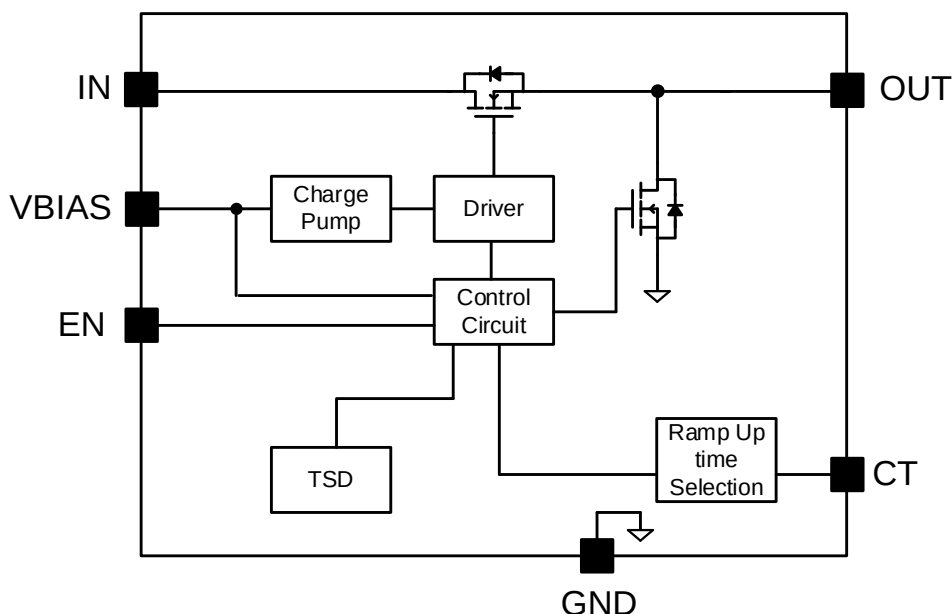


Figure 2. Block Diagram

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 V _{IN}	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}	$R_L=10\Omega, C_L=0.1\mu F, V_{BIAS}=V_{IN}=3.3V, V_{EN}=0V \text{ to } 3.3V$	20	35	50	μs
EN OFF Delay Time	t_{d_OFF}	$R_L=10\Omega, C_L=0.1\mu F, V_{BIAS}=V_{IN}=3.3V, V_{EN}=3.3V \text{ to } 0V,$	2	5	8	μs
VOUT Rise Slew Rate	SR	$R_L=10\Omega, C_L=4.7\mu F, V_{BIAS}=V_{IN}=3.3V, V_{EN}=0V \text{ to } 3.3V, CT \text{ Floating}$	13.34	16.67	20	V/ms
		$R_L=10\Omega, C_L=4.7\mu F, V_{BIAS}=V_{IN}=3.3V, V_{EN}=0V \text{ to } 3.3V, CT \text{ Pull-up}$	1.6	2	2.4	V/ms
		$R_L=10\Omega, C_L=4.7\mu F, V_{BIAS}=V_{IN}=3.3V, V_{EN}=0V \text{ to } 3.3V, CT \text{ Pull-down}$	0.8	1	1.2	V/ms
VOUT Fall Time	t_{fall}	$R_L=10\Omega, C_L=4.7\mu F, V_{BIAS}=V_{IN}=3.3V, V_{EN}=3.3V \text{ to } 0V, CT \text{ Pull up}$		117		μs
		$R_L=10\Omega, C_L=4.7\mu F, V_{BIAS}=V_{IN}=3.3V, V_{EN}=3.3V \text{ to } 0V, CT \text{ Floating}$		117		μs
		$R_L=10\Omega, C_L=4.7\mu F, V_{BIAS}=V_{IN}=3.3V, V_{EN}=3.3V \text{ to } 0V, CT \text{ Pull low}$		117		μs
Thermal Shutdown Temperature	T_{SD}			150		$^{\circ}C$
Thermal Shutdown Hysteresis	T_{HYS}			20		$^{\circ}C$

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 $T_A=25^{\circ}C$ 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 $T_A \cong T_J = 25^{\circ}C$. 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

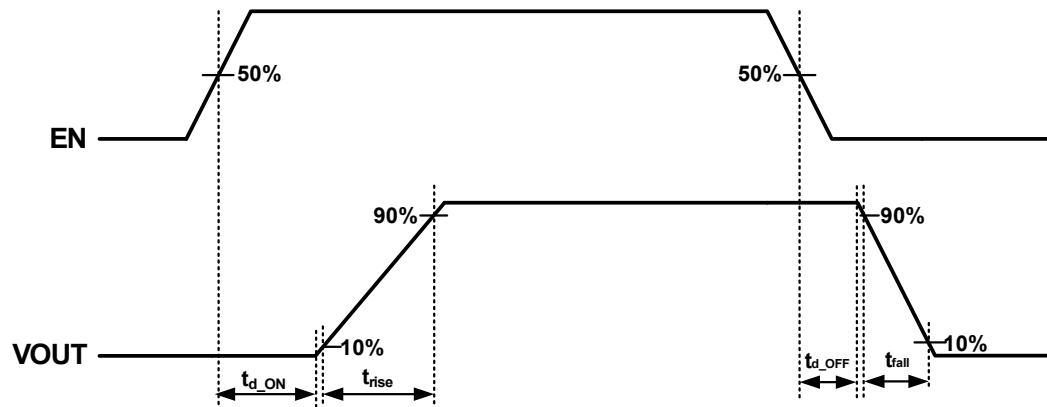
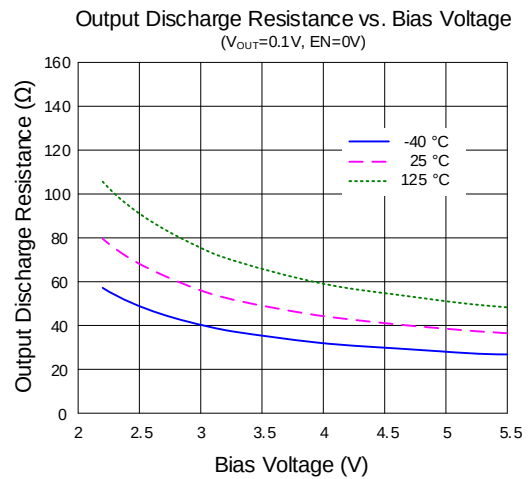
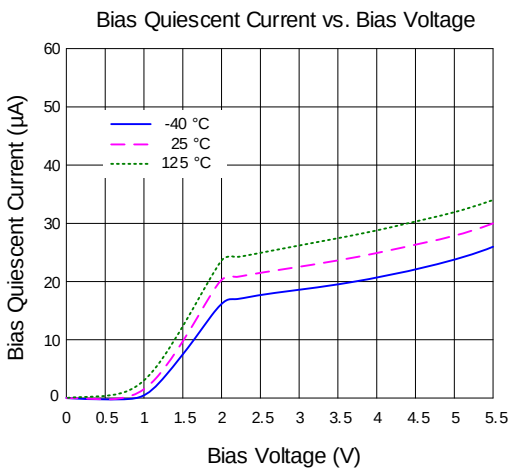
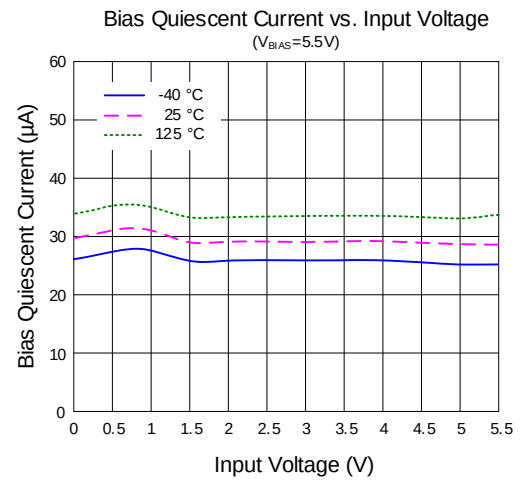
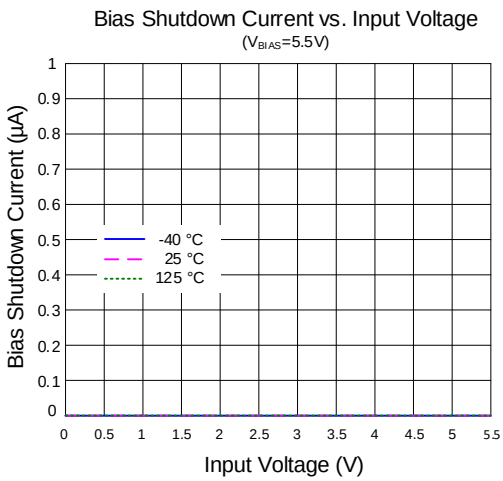
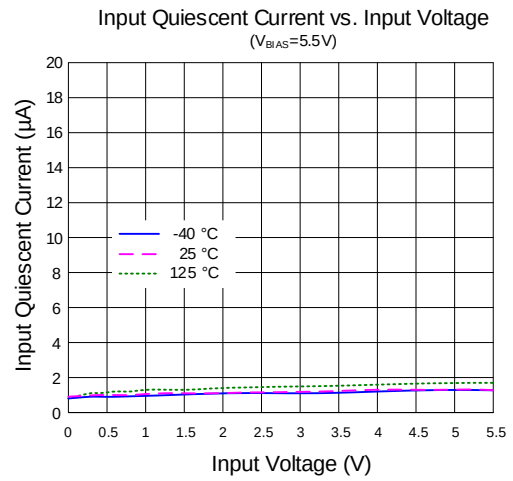
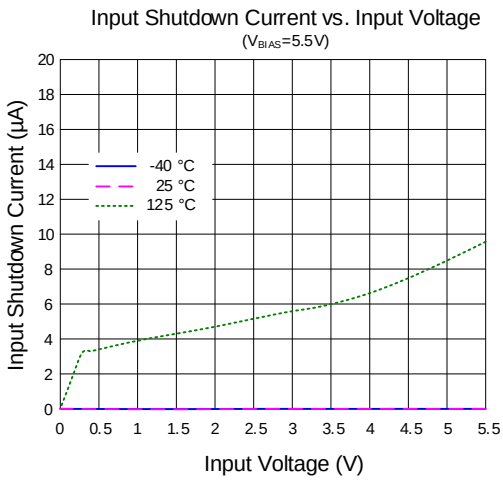
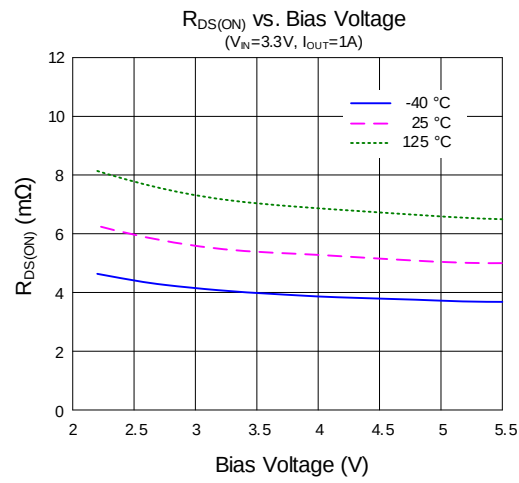
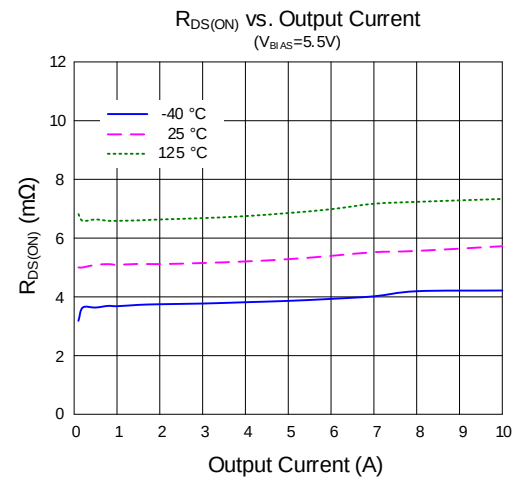
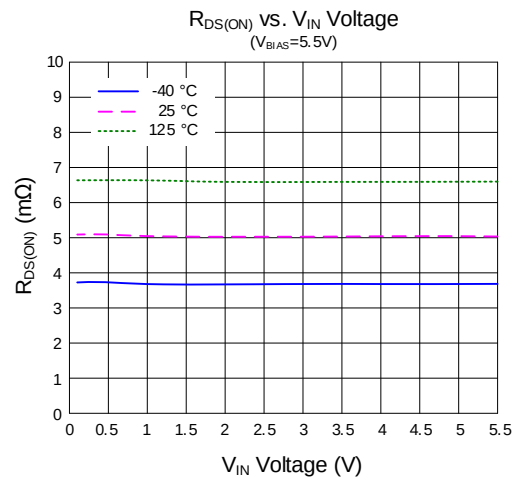


Figure 3. Soft Start Time

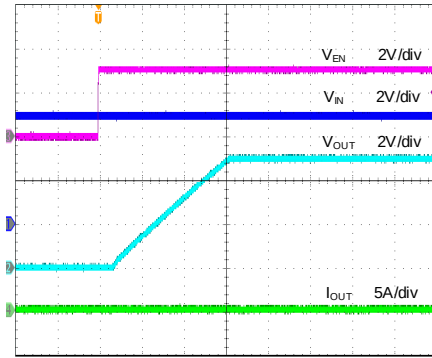
Typical Performance Characteristics





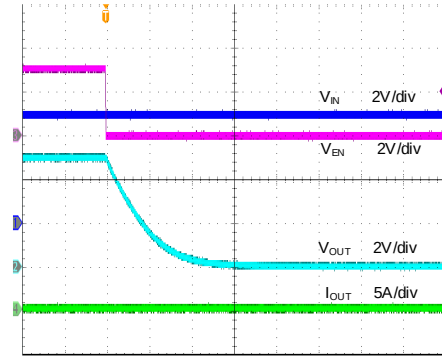
Typical Performance Characteristics

EN ON
($V_{BIAS}=V_N=5V$, $C_N=10\mu F$, $C_{OUT}=4.7\mu F$, CT Floating, Null load)



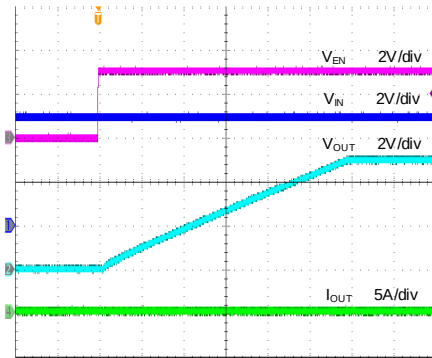
Time (100μs/div)

EN OFF
($V_{BIAS}=V_N=5V$, $C_N=10\mu F$, $C_{OUT}=4.7\mu F$, CT Floating, Null load)



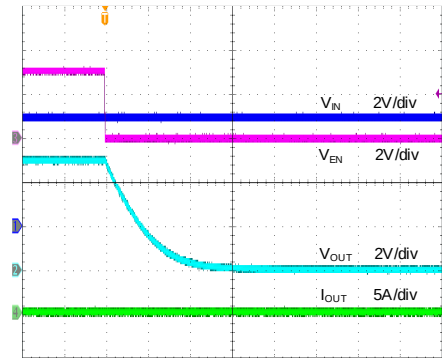
Time (400μs/div)

EN ON
($V_{BIAS}=V_N=5V$, $C_N=10\mu F$, $C_{OUT}=4.7\mu F$, CT High, Null load)



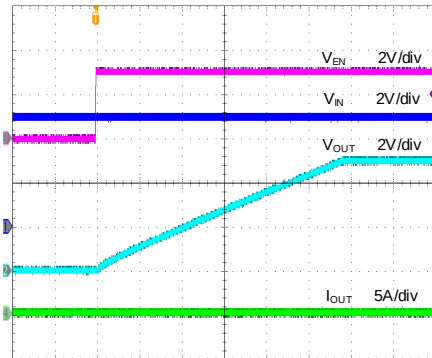
Time (400μs/div)

EN OFF
($V_{BIAS}=V_N=5V$, $C_N=10\mu F$, $C_{OUT}=4.7\mu F$, CT High, Null load)



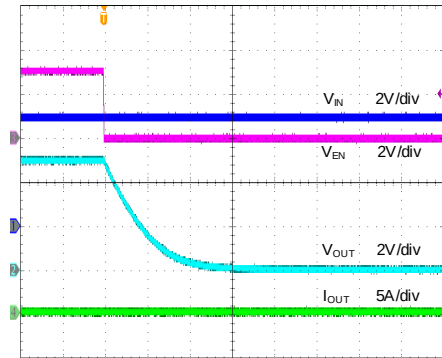
Time (400μs/div)

EN ON
($V_{BIAS}=V_N=5V$, $C_N=10\mu F$, $C_{OUT}=4.7\mu F$, CT Low, Null load)

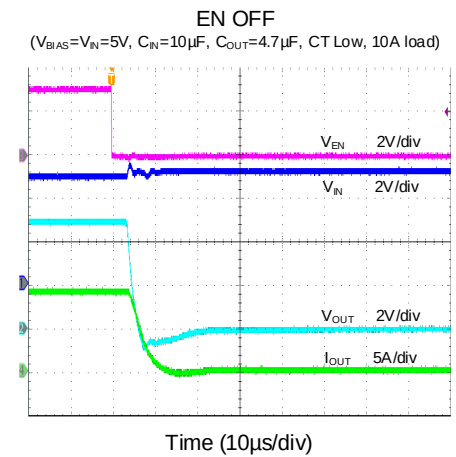
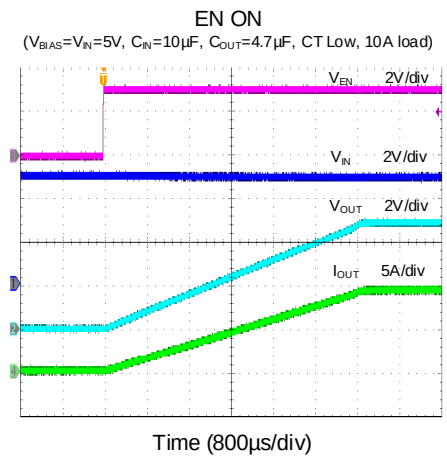
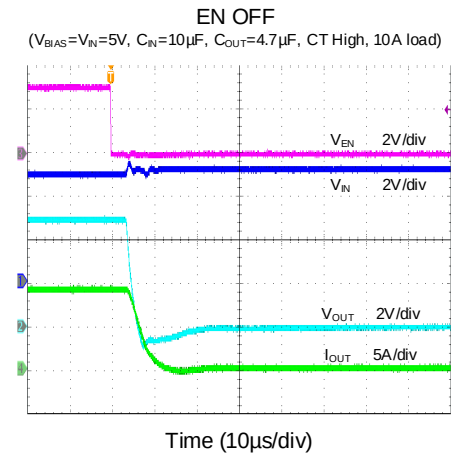
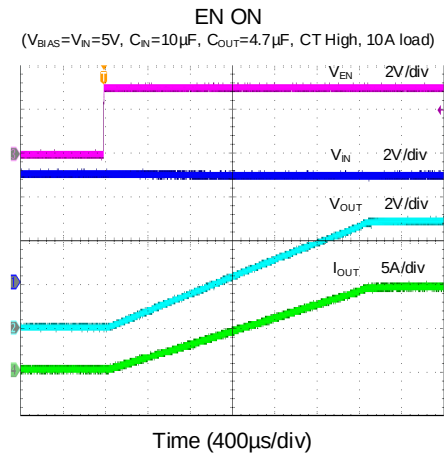
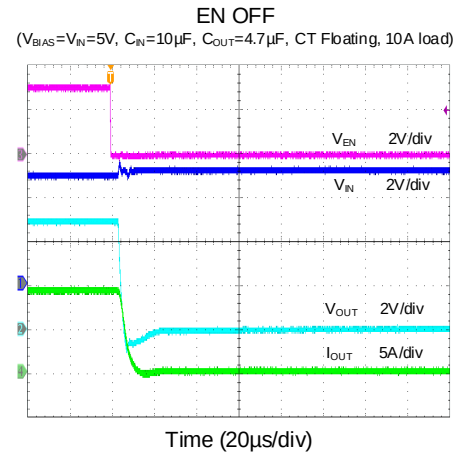
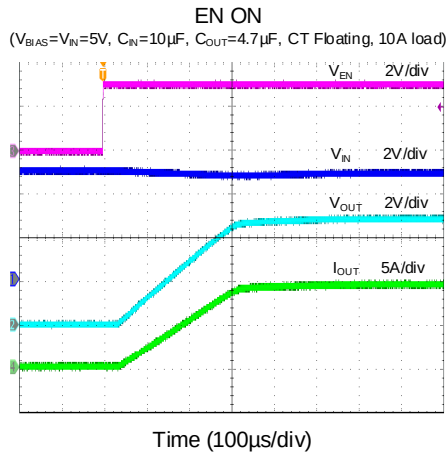


Time (800μs/div)

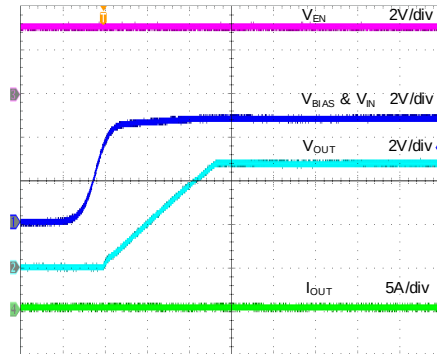
EN OFF
($V_{BIAS}=V_N=5V$, $C_N=10\mu F$, $C_{OUT}=4.7\mu F$, CT Low, Null load)



Time (400μs/div)

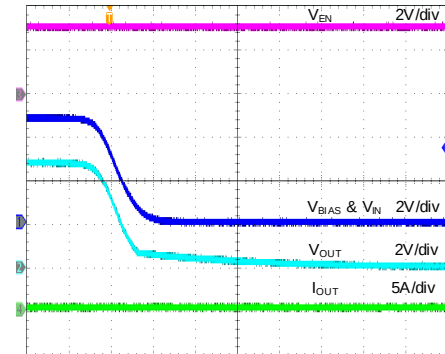


V_{BIAS} & V_{IN} ON
(V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Floating, Null load)



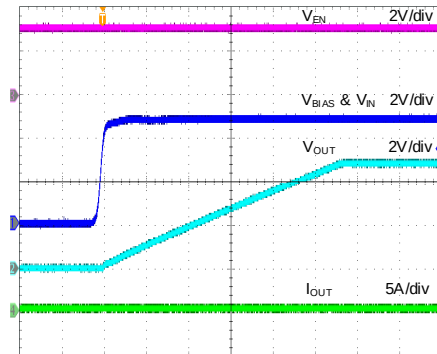
Time (100μs/div)

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



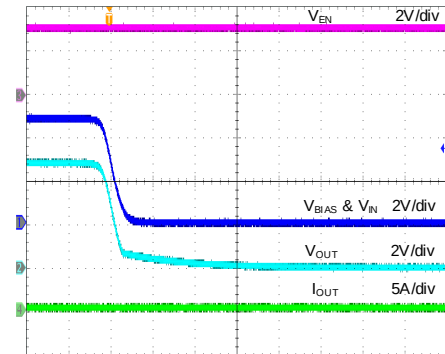
Time (100μs/div)

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



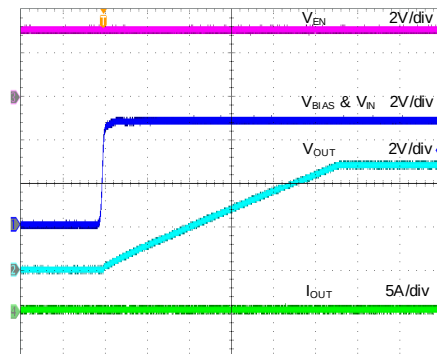
Time (400μs/div)

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



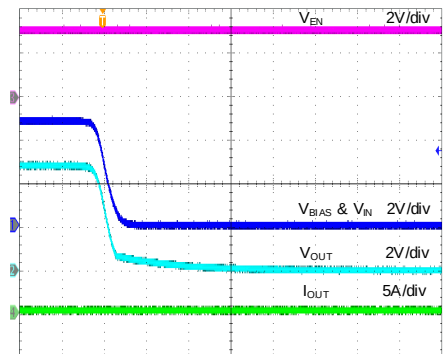
Time (200μs/div)

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



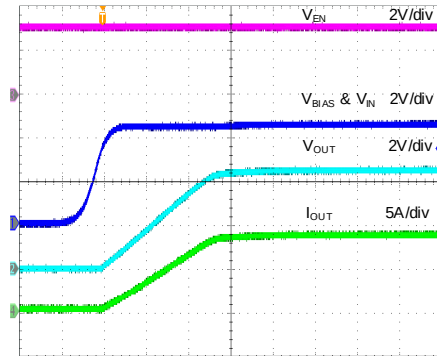
Time (800μs/div)

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



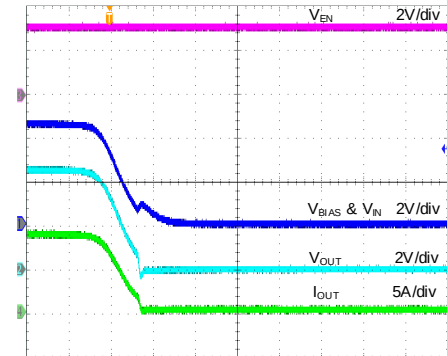
Time (200μs/div)

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



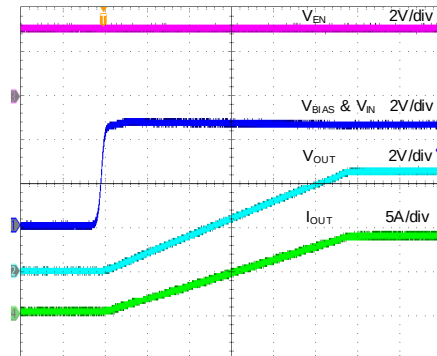
Time (100μs/div)

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



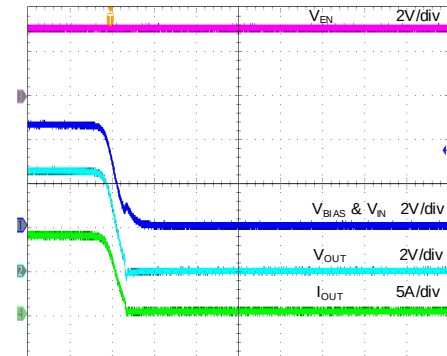
Time (100μs/div)

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



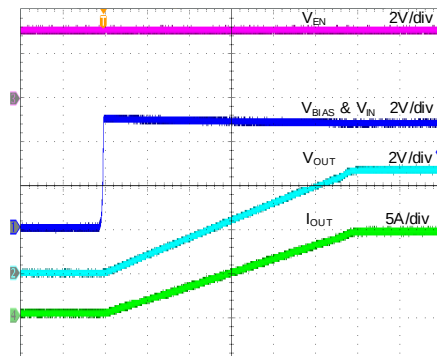
Time (400μs/div)

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



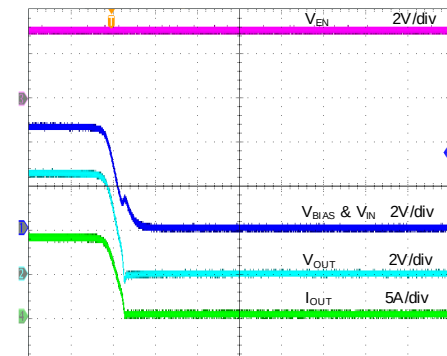
Time (200μs/div)

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



Time (800μs/div)

V_{BIAS} & V_{IN} OFF
(V_{BIAS}=V_{IN}=5V, C_N=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.

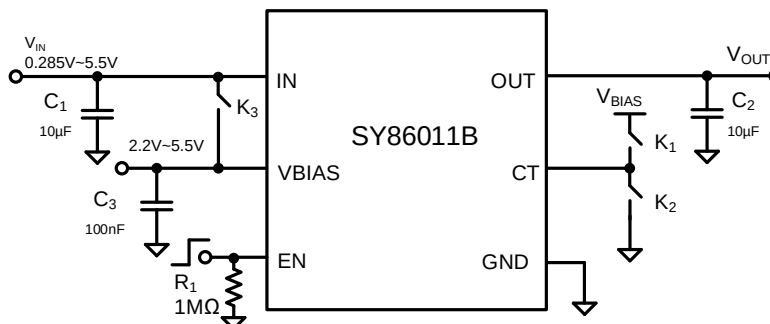
$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_{GND}$$

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
C1, C2	10µF/10V, ±10%, X5R, 0805	GRM21BR71A106K	Murata
C3	100nF/50V, ±10%, X7R, 0603	GRM188R61H104K	Murata
R1	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.

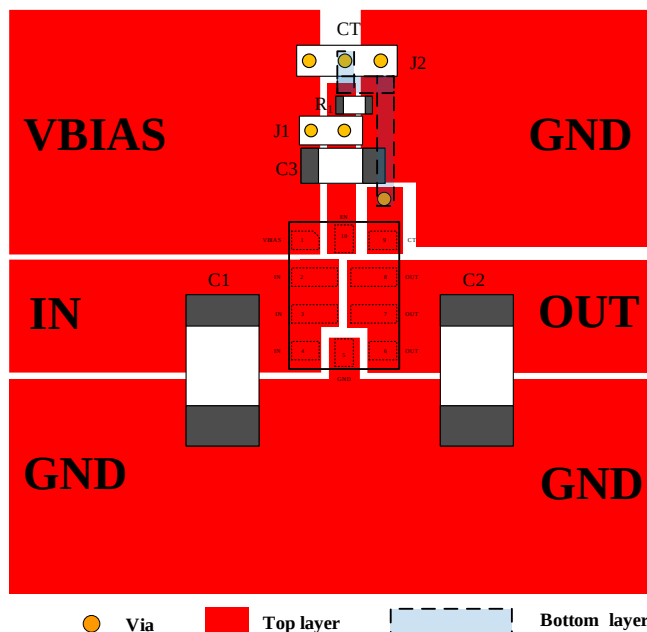
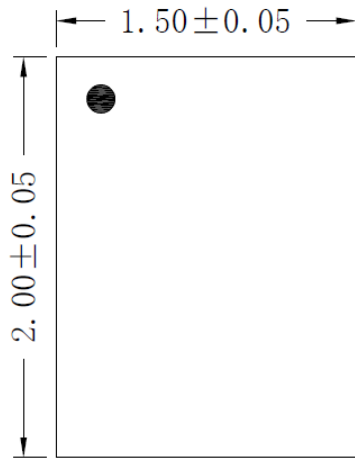
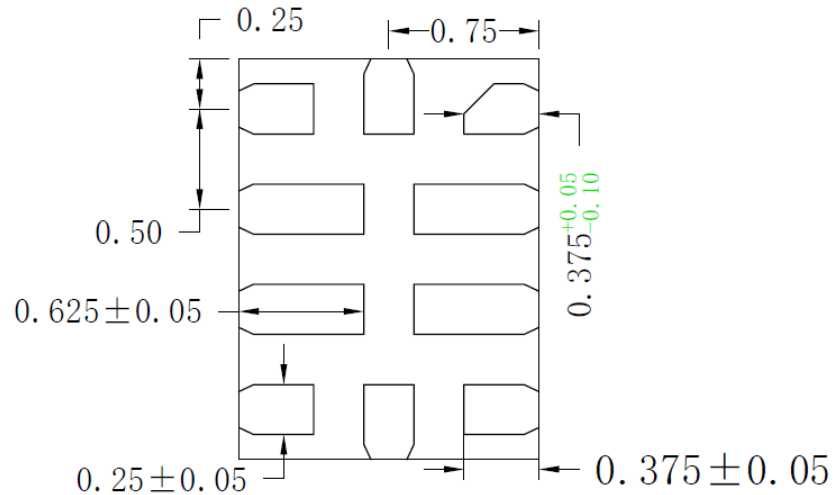


Figure 4. PCB Layout Suggestion

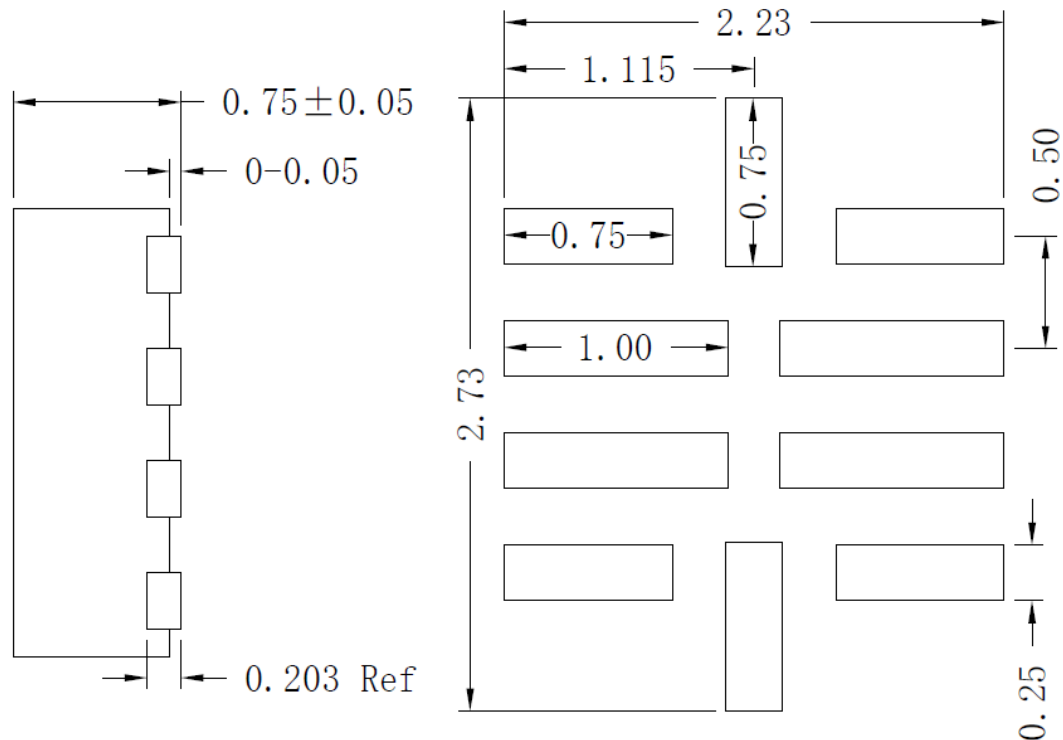
QFN1.5×2-10 Package Outline



Top View



Bottom View



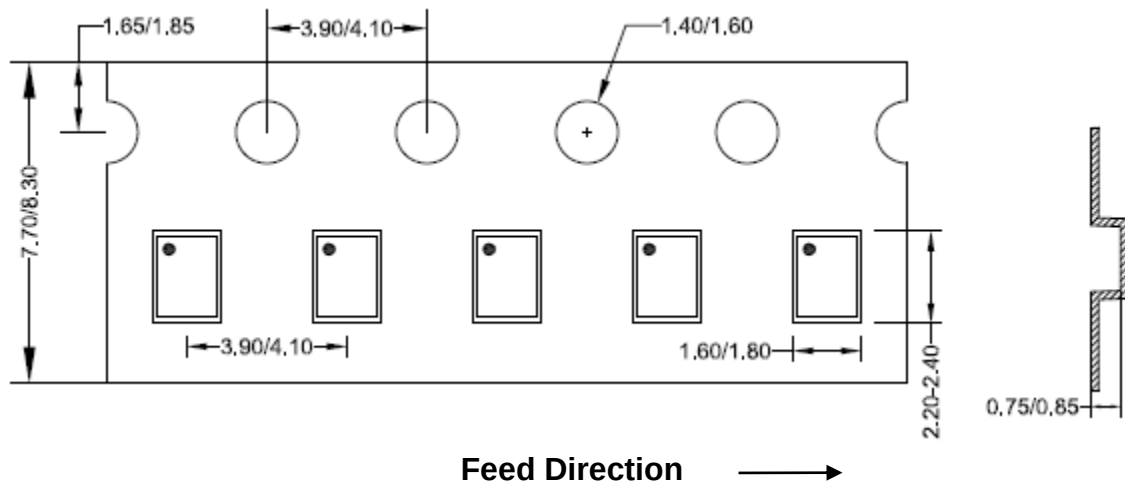
Side View

**Recommended PCB Layout
(Reference Only)**

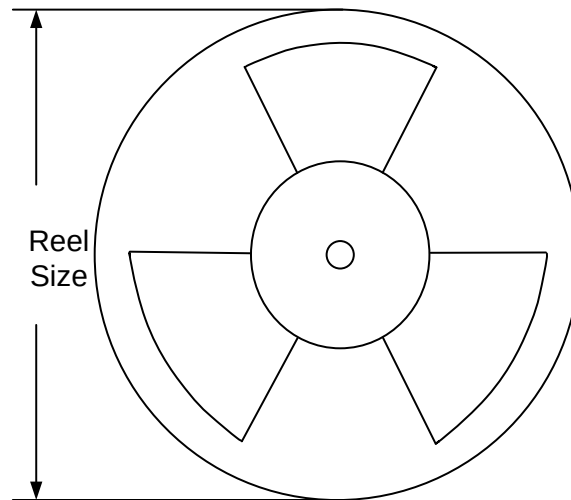
Note: All dimensions in millimeters and exclude mold flash & metal burr.

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

IMPORTANT NOTICE

1. **Right to make changes.** Silergy and its subsidiaries (hereafter Silergy) reserve the right to change any information published in this document, including but not limited to circuitry, specification and/or product design, manufacturing or descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products are sold subject to Silergy's standard terms and conditions of sale.
2. **Applications.** Application examples that are described herein for any of these products are for illustrative purposes only. Silergy makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification. Buyers are responsible for the design and operation of their applications and products using Silergy products. Silergy or its subsidiaries assume no liability for any application assistance or designs of customer products. It is customer's sole responsibility to determine whether the Silergy product is suitable and fit for the customer's applications and products planned. To minimize the risks associated with customer's products and applications, customer should provide adequate design and operating safeguards. Customer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Silergy assumes no liability related to any default, damage, costs or problem in the customer's applications or products, or the application or use by customer's third-party buyers. Customer will fully indemnify Silergy, its subsidiaries, and their representatives against any damages arising out of the use of any Silergy components in safety-critical applications. It is also buyers' sole responsibility to warrant and guarantee that any intellectual property rights of a third party are not infringed upon when integrating Silergy products into any application. Silergy assumes no responsibility for any said applications or for any use of any circuitry other than circuitry entirely embodied in a Silergy product.
3. **Limited warranty and liability.** Information furnished by Silergy in this document is believed to be accurate and reliable. However, Silergy makes no representation or warranty, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. In no event shall Silergy be liable for any indirect, incidental, punitive, special or consequential damages, including but not limited to lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges, whether or not such damages are based on tort or negligence, warranty, breach of contract or any other legal theory. Notwithstanding any damages that customer might incur for any reason whatsoever, Silergy' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Standard Terms and Conditions of Sale of Silergy.
4. **Suitability for use.** Customer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of Silergy components in its applications, notwithstanding any applications-related information or support that may be provided by Silergy. Silergy products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of a Silergy product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Silergy assumes no liability for inclusion and/or use of Silergy products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.
5. **Terms and conditions of commercial sale.** Silergy products are sold subject to the standard terms and conditions of commercial sale, as published at <http://www.silergy.com/stdterms>, unless otherwise agreed in a valid written individual agreement specifically agreed to in writing by an authorized officer of Silergy. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. Silergy hereby expressly objects to and denies the application of any customer's general terms and conditions with regard to the purchase of Silergy products by the customer.
6. **No offer to sell or license.** Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights. Silergy makes no representation or warranty that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right. Information published by Silergy regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from Silergy under the patents or other intellectual property of Silergy.

For more information, please visit: www.silergy.com

©2024 Silergy Corp.

All Rights Reserved.