



SILERGY

SY86011B

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

General Description

The SY86011B is a 5.3m Ω , single-channel load switch with an N-channel MOSFET that can operate over an input voltage range from 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 power loss from the load switch.

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 SY86011B has an optional 50 Ω discharge resistor for quick discharge of the output when switch is disabled to avoid any unknown state caused by floating supply to the downstream load.

The SY86011B is available in a small, space-saving QFN1.5 \times 2 package. The device is characterized for operation over the free-air temperature range of -40 $^{\circ}$ C to +105 $^{\circ}$ 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
 - $R_{ON} = 5.3m\Omega$ (typical) at $V_{IN}=5V$ ($V_{BIAS}=5V$)
 - $R_{ON} = 5.3m\Omega$ (typical) at $V_{IN}=3.3V$ ($V_{BIAS}=3.3V$)
- 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 PC
- SSDs
- Servers
- Telecom Systems

Typical Application

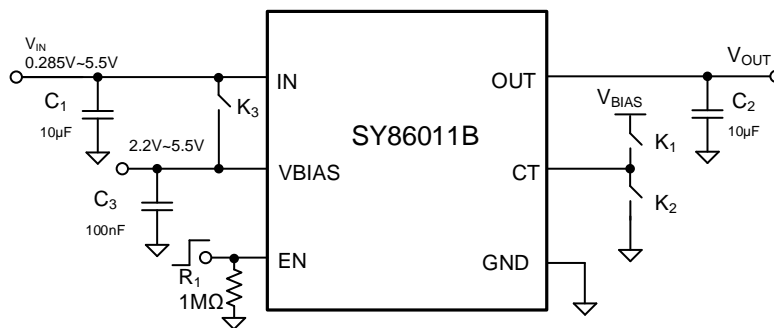


Figure 1. Schematic Diagram

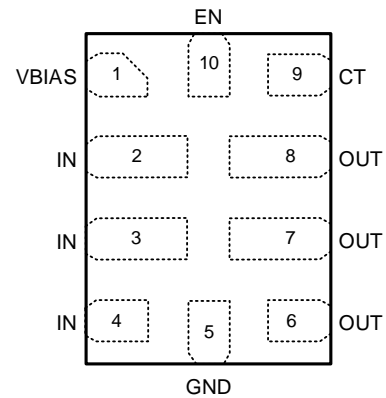
Ordering Information

Ordering Part Number	Package Type	Top Mark
SY86011BWPQ	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 at least a 10μF ceramic capacitor.
GND	5	Ground pin.
OUT	6,7,8	Switch output. Decouple this pin to GND with at least a 10μF ceramic capacitor.
CT	9	Soft start programmable pin, Tri-state Selection for Soft start time without external capacitor. The pull-high and pull-low resistor should be less than 50kΩ.
EN	10	Enable interface pin. Active high switch control input. Do not leave it floating.

Block Diagram

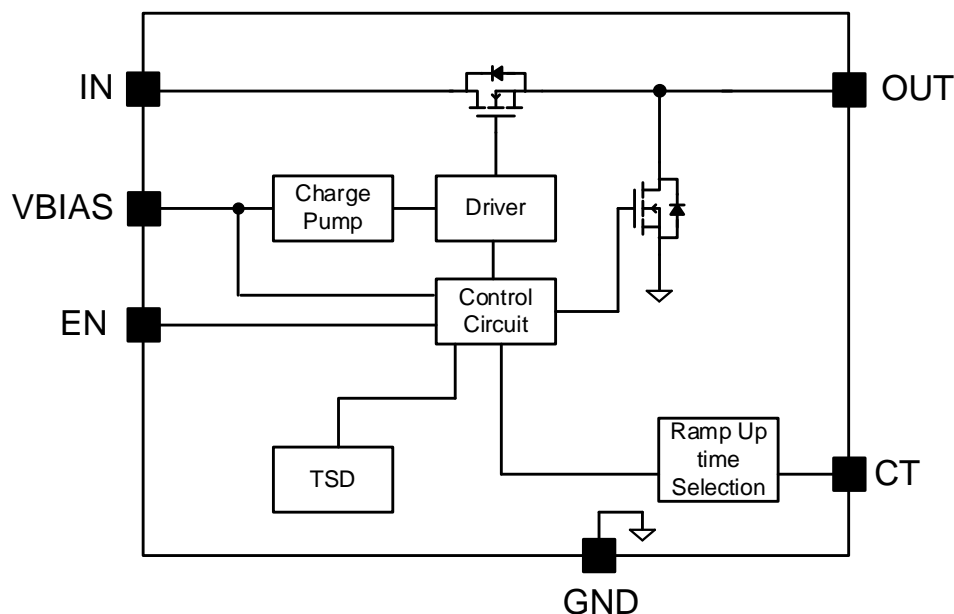


Figure2. Block Diagram



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 specification in the following table applies over the operating ambient temp - 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
Integrate FET RON	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 _{D_{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
V _{OUT} 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 low	0.8	1	1.2	V/ms
V _{OUT} 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 simulated in the 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 ≅ 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

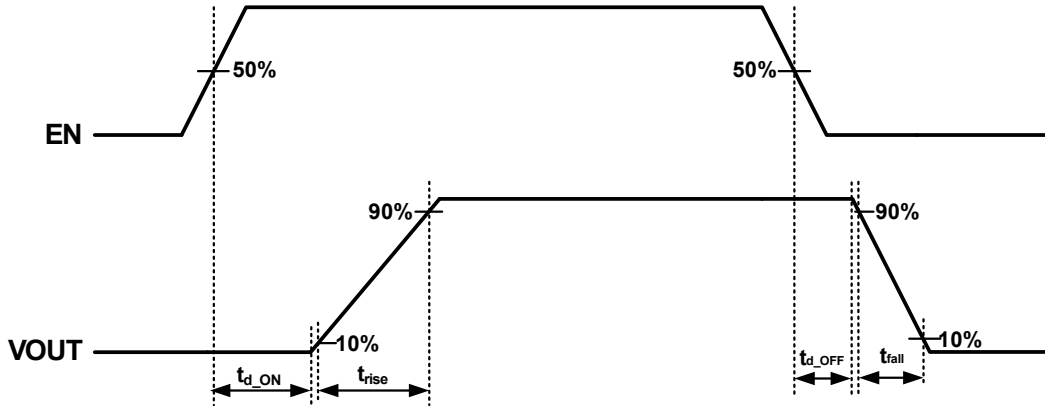
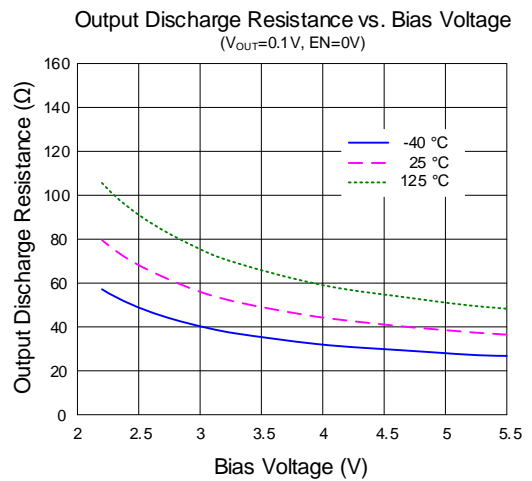
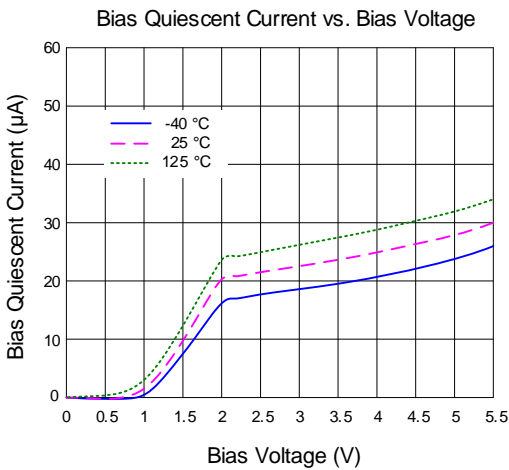
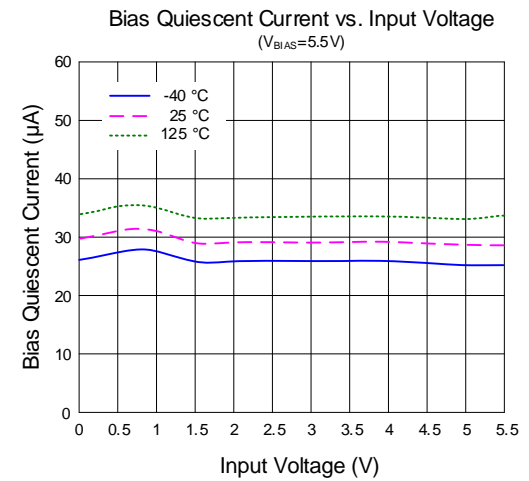
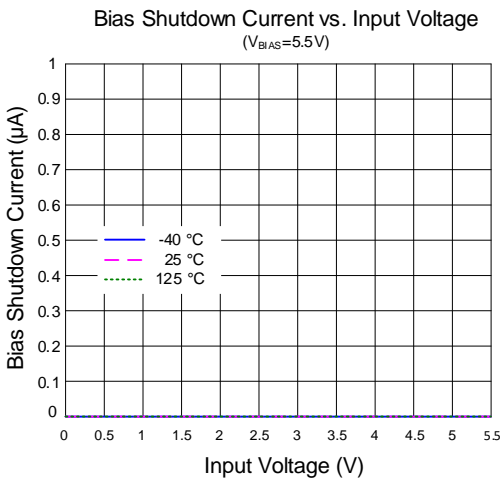
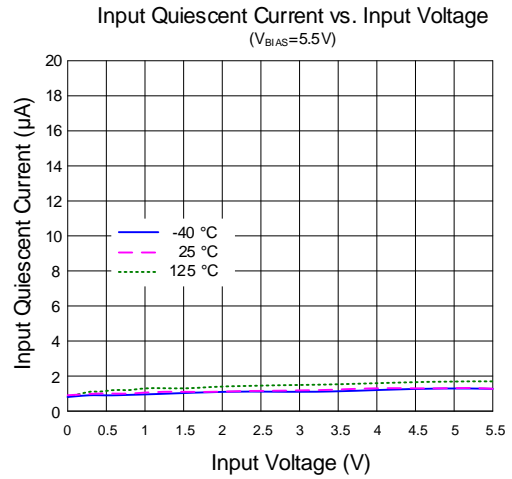
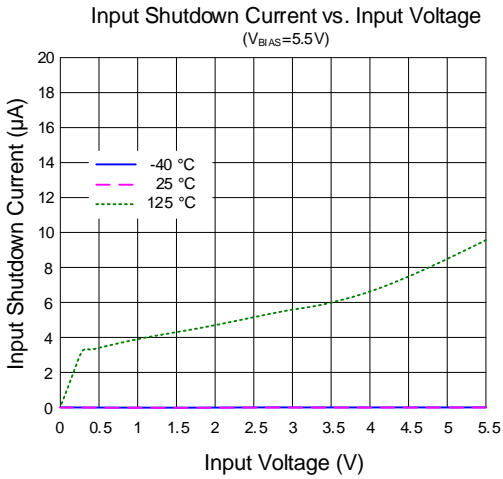
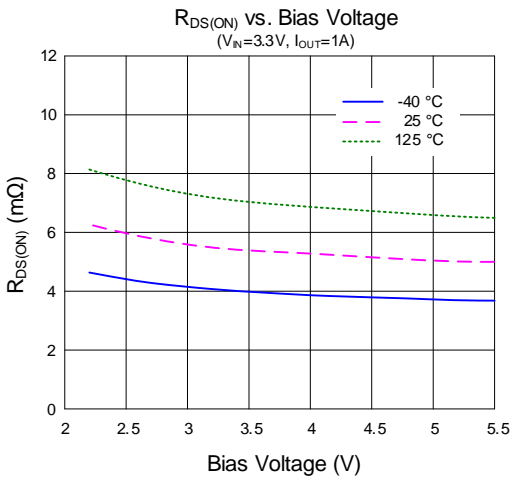
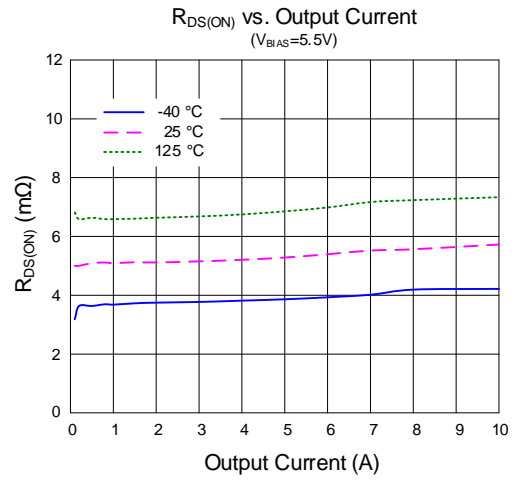
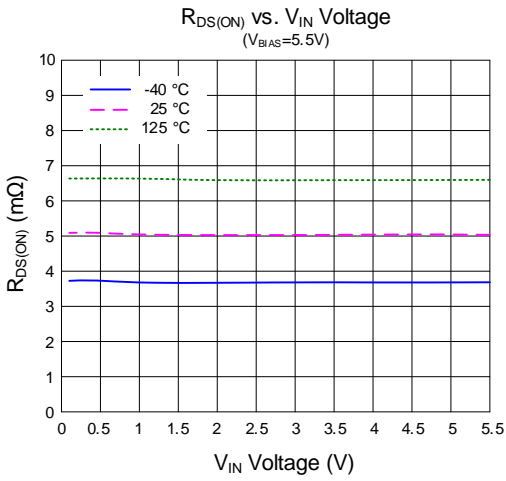


Figure 3. Soft Start Time

Typical Performance Characteristics

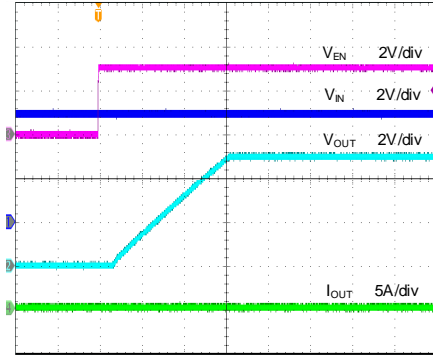






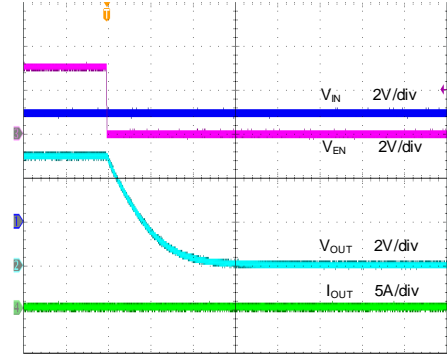
Typical Performance Characteristics

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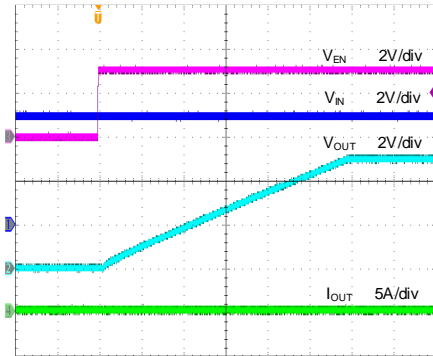
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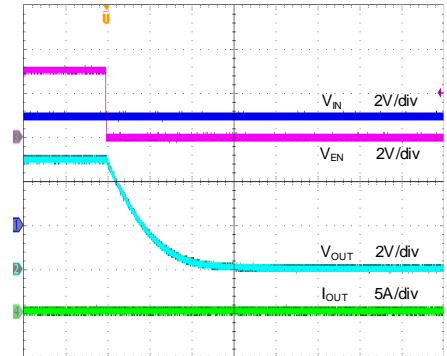
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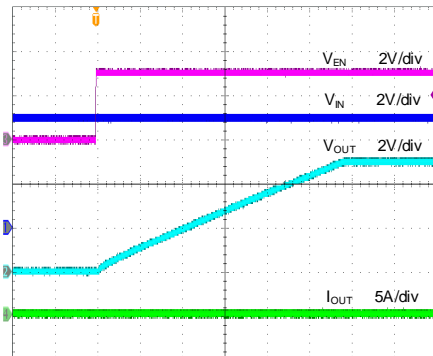
Time (400µs/div)

EN OFF
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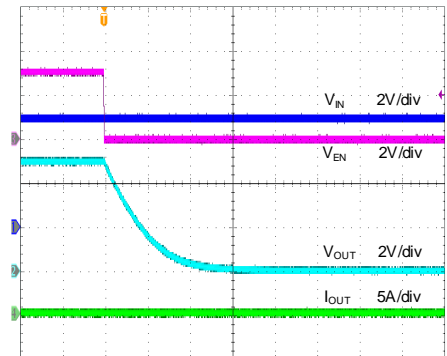
Time (400µs/div)

EN ON
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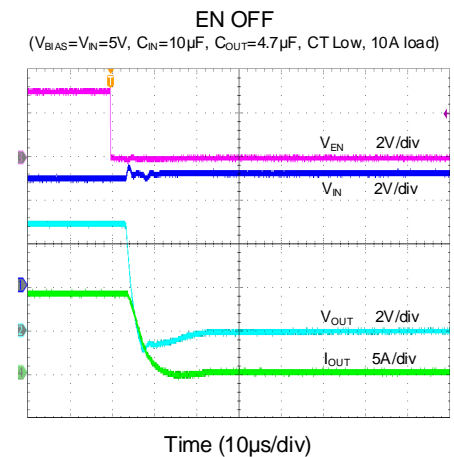
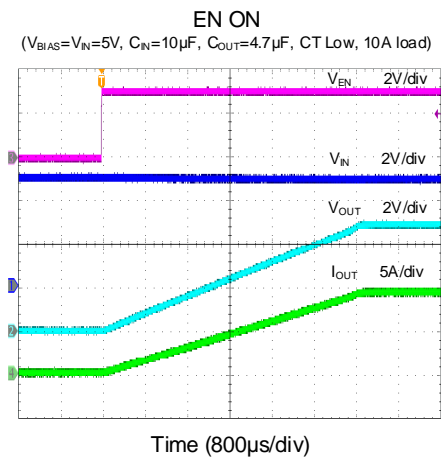
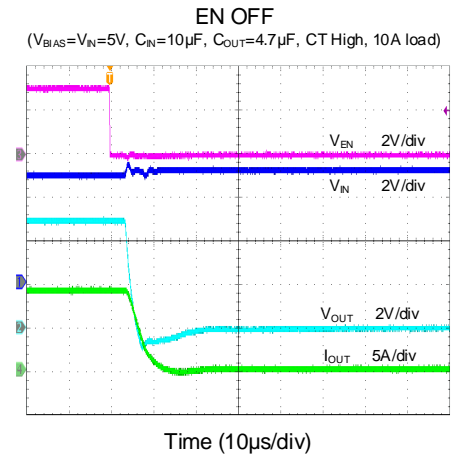
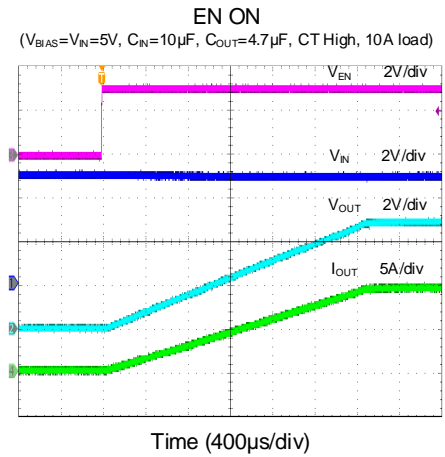
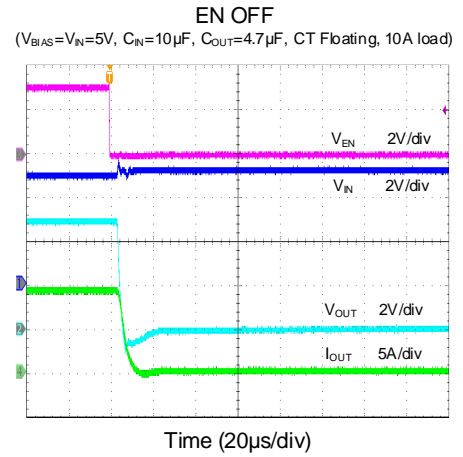
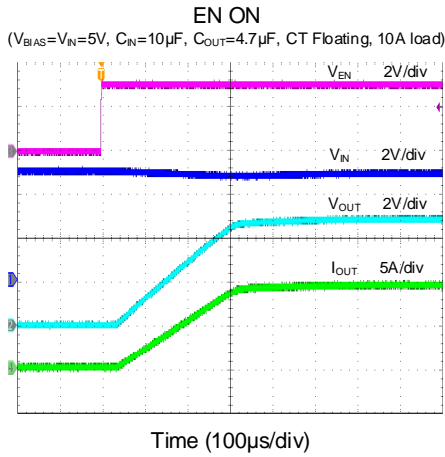


Time (800µs/div)

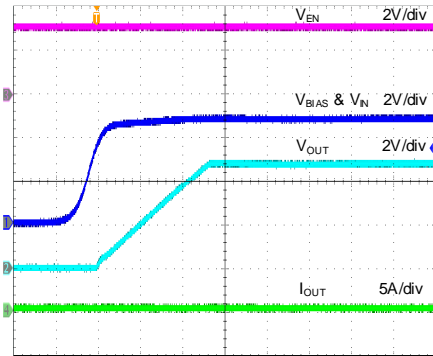
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Time (400µs/div)

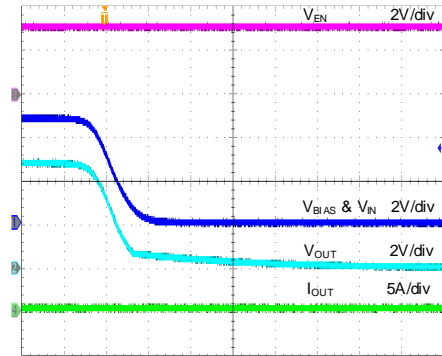


V_{BIAS} & V_{IN} ON
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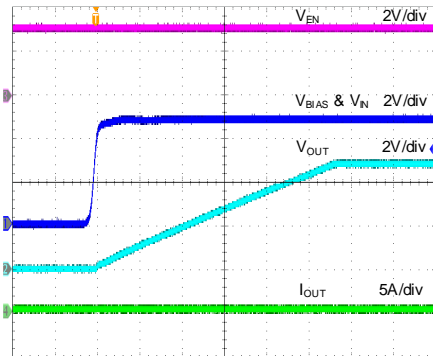
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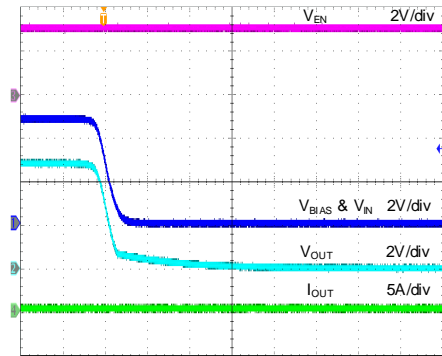
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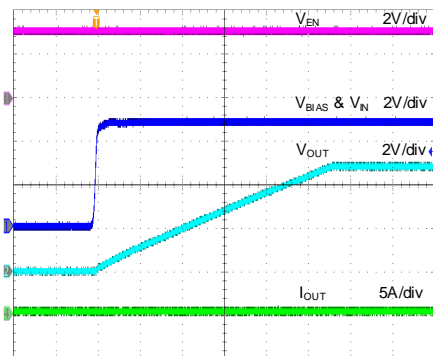
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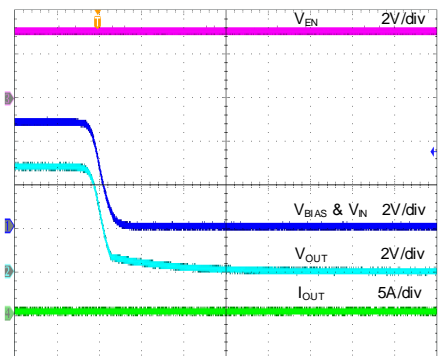
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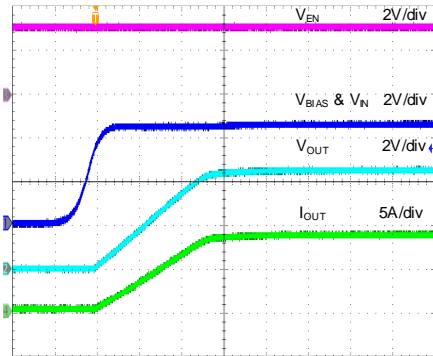
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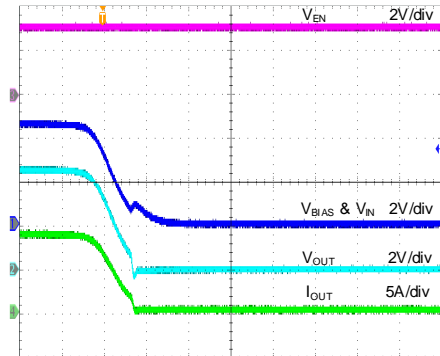
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V_{BIAS} & V_{IN} ON
 (V_{BIAS}=V_{IN}=5V, C_{IN}=10μF, C_{OUT}=4.7μF, CT Floating, 10A load)



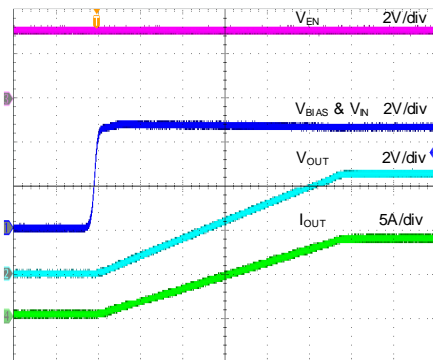
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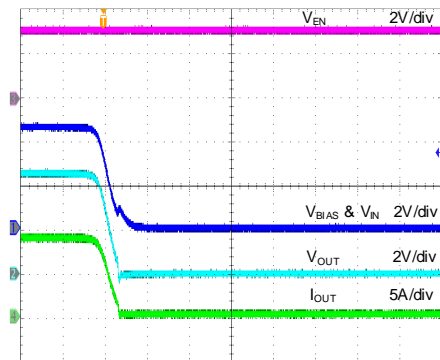
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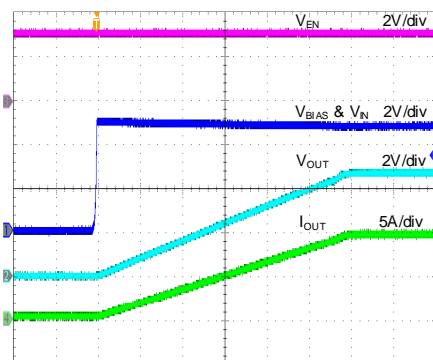
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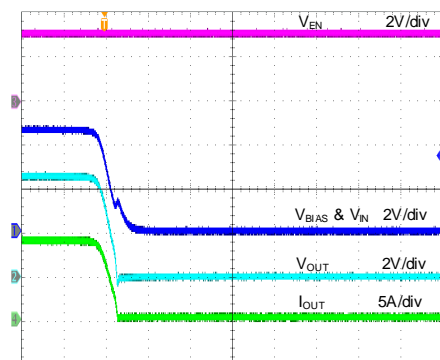
Time (200μs/div)

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 SY86011B is a 5.3mΩ, single-channel load switch with an N-channel MOSFET that can operate over an input voltage range from 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 power loss from the load switch.

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

Applications 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 for reducing the voltage drop experienced as the switch is turned on into large capacitive load. To minimize the potential noise problem, C_{IN} should be placed really close to the IN and GND pins.

Output Capacitor C_{OUT}:

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 value of C_{OUT} can be used for further reducing the voltage drop during high current application.

Output Discharge:

The SY86011B integrate a 50Ω pull down resistor for quick output discharge. The resistor is activated when the switch is turned off.

Soft Start Function:

The SY86011B has controlled rise time for inrush current control. Tri-state Selection for soft-start time without external capacitor. The pull-high and pull-low resistor should be less than 50kΩ.

Thermal Considerations:

The SY86011B can deliver a current of up to 10A over the full operating temperature range. However, the maximum output current must be derated at higher ambient temperature. With 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 regulator.

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

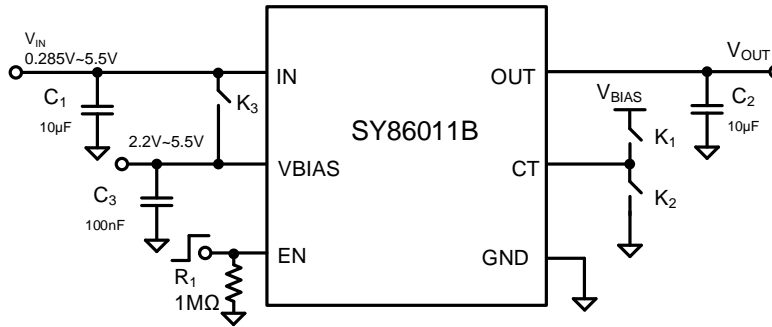
The final operating junction temperature for any set of condition can be estimated by the following thermal equation:

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

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



Schematic



BOM List

Reference Designator	Description	Part Number	Manufacturer
C ₁ , C ₂	10µF/10V, ±10%, X5R, 0805	GRM21BR71A106K	Murata
C ₃	100nF/50V, ±10%, X7R, 0603	GRM188R61H104K	Murata
R ₁	1MΩ, 1%, 0.1W, 0603	RC0603FR-071ML	YAGEO

PCB Layout Guide

For the best performance of the SY86011B, the following guidelines must be strictly followed:

- 1) Keep all Power traces (VIN / OUT / BIAS/ GND) as short and wide as possible and use at least 2-ounce copper for all Power traces.
- 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 closed to the SY86011B and connected to ground plane to reduce noise coupling.

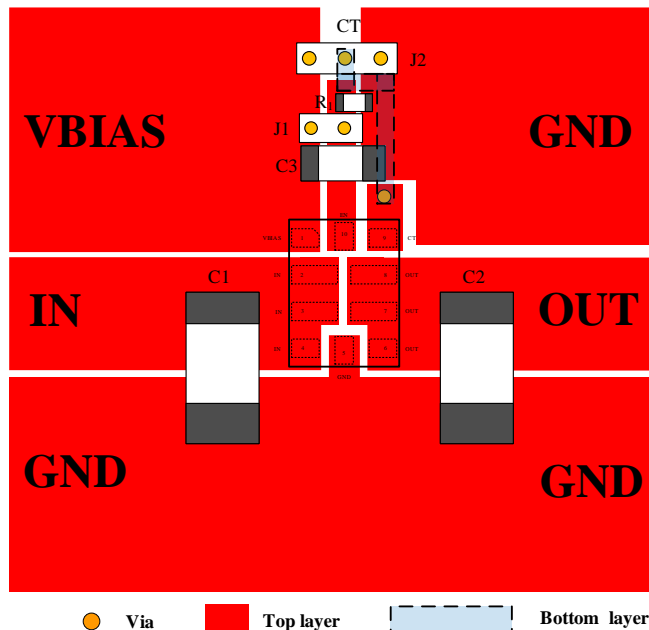
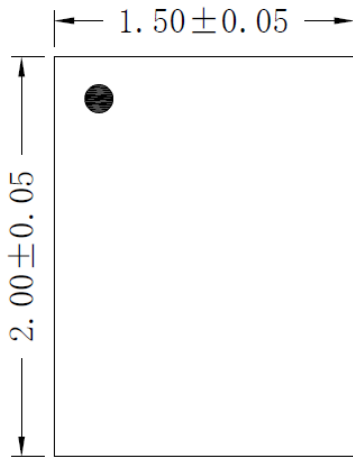
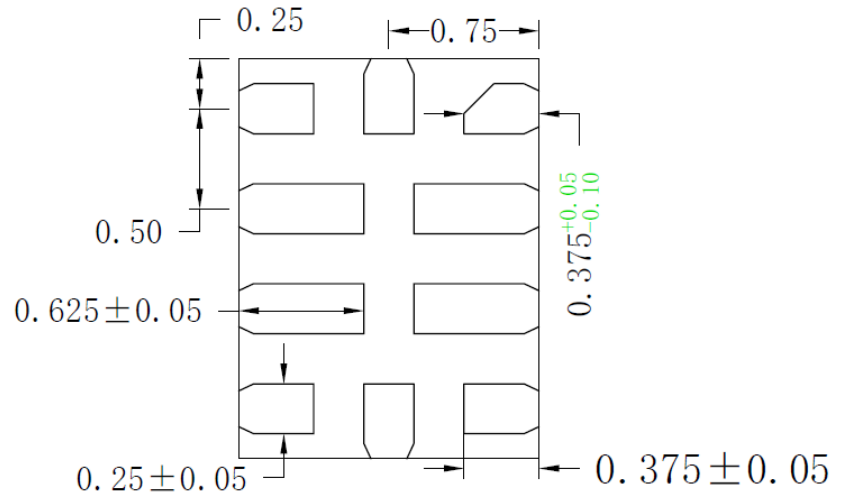


Figure4. PCB Layout Suggestion

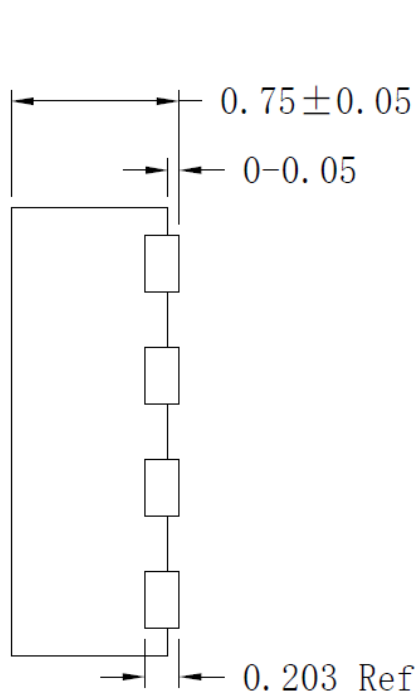
QFN1.5x2-10 Package Outline



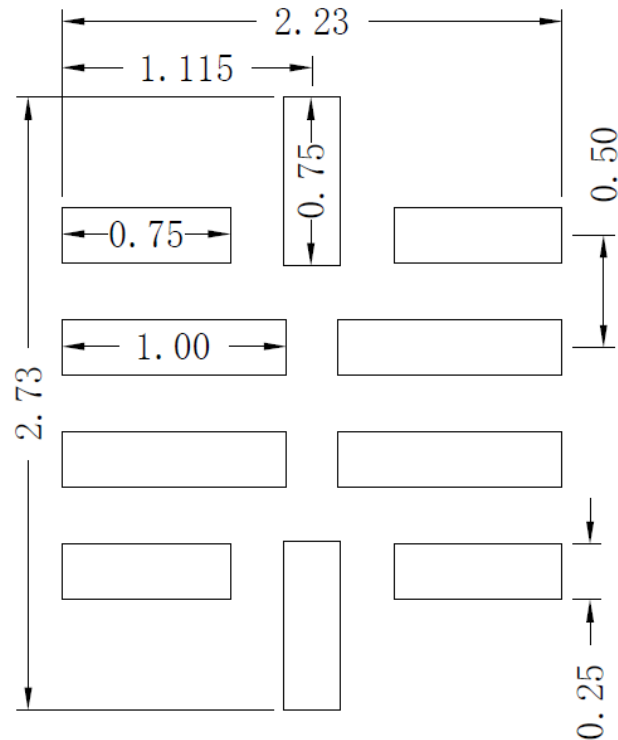
Top View



Bottom View



Side View

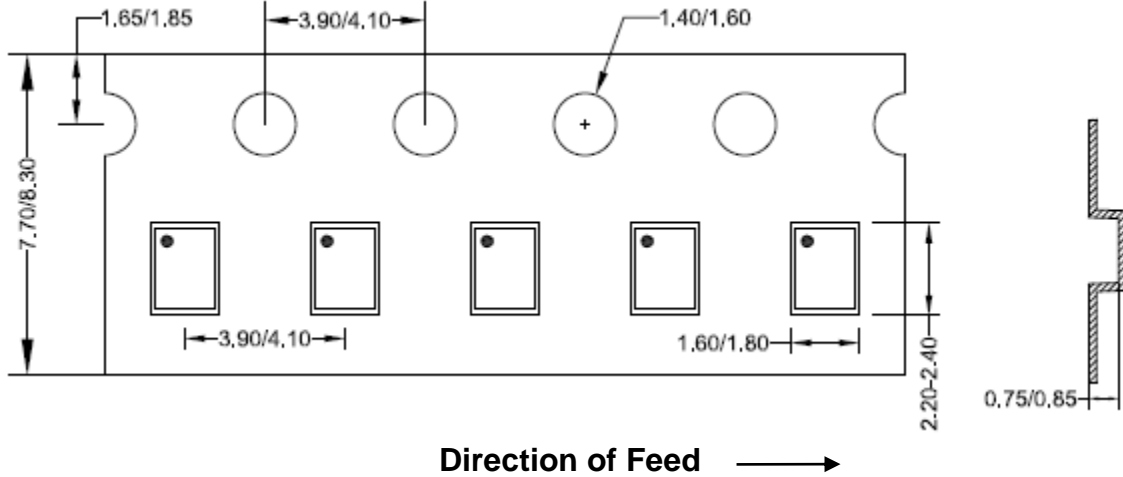


**Recommended PCB Layout
(Reference only)**

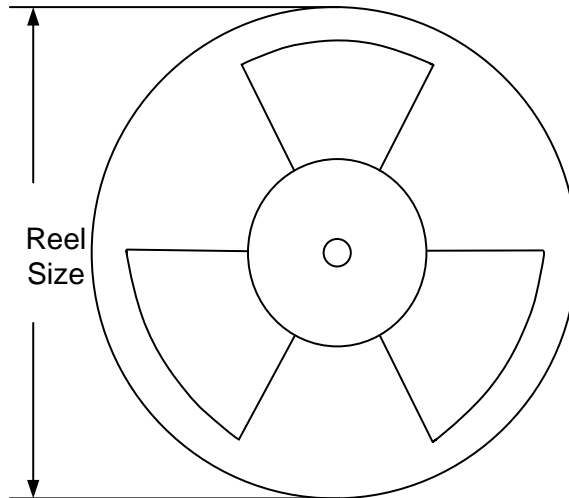
Notes: All dimension in millimeter and exclude mold flash & metal burr.

Tape and Reel Information

1. Tape dimensions and Pin1 orientation



2. Reel dimensions



Package types	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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