SC33021

2A Load Switch with Reverse Current Blocking

POWER MANAGEMENT

Features

- Input Voltage Range – 1.6V to 5.5V
- 2A Continuous Output Current
- Ultra Low Ron – 32mΩ
- Reverse Current Blocking
- Automatic Output Discharge
- Low Quiescent Current – 0.8µA
- Low Shutdown Current – 0.3µA
- Internal Soft Start
- Hardened ESD Protection 5kV
- Package: CSP – 0.9mm x 0.9mm 4–Bump

Applications

- Wearable Electronics
- Tablet PCs, eReaders
- Smartphones
- Notebook PCs, Ultrabooks
- Battery Powered Equipment
- Other Portable Devices

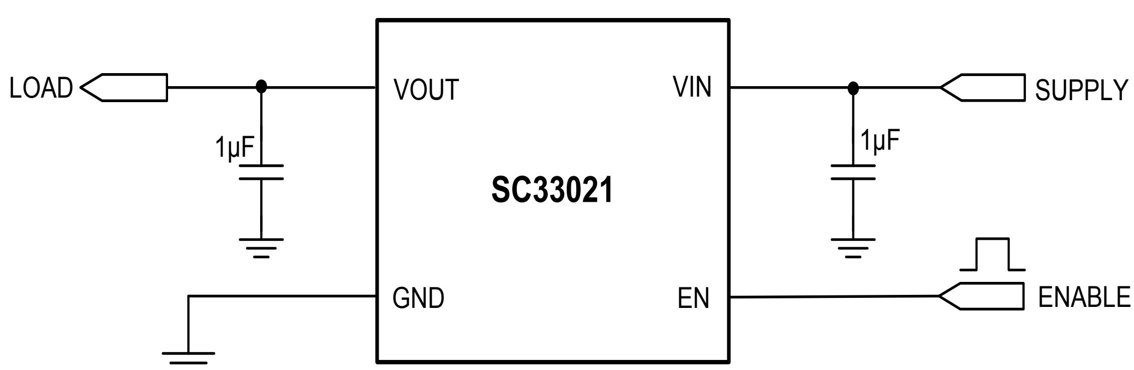
Description

The SC33021 is an integrated 2A Load Switch with reverse current blocking. It operates from a 1.6V to 5.5V input supply. The SC33021 includes an automatic output discharge.

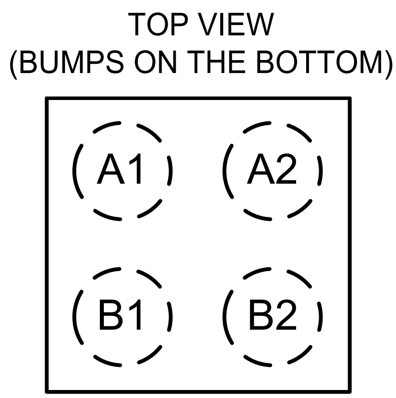
The device provides extremely low 32mΩ ON resistance (R_{ON}) in an ultra-small package. The reverse blocking feature prevents current from flowing in reverse direction from the output through the device to the input supply rail. Whenever VOUT to VIN voltage exceeds the reverse blocking threshold, reverse blocking is activated regardless of the IC enable state (either ON or OFF).

The SC33021 is offered in a tiny 0.9mm x 0.9mm x 0.6mm, 4 Bump CSP package.

Typical Application Circuit



Pin Configuration



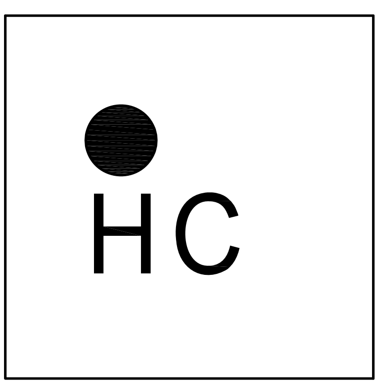
CSP 0.9mm x 0.9mm, 4 Bump

Ordering Information

Device	Package
SC33021CSTRT	CSP 0.9mm x 0.9mm 4-bump
SC33021CSEVB	Evaluation Board

Notes:
(1) Available in tape and reel only. A reel contains 5,000 devices.
(2) Lead-free package only. Device is WEEE and RoHS compliant, and halogen free.

Marking Information



Marking for the 0.9mm x 0.9 mm CSP 4 Lead Package :

O = Pin 1 ID

nn = Part No. Code (Example: HC) - Reference Part No.

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Absolute Maximum Ratings

V_{VIN} to GND (V) . . . . -0.3 to +6.0
V_{EN} to GND (V) . . . . -0.3 to +6.0
V_{VOUT} to GND (V). . . . . -0.3 to (V_{VIN}+0.3)
ESD Protection Level HBM [1] (kV). 5

Recommended Operating Conditions

Maxiumum Output Current (A) 2
V_{VIN} (V). . . . . 1.6 to 5.5

Thermal Information

Thermal Resistance, Junction to Ambient[2] (°C/W) . . . 140
Maximum Junction Temperature (°C) . . . . +125
Storage Temperature Range (°C). . . . . -65 to +150
Peak IR Reflow Temperature (10s to 30s) (°C) . . . . +260

Exceeding the above specifications may result in permanent damage to the device or device malfunction. Operation outside of the parameters specified in the Electrical Characteristics section is not recommended.

NOTES:
(1) Tested according to JEDEC standard JS-001-2012.
(2) Calculated from package in still air, mounted to 3 x 4.5 (in), 4 layer FR4 PCB with thermal vias under the exposed pad per JESD51 standards.

Electrical Characteristics

Unless noted otherwise, T_A = 25°C for typical, -40°C ≤ T_A ≤ +85°C for min and max, V_{VIN} = 2.8V, C_{VIN} = 1µF, C_{VOUT} = 1µF, V_{EN} = V_{VIN}.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Under Voltage Lockout	V_{UVLO}	V_{VIN} increasing, V_{EN}=2V, I_{VOUT}=100mA			1.2	V
		V_{VIN} decreasing, V_{EN}=2V, R_L=10Ω	0.5			V
Ron	R_{ON}	V_{VIN}=5.5V, I_{VOUT} = 200mA, V_{EN} =1.5V		25	41	mΩ
		V_{VIN}=4.3V, I_{VOUT} = 200mA, V_{EN} =1.5V		28	46	
		V_{VIN}=3.3V, I_{VOUT} = 200mA, V_{EN} =1.5V		32	53	
		V_{VIN}=2.5V, I_{VOUT} = 200mA, V_{EN} =1.5V		40	64	
		V_{VIN}=1.6V, I_{VOUT} = 200mA, V_{EN} =1.5V		65	100	
Shutdown Current	I_{SD}	V_{VIN}=5.5V, V_{EN}=0V, V_{VOUT} = open		0.7	11	µA
		V_{VIN}=3.3V, V_{EN}=0V, V_{VOUT} = open		0.4	11	
		V_{VIN}=2.8V, V_{EN}=0V, V_{VOUT} = open		0.3	10	
		V_{VIN}=1.6V, V_{EN}=0V, V_{VOUT} = open		0.1	5	
Quiescent Current[1]	I_Q	V_{VIN}=V_{EN}=5.5V, V_{VOUT} = open		1.6	7	µA
		V_{VIN}=V_{EN}=3.3V, V_{VOUT} = open		0.9	3	
		V_{VIN}=V_{EN}=2.8V, V_{VOUT} = open		0.8	3	
		V_{VIN}=V_{EN}=1.6V, V_{VOUT} = open		0.4	1.2	

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Electrical Characteristics (continued)

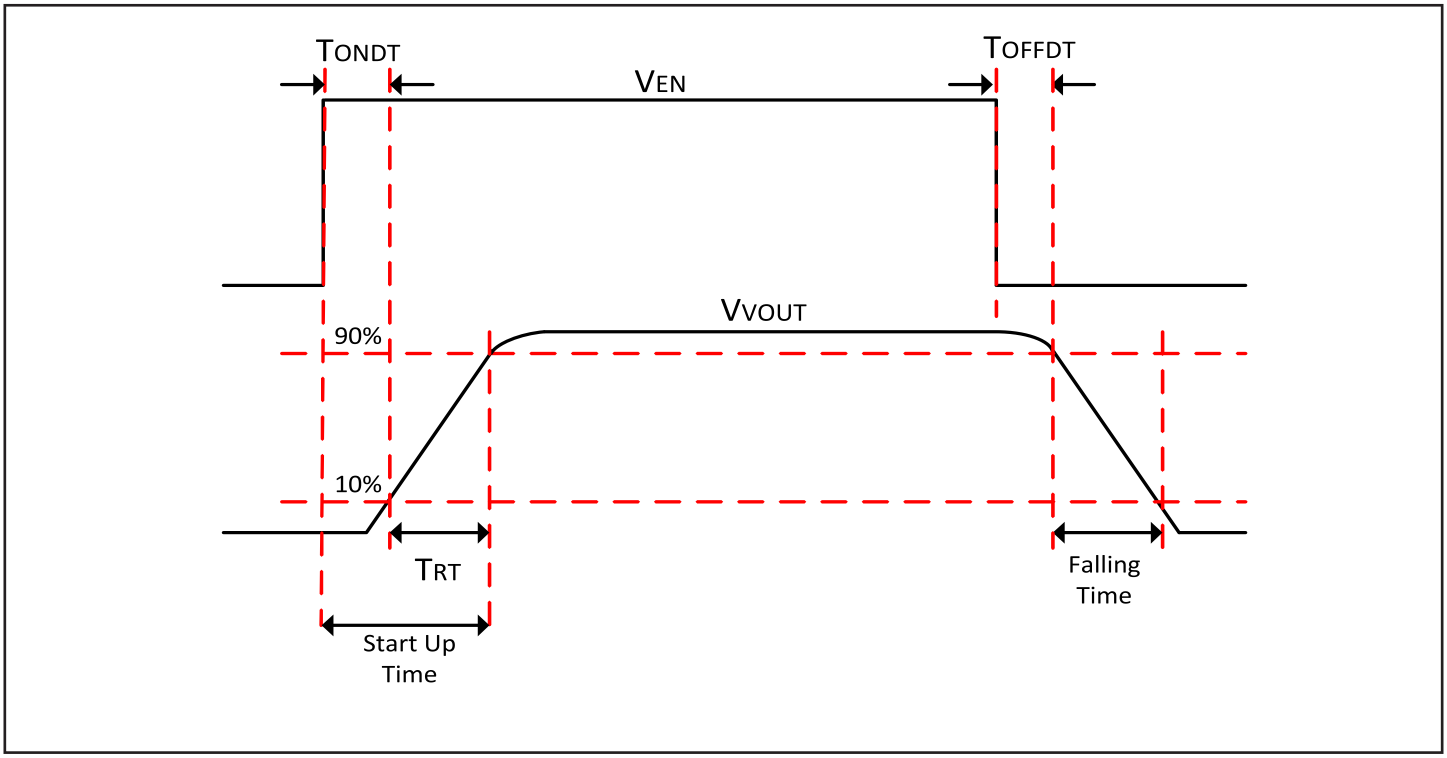
Parameter	Symbol	Conditions	Min	Typ	Max	Units
Leakage Current	I_{LK}	V_{VOUT} =0V, V_{VIN}=5.5V, V_{EN}=0V		1	11	µA
		V_{VOUT} =0V, V_{VIN}=3.6V, V_{EN}=0V		0.3	4.5	µA
		V_{VOUT} =0V, V_{VIN}=1.6V, V_{EN}=0V		0.1	3	µA
VIN = 5.5V, T_A = 25°C						
Turn-on Delay Time	T_{ONDT}	V_{EN}=1.5V, R_L=27.5Ω, C_{VOUT}=1µF		275		µs
Turn-off Delay Time	T_{OFFDT}	V_{EN}=1.5V, R_L=27.5Ω, C_{VOUT}=1µF		9		
Rising Time	T_{RT}	V_{EN}=1.5V, R_L=27.5Ω, C_{VOUT}=1µF		502		
VIN = 3.6V, T_A = 25°C						
Turn-on Delay Time	T_{ONDT}	V_{EN}=1.5V, R_L=18Ω, C_{VOUT}=1µF		440		µs
Turn-off Delay Time	T_{OFFDT}	V_{EN}=1.5V, R_L=18Ω, C_{VOUT}=1µF		10		
Rising Time	T_{RT}	V_{EN}=1.5V, R_L=18Ω, C_{VOUT}=1µF		640		
VIN = 1.6V, T_A = 25°C						
Turn-on Delay Time	T_{ONDT}	V_{EN}=1.5V, R_L=8Ω, C_{VOUT}=1µF		1221		µs
Turn-off Delay Time	T_{OFFDT}	V_{EN}=1.5V, R_L=8Ω, C_{VOUT}=1µF		27		
Rising Time	T_{RT}	V_{EN}=1.5V, R_L=8Ω, C_{VOUT}=1µF		1492		
Reverse Blocking						
Reverse Blocking Current	I_{RCENL}	V_{EN}=0V, V_{VIN}=0V, V_{VOUT}=5.5V		3	13	µA
Reverse Blocking Threshold	V_{RBT}	V_{VOUT}=2.8V, V_{VOUT} – V_{VIN}		40		mV
Reverse Blocking Hysteresis	V_{RBH}	V_{VOUT}=2.8V		18		mV
Reverse Current Response Delay	T_{RCRD}	V_{VIN}=5V		41		µs
EN Digital Input						
EN Input High Threshold	V_{EN-IH}		1.0			V
EN Input Low Threshold	V_{EN-IL}				0.4	V
EN Input Pull-Down Resistance	R_{EN}			7		MΩ
Output Discharge						
Output Pull-Down Resistance	R_{PD}			95		Ω

NOTES:
(1) I_Q current includes EN pull-down current.

Pin Descriptions

SC33021 Pin#	Pin Name	Pin Function
A1	VOUT	Output voltage.
B1	GND	Ground.
A2	VIN	Input supply voltage.
B2	EN	Enable input. A 7MΩ internal resistor is connected from this pin to GND. Drive HIGH to turn on the switch; drive LOW to turn off the switch. When the EN pin is floated, the switch is OFF.

Timing Diagram



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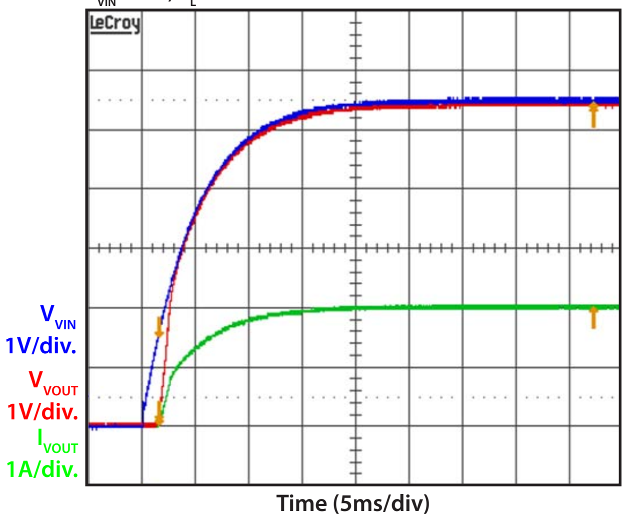
Typical Characteristics (SC33021)

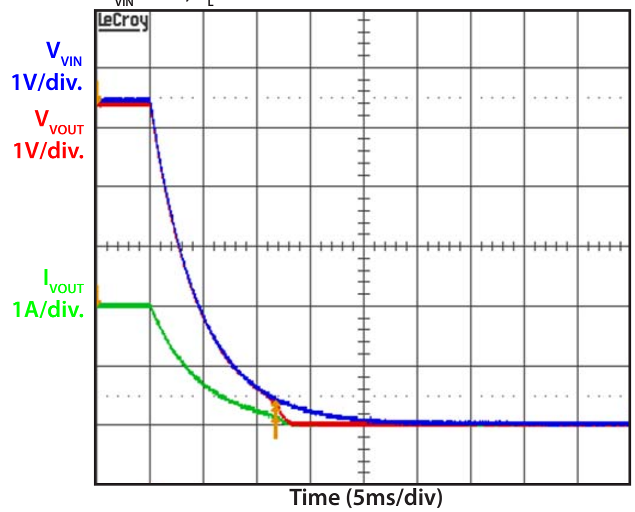
Start Up by VIN

V_{VIN}=5.5V, R_L=2.75 Ω



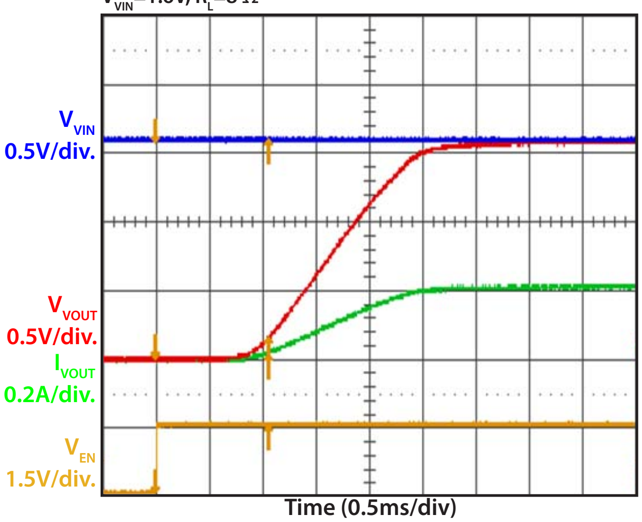
Shut Down by VIN

V_{VIN}=5.5V, R_L=2.75 Ω



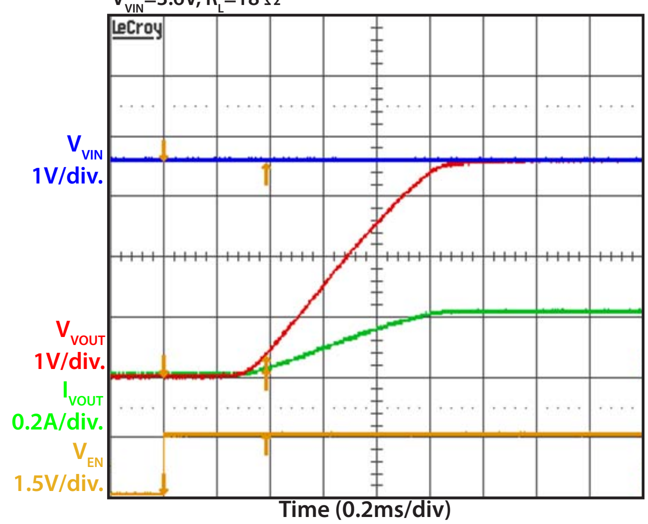
Start Up by EN

V_{VIN}=1.6V, R_L=8 Ω



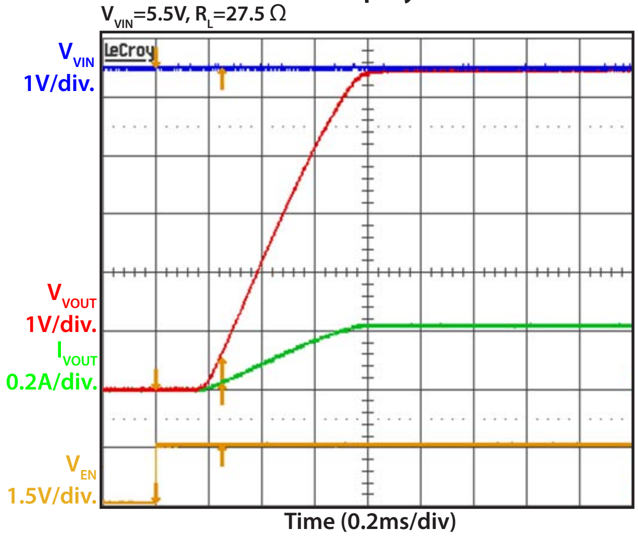
Start Up by EN

V_{VIN}=3.6V, R_L=18 Ω



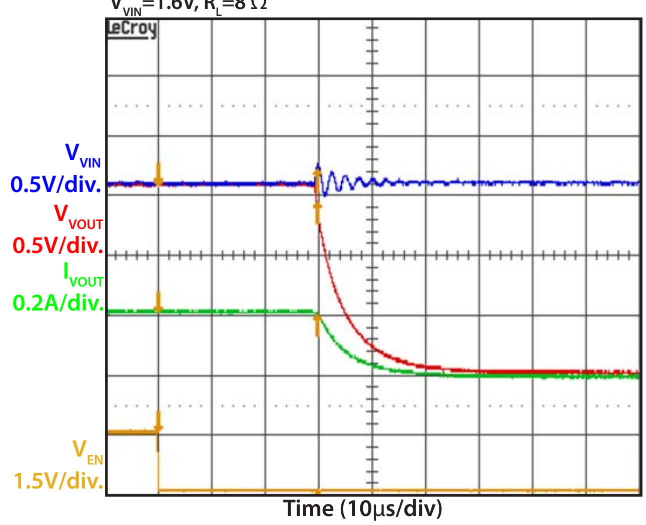
Start Up by EN

V_{VIN}=5.5V, R_L=27.5 Ω



Shut Down by EN

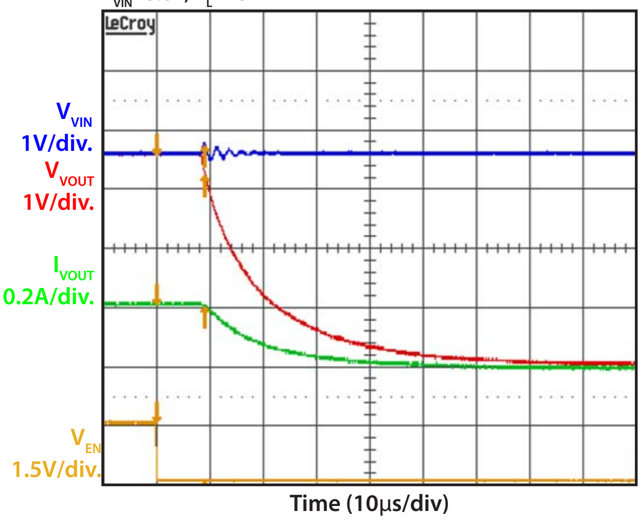
V_{VIN}=1.6V, R_L=8 Ω



Typical Characteristics (SC33021)

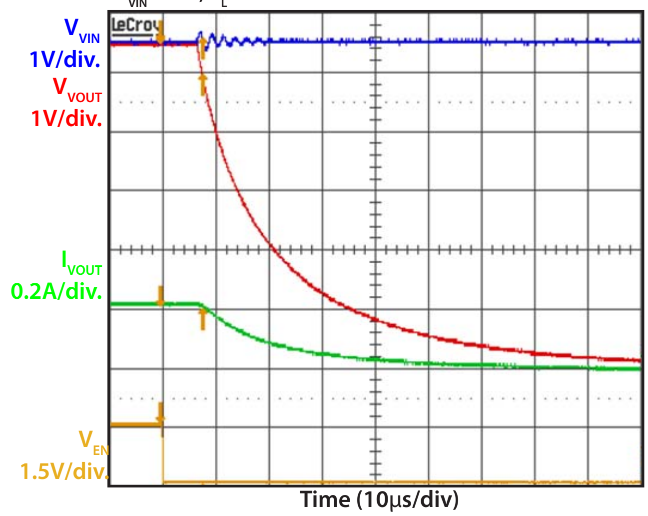
Shut Down by EN

V_{VIN}=3.6V, R_L=18 Ω



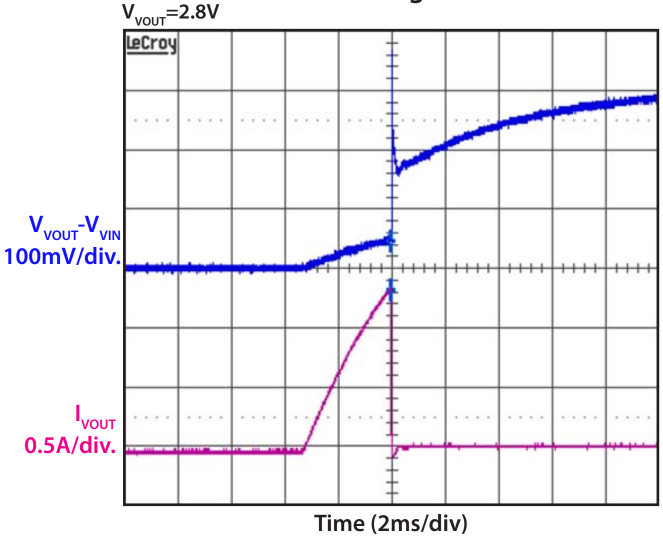
Shut Down by EN

V_{VIN}=5.5V, R_L=27.5 Ω

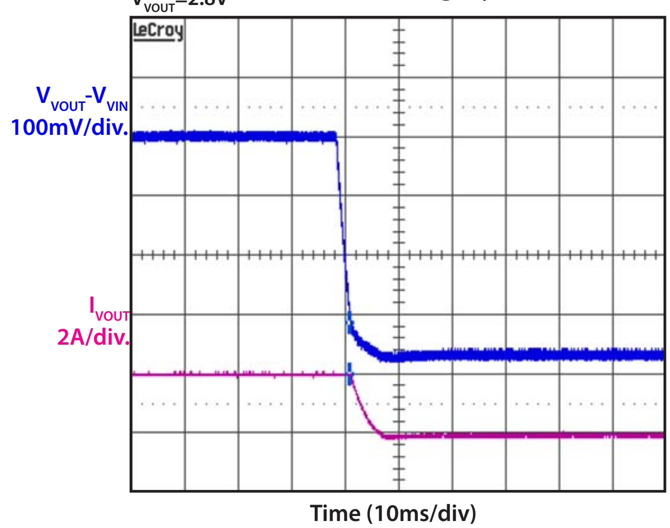


Reverse Blocking Threshold

V_{VOUT}=2.8V

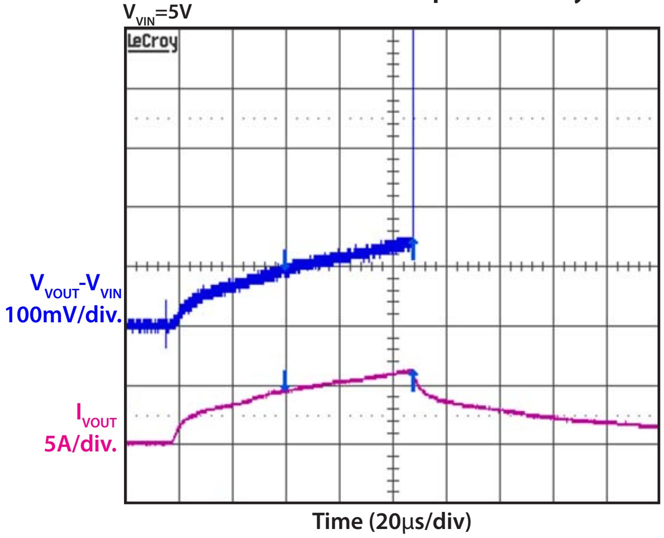


V_{VOUT}=2.8V Reverse Blocking Hysteresis

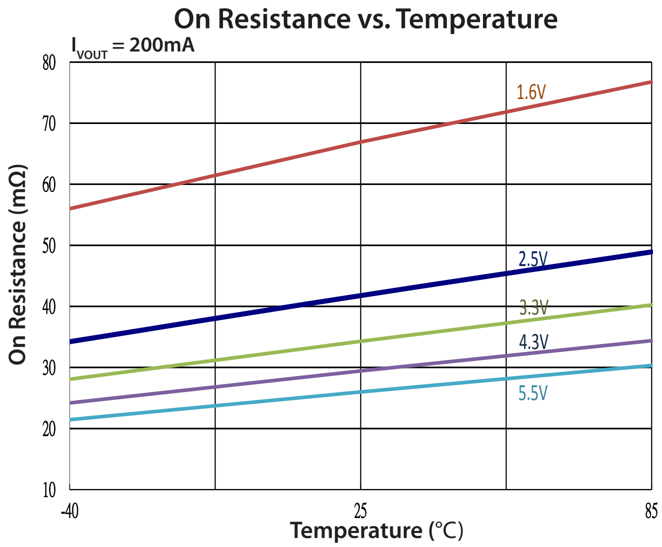


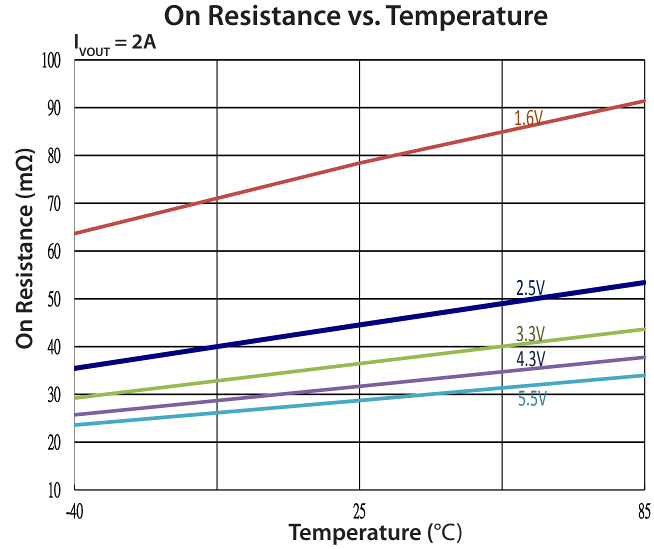
Reverse Current Response Delay

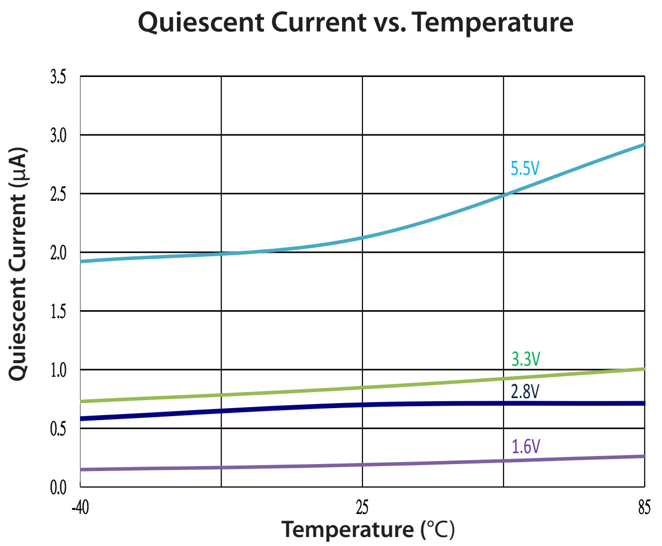
V_{VIN}=5V

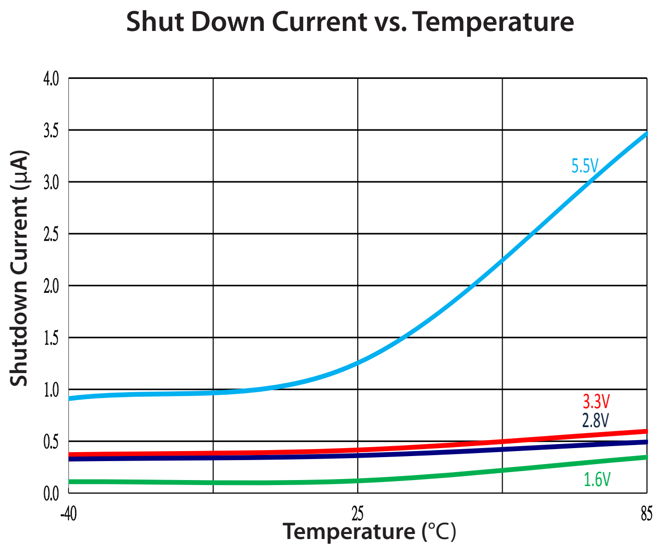


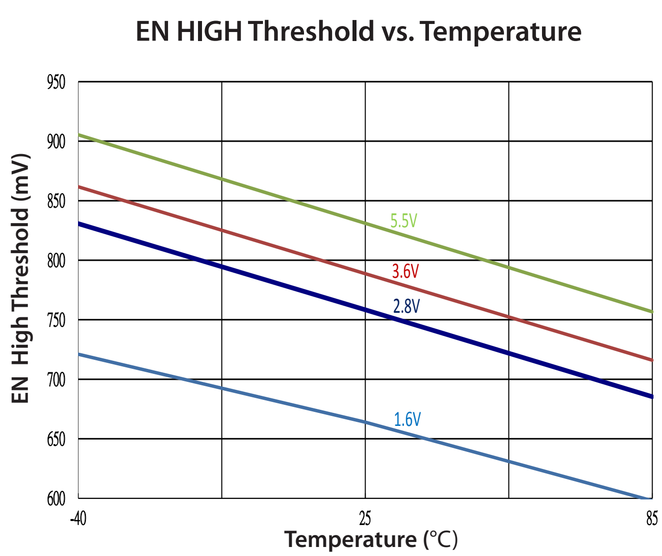
Typical Characteristics, Cont.

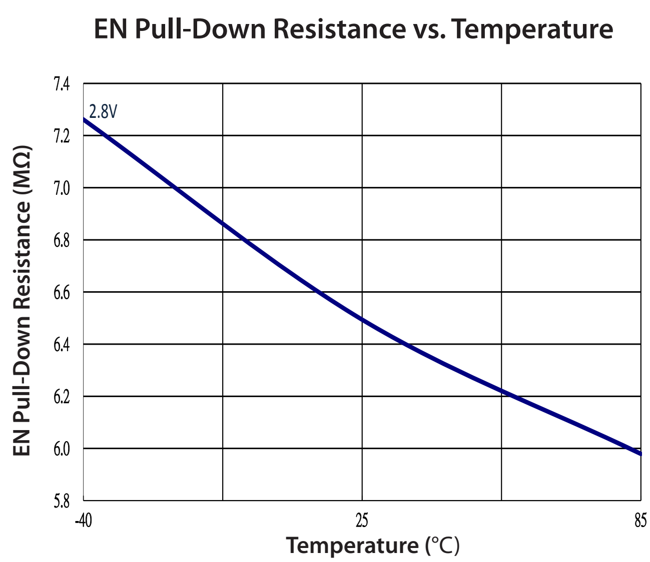






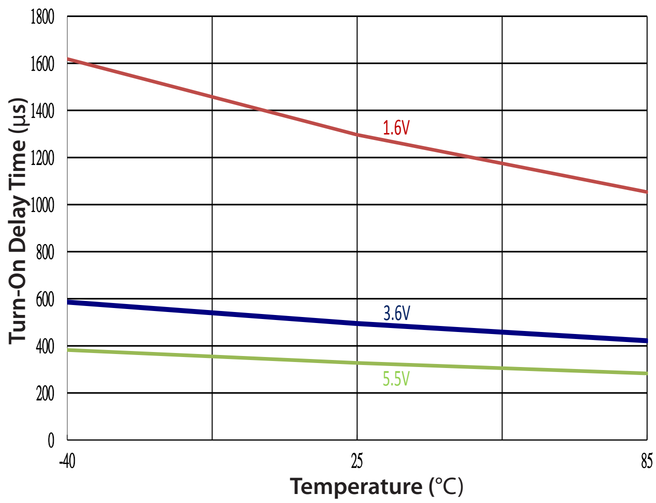




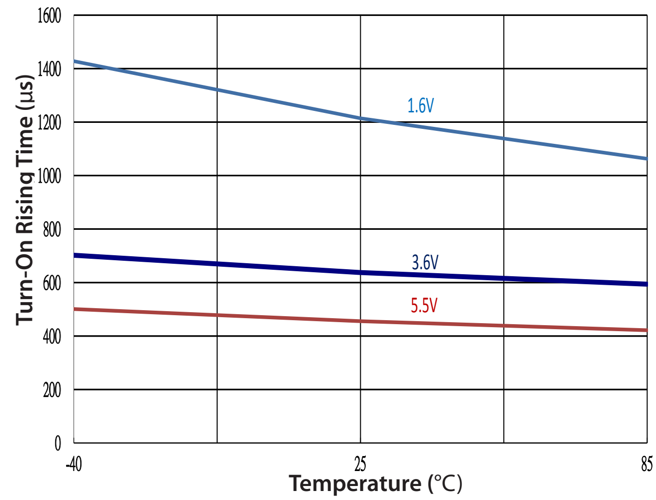


Typical Characteristics, Cont.

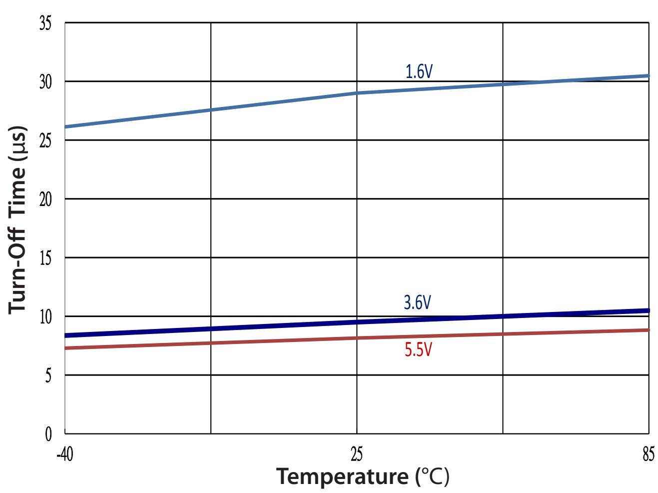
Turn-on Delay Time vs. Temperature



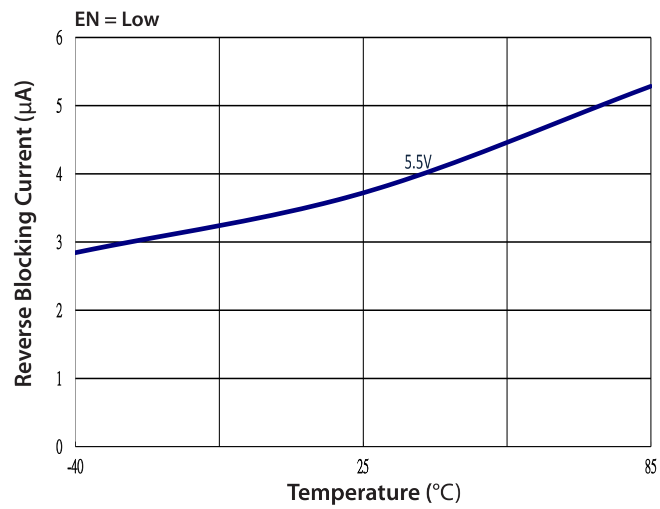
Rising Time vs. Temperature



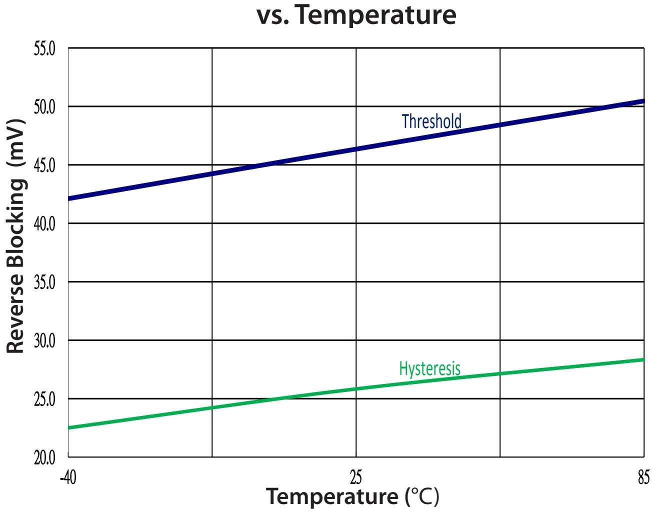
Turn-off Delay Time vs. Temperature



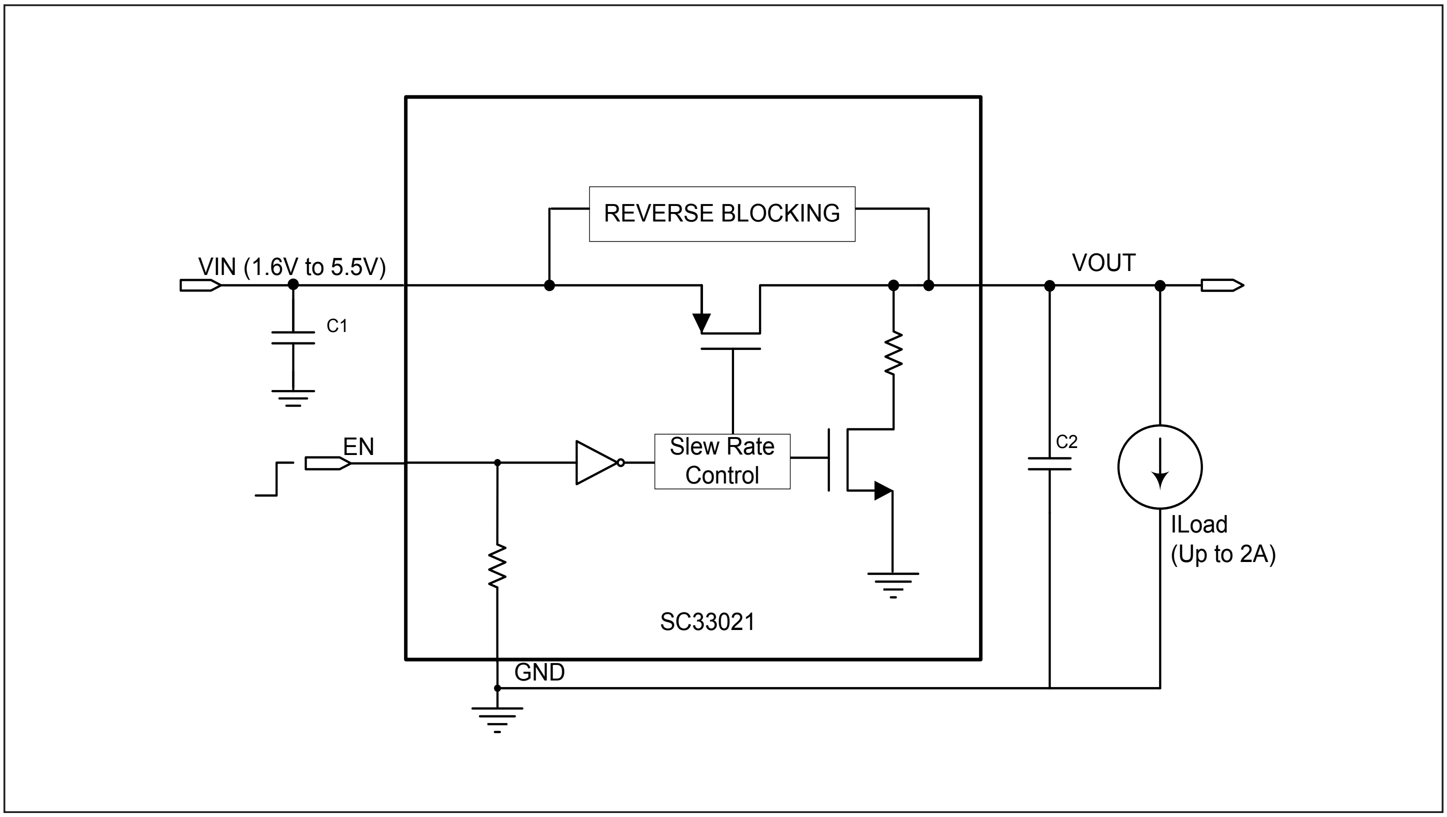
Reverse Blocking Current vs. Temperature



Reverse Blocking Threshold and Hysteresis vs. Temperature



SC33021 Block Diagram



Application Information

Operation

The SC33021 is an integrated high-side PMOS load switch that is designed to support up to 2A continuous output current and operates from an input voltage from 1.6V to 5.5V. The internal PMOS pass element has a very low ON resistance of 32mΩ (typical) at V_{VIN} = 3.3V. The SC33021 also provides ultra-low shutdown and quiescent current for extended battery life during shutdown and standby conditions.

An internal soft start circuit is used to control the start-up time of thej load switch to reduce inrush current during start-up.

Enable

The EN pin controls the ON/OFF state of the load switch. Pulling the EN pin HIGH turns on the load switch. Pulling the EN pin LOW turns off the load switch. The EN pin incorporates a 7MΩ (typical) pull-down resistor, so that when the EN pin is floating the SC33021 is disabled.

Reverse Blocking

The SC33021 integrates a reverse current blocking circuit to prevent current flow from VOUT to VIN during both ON and OFF states. The reverse current blocking circuit is active when voltage is present on either the VIN or the VOUT pins. A comparator is used to sense and compare the VOUT voltage to the VIN voltage. Whenever the VOUT voltage is 40mV (typical at 25°C) higher than VIN, the Reverse Blocking circuit is triggered and reverse current is blocked from VOUT to VIN. Please note that when 0 < VOUT - VIN < 40mV (typical at 25°C), some small reverse current is possible. An example is shown in Fig. 1. Usually, worst case for reverse current occurs at elevated input voltages and reduced temperatures.

The following formula can be used to calculate the reverse peak current before the Reverse Blocking circuit is triggered.

$$I_{RCENH} = \frac{V_{RBT}}{R_{ON}}$$

I_{RCENH} - Reverse peak current.
R_{ON} - On Resistance, (Usually, is smaller resistance at higher V_{IN} and lower temperature.)
V_{RBT} - Reverse voltage threshold.

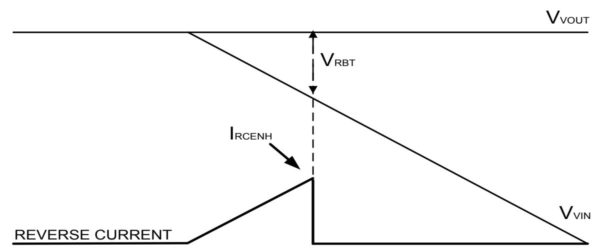


Figure 1

Output Voltage Pull-down

The SC33021 also includes an automatic output discharge function. It employs a 95Ω (typical) discharge path to ground when the EN pin is disabled.

Input Capacitor

In order to reduce the effect of voltage drop, noise and bounce at the VIN pin, a filter/decoupling capacitor between VIN to GND is recommended. A 1μF ceramic capacitor is sufficient for most application conditions. However, it should be noted that suppressing bounce at the input loop after EN is changed from HIGH to LOW can require greater capacitor values depending on particular designs.

In circuit design, ceramic capacitors should be derated for operating temperature and voltage. For applications up to 3.6V, capacitors should be rated at 6.3V or higher. For applications up to 5.5V, capacitors should be rated at 10V or higher.

Output Capacitor

A 1μF ceramic capacitor is normally used at the VOUT pin to filter noise. If a larger output capacitance value is used, the input inrush current should be considered because the power-on transient is also dependent on the output capacitor value. Please use the same derating criteria for the output capacitor selection.

Application Information, Cont.

Board Layout Considerations

Fig. 2 shows a typical application circuit with PCB inductance on the circuit board. An important objective of the layout is to minimize the PCB inductance by reducing the length and increasing the width of the traces. PCB inductance can affect circuit performance during turn-off, load transients, and Reverse Blocking. Fig. 2 shows three current loops during the opening or closing of the load switch. The magnitude of the voltage ringing at VIN or VOUT pin is related to the PCB stray inductance and the placement of the capacitors. The input capacitor C1 and output capacitor C2 need to be placed close to the SC33021. It is important to keep the voltage ringing below the maximum voltage rating of the SC33021.

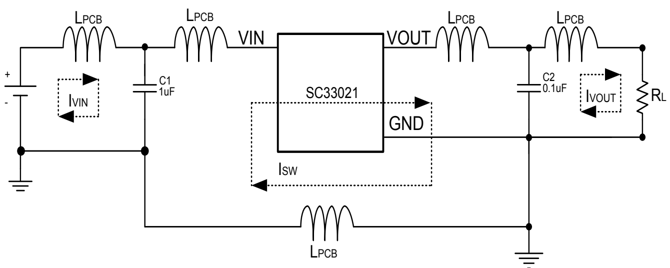


Figure 2 - PCB Circuit with Equivalent Parasitic Inductance

Evaluation Board Information

The Top Layer and Bottom Layer of a standard evaluation board are shown in Fig. 3 and Fig. 4, respectively.

Both T1 and T2 test points are Kelvin connections which can be used to minimize the measurement error of R_{ON}. To enable the part, a jumper can be used between VIN and EN on J1. To disable the part, a jumper can be connected between EN and GND on J1. C3 is an optional solution to improve ringing at input rail during turn-off and reverse blocking conditions.

Top Layer, SC33021

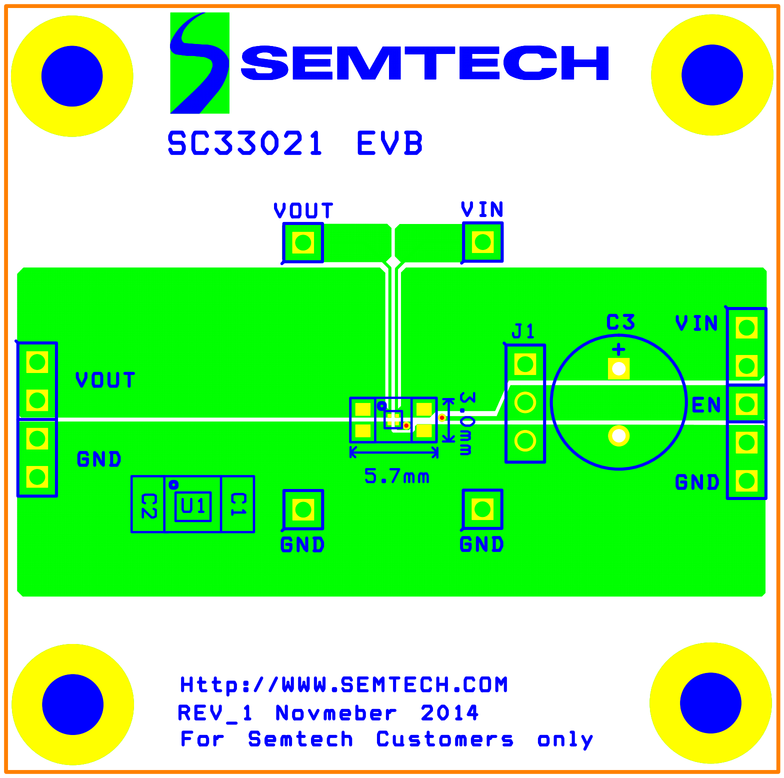


Figure 3

Bottom Layer, SC33021

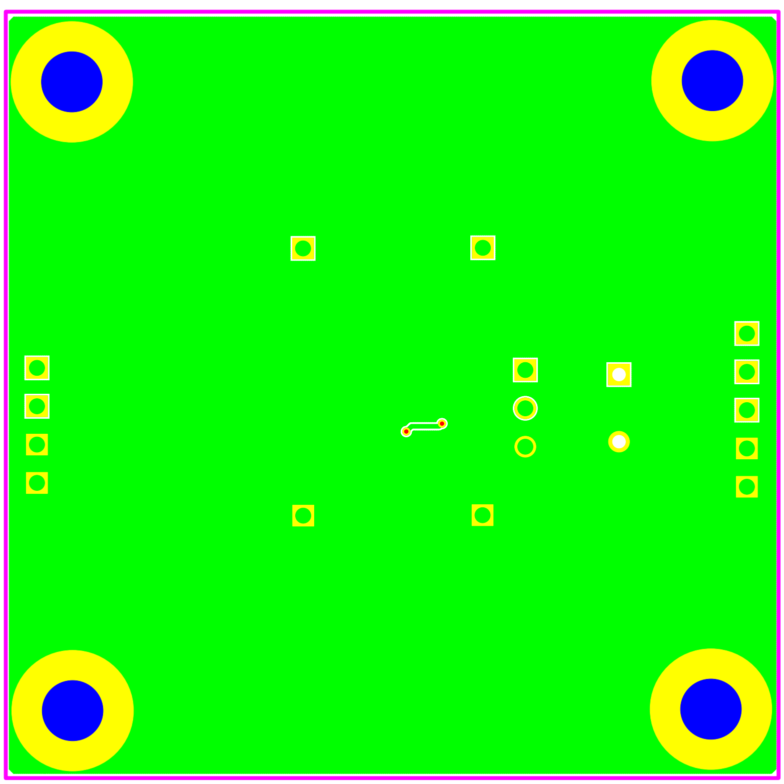
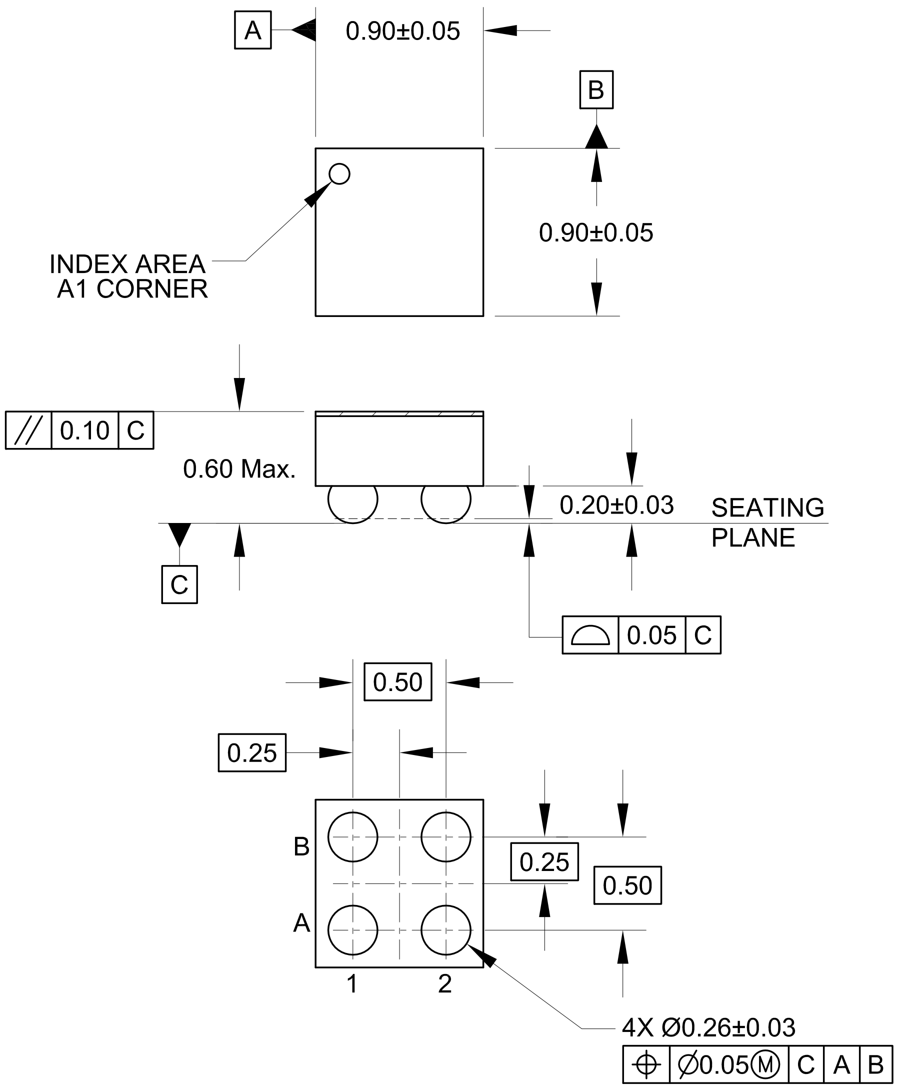


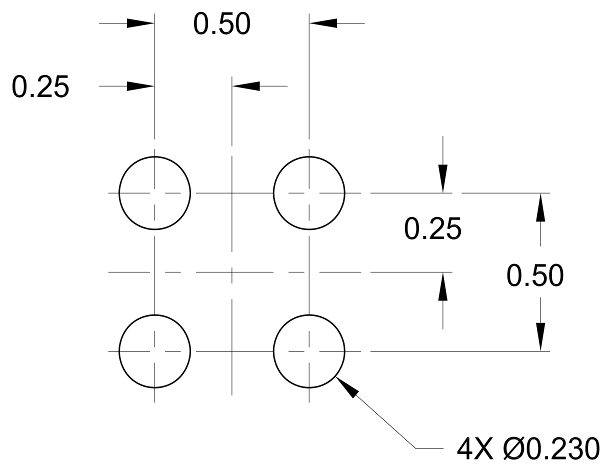
Figure 4

Outline Drawing — CSP 0.9mm X 0.9mm, 4 Lead



NOTES:
1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS

Land Pattern — CSP 0.9mm X 0.9mm, 4 Lead



NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS
2. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.

Contact Information

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Стандарт
Электрон
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