

### 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

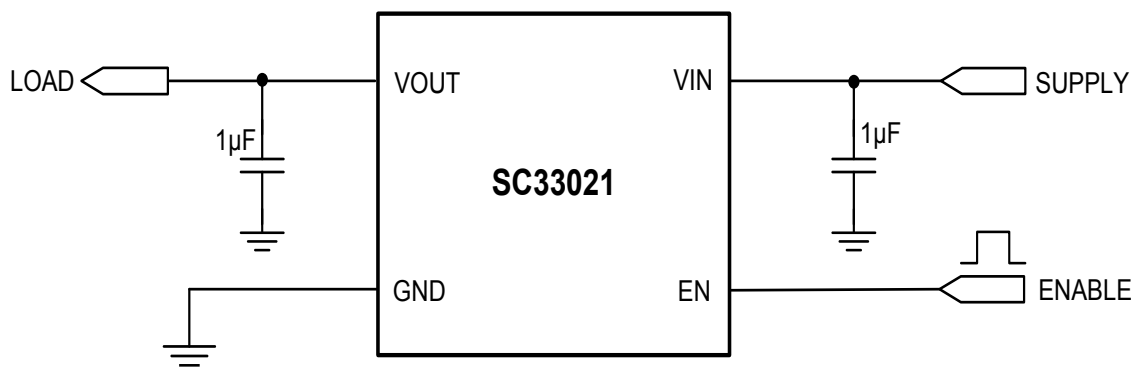
#### Description

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).

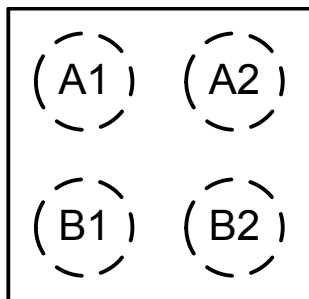
The SC33021 is offered in a tiny 0.9mm x 0.9mm x 0.6mm, 4 Bump CSP package.

### Typical Application Circuit



## Pin Configuration

TOP VIEW  
(BUMPS ON THE BOTTOM)



CSP 0.9mm x 0.9mm, 4 Bump

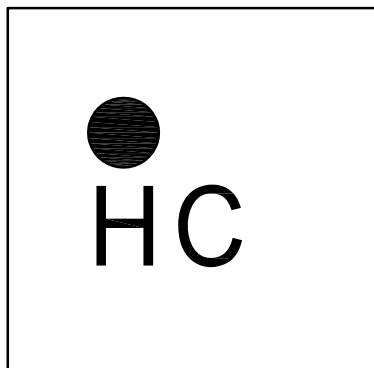
## Ordering Information

| 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.

## 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 <sup>(1)</sup> (kV)..... | 5                         |

## Recommended Operating Conditions

|                                  |            |
|----------------------------------|------------|
| Maximum Output Current (A) ..... | 2          |
| $V_{VIN}$ (V).....               | 1.6 to 5.5 |

## Thermal Information

|                                                                   |             |
|-------------------------------------------------------------------|-------------|
| Thermal Resistance, Junction to Ambient <sup>(2)</sup> (°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,  $T_A = 25^\circ\text{C}$  for typical,  $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$  for min and max,  $V_{VIN} = 2.8\text{V}$ ,  $C_{VIN} = 1\mu\text{F}$ ,  $C_{VOUT} = 1\mu\text{F}$ ,  $V_{EN} = V_{VIN}$ .

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

**Electrical Characteristics (continued)**

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

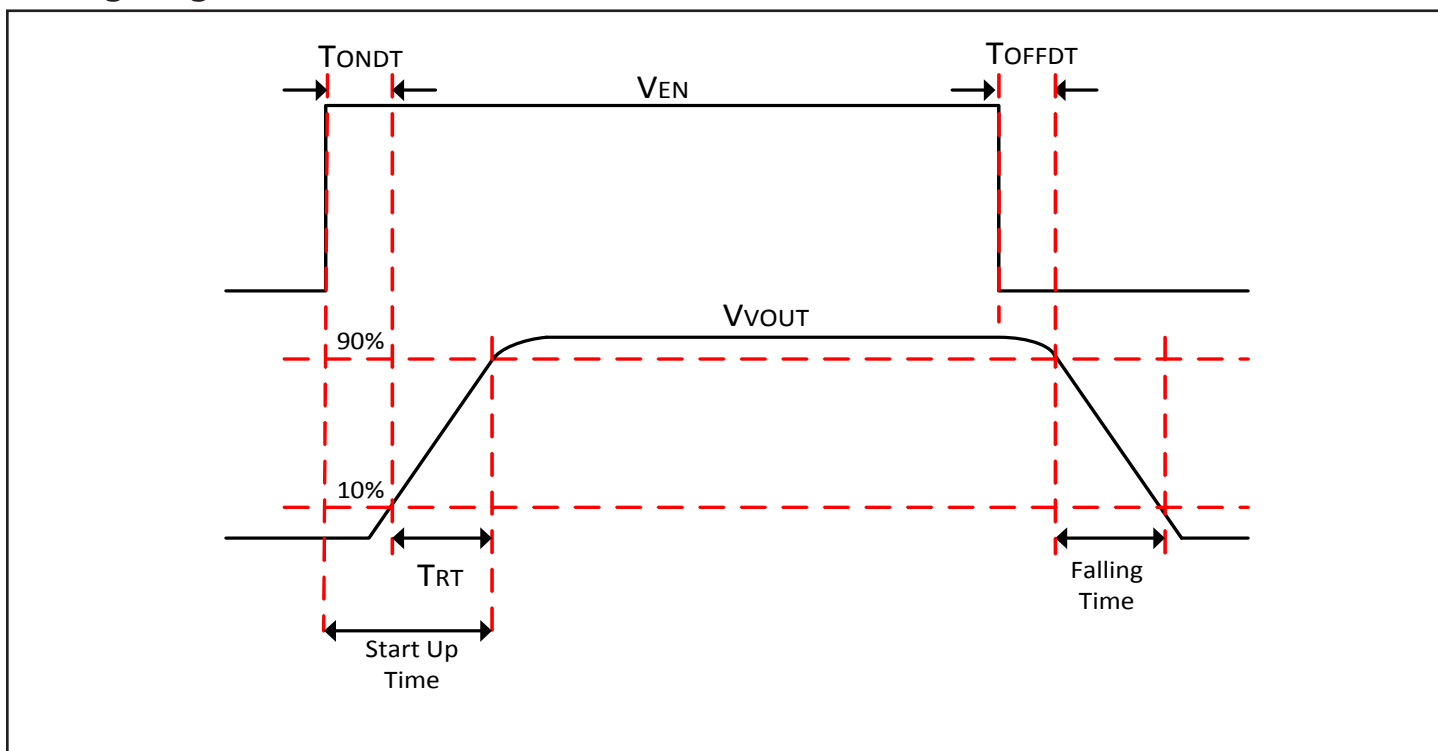
NOTES:

(1)  $I_Q$  current includes EN pull-down current.

## Pin Descriptions

| SC33021<br>Pin# | Pin<br>Name | Pin Function                                                                                                                                                                                        |
|-----------------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1              | VOUT        | Output voltage.                                                                                                                                                                                     |
| B1              | GND         | Ground.                                                                                                                                                                                             |
| A2              | VIN         | Input supply voltage.                                                                                                                                                                               |
| B2              | EN          | Enable input. A 7M $\Omega$ 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. |

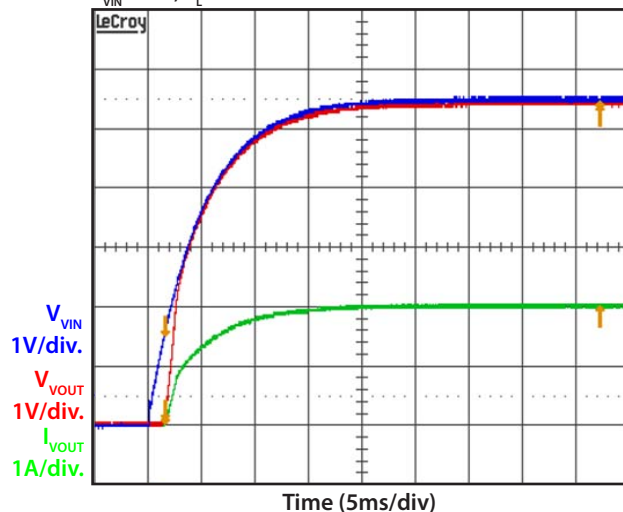
## Timing Diagram



## Typical Characteristics (SC33021)

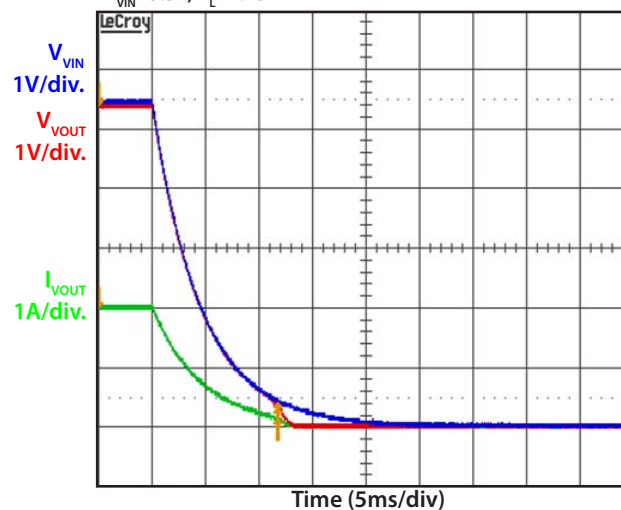
Start Up by VIN

$V_{IN}=5.5V, R_L=2.75\ \Omega$



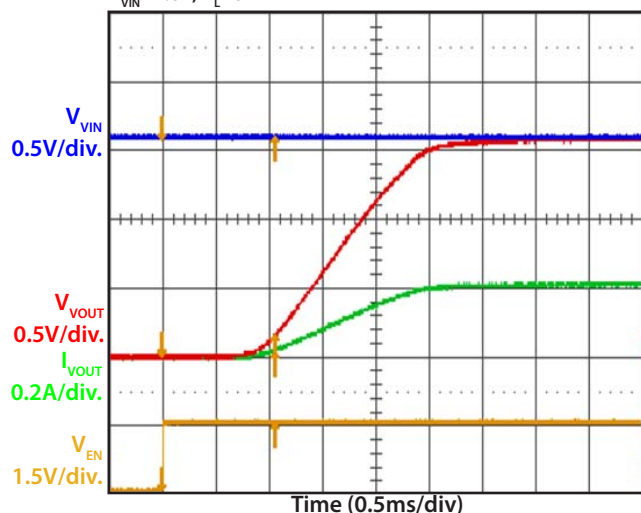
Shut Down by VIN

$V_{IN}=5.5V, R_L=2.75\ \Omega$



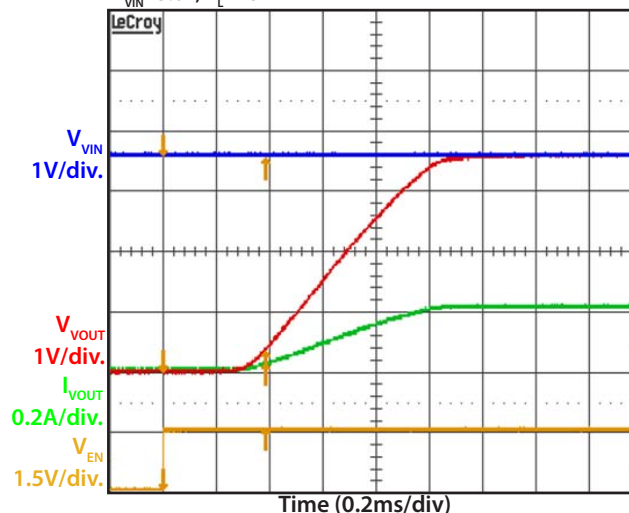
Start Up by EN

$V_{IN}=1.6V, R_L=8\ \Omega$



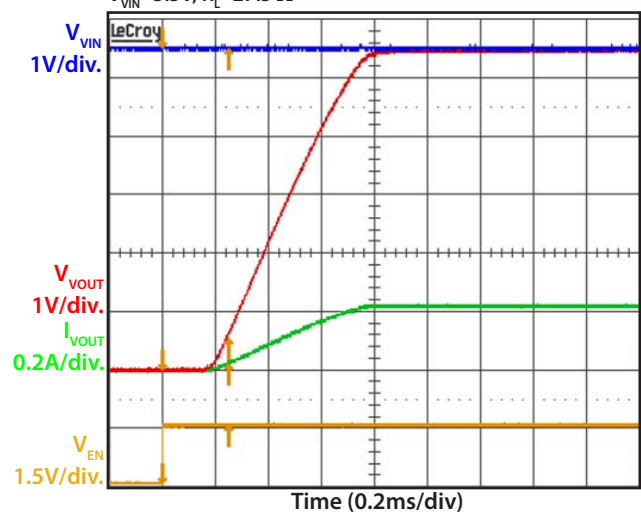
Start Up by EN

$V_{IN}=3.6V, R_L=18\ \Omega$



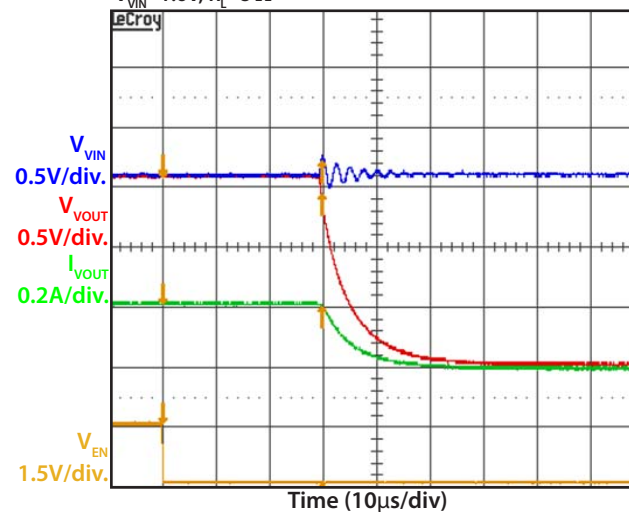
Start Up by EN

$V_{IN}=5.5V, R_L=27.5\ \Omega$



Shut Down by EN

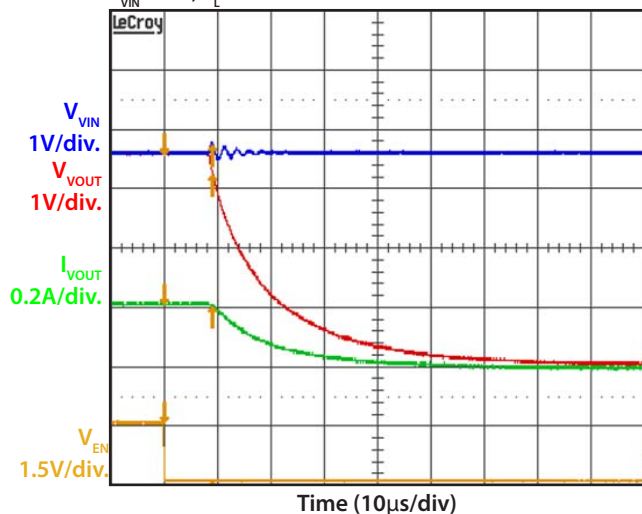
$V_{IN}=1.6V, R_L=8\ \Omega$



## Typical Characteristics (SC33021)

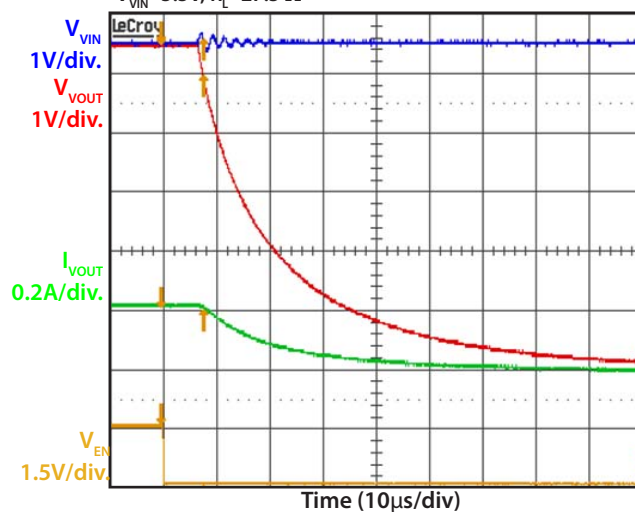
Shut Down by EN

$V_{IN}=3.6V, R_L=18\Omega$



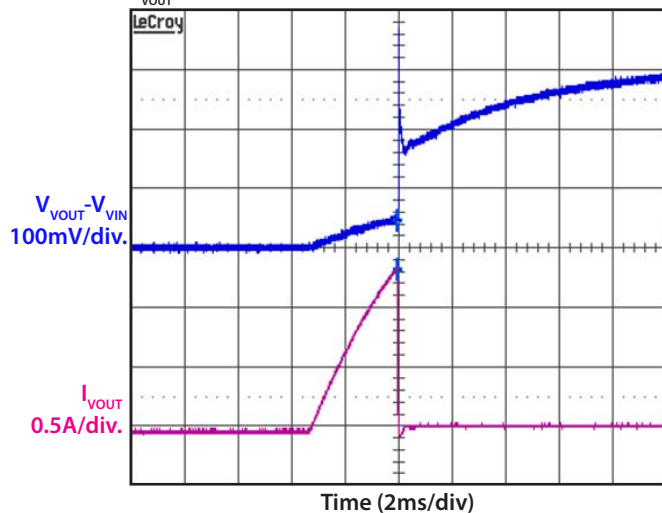
Shut Down by EN

$V_{IN}=5.5V, R_L=27.5\Omega$



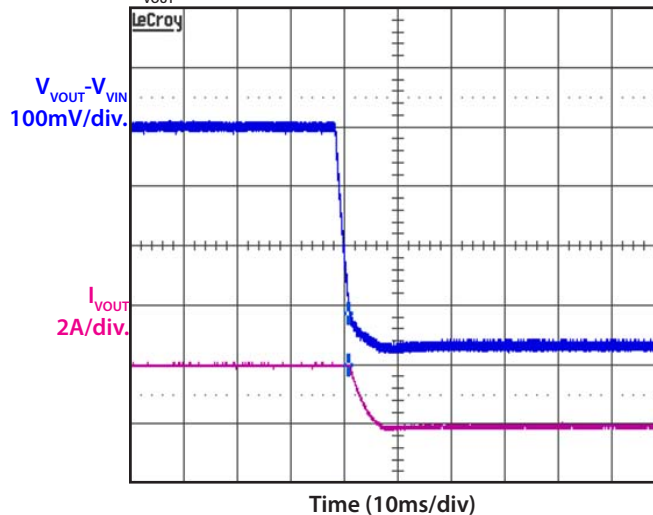
Reverse Blocking Threshold

$V_{OUT}=2.8V$



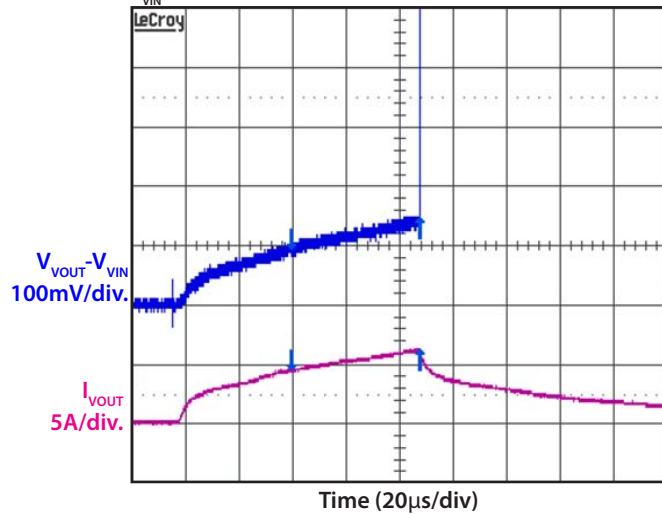
Reverse Blocking Hysteresis

$V_{OUT}=2.8V$



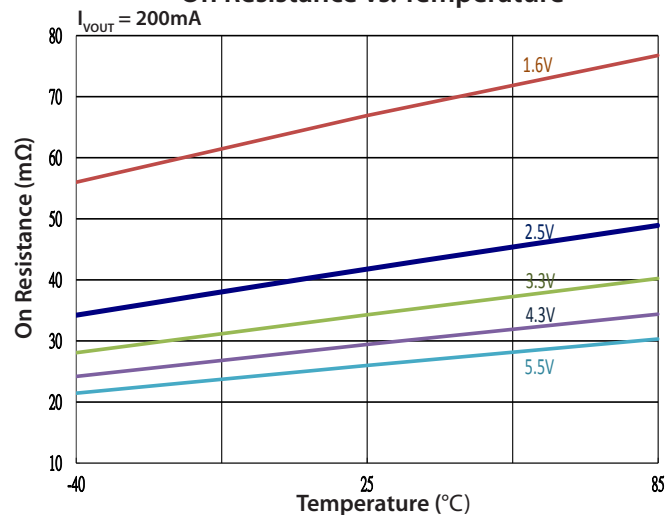
Reverse Current Response Delay

$V_{IN}=5V$

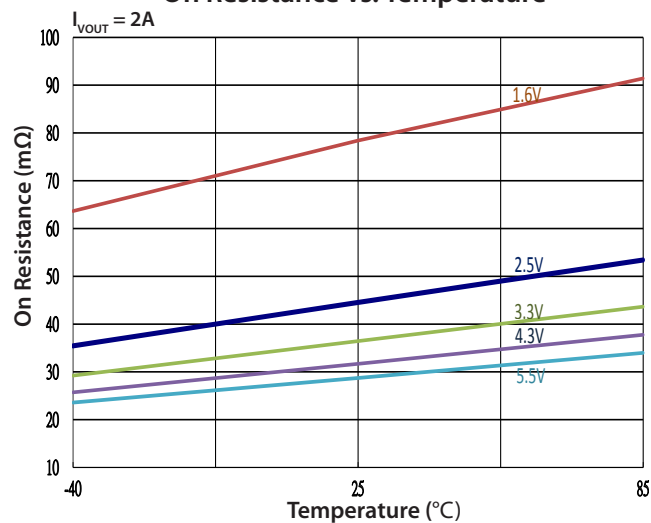


## Typical Characteristics, Cont.

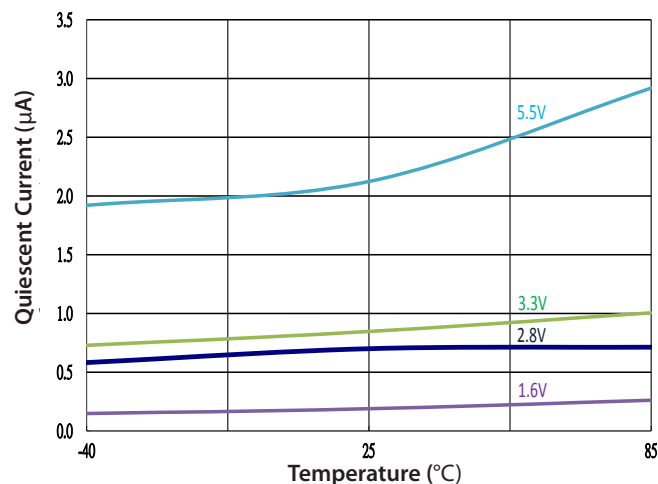
On Resistance vs. Temperature



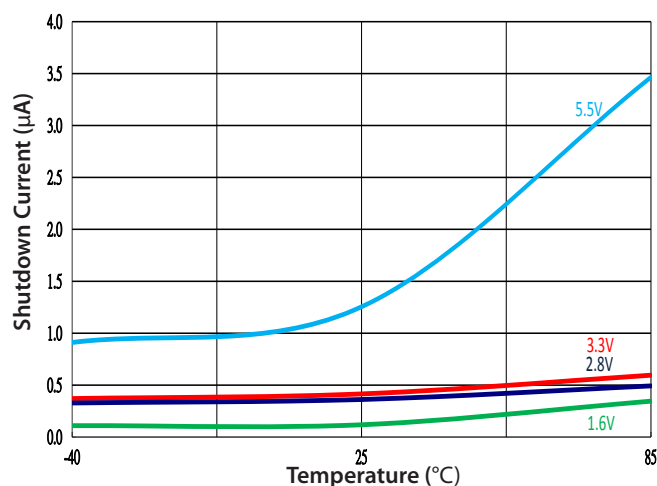
On Resistance vs. Temperature



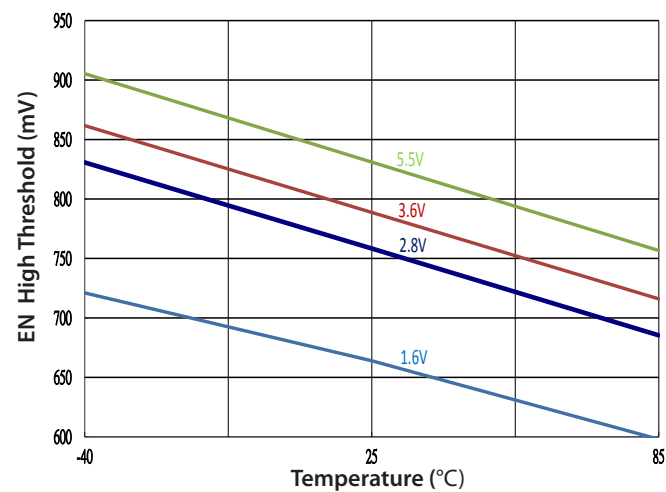
Quiescent Current vs. Temperature



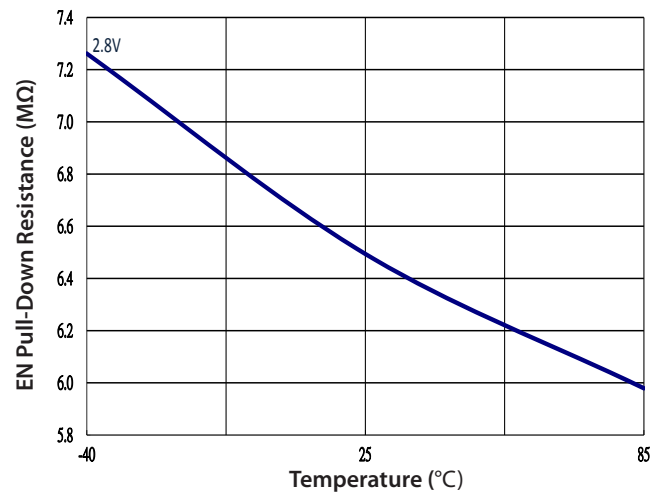
Shut Down Current vs. Temperature



EN HIGH Threshold vs. Temperature

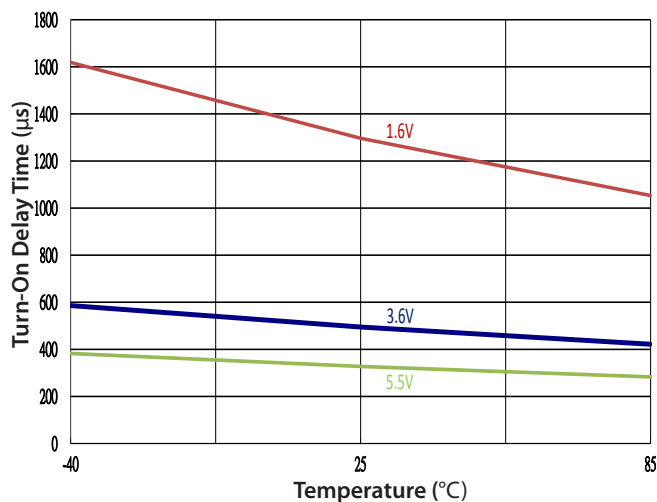


EN Pull-Down Resistance vs. Temperature

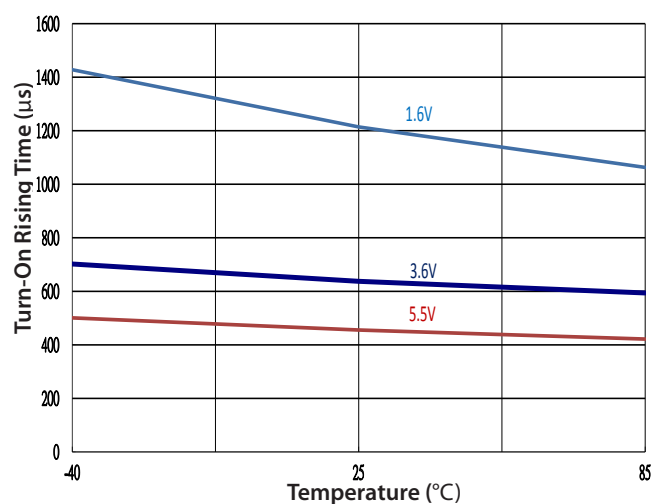


## Typical Characteristics, Cont.

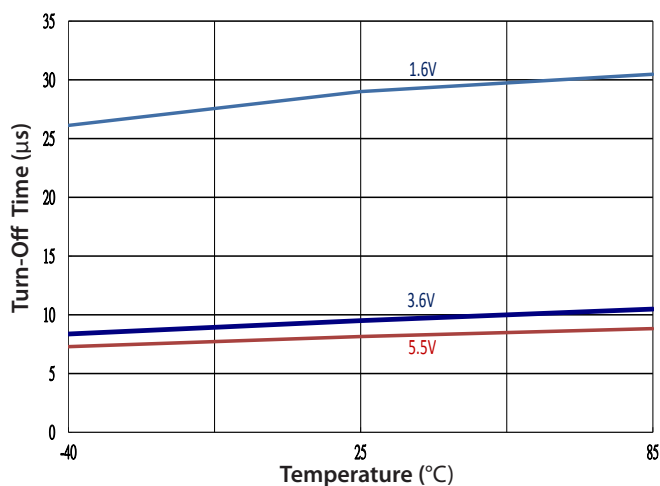
Turn-on Delay Time vs. Temperature



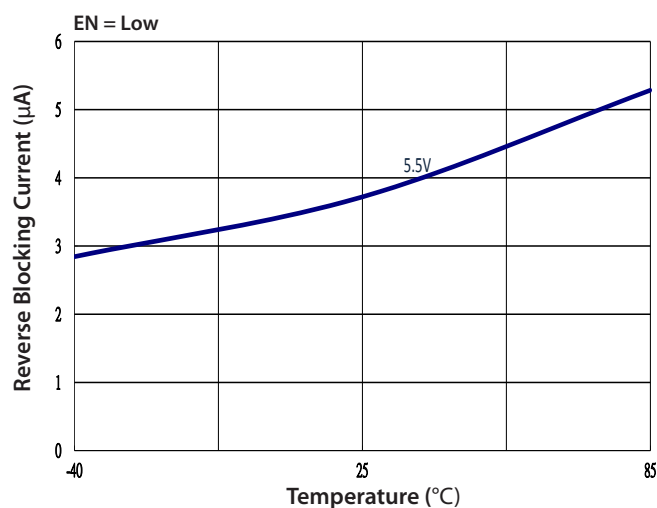
Rising Time vs. Temperature



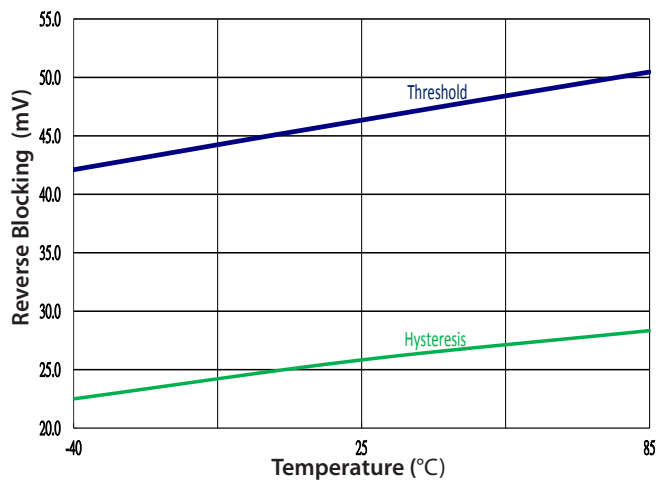
Turn-off Delay Time vs. Temperature



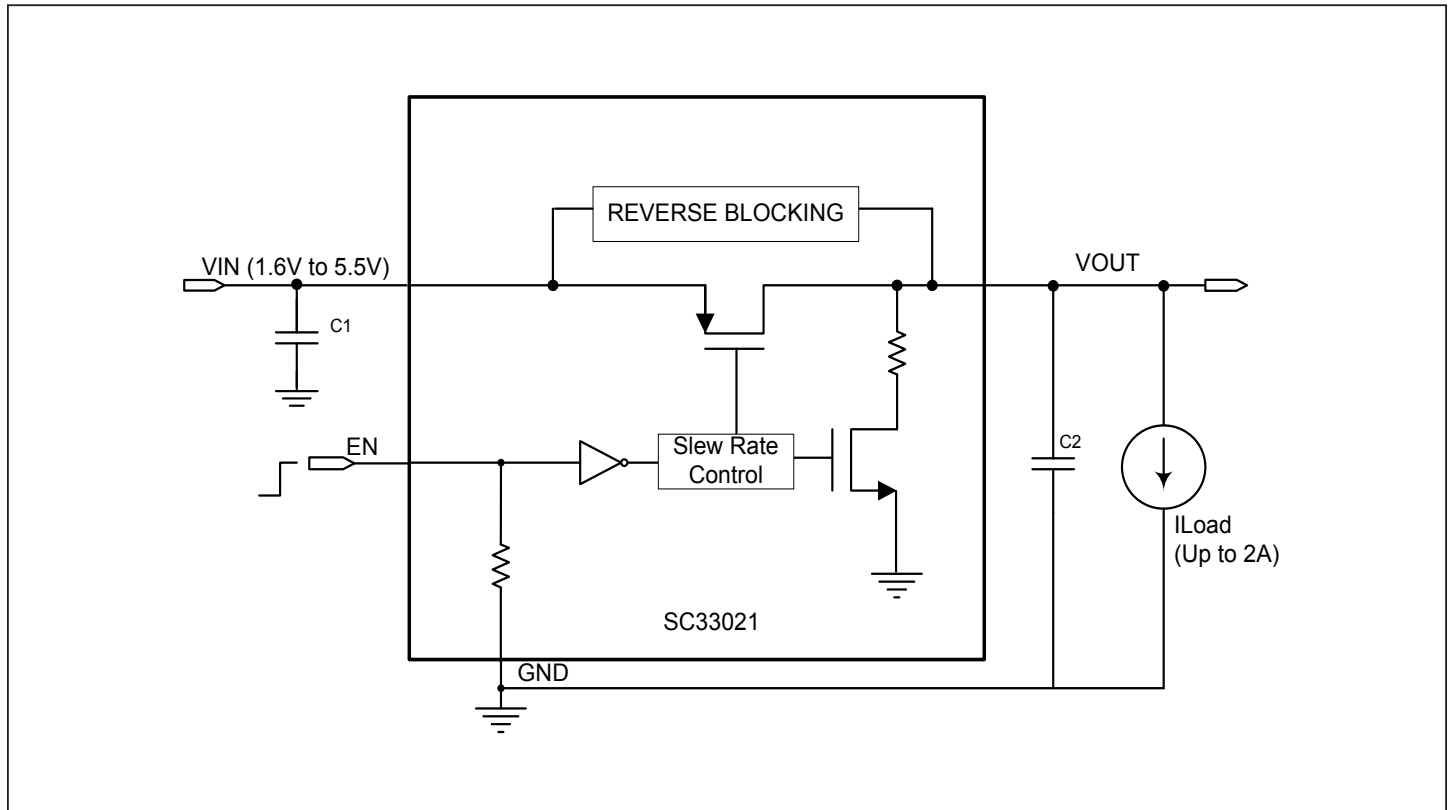
Reverse Blocking Current vs. Temperature



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  $V_{IN} = 3.3V$ . 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 the 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.

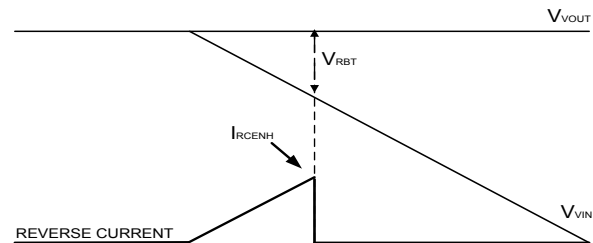


Figure 1

### 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.

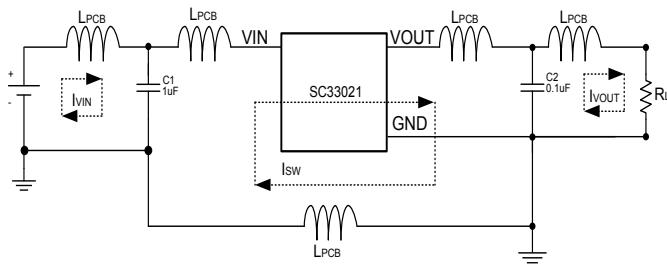
### Output Capacitor

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.

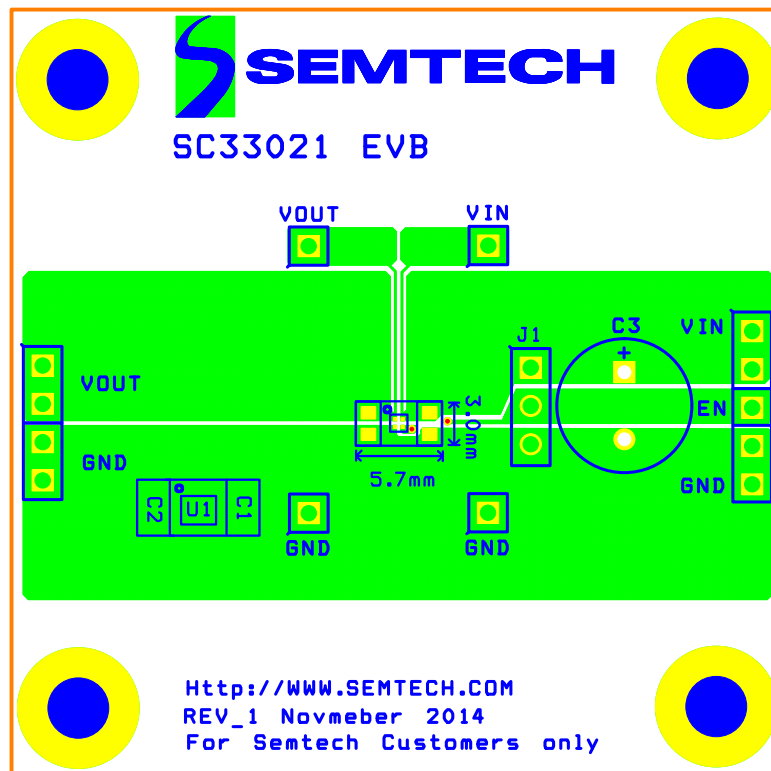
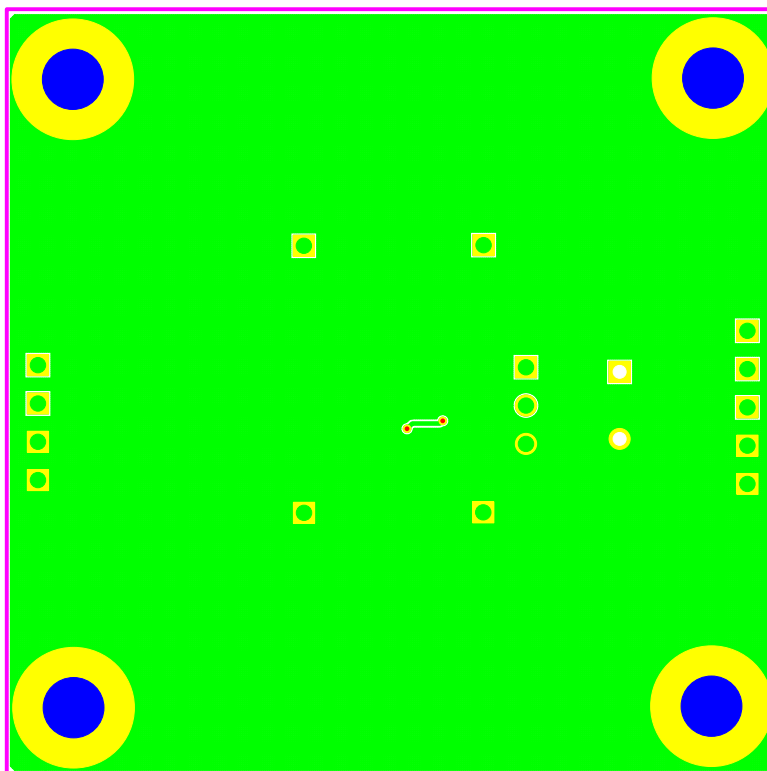


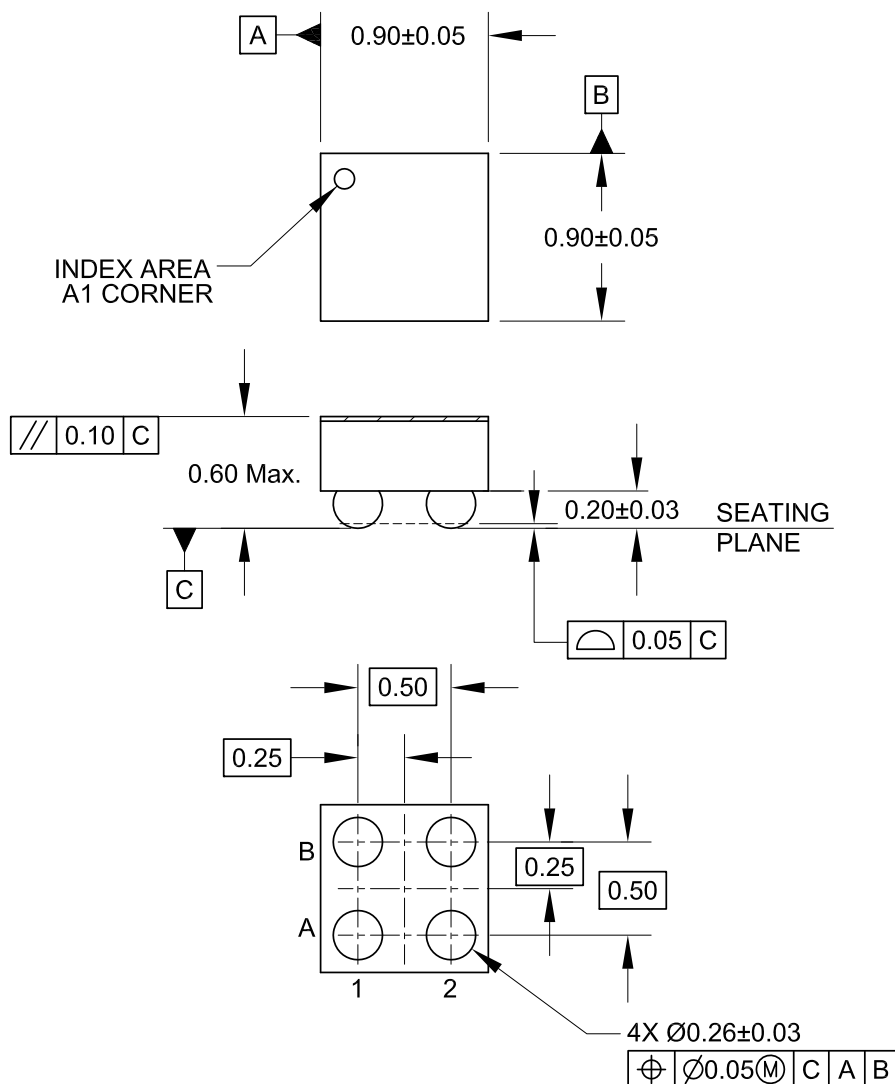
**Figure 2 - PCB Circuit with Equivalent Parasitic Inductance**

### Evaluation Board Information

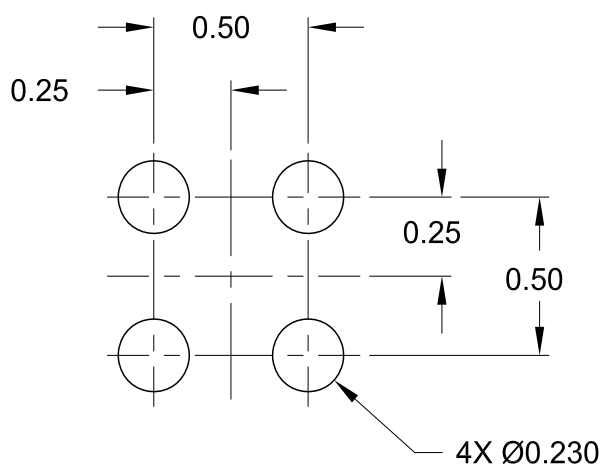
The Top Layer and Bottom Layer of a standard evaluation board are shown in Fig. 3 and Fig. 4, respectively.

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.  
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Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели,  
кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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