

## High-Current, Low-Dropout, 1.1 to 5 V Regulator

### Features and Benefits

- 3 A Output Current
- 0.7 V Maximum Dropout Voltage at  $I_O = 3\text{ A}$
- 1  $\mu\text{A}$  Maximum Standby Current
- Adjustable 1.1 to 5 V Output Voltage
- Remote Voltage Sensing
- Foldback Current Limiting
- Thermal Protection

### Applications

- TVs, VCRs, Electronic Games
- Embedded Core, Memory, or Logic Supplies
- Printers and Other Office Equipment
- Industrial Machinery
- Secondary-Side Stabilization of Multi-Output SMPS

### Package: 5-pin TO-220

Not to scale



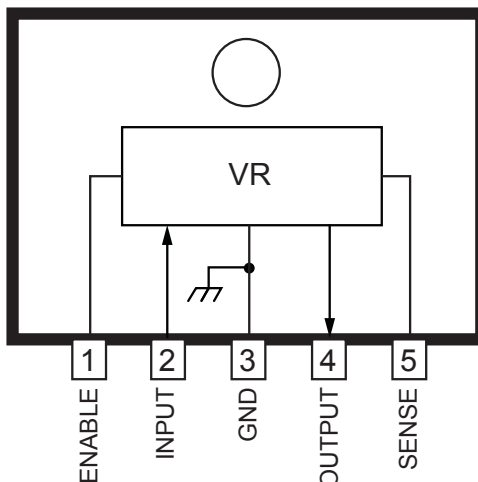
### Description

Designed to meet the high-current requirements in industrial and consumer applications; embedded core, memory, or logic supplies; TVs, VCRs, and office equipment, the SI-3011ZF voltage regulator offers the reduced dropout voltage and low quiescent current essential for improved efficiency. This device delivers a regulated output at up to 3 A. Integrated thermal and overcurrent protection enhance overall system reliability. Devices with fixed output voltages of 2.5 V or 3.3 V are also available.

Quiescent current does not increase significantly as the dropout voltage is approached, an ideal feature in standby/resume power systems where data integrity is crucial. Regulator accuracy and excellent temperature characteristics are provided by a bandgap reference. An LS-TTL/CMOS-compatible input gives the designer complete control over power up, standby, or power down. A pnp pass element provides a dropout voltage of less than 700 mV at 3 A of load current. Low output voltages eliminate the need for expensive PWM buck converters. The low dropout voltage permits more efficient regulation before output regulation is lost.

This device is supplied in a fully molded TO-220-style 5-lead flange-mounted, high power, isolated plastic package. A similar device in a lower-power surface-mount plastic package is the SI-3011ZD.

### Pin-Out Diagram



SI-3011ZF

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Selection Guide

Part Number
SI-3011ZF

For the availability of parts meeting -40°C requirements, contact a Sanken Sales Representative.

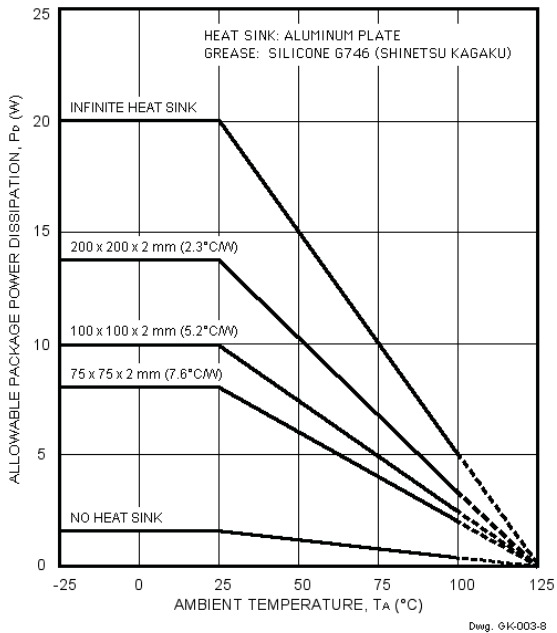
Absolute Maximum Ratings

Characteristic	Symbol	Notes	Rating	Units
Input Voltage	V <sub>I</sub>		10	V
Output Current	I <sub>O</sub>	Output current rating is limited by input voltage, duty cycle, and ambient temperature. Under any set of conditions, do not exceed a junction temperature of +125°C.	3	A
Enable Input Voltage	V <sub>E</sub>		6	V
Junction Temperature	T <sub>J</sub>		125	°C
Storage Temperature	T <sub>stg</sub>		-40 to 125	°C

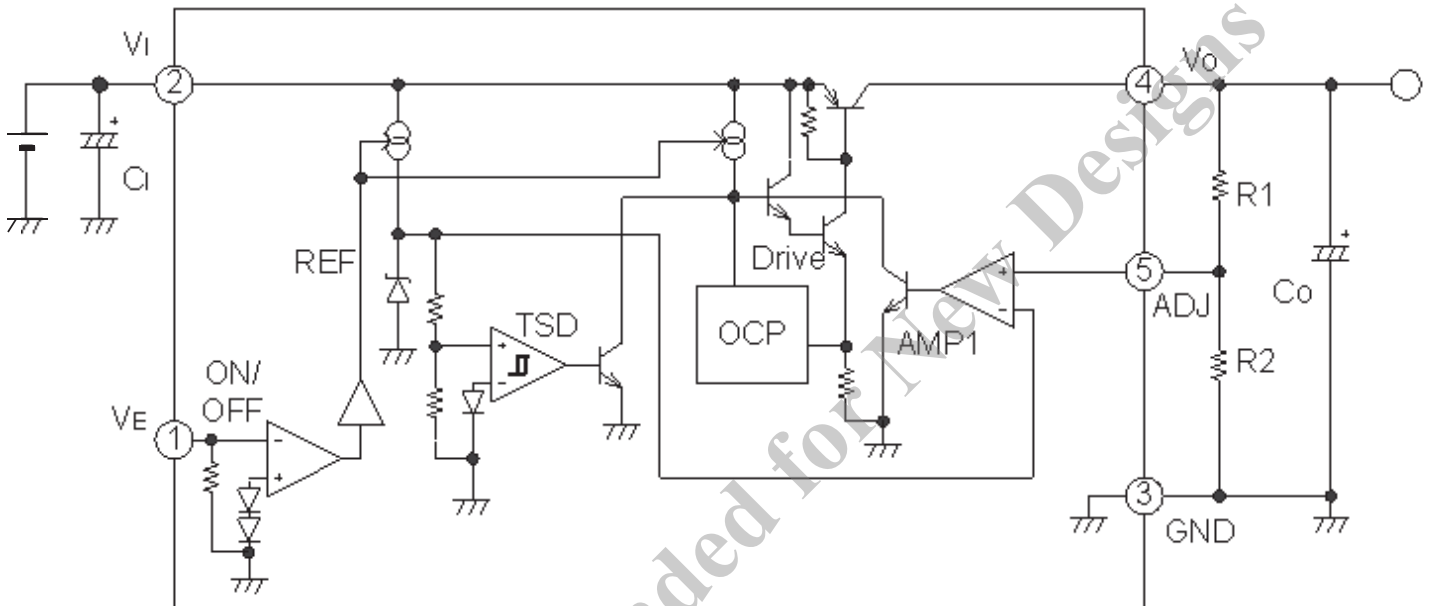
Recommended Operating Conditions

Characteristic	Symbol	Conditions	Min.	Max.	Unit
DC Input Voltage	V <sub>I</sub>		–	6	V
DC Output Current	I <sub>O</sub>		0	3	A
Adjustable Voltage Range	V <sub>ADJ</sub>		1.2	5	V
Operating Junction Temperature	T <sub>J</sub>		-20	100	°C

Allowable Package Power Dissipation



Functional Block Diagram



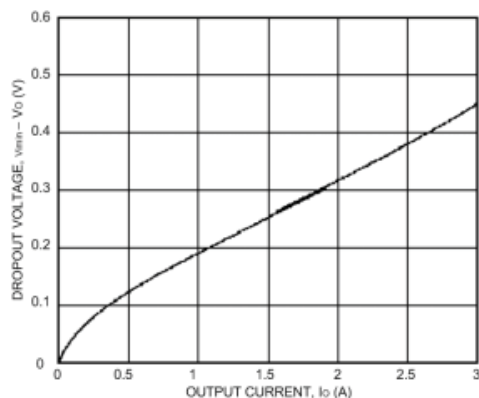
**ELECTRICAL CHARACTERISTICS at  $T_A = 25^\circ\text{C}$ ,  $V_O = 2.5\text{ V}$  adjusted,  $V_E = 2\text{ V}$ , unless otherwise noted**

Characteristics	Symbol	Test Conditions	Min.	Typ. <sup>1</sup>	Max.	Unit
Output Voltage	$V_O$	$V_I = V_{O(\text{nom})} + 1\text{ V}$ , $I_O = 10\text{ mA}$	–	$V_{O(\text{nom})}$	–	V
	$V_{O(\text{off})}$	$V_E = 0\text{ V}$	–	–	0.5	V
Output Voltage Temperature Coefficient	$a_{VO}$	$0^\circ\text{C} \leq T_J \leq 100^\circ\text{C}$	–	$\pm 0.3$	–	mV/ $^\circ\text{C}$
Internal Reference Voltage	$V_{\text{ref}}$	$V_I = V_{O(\text{nom})} + 1\text{ V}$ , $I_O = 10\text{ mA}$	1.078	1.100	1.122	V
Output Short-Circuit Current <sup>2</sup>	$I_{\text{OM}}$	$V_I = V_{O(\text{nom})} + 1\text{ V}$	3.2	–	–	A
Line Regulation	$\Delta V_{O(\Delta V_I)}$	$V_I = 3.0\text{ to }5.0\text{ V}$ , $I_O = 10\text{ mA}$	–	–	10	mV
Load Regulation	$\Delta V_{O(\Delta I_O)}$	$V_I = 3.3\text{ V}$ , $I_O = 0\text{ to }3.0\text{ A}$	–	–	40	mV
Dropout Voltage	$V_{I(\text{min})} - V_O$	$I_O = 3.0\text{ A}$	–	–	0.7	V
Ground Terminal Current	$I_{\text{GND}}$	$V_I = V_{O(\text{nom})} + 1\text{ V}$ , $I_O = 0\text{ mA}$ , $V_E = 2.0\text{ V}$	–	1.0	1.5	mA
		$V_I = V_{O(\text{nom})} + 1\text{ V}$ , $V_E = 0\text{ V}$	–	–	1.0	$\mu\text{A}$
Enable Input Voltage	$V_{\text{EH}}$	Output on	2.0	–	–	V
	$V_{\text{EL}}$	Output off	–	–	0.8	V
Enable Input Current	$I_{\text{EH}}$	$V_E = 2.7\text{ V}$	–	–	100	$\mu\text{A}$
	$I_{\text{EL}}$	$V_E = 0\text{ V}$	–	0	–5.0	$\mu\text{A}$
Ripple Rejection Ratio	PSRR	$V_I = V_{O(\text{nom})} + 1\text{ V}$ , $100\text{ Hz} \leq f \leq 120\text{ Hz}$	–	60	–	dB
Thermal Shutdown	$T_J$		135	152	–	$^\circ\text{C}$

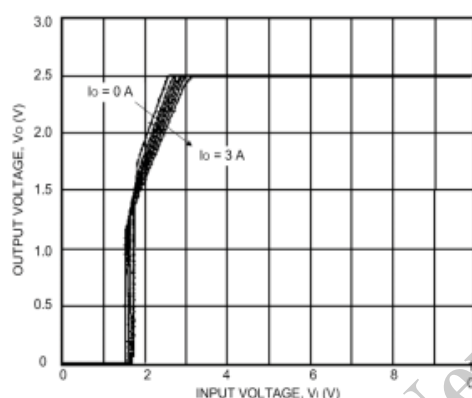
<sup>1</sup>Typical values are given for circuit design information only.<sup>2</sup>Output short-circuit current is at the point where output voltage has decreased 5% below  $V_{O(\text{nom})}$ .

**Typical Characteristics**  
( $V_O = 2.5\text{ V}$  adjust,  $T_A = 25^\circ\text{C}$ )

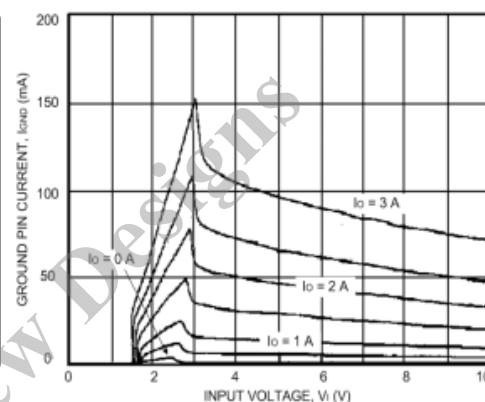
■ Dropout Voltage



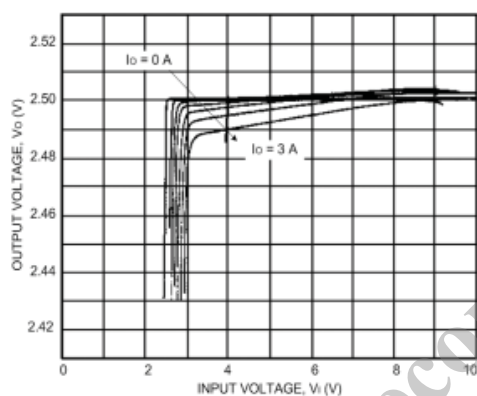
■ Low-Voltage Behavior



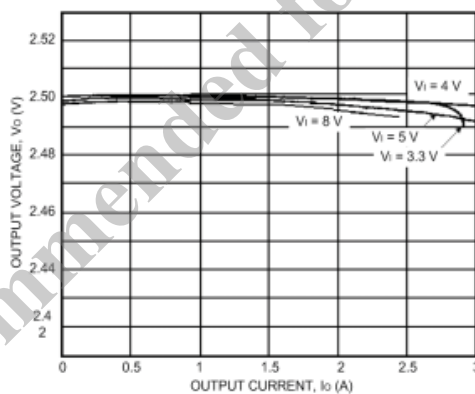
■ GND Pin Current



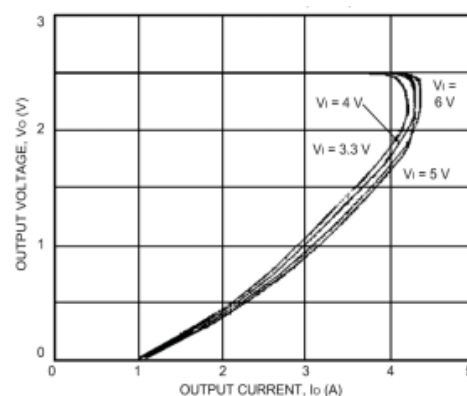
■ Line Regulation



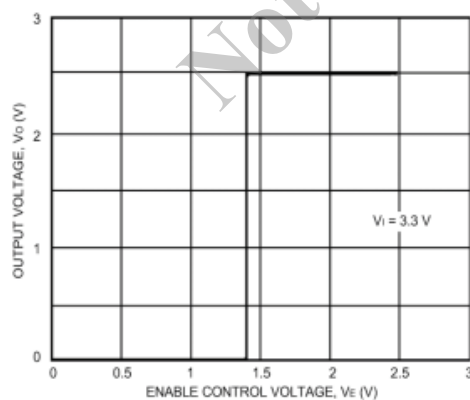
■ Load Regulation



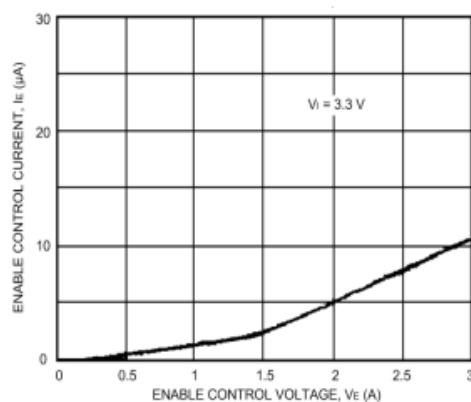
■ Overcurrent Protection



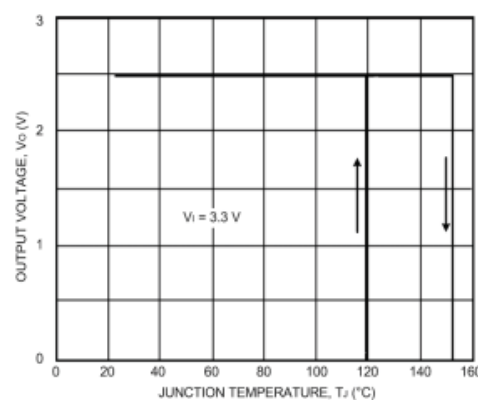
■ ENABLE Control Voltage



■ ENABLE Control Current



■ Thermal Protection



**Input Capacitor** ( $C_I$ , approximately 10  $\mu\text{F}$ ). This is necessary either when the input line includes inductance or when the wiring is long.

**Output Capacitor** ( $C_O$ , > 47  $\mu\text{F}$ ). This device is not designed for a use with a very low ESR output capacitor such as a ceramic capacitor. Output oscillation may occur with that kind of capacitor.

**Output Voltage Adjustable Resistors** (R1 and R2). The output voltage is adjusted by R1 and R2. 10 k $\Omega$  or 11 k $\Omega$  for R2 is recommended.

$$R1 = (V_O - V_{\text{ref}}) / (V_{\text{ref}} / R2)$$

For an output voltage of 1.8 V or less, add a 10 k $\Omega$  resistor between ADJ and the junction of R1 and R2.

**Determination of DC Input Voltage.** The minimum input voltage  $V_I(\text{min})$  should be higher than the sum of the fixed output voltage and the maximum rated dropout voltage. If setting the output voltage lower than 2.0 V, the minimum input voltage should be more than 2.4 V.

**Overcurrent Protection.** The SI-3000ZD series has a built-in fold-back type overcurrent protection circuit, which limits the output current at a start-up mode. It thus cannot be used in applications that require current at the start-up mode such as:

- (1) constant-current load,
- (2) power supply with positive and negative outputs to common load (a center-tap type power supply), or
- (3) raising the output voltage by putting a diode or a resistor between the device ground and system ground.

**Thermal Protection.** Circuitry turns off the pass transistor when the junction temperature rises above 135°C. It is intended only to protect the device from failures due to excessive junction temperatures and should not imply that output short circuits or continuous overloads are permitted.

**Heat Radiation and Reliability.** The reliability of the IC is directly related to the junction temperature ( $T_J$ ) in its operation. Accordingly, careful consideration should be given to heat dissipation. The graph on page 2 illustrates the effect of thermal resistance on the allowable package power dissipation.

The junction temperature ( $T_J$ ) can be determined from either of the following equations:

$$T_J = (P_D \times R_{\theta JA}) + T_A$$

or

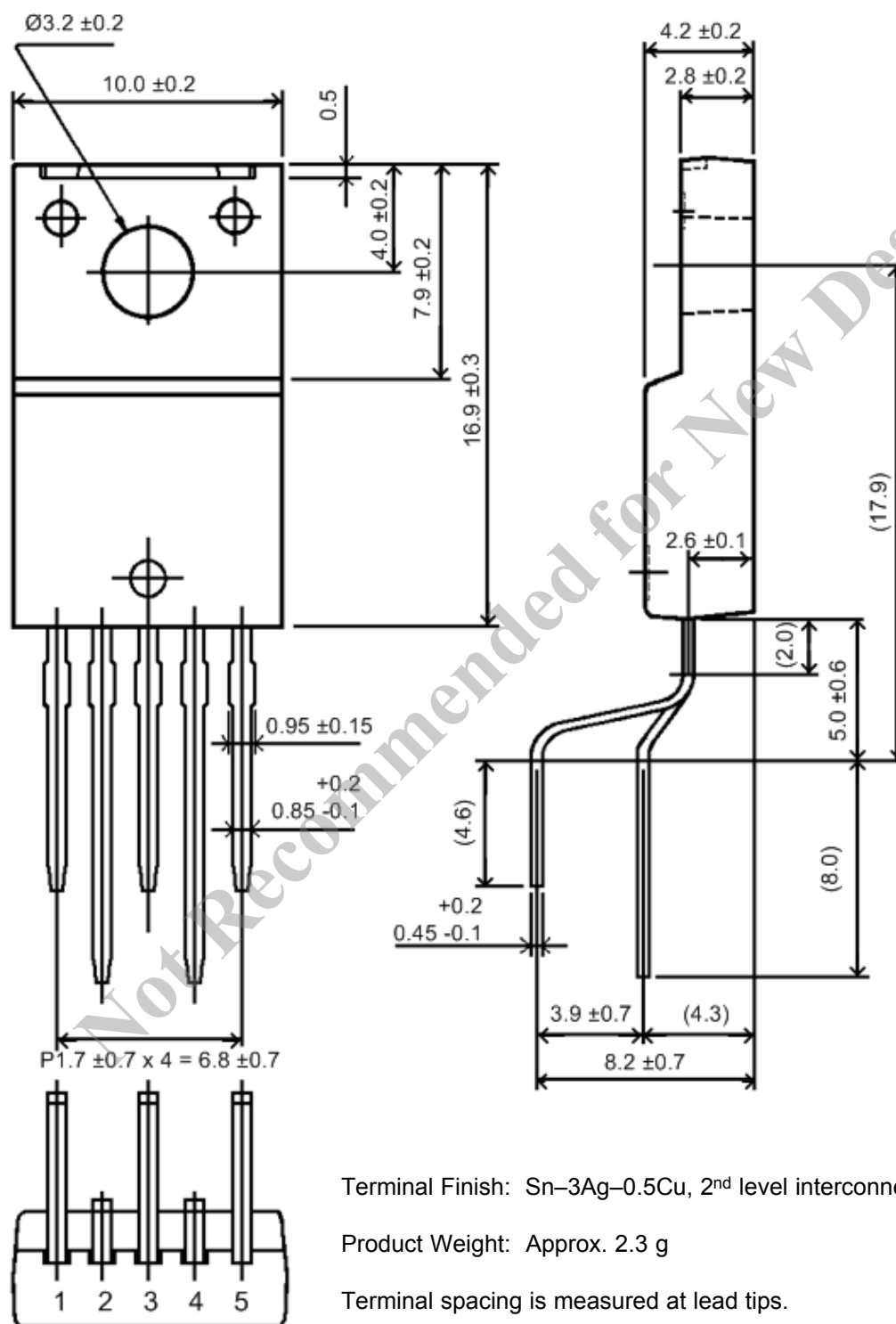
$$T_J = (P_D \times R_{\theta JC}) + T_C$$

where  $P_D = I_O \times (V_I - V_O)$  and

$$R_{\theta JC} = 5 \text{ } ^\circ\text{C/W.}$$

**Parallel Operation.** Parallel operation to increase load current is not permitted.

## Dimensions in Millimeters



Terminal Finish: Sn-3Ag-0.5Cu, 2<sup>nd</sup> level interconnect category (e1)

Product Weight: Approx. 2.3 g

Terminal spacing is measured at lead tips.

Because reliability can be affected adversely by improper storage environments and handling methods, please observe the following cautions.

Cautions for Storage

- Ensure that storage conditions comply with the standard temperature (5°C to 35°C) and the standard relative humidity (around 40% to 75%); avoid storage locations that experience extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present and avoid direct sunlight.
- Reinspect for rust on leads and solderability of the products that have been stored for a long time.

Cautions for Testing and Handling

- When tests are carried out during inspection testing and other standard test periods, protect the product from power surges from the testing device, shorts between adjacent product packages, and shorts to the heatsink.
- The screwing torque for attaching a heatsink shall be 58.8 to 68.6 N•cm (6.0 to 7.0 kgf•cm).
- Ensure there are no foreign objects between the heatsink and thermal pad; only silicone thermal grease is allowed.

Remarks About Using Silicone Grease with a Heatsink

- When silicone grease is used in mounting this product with a heatsink, grease shall be applied evenly and thinly. If more silicone grease than required is applied, it may produce stress.
- Volatile-type silicone greases may permeate the product and produce cracks after long periods of time, resulting in reduced heat radiation effect, and possibly shortening the lifetime of the product.
- Hard silicone greases may cause cracks in the product when screwing the product to a heatsink.

- Our recommended silicone greases for heat radiation purposes, which will not cause any adverse effect on the product life, are indicated below:

Type	Suppliers
G746	Shin-Etsu Chemical Co., Ltd.
YG6260	Momentive Performance Materials LLC
SC102	Dow Corning Toray Co., Ltd.

Soldering

- When soldering the products, please be sure to minimize the working time, within the following limits:  
260±5°C    10 s  
380±5°C    5 s
- Soldering should be at a distance of at least 1.5 mm from the body of the product.

Electrostatic Discharge

- When handling the products, the operator must be grounded. Grounded wrist straps worn should have at least 1 MΩ of resistance from the operator to ground to prevent shock hazard, and it should be placed near the operator.
- Workbenches where the products are handled should be grounded and be provided with conductive table and floor mats.
- When using measuring equipment such as a curve tracer, the equipment should be grounded.
- When soldering the products, the head of soldering irons or the solder bath must be grounded in order to prevent leak voltages generated by them from being applied to the product.
- The product should always be stored and transported in Sanken shipping containers or conductive containers, or be wrapped in aluminum foil.



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In addition, it should be noted that since power devices or IC's including power devices have large self-heating value, the degree of derating of junction temperature affects the reliability significantly.

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