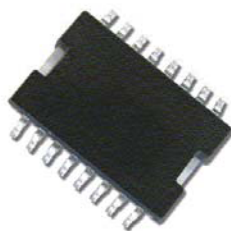
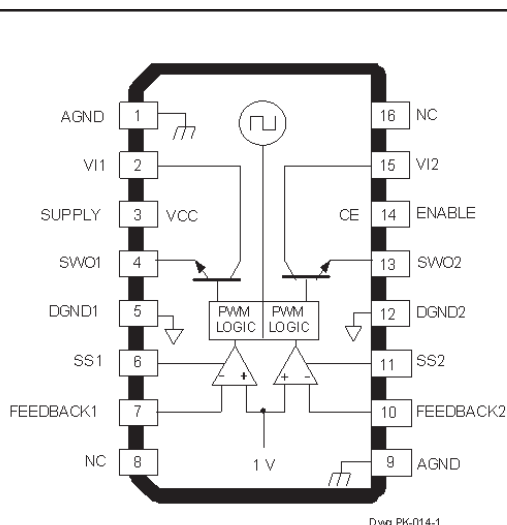


*Dual 1.5 A, DC/DC Step-Down Converter***ABSOLUTE MAXIMUM RATINGS**Input Voltage,  $V_I$ ,  $V_{CC}$ ,  $V_{CE}$  . . . . . **21 V**Output Current,  $I_O$  . . . . . **1.5 A\***Junction Temperature,  $T_J$  . . . . . **+135°C**Storage Temperature Range,  
 $T_S$  . . . . . **-40°C to +135°C**

\* 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 +135°C.

Designed to meet high-current requirements at high efficiency in industrial and consumer applications; embedded core, memory, or logic supplies; TVs, VCRs, and office equipment, the SPI-8001TW dc/dc step-down (buck) converter offers a constant 250 kHz switching frequency essential for small external components. The n-channel high-current FET is included on the die along with the oscillator, control, and logic circuitry.

A wide input voltage range and integrated thermal and overcurrent protection enhance overall system reliability. Reference accuracy and excellent temperature characteristics are provided. A chip-enable input gives the designer complete control over power up, standby, or power down. A similar device, with increased input and output voltage ratings, is the SPI-8002TW.

This device is supplied in a 16-lead surface-mount plastic SOIC with exposed pad to provide a low-resistance path for maximum power dissipation, low junction temperature, and improved reliability.

**FEATURES**

- To 20 V Input Range
- Adjustable 1 V to 16 V Output Range
- 1% Output Voltage Tolerance
- To 1.5 A Output Current
- Foldback Current Limiting
- Constant 250 kHz Switching Frequency
- 1.0  $\mu$ A Maximum Standby Current
- 1.0 V Feedback Reference Voltage
- Soft Start Avoids Supply Voltage Dip
- Remote Voltage Sensing
- Exposed Pad for Superior Heat Dissipation
- Thermal Protection

**APPLICATIONS**

- TVs, VCRs, Electronic Games
- Embedded Core, Memory, or Logic Supplies
- Printers and Other Office Equipment
- Industrial Machinery

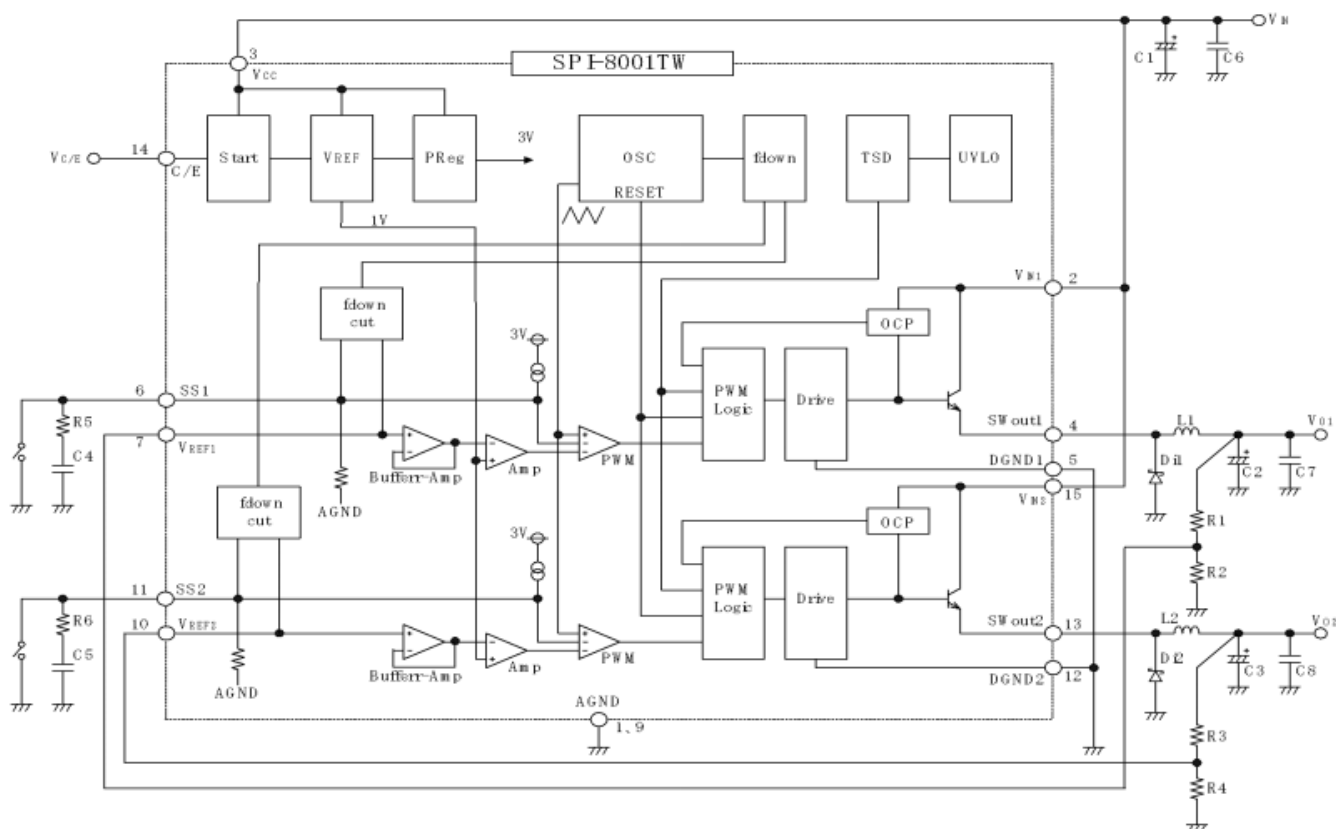
Always order by complete part number, e.g., **SPI-8001TW-TL** , where "-TL" indicates tape and reel.

# SPI-8001TW

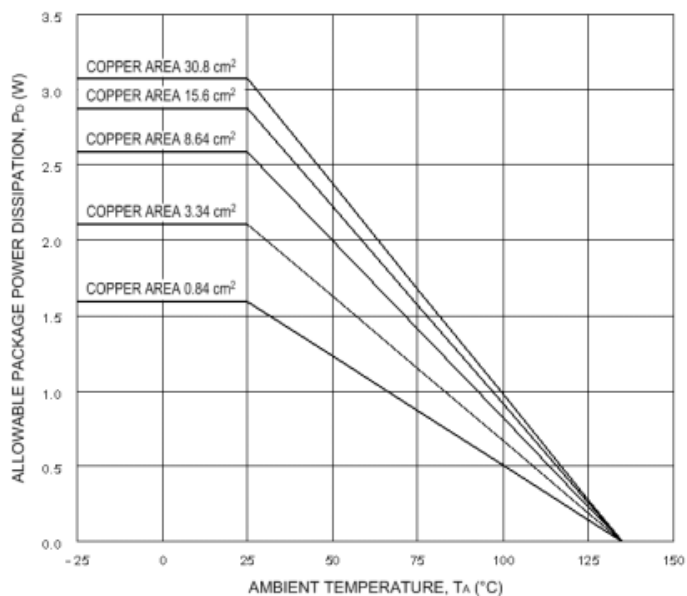
## Dual 1.5 A, DC/DC Step-Down Converter

Switching  
Regulators

### FUNCTIONAL BLOCK DIAGRAM



### Allowable Package Power Dissipation



### Recommended Operating Conditions

	Min	Max	Units
DC Input Voltage, $V_I$ *	$V_O + 3$	20	V
DC Input Voltage, $V_{CC}$	4.5	20	V
DC Output Current, $I_O$	0	1.5	A
DC Output Voltage, $V_O$	1	16	V
Operating Junction Temp.	-30	+135	°C†

\*The recommended maximum value is 20 V when the output value is more than 2 V, derated linearly to 10 V when the output is 1 V.

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

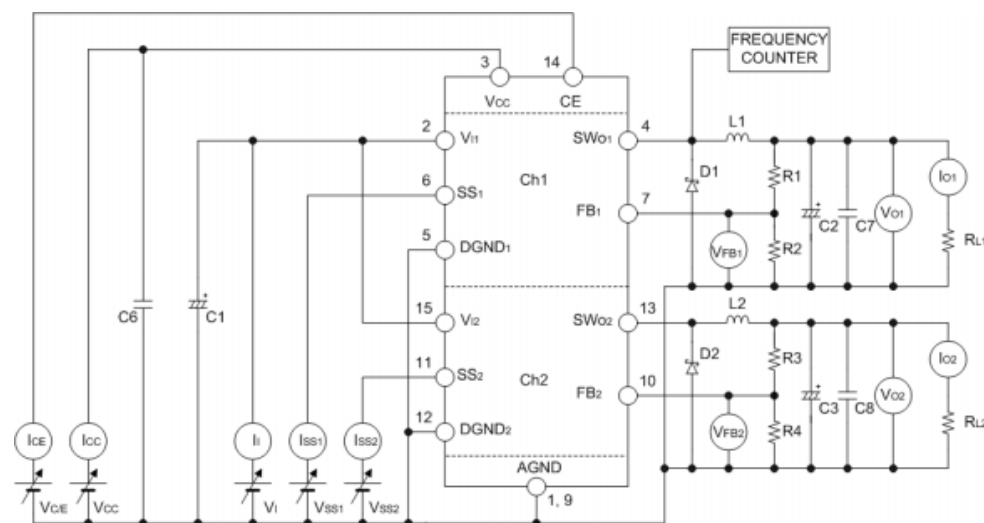
This data sheet is based on Sanken data sheet SSJ-02097E

**ELECTRICAL CHARACTERISTICS** at  $T_A = +25^\circ\text{C}$ ,  $V_I = V_{CC} = 15\text{ V}$  (unless otherwise noted).

Characteristic	Symbol	Test Conditions	Limits			
			Min.	Typ.	Max.	Units
Internal Reference Voltage	$V_{\text{ref}}$	$V_I = 10\text{ V}$ , $V_O = 1\text{ V}$ , $I_O = 0.1\text{ A}$	0.996	1.006	1.016	V
Ref. Volt. Temp. Coeff.	$a_{V_{\text{ref}}}$	$V_I = 10\text{ V}$ , $V_O = 1\text{ V}$ , $I_O = 0.1\text{ A}$	—	$\pm 0.1$	—	mV/ $^\circ\text{C}$
Output Short-Circuit Current	$I_{\text{OM}}$	See note	1.6	—	—	A
Efficiency	$\eta$	$V_O = 5\text{ V}$ , $I_O = 0.5\text{ A}$ , $I_I$ includes $I_{\text{CC}}$	—	80	—	%
		$V_{\text{CC}} = 5\text{ V}$ , $V_O = 5\text{ V}$ , $I_O = 0.5\text{ A}$ , $I_I$ does not include $I_{\text{CC}}$	—	83	—	%
Operating Frequency	$f$	$V_O = 5\text{ V}$ , $I_O = 0.5\text{ A}$	—	250	—	kHz
Line Regulation	$\Delta V_{O(\Delta V_I)}$	$V_I = V_{\text{CC}} = 10\text{ V} \sim 20\text{ V}$ , $V_O = 5\text{ V}$ , $I_O = 1\text{ A}$	—	30	60	mV
Load Regulation	$\Delta V_{O(\Delta I_O)}$	$V_O = 5\text{ V}$ , $I_O = 0.2\text{ A} \sim 1.5\text{ A}$	—	10	40	mV
Supply Current	$I_{\text{CC}}$	$I_O = 0\text{ A}$	—	8.5	—	mA
Quiescent Current	$I_{\text{IQ}}$	$V_{\text{CC}} = 5\text{ V}$ , $I_O = 0\text{ A}$ , $V_O \leq 12\text{ V}$	—	4.0	—	mA
		$V_{\text{CE}} = 0\text{ V}$ or open	—	—	1.0	$\mu\text{A}$
	$I_{\text{CCQ}}$	$V_{\text{CE}} = 0\text{ V}$ or open	—	—	1.0	$\mu\text{A}$
Chip Enable Voltage	$V_{\text{CEH}}$		2.0	—	—	V
	$V_{\text{CEL}}$		—	—	0.8	V
Chip Enable Input Current	$I_{\text{CE}}$	$V_{\text{CE}} = 20\text{ V}$	—	95	—	$\mu\text{A}$
Soft-Start Voltage	$V_{\text{SS}}$	Converter turn-off voltage	—	—	0.5	V
Soft-Start Current	$I_{\text{SS}}$	$V_{\text{SS}} = 0\text{ V}$	—	-60	-80	$\mu\text{A}$

Typical values are given for circuit design information only.

Note: Output short-circuit current is at point where output voltage has decreased 5% below  $V_{O(\text{nom})}$ .



**Test Circuit**

# SPI-8001TW

## Dual 1.5 A, DC/DC

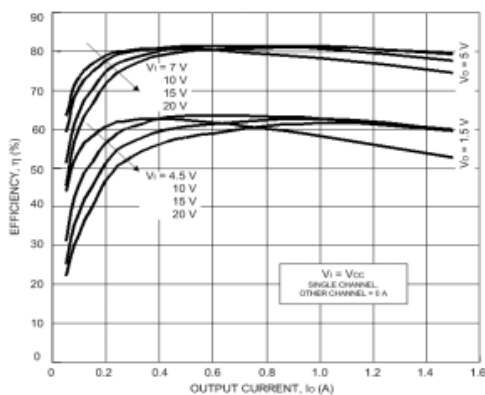
### Step-Down Converter

Switching  
Regulators

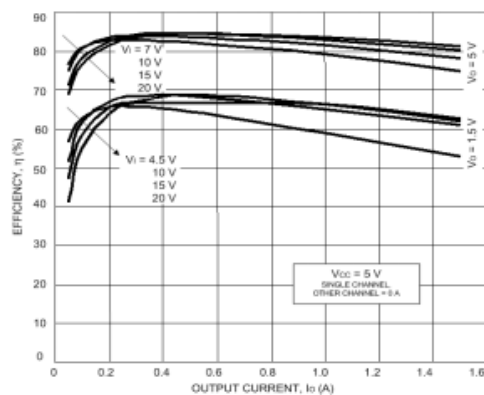
## TYPICAL CHARACTERISTICS

( $T_A = 25^\circ\text{C}$ )

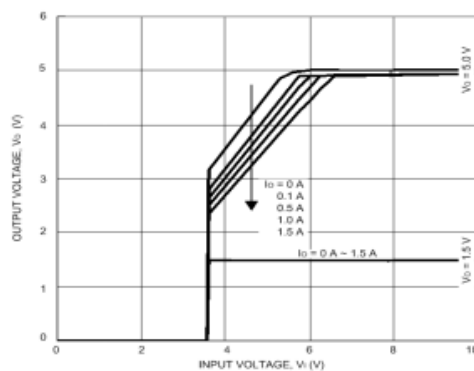
### ■ Efficiency



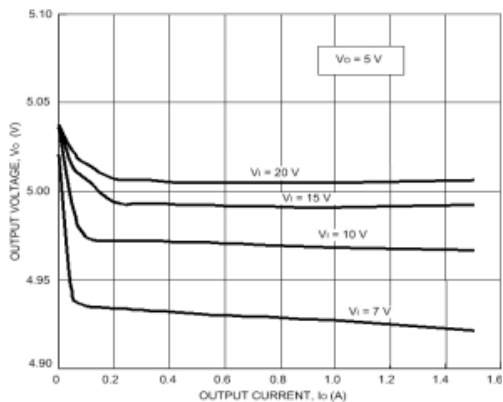
### ■ Efficiency



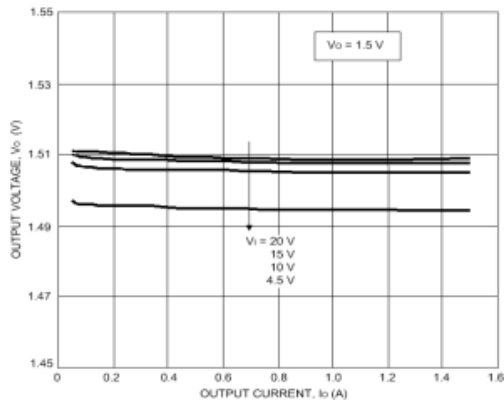
### ■ Low-Voltage Behavior



### ■ Load Regulation



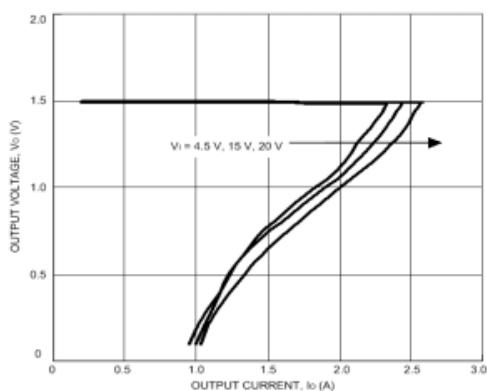
### ■ Load Regulation



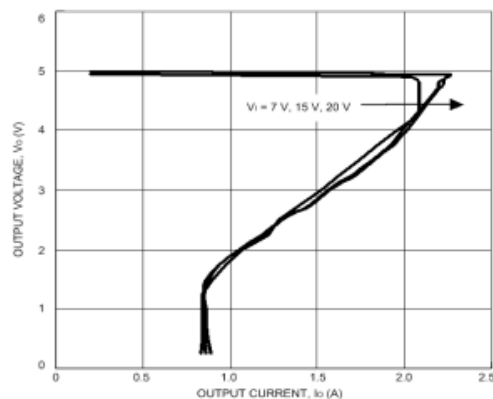
**TYPICAL CHARACTERISTICS (cont.)**

( $T_A = 25^\circ\text{C}$ )

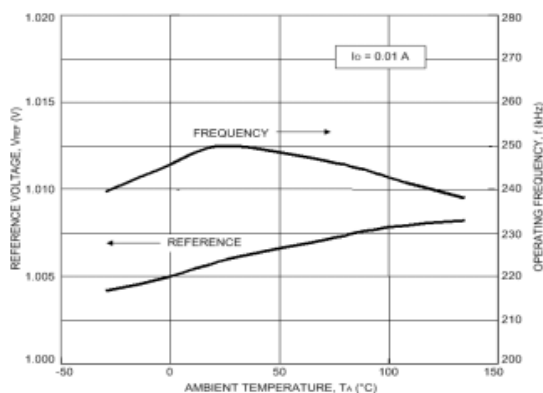
■ Overcurrent Protection



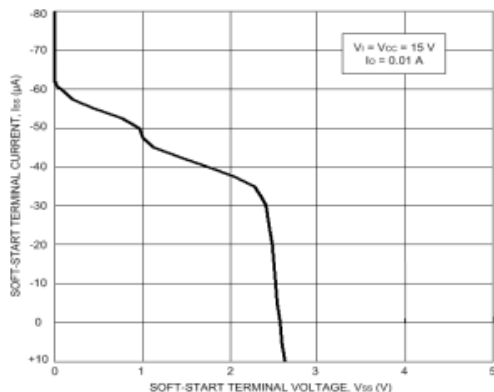
■ Overcurrent Protection



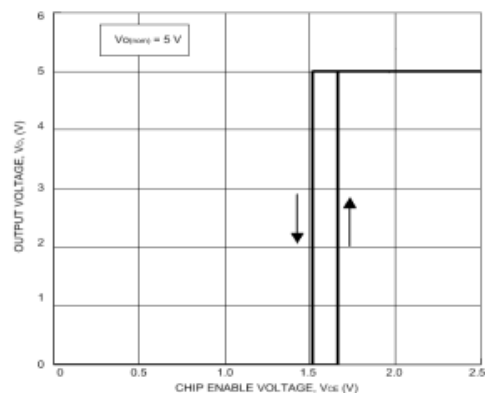
■ Temperature Stability



■ Soft-Start Current



■ Chip Enable Control Voltage



# SPI-8001TW

## Dual 1.5 A, DC/DC

### Step-Down Converter

Switching  
Regulators

## APPLICATIONS INFORMATION

**Input Capacitors** (C1 and C6). Capacitors with low impedance for high-frequency ripple current must be used.

**Output Capacitors** (C2, C3, C7, and C8). Capacitors with low impedance for high-frequency ripple current must be used. Especially when the C2 and C3 impedance is high, the switching waveform may not be normal at low temperatures. Film or tantalum capacitors for C2 and C3 may cause abnormal oscillations.

**Catch Diodes** (D1 and D2). Diode D1 and D2 must be Schottky diodes. Other diode types will result in increased forward voltage spikes, reverse current flow, increased IC power dissipation during the off period, and possible destruction of the IC.

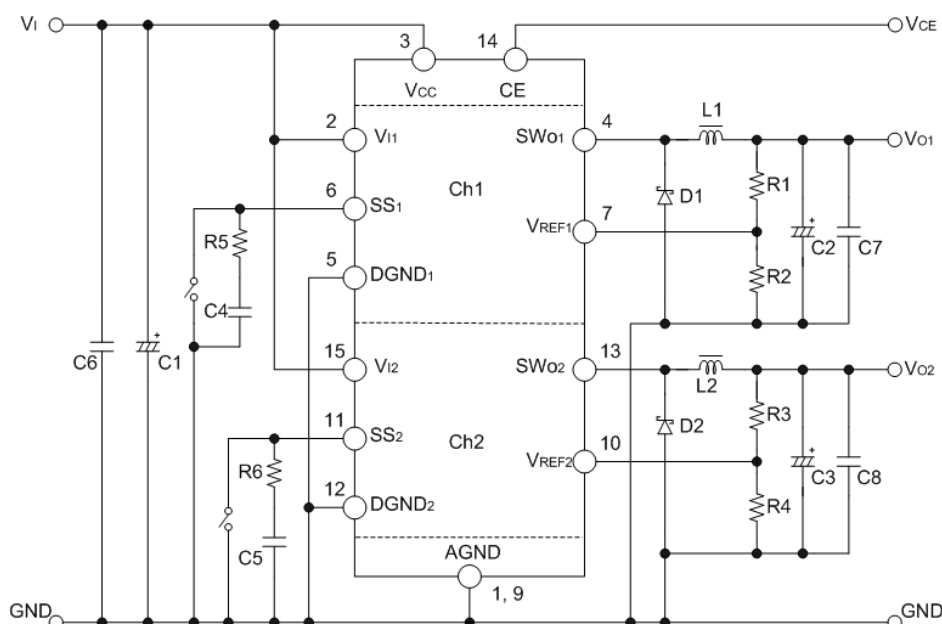
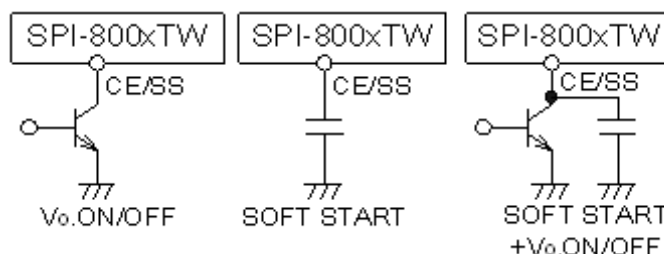
**Choke Coils** (L1 and L2). If the winding resistance of the choke coil is too high, the circuit efficiency will decrease. As the overcurrent protection start current is approximately 2 A, attention must be paid to the heating of the coil by magnetic saturation due to overload. To reduce the output ripple, the inductor may be increased at the expense of excessive board area and cost.

**Output Voltage Adjustable Resistors** (R1, R2, R3, and R4). The output voltages are adjusted by R1 and R3. 1000  $\Omega$  for R2 and R4 is recommended.

$$R1 = (V_{O1} - V_{ref}) / (V_{ref} / R2)$$

$$R3 = (V_{O2} - V_{ref}) / (V_{ref} / R4)$$

**Soft-Start Capacitors** (C4 and C5). Soft start for each converter channel is enabled by connecting a capacitor between terminal 6 and/or 11 and ground. The channel may be turned off by decreasing the terminal 6 and/or 11 voltage below 0.5 V with either an npn small-signal transistor or the output of open-collector TTL. If both a large soft-start capacitor and on/off control are desired, collector current limiting (R5 and R6) must be used to prevent transistor damage. No external voltage can be applied to terminal 6 or 11.



## Typical Application

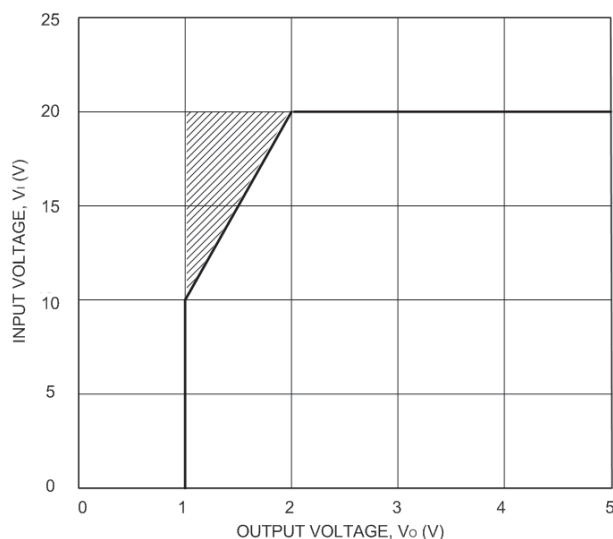
C1	220 $\mu$ F/63 V
C2, C3	470 $\mu$ F/25 V
C4, C5	1 $\mu$ F
C6, C7, C8	0.1 $\mu$ F
R5, R6	1 k $\Omega$
L1, L2	47 $\mu$ H
D1, D2	Sanken SFPB-66

## APPLICATIONS INFORMATION (cont.)

**Overcurrent Protection.** The SPI-8000TW 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:

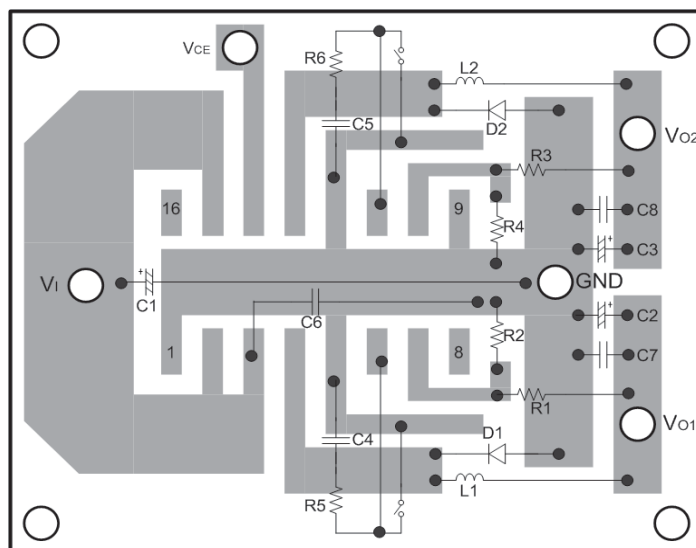
- (1) constant-current load,
- (2) power supply with positive and negative outputs to common load (a center-tap type power supply), or
- (3) raising the output voltage by putting a diode or a resistor between the device ground and system ground.

**Determination of DC Input Voltage.** The minimum value of dc input voltage is  $V_O + 3\text{ V}$ . The recommended maximum value is 20 V when the output value is more than 2 V, derated linearly to 10 V when the output is 1 V.



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

**Thermal Protection.** Circuitry turns off the device 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.



## Layout Guideline

**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 inner frame on which the integrated circuit is mounted is connected to the exposed pad. Therefore, it is very effective for heat radiation to enlarge the copper area that is connected to the pad. The graph on page 2 illustrates the effect of the copper area on the junction-to-ambient thermal resistance ( $R_{\theta JA}$ ).

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

$$T_J = (P_D \times R_{\theta JL}) + T_L$$

where

$$R_{\theta JL} = 9^\circ\text{C/W}$$

and

$$P_D = V_O \times I_O \left( \frac{100}{\eta x} - 1 \right) - V_F \times I_O \left( 1 - \frac{V_O}{V_{IN}} \right)$$

where  $V_O$  is the output voltage,  $V_{IN}$  is the input voltage,  $I_O$  is the output current  $\eta x$  is efficiency (%) and  $V_F$  is the diode forward voltage SFPB-66 (0.45 V,  $I_O = 1\text{ A}$ ).

## Switching Regulators

Lead Temperature  
( $T_L$ ) Measured at  
Terminal 1 or 9



Technical drawing of a mechanical part with dimensions and tolerances. The drawing shows a central vertical section with a central hole. The dimensions and tolerances are as follows:

- Top left dimension: 1 pin
- Top right dimension: 16 pin
- Bottom left dimension: 8 pin
- Bottom right dimension: 9 pin
- Bottom left dimension: 1.5 ± 0.1
- Bottom left dimension: 0.5 ± 0.1
- Bottom left dimension: 7.5 ± 0.2
- Bottom left dimension: (11.1)
- Bottom left dimension: (+.5)
- Bottom right dimension: (0.4)
- Bottom right dimension: (0.87)



8

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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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