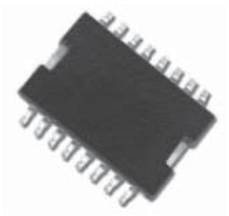
# SPI-8003TW

## *Dual 1.5 A DC-to-DC Step-Down Converter*

### Features and Benefits

- Input range to 38 V
- Adjustable 1 to 24 V output range
- 1% output voltage tolerance
- Output current to 1.5 A
- Foldback current Limiting
- 200 to 400 kHz switching frequency
- 1.0 µA 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

### Package: 16 pin SOIC



*Not to scale*

### Description

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-8003TW DC-to-DC step-down (buck) converter offers a variable 200 to 400 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.

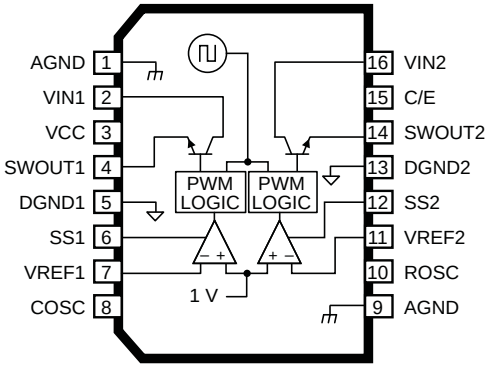
A wide input voltage range and integrated thermal and overcurrent protection enhance overall system reliability. Reference accuracy and excellent temperature characteristics are provided. A chip-enable input gives the designer complete control over power-up, standby, or power-down.

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.

Applications include:

- TVs, VCRs, and electronic games
- Embedded core, memory, or logic supplies
- Printers and other office equipment
- Industrial machinery

### Pin-out Diagram






SANKEN ELECTRIC CO., LTD.
http://www.sanken-ele.co.jp/en/

### Selection Guide

| Part Number | Package | Packing* |
|---|---|---|
| SPI-8003TW-TL | SOIC-16 surface mount | 1400 pieces reel |

*Contact Allegro for additional packing options

### ABSOLUTE MAXIMUM RATINGS

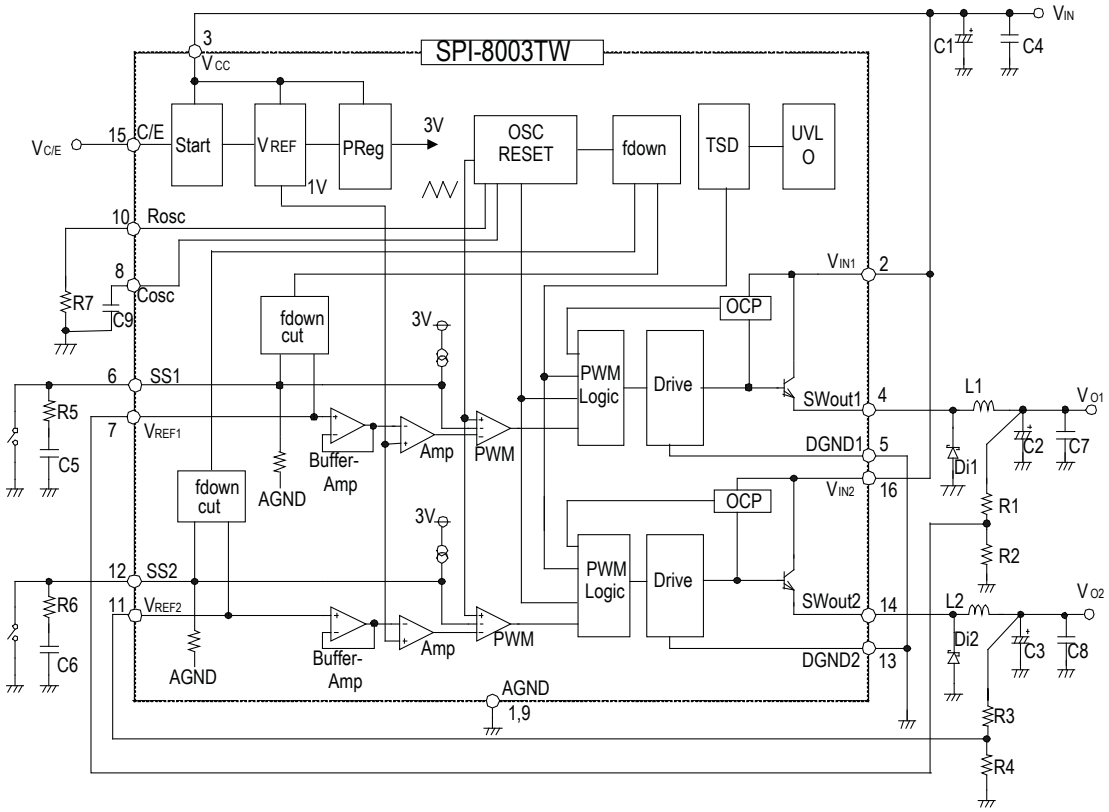
| Characteristic | Symbol | Notes | Rating | Units |
|---|---|---|---|---|
| Input Voltage | $V_I$, $V_{CC}$, $V_{CE}$ | | 40 | V |
| Junction Temperature | $T_J$ | | 150 | °C |
| Storage Temperature Range | $T_{stg}$ | | –40 to 150 | °C |

### Recommended Operating Conditions

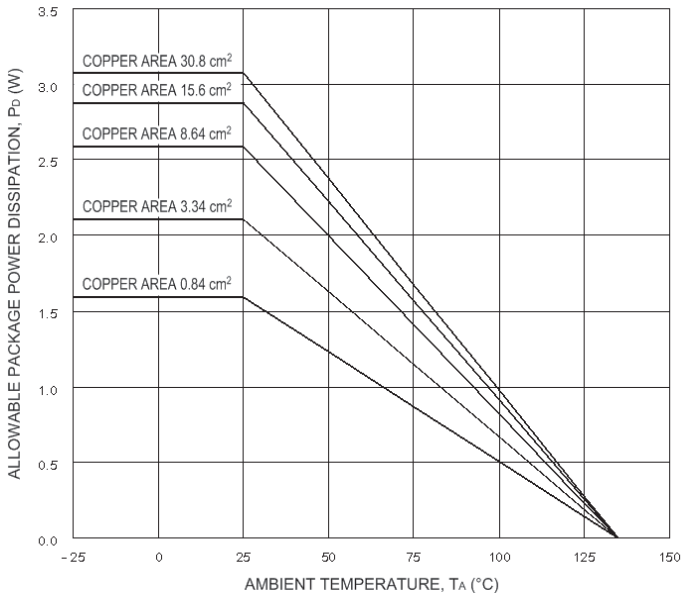
| Characteristic | Symbol | Notes | Min | Max | Units |
|---|---|---|---|---|---|
| Dc Input Voltage | $V_I$ | The recommended maximum value is 38 V when the output value is more than 4.75 V, derated linearly to 8 V when the output is 1 V. | $V_O$ + 3 | 38 | V |
| Dc Input Voltage | $V_{CC}$ | | 4.5 | 38 | V |
| Dc Output Current | $I_O$ | | 0 | 1.5 | A |
| Dc Output Voltage | $V_O$ | | 1 | 24 | V |
| Operating Junction Temperature | $T_{JOP}$ | | –30 | 125 | °C |

All performance characteristics given are typical values for circuit or system baseline design only and are at the nominal operating voltage and an ambient temperature, $T_A$, of 25°C, unless otherwise stated.

## FUNCTIONAL BLOCK DIAGRAM




## Allowable Package Power Dissipation



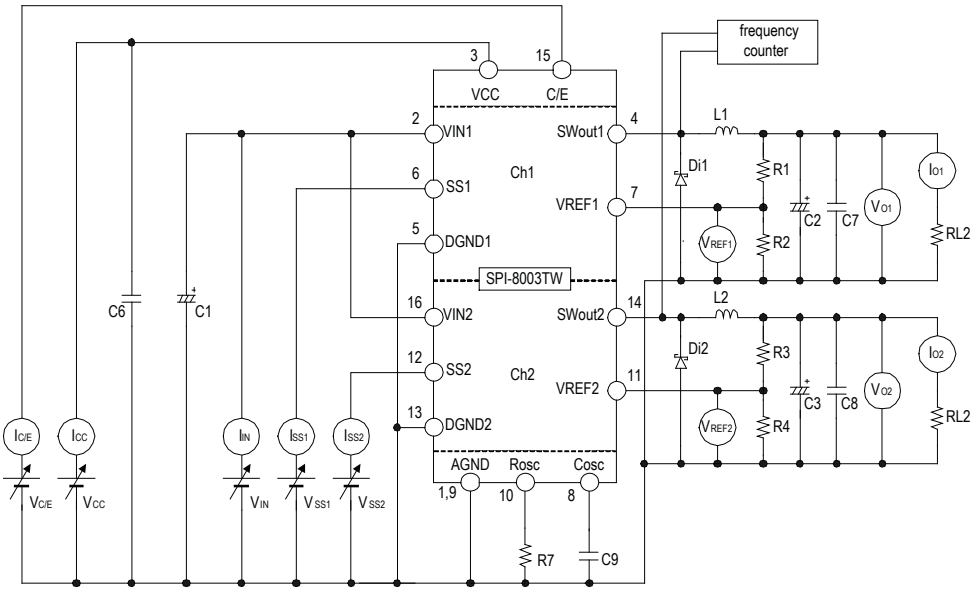
**ELECTRICAL CHARACTERISTICS,[a] valid at $T_A$=25°C**

| Characteristic | Symbol | Test conditions | Min. | Ttp. | Max. | Units |
|---|---|---|---|---|---|---|
| Reference Voltage | $V_{REF}$ | $V_{IN}$=14 V, $I_O$=0.1 A | 0.996 | 1.006 | 1.016 | V |
| Reference Voltage Temperature Coefficient | $\Delta V_{REF}/\Delta T$ | $V_{IN}$=14 V, $I_O$=0.1 A,$T_A$= –30°C to 125°C | – | ±0.1 | – | mV/°C |
| Efficiency 1[b] | Eff1 | $V_{IN}$=$V_{CC}$=14 V,$V_O$= 5 V,$I_O$= 0.5 A, $I_{IN}$ includes $I_{CC}$ | – | 78 | – | % |
| Efficiency 2[b] | Eff2 | $V_{IN}$=14 V, $V_O$ =5 V,$I_O$= 0.5 A,$V_{CC}$ =5 V, $I_{IN}$ does not include $I_{CC}$ | – | 81 | – | % |
| Operating Frequency Range | $f_{OSC}$ | $V_{IN}$=14 V, $I_O$= 0.1 A, $C_{OSC}$= 100 pF | 200 | – | 400 | kHz |
| Line Regulation | $V_{Line}$ | $V_{IN}$=$V_{CC}$= 9 to 18 V, $V_O$= 5 V, $I_O$ = 1 A | – | 30 | 60 | mV |
| Load Regulation | $V_{Load}$ | $V_{IN}$= $V_{CC}$=14 V, $V_O$ = 5 V, $I_O$= 0.2 to1.5 A | – | 10 | 40 | mV |
| Overcurrent Protection Starting Current | $I_S$ | $V_{IN}$= $V_{CC}$=14 V | 1.6 | – | – | A |
| Quiescent Current 1 | $I_{IN}$ | $V_{IN}$= 14 V, $V_{CC}$= 5 V, $I_O$= 0 A,$V_O$ ≤12 V | – | 4 | – | mA |
| Quiescent Current 2 | $I_{CC}$ | $V_{CC}$= 14 V, $I_O$= 0 A | – | 8.5 | – | mA |
| Quiescent Current 3 | $I_{IN(off)}$ | $V_{IN}$= 14 V, $V_{C/E}$ = low or open | – | – | 1 | µA |
| Quiescent Current 4 | $I_{CC(off)}$ | $V_{CC}$= 14 V, $V_{C/E}$ = low or open | – | – | 1 | µA |
| Quiescent Current 5 | $I_{IN(SS0V)}$ | $V_{IN}$= 14 V, $V_{CC}$= 5 V, $I_O$= 0 A, SS1= SS2 = 0 V | – | 4 | – | mA |
| Quiescent Current 6 | $I_{CC(SS0V)}$ | $V_{CC}$= 14 V, $I_O$= 0 A, SS1=SS2= 0 V | – | 8.5 | – | mA |
| C/E Terminal High Level Voltage | $V_{C/E(H)}$ | $V_{IN}$=$V_{CC}$= 14 V | – | 2.0 | – | V |
| C/E Terminal Low Level Voltage | $V_{C/E(L)}$ | $V_{IN}$=$V_{CC}$= 14 V | – | – | 0.8 | V |
| C/E Terminal Inflow Current At High Level Voltage | $I_{C/E(H)}$ | $V_{C/E}$ = 20 V | – | 95 | – | µA |
| SSx Terminal Low Level Voltage[c] | $V_{SSL}$ | $V_{IN}$= $V_{CC}$= 14 V | – | – | 0.5 | V |
| SSx Terminal Outflow Current at Low Level Voltage | $I_{SSL}$ | $V_{SSL}$ = 0 V, $V_{IN}$ = $V_{CC}$ = 14 V | – | 60 | 80 | µA |

[a]Electrical characteristics indicate specific limits, which are guaranteed when IC is operated under the measurement conditions shown in the Test Circuit diagram, below.

[b]Efficiency is calculated by the following equation: $\eta$ (%) = $[(V_O \times I_O) / (V_{IN} \times I_{IN})] \times 100$ .

[c]Terminals 6 and 12, SS1 and SS2, are used to enable soft start by connecting a capacitor. The output can be turned on and off by using a SS*x* terminal. The output is stopped by decreasing the SS*x* terminal voltage below $V_{SSL}$. In order to perform ON/OFF operation of $V_O$, it is required to connect an NPN transistor or the output of an open collector type TTL transistor between SS1 or SS2 terminals and AGND. In case both soft start and $V_O$ ON/OFF are used, a protection measure such as limitation of current is required, because the discharge current of C4 and C5 (see Typical Application diagram, page 7) flows across a transistor for ON/OFF operation, if the capacitance of C4 and C5 is large. Because a pull-up type resistor is provided inside the IC, no external voltage can be applied.

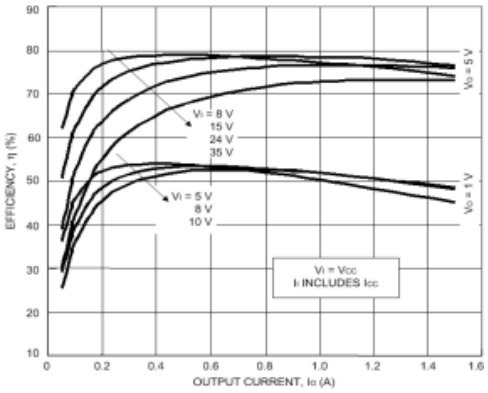



Test Circuit

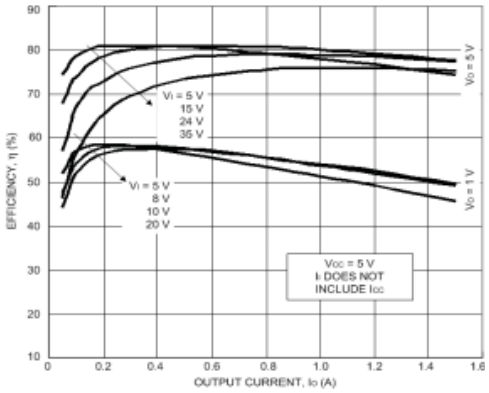
## TYPICAL CHARACTERISTICS

($T_A$ = 25°C)

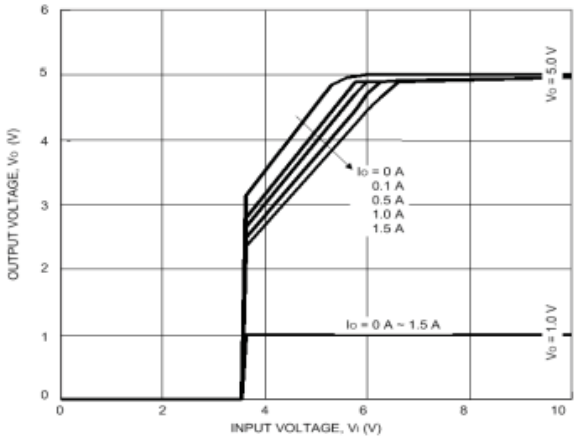
■ Efficiency



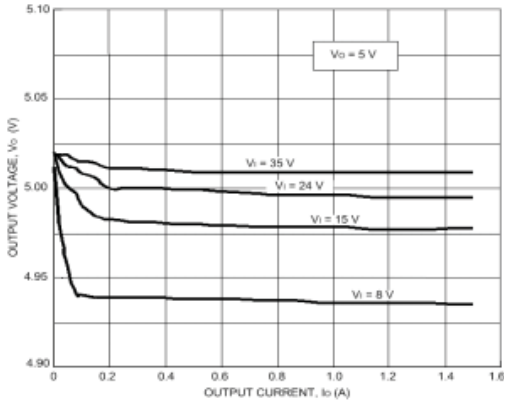

■ Efficiency



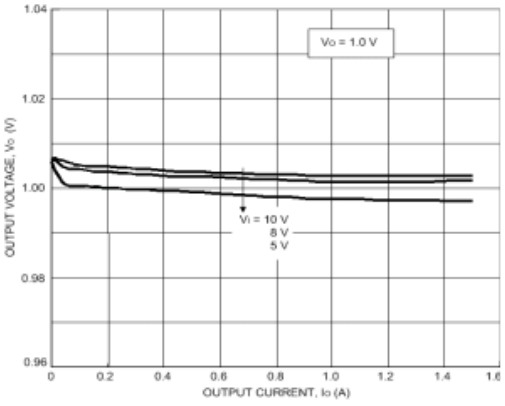

■ Low-Voltage Behavior




■ Load Regulation



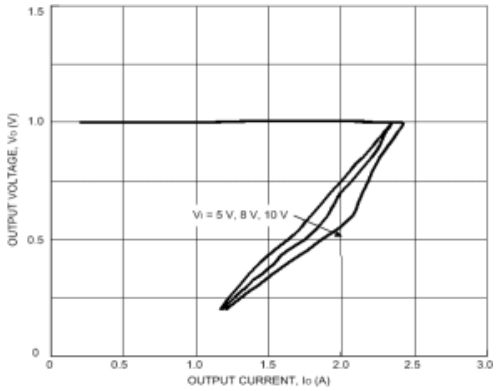

■ Load Regulation



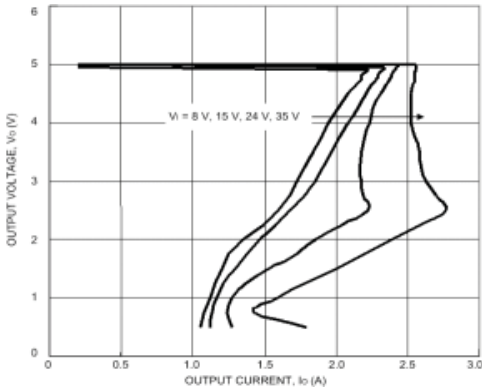
## TYPICAL CHARACTERISTICS (cont.)

($T_A$ = 25°C)

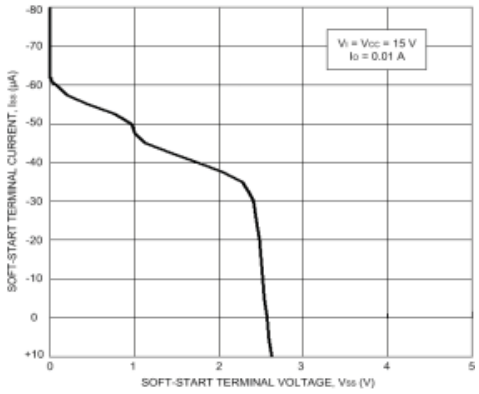
■ Overcurrent Protection



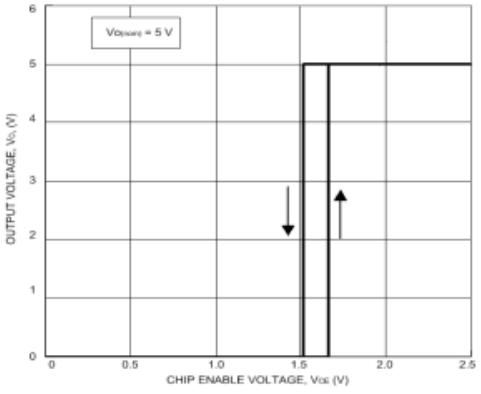

■ Overcurrent Protection




■ Soft-Start Current




■ Chip Enable Control Voltage



## APPLICATIONS INFORMATION

**Input Capacitors** (C1 and C4). 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.

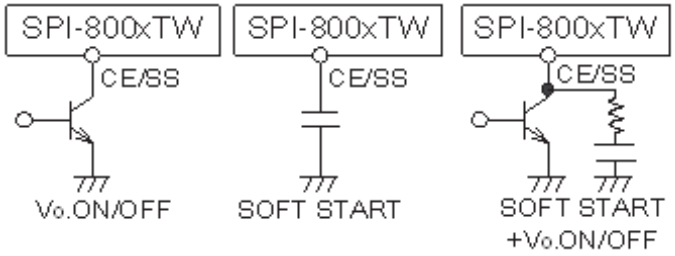
**Catch Diodes** (D1 and D2). Diode D1 and D2 must be Schottky diodes. Other diode types will result in increased forward voltage spikes, reverse current flow, increased IC power dissipation during the off period, and possible destruction of the IC.

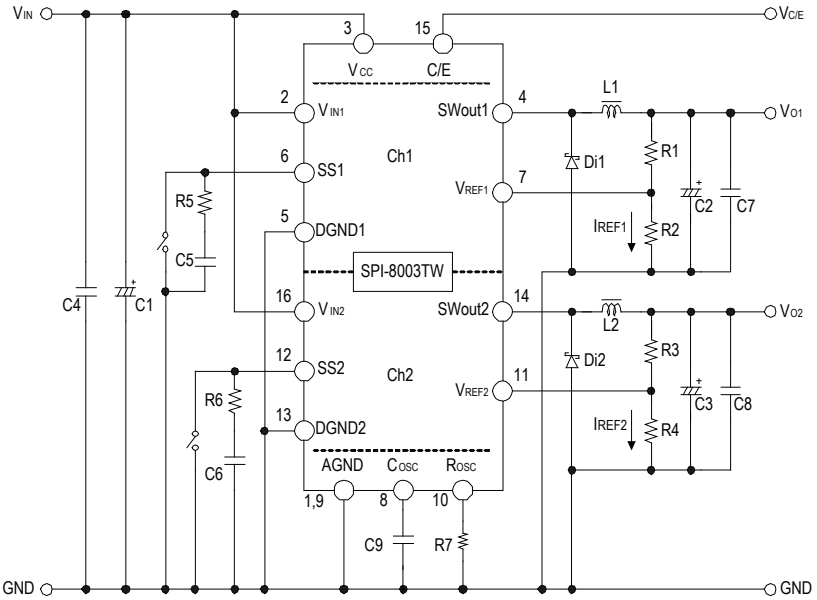
**Choke Coils** (L1 and L2). If the winding resistance of the choke coil is too high, the circuit efficiency will decrease. As the overcurrent protection start current is approximately 2 A, attention must be paid to the heating of the coil by magnetic saturation due to overload. To reduce the output 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 Ω 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** (C5 and C6). Soft start for each converter channel is enabled by connecting a capacitor between terminal 6 and/or 12 and ground. The channel may be turned off by decreasing the terminal 6 and/or 12 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 12.



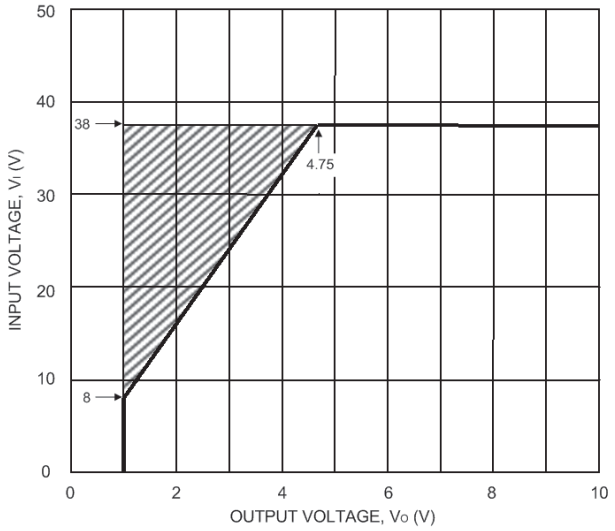

### Typical Application

| | |
|---|---|
| C1, | 220 µF/50 V |
| C2, C3 | 470 µF/25 V |
| C4 | 0.1 µF/50 V |
| C5, C6 | 1 uF/10 V |
| C7, C8 | 0.1 µF/50 V |
| C9 | 100 pF/10 V |
| L1, L2 | 47 µH |
| R2, R4 | 1 kΩ |
| R5, R6 | 1 kΩ |
| R7 | 30 kΩ |

## APPLICATIONS INFORMATION (cont.)

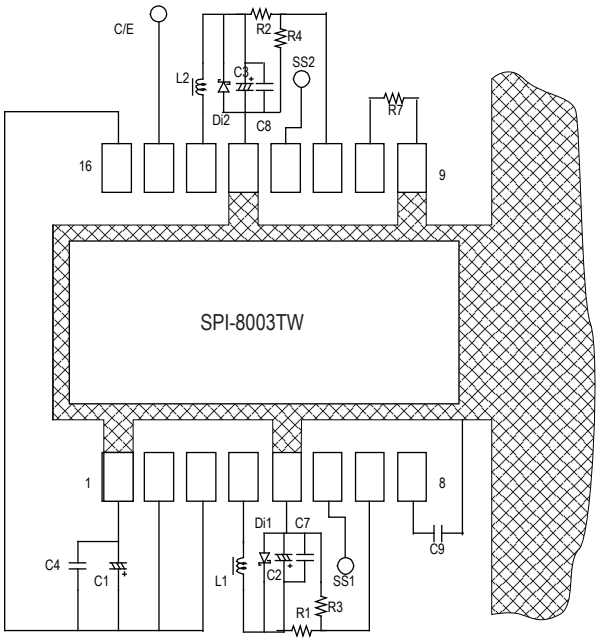
**Overcurrent Protection.** The SPI-8000TW series has a built-in fold-back type overcurrent protection circuit, which limits the output current at a start-up mode. It thus cannot be used in applications that require current at the start-up mode such as:
(1) constant-current load,
(2) power supply with 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 V. The recommended maximum value is 38 V when the output value is more than 4.75 V, derated linearly to 8 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 3 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:

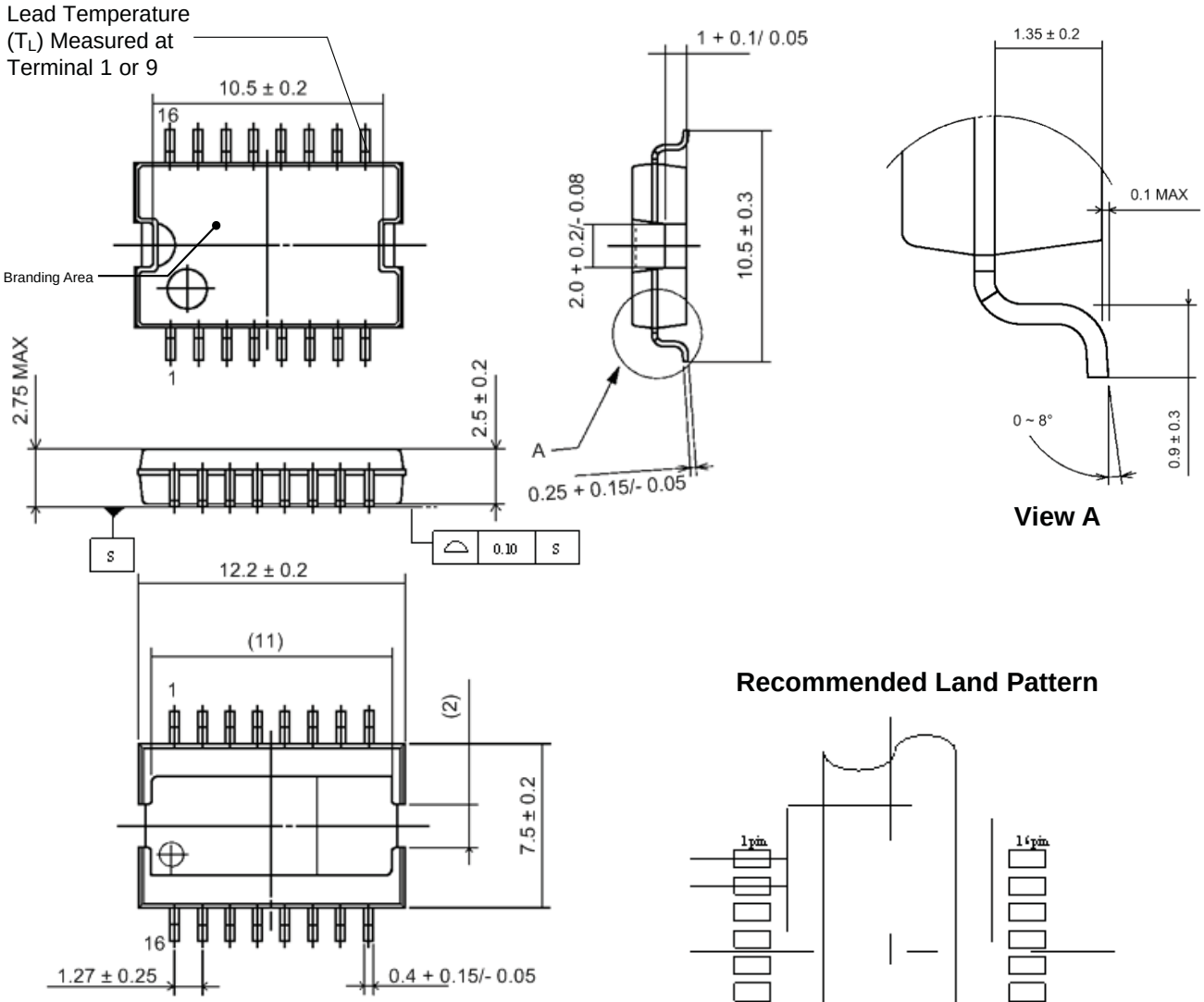
$$T_J = (P_D \times R_{\theta JA}) + T_A$$

or

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

where $P_D = I_{O1}(V_{I1} - V_{O1}) + I_{O2}(V_{I2} - V_{O2}) + V_{CC}I_{CC}$ and
$R_{\theta JL}$ = 9°C/W.

**Dimensions in Millimeters**




Branding codes (exact appearance at manufacturer discretion):
1st line, type: 8003TW
2nd line, lot: *YMW*
where: Y is the last digit of the year of manufacture
M is the month (*1* to *9*, *O*, *N*, *D*)
W is the week of the month (1 to 6)
3rd line, tracking number: *nnnnn*

**Recommended Land Pattern**




Product Weight: Approx. 0.859 g
Devices are lead (Pb) free.

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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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