

## SPI-8001TW/SPI-8002TW/SPI-8003TW 2-Output, Step-down Switching Mode

### ■ Features

- 2 regulators combined in one package
- Output current: 1.5A × 2 (HSOP 16 Pin Surface mount package)
- High efficiency: TYP80% (SPI-8001TW), TYP78% (SPI-8002TW)
- Variable output voltage: 1.0 to 16V (SPI-8001TW), 1.0 to 24V (SPI-8002TW)
- Built-in reference oscillator (250kHz): Enables to downsize a choke-coil
- Low circuit current consumption:  $\leq 1\mu\text{A}$  (at output OFF)
- High accuracy reference voltage:  $\pm 1\%$
- Built-in foldback-overcurrent and thermal protection circuits
- Built-in ON/OFF circuit (soft start available) – per output

### ■ Applications

- Onboard local power supplies
- OA equipment
- For stabilization of the secondary-side output voltage of switching power supplies

### ■ Absolute Maximum Ratings\*1

Parameter	Symbol	Ratings			Unit
		SPI-8001TW	SPI-8002TW	SPI-8003TW	
Input Voltage	V <sub>IN</sub>	21	40	40	V
	V <sub>CC</sub>	21	40	40	V
	V <sub>C/E</sub>	21	40	40	V
Power Dissipation*2, *3	P <sub>D</sub>	3.0			W
Junction Temperature	T <sub>J</sub>	+135		+150	°C
Storage Temperature	T <sub>stg</sub>	-40 to +135		-40 to +150	°C
Thermal Resistance (junction to case)*2	$\theta_{j-c}$	9.0			°C/W
Thermal Resistance (junction to ambient air)*2	$\theta_{j-a}$	35.8			°C/W

\*1: Absolute maximum ratings show the destructive limit. No parameter should exceed the ratings in transient or normal operations.

\*2: When mounted on glass-epoxy board 70cm<sup>2</sup> (copper laminate area 30.8cm<sup>2</sup>).

\*3: Limited by thermal protection.

### ■ Recommended Operating Conditions\*1

Parameter	Symbol	Ratings						Unit
		SPI-8001TW		SPI-8002TW		SPI-8003TW		
		min.	max.	min.	max.	min.	max.	
Input Voltage Range	V <sub>IN</sub>	V <sub>O+3</sub>	20	V <sub>O+3</sub>	38	V <sub>O+3</sub>	38	V
	V <sub>CC</sub>	4.5	20	4.5	38	4.5	38	V
	V <sub>C/E</sub>		20		38		38	V
Output Voltage Range	V <sub>O</sub>	1	16	1	24	1	24	V
Output Current Range	I <sub>O</sub>		1.5		1.5		1.5	A
Operating Junction Temperature Range	T <sub>jop</sub>	-30	+135	-30	+135	-30	+125	°C
Operating Temperature Range	T <sub>op</sub>	-30	+135	-30	+135	-30	+85	°C

\*1: Recommended operating conditions show the operating conditions required for the normal circuit function described in the electrical characteristics. These conditions must be followed in actual use.

■Electrical Characteristics\*1

(Ta=25°C)

Parameter	Symbol	Ratings									Unit	
		SPI-8001TW			SPI-8002TW			SPI-8003TW				
		min.	typ.	max.	min.	typ.	max.	min.	typ.	max.		
Reference Voltage	V <sub>REF</sub>	0.996	1.006	1.016	0.996	1.006	1.016	0.966	1.006	1.016	V	
	Conditions	V <sub>IN</sub> =10V, V <sub>O</sub> =1V, I <sub>O</sub> =0.1A						V <sub>IN</sub> =14V, I <sub>O</sub> =0.1A				
Temperature Coefficient of Reference Voltage	ΔV <sub>REF</sub> /ΔT		±0.1			±0.1			±0.1		mV/°C	
	Conditions	V <sub>IN</sub> =10V, V <sub>O</sub> =1V, I <sub>O</sub> =0.1A, Ta=-30 to +135°C						V <sub>IN</sub> =14V, I <sub>O</sub> =0.1A, Ta=-30 to +125°C				
Efficiency 1 <sup>2</sup>	Eff1		80			78			78		%	
	Conditions	V <sub>IN</sub> =V <sub>CC</sub> =15V, V <sub>O</sub> =5V, I <sub>O</sub> =0.5A, I <sub>IN</sub> : including I <sub>CC</sub>						V <sub>IN</sub> =V <sub>CC</sub> =14V, V <sub>O</sub> =5V, I <sub>O</sub> =0.5A, I <sub>IN</sub> : including I <sub>CC</sub>				
Efficiency 2 <sup>2</sup>	Eff2		83			81			81		%	
	Conditions	V <sub>IN</sub> =15V, V <sub>O</sub> =5V, I <sub>O</sub> =0.5A, V <sub>CC</sub> =5V, I <sub>IN</sub> : excluding I <sub>CC</sub>						V <sub>IN</sub> =14V, V <sub>CC</sub> =5V, V <sub>O</sub> =5V, I <sub>O</sub> =0.5A, I <sub>IN</sub> : excluding I <sub>CC</sub>				
Oscillation Frequency	f <sub>osc</sub>		250		215	250	285	200		400	kHz	
	Conditions	V <sub>IN</sub> =V <sub>CC</sub> =15V, V <sub>O</sub> =5V, I <sub>O</sub> =0.5A						V <sub>IN</sub> =14V, I <sub>O</sub> =0.1A, C <sub>OSC</sub> =100pF				
Line Regulation	V <sub>LINE</sub>		30	60		30	60		30	60	mV	
	Conditions	V <sub>IN</sub> =V <sub>CC</sub> =10 to 20V, V <sub>O</sub> =5V, I <sub>O</sub> =1A						V <sub>IN</sub> =V <sub>CC</sub> =9 to 18V, V <sub>O</sub> =5V, I <sub>O</sub> =1A				
Load Regulation	V <sub>LOAD</sub>		10	40		10	40		10	40	mV	
	Conditions	V <sub>IN</sub> =V <sub>CC</sub> =15V, V <sub>O</sub> =5V, I <sub>O</sub> =0.2 to 1.5A						V <sub>IN</sub> =V <sub>CC</sub> =14V, V <sub>O</sub> =5V, I <sub>O</sub> =0.2 to 1.5A				
Overcurrent Protection Starting Current	I <sub>S</sub>	1.6			1.6			1.6			A	
	Conditions	V <sub>IN</sub> =V <sub>CC</sub> =15V						V <sub>IN</sub> =V <sub>CC</sub> =14V				
Quiescent Circuit Current 1	I <sub>IN</sub>		4			4			4		mA	
	Conditions	V <sub>IN</sub> =15V, V <sub>CC</sub> =5V, I <sub>O</sub> =0V, V <sub>O</sub> ≤12V						V <sub>IN</sub> =14V, V <sub>CC</sub> =5V, I <sub>O</sub> =0A, V <sub>O</sub> ≤12V				
Quiescent Circuit Current 2	I <sub>CC</sub>		8.5			8.5			8.5		mA	
	Conditions	V <sub>CC</sub> =15V, I <sub>O</sub> =0A						V <sub>CC</sub> =14V, I <sub>O</sub> =0A				
Quiescent Circuit Current 3	I <sub>IN (off)</sub>			1			1			1	μA	
	Conditions	V <sub>IN</sub> =15V, V <sub>CE</sub> =0V or Open						V <sub>IN</sub> =14V, V <sub>CE</sub> =0V or Open				
Quiescent Circuit Current 4	I <sub>CC (off)</sub>			1			1			1	μA	
	Conditions	V <sub>CC</sub> =15V, V <sub>CE</sub> =0V or Open						V <sub>IN</sub> =14V, V <sub>CE</sub> =0V or Open				
Quiescent Circuit Current 5	I <sub>IN (ssov)</sub>								4		mA	
	Conditions							V <sub>IN</sub> =14V, V <sub>CC</sub> =5V, I <sub>O</sub> =0A, SS1=SS2=0V				
Quiescent Circuit Current 6	I <sub>CC (ssov)</sub>								8.5		mA	
	Conditions							V <sub>CC</sub> =14V, I <sub>O</sub> =0V, SS1=SS2=0V				
C/E Pin	High Level Voltage	V <sub>CEH</sub>	2			2			2		V	
		Conditions	V <sub>IN</sub> =V <sub>CC</sub> =15V						V <sub>IN</sub> =V <sub>CC</sub> =14V			
	Low Level Voltage	V <sub>CEL</sub>			0.8			0.8			0.8	V
		Conditions	V <sub>IN</sub> =V <sub>CC</sub> =15V						V <sub>IN</sub> =V <sub>CC</sub> =14V			
Inflow Current at High	I <sub>CEH</sub>		95			95			95		μA	
	Conditions	V <sub>CE</sub> =20V						V <sub>CE</sub> =20V				
SS Pin <sup>3</sup>	Low Level Voltage	V <sub>SSL</sub>			0.5		0.5			0.5	V	
		Conditions	V <sub>IN</sub> =V <sub>CC</sub> =15V						V <sub>IN</sub> =V <sub>CC</sub> =14V			
	Inflow Current at Low	I <sub>SSL</sub>		60	80		60	80		60	80	μA
		Conditions	V <sub>SSL</sub> =0V, V <sub>IN</sub> =V <sub>CC</sub> =15V						V <sub>SSL</sub> =0V, V <sub>IN</sub> =V <sub>CC</sub> =14V			

\*1: Electrical characteristics show the characteristic ratings guaranteed when operating the ICs under the measurement conditions described in the above table.

\*2: Efficiency is calculated from the following formula.

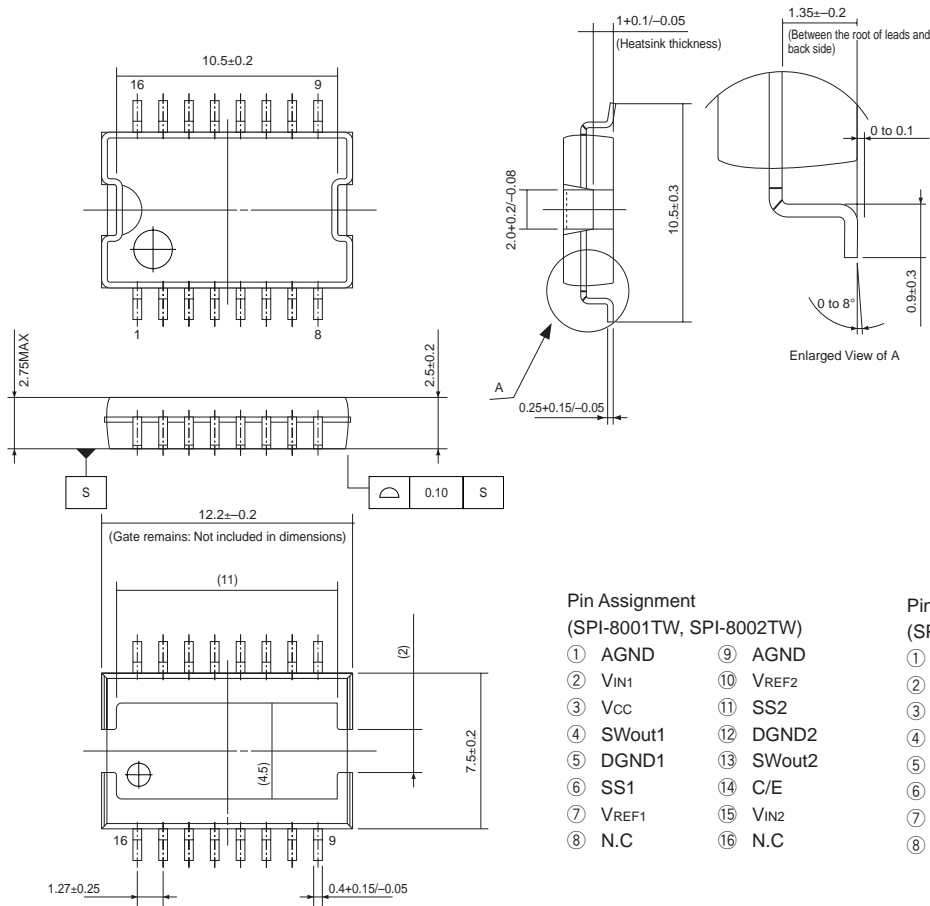
$$\eta (\%) = \frac{V_O \cdot I_O}{V_{IN} \cdot I_{IN}} \times 100$$

\*3: Pin 6 and pin 11 are the SS pins. Soft start at power on can be performed with capacitors connected to these pins. The outputs can also be turned ON/OFF with these pins. The outputs are stopped by setting the voltages of these pins to V<sub>SSL</sub> or lower. SS-pin voltages can be changed with open-collector drive circuits of transistors.

When using both the soft-start and ON/OFF functions together, the discharge currents from C<sub>4</sub> and C<sub>5</sub> flow into the ON/OFF control transistors respectively. Therefore, limit the currents securely to protect the transistors if C<sub>4</sub> and C<sub>5</sub> capacitances are large. The SS pins are pulled up to the power supply in the ICs, so applying the external voltages are prohibited.

External Dimensions (HSOP16)

(Unit : mm)



Pin Assignment

(SPI-8001TW, SPI-8002TW)

- ① AGND
- ② VIN1
- ③ VCC
- ④ SWout1
- ⑤ DGND1
- ⑥ SS1
- ⑦ VREF1
- ⑧ N.C
- ⑨ AGND
- ⑩ VREF2
- ⑪ SS2
- ⑫ DGND2
- ⑬ SWout2
- ⑭ C/E
- ⑮ VIN2
- ⑯ N.C

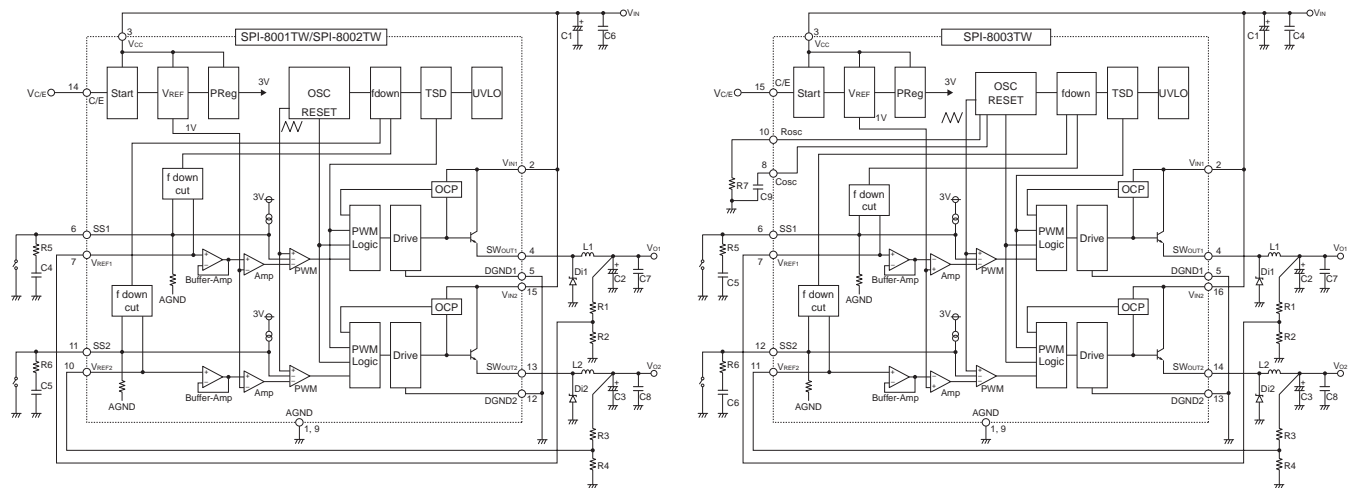
Pin Assignment

(SPI-8003TW)

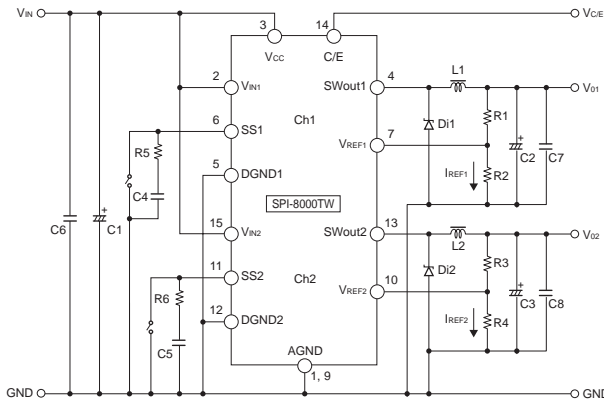
- ① AGND
- ② VIN1
- ③ VCC
- ④ SWout1
- ⑤ DGND1
- ⑥ SS1
- ⑦ VREF1
- ⑧ CosC
- ⑨ AGND
- ⑩ Rosc
- ⑪ VREF2
- ⑫ SS2
- ⑬ DGND2
- ⑭ SWout2
- ⑮ C/E
- ⑯ VIN2

Product Mass : Approx.0.86g

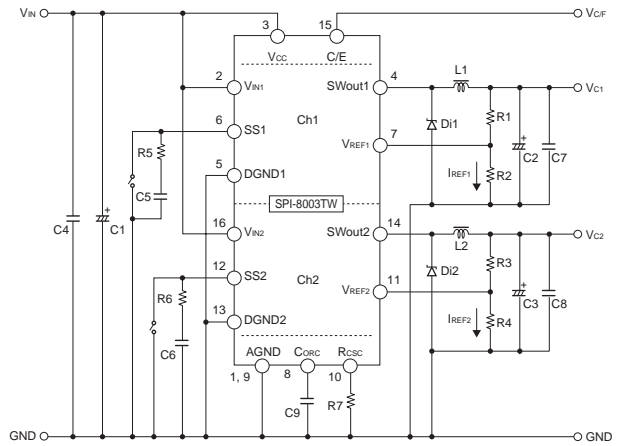
Block Diagram



Typical Connection Diagram



- C1 : 220 μF/50V
- C2, C3 : 470 μF/25V
- C4, C5 : 1 μF
- C6, C7, C8 : 0.1 μF
- R5, R6 : 1kΩ
- L1, L2 : 47 μH
- Di1, Di2 : SJPB-H6 (Sanken)



- C1 : 220 μF/50V
- C2, C3 : 470 μF/25V
- C4 : 1 μF/50V
- C5, C6 : 1 μF/10V
- C7, C8 : 0.1 μF/50V
- C9 : 100pF/10V
- L1, L2 : 47 μH
- R2, R4 : 1kΩ
- R5, R6 : 1kΩ
- Di1, Di2 : SJPB-H6 (Sanken)

Diodes Di1, Di2

- Be sure to use Schottky-barrier diodes for Di1 and Di2.
- If other diodes like fast recovery diodes are used, IC may be destroyed because of the reverse voltage generated by the recovery voltage or ON voltage.

Choke coils L1, L2

- If the winding resistance of the choke coil is too high, the efficiency may drop below the rated value.
- As the overcurrent protection starting current is about 2.0A, take care concerning heat radiation from the choke coil caused by magnetic saturation due to overload or short-circuited load.
- Use a closed-magnetic-path coil to prevent interference between the channels SWout1 and SWout2.

Capacitors C1, C2, C3

- As large ripple currents flow through C1, C2 and C3, use high-frequency and low-impedance capacitors suitable for switching mode power supplies. Especially when the impedance of C2 and C3 are high, the switching waveforms may become abnormal at low temperatures. For C2 and C3, do not use capacitors with extremely low equivalent series resistance (ESR) such as OS capacitors or tantalum capacitors, which may cause abnormal oscillation.

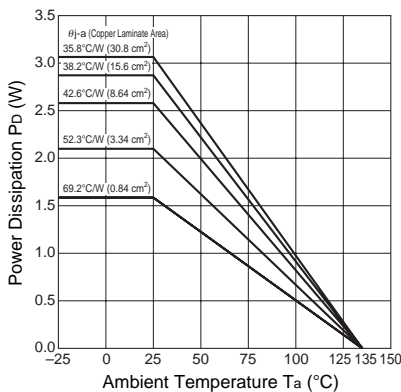
Resistors R1, R2, R3, R4

- R1, R2, R3 and R4 are resistors for setting output voltages. Set the resistors so that IREF is approx. 1 mA. For example, R1 and R2 can be calculated as shown below.

$$R1 = \frac{(VO1 - VREF1)}{IREF1} = \frac{(VO1 - V)}{1 \times 10^{-3}} (\Omega), R2 = \frac{VREF1}{IREF1} = \frac{1}{1 \times 10^{-3}} \approx 1(K\Omega)$$

© To create the optimum operating conditions, place the components as close as possible to each other.

Ta-Pd Characteristics



$$Pd = VO \cdot IO \left( \frac{100}{\eta\chi} - 1 \right) - VF \cdot IO \left( 1 - \frac{VO}{VIN} \right)$$

- VO : Output Voltage
- VIN : Input Voltage
- IO : Output Current
- ηχ : Efficiency (%)
- VF : D1 Forward Voltage  
SJPB-H6...0.45V (IO=1A)

Note 1: The efficiency depends on the input voltage and the output current. Therefore, obtain the value from the efficiency graph and substitute the percentage in the formula above.

Note 2: Thermal design for D1 must be considered separately.