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: ≤ 1μA (at output OFF)
- High accuracy reference voltage: ±1%
- Built-in foldback-overcurrent and thermal protection circuits
- Built-in ON/OFF circuit (soft start available) – per output

■Absolute Maximum Ratings*1

Parameter	Symbol	Ratings			Unit
		SPI-8001TW	SPI-8002TW	SPI-8003TW	
Input Voltage	V_{IN}	21	40	40	V
	V_{CC}	21	40	40	V
	$V_{C/E}$	21	40	40	V
Power Dissipation*2, *3	P_D	3.0			W
Junction Temperature	T_j	+135		+150	°C
Storage Temperature	T_{stg}	–40 to +135		–40 to +150	°C
Thermal Resistance (junction to case)*2	$\theta_{j\text{-}c}$	9.0			°C/W
Thermal Resistance (junction to ambient air)*2	$\theta_{j\text{-}a}$	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^2 (copper laminate area 30.8cm^2).
*3: Limited by thermal protection.

■Applications

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

■Recommended Operating Conditions*1

Parameter	Symbol	Ratings						Unit
		SPI-8001TW		SPI-8002TW		SPI-8003TW		
		min.	max.	min.	max.	min.	max.	
Input Voltage Range	V_{IN}	V_O+3	20	V_O+3	38	V_O+3	38	V
	V_{CC}	4.5	20	4.5	38	4.5	38	V
	$V_{C/E}$		20		38		38	V
Output Voltage Range	V_O	1	16	1	24	1	24	V
Output Current Range	I_O		1.5		1.5		1.5	A
Operating Junction Temperature Range	T_{jop}	–30	+135	–30	+135	–30	+125	°C
Operating Temperature Range	T_{op}	–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_{REF}	0.996	1.006	1.016	0.996	1.006	1.016	0.966	1.006	1.016	V
		Conditions	V_{IN}=10V, V_O=1V, I_O=0.1A						V_{IN}=14V, I_O=0.1A			
Temperature Coefficient of Reference Voltage		$\Delta V_{REF}/\Delta T$		±0.1			±0.1			±0.1		mV/°C
		Conditions	V_{IN}=10V, V_O=1V, I_O=0.1A, Ta=−30 to +135°C						V_{IN}=14V, I_O=0.1A, Ta=−30 to +125°C			
Efficiency 1[*2]		Eff1		80			78			78		%
		Conditions	V_{IN}=V_{CC}=15V, V_O=5V, I_O=0.5A, I_{IN}: including Icc						V_{IN}= V_{CC}=14V, V_O=5V, I_O=0.5A, I_{IN}: including Icc			
Efficiency 2[*2]		Eff2		83			81			81		%
		Conditions	V_{IN}=15V, V_O=5V, I_O=0.5A, V_{CC}=5V, I_{IN}: excluding Icc						V_{IN}=14V, V_{CC}=5V, V_O=5V, I_O=0.5A, I_{IN}: excluding Icc			
Oscillation Frequency		f_{osc}		250		215	250	285	200		400	kHz
		Conditions	V_{IN}=V_{CC}=15V, V_O=5V, I_O=0.5A						V_{IN}=14V, I_O=0.1A, C_{OSC}=1000pF			
Line Regulation		V_{LINE}		30	60		30	60		30	60	mV
		Conditions	V_{IN}=V_{CC}=10 to 20V, V_O=5V, I_O=1A						V_{IN}=V_{CC}=9 to 20V, V_O=5V, I_O=1A			
Load Regulation		V_{LOAD}		10	40		10	40		10	40	mV
		Conditions	V_{IN}=V_{CC}=15V, V_O=5V, I_O=0.2 to 1.5A						V_{IN}=V_{CC}=14V, V_O=5V, I_O=0.2 to 1.5A			
Overcurrent Protection Starting Current		I_S	1.6			1.6			1.6			A
		Conditions	V_{IN}=V_{CC}=15V						V_{IN}=V_{CC}=14V			
Quiescent Circuit Current 1		I_{IN}		4			4			4		mA
		Conditions	V_{IN}=15V, V_{CC}=5V, I_O=0V, V_O≤12V						V_{IN}=14V, V_{CC}=5V, I_O=0A, V_O≤12V			
Quiescent Circuit Current 2		I_{CC}		8.5			8.5			8.5		mA
		Conditions	V_{CC}=15V, I_O=0A						V_{CC}=14V, I_O=0A			
Quiescent Circuit Current 3		$I_{IN\ (off)}$			1			1			1	μA
		Conditions	V_{IN}=15V, $V_{C/E}$=0V or Open						V_{IN}=14V, $V_{C/E}$=0V or Open			
Quiescent Circuit Current 4		$I_{CC\ (off)}$			1			1			1	μA
		Conditions	V_{CC}=15V, $V_{C/E}$=0V or Open						V_{IN}=14V, $V_{C/E}$=0V or Open			
Quiescent Circuit Current 5		$I_{IN\ (ssov)}$	—							4		mA
		Conditions	—						V_{IN}=14V, V_{CC}=5V, I_O=0A, SS1=SS2=0V			
Quiescent Circuit Current 6		$I_{CC\ (ssov)}$	—							8.5		mA
		Conditions	—						V_{CC}=14V, I_O=0V, SS1=SS2=0V			
C/E Pin	High Level Voltage	$V_{C/EH}$	2			2			2			V
		Conditions	V_{IN}=V_{CC}=15V						V_{IN}=V_{CC}=14V			
	Low Level Voltage	$V_{C/EL}$			0.8			0.8			0.8	V
		Conditions	V_{IN}=V_{CC}=15V						V_{IN}=V_{CC}=14V			
	Inflow Current at High	$I_{C/EH}$		95			95			95		μA
		Conditions	$V_{C/E}$=20V						$V_{C/E}$=20V			
SS Pin[*3]	Low Level Voltage	V_{SSL}			0.5			0.5			0.5	V
		Conditions	V_{IN}=V_{CC}=15V						V_{IN}=V_{CC}=14V			
	Inflow Current at Low	I_{SSL}		60	80		60	80		60	80	μA
		Conditions	V_{SSL}=0V, V_{IN}=V_{CC}=15V						V_{SSL}=0V, V_{IN}=V_{CC}=14V			

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

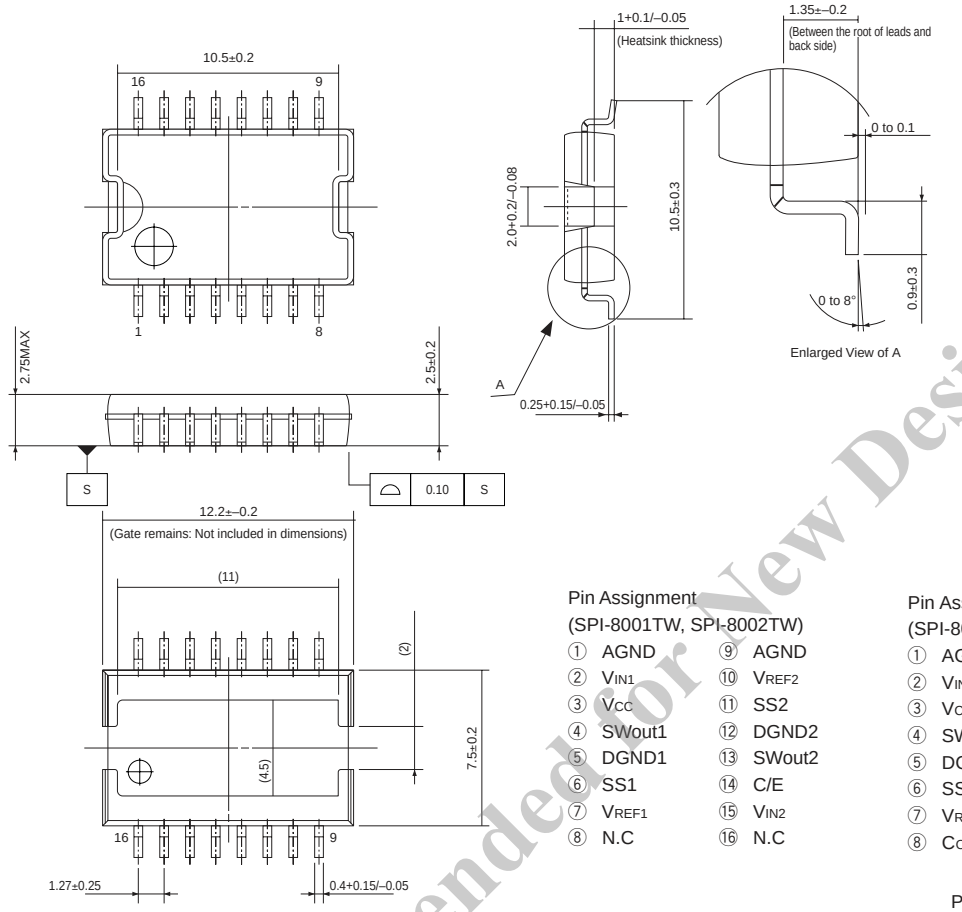
*2: Efficiency is calculated from the following formula.

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

*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_{SSL} 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_4 and C_5 flow into the ON/OFF control transistors respectively. Therefore, limit the currents securely to protect the transistors if C_4 and C_5 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)

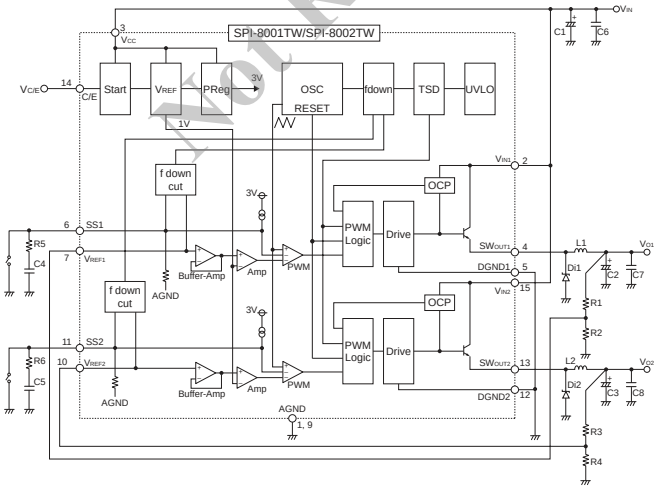
①	AGND	⑨	AGND
②	V_{IN1}	⑩	V_{REF2}
③	V_{CC}	⑪	SS2
④	SWout1	⑫	DGND2
⑤	DGND1	⑬	SWout2
⑥	SS1	⑭	C/E
⑦	V_{REF1}	⑮	V_{IN2}
⑧	N.C	⑯	N.C

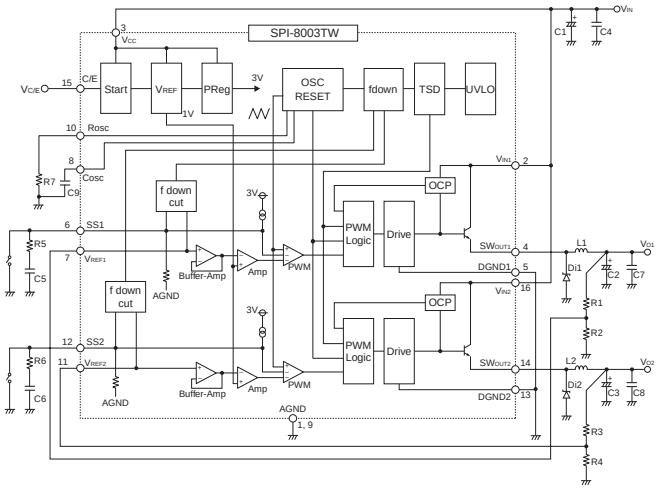
Pin Assignment
(SPI-8003TW)

①	AGND	⑨	AGND
②	V_{IN1}	⑩	Rosc
③	V_{CC}	⑪	V_{REF2}
④	SWout1	⑫	SS2
⑤	DGND1	⑬	DGND2
⑥	SS1	⑭	SWout2
⑦	V_{REF1}	⑮	C/E
⑧	Cosc	⑯	V_{IN2}

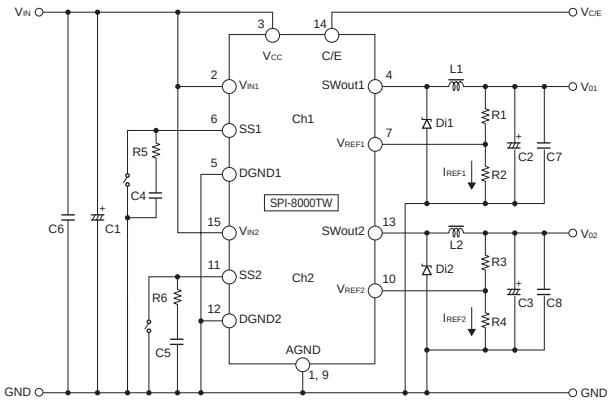
Product Mass : Approx.0.86g

■Block Diagram

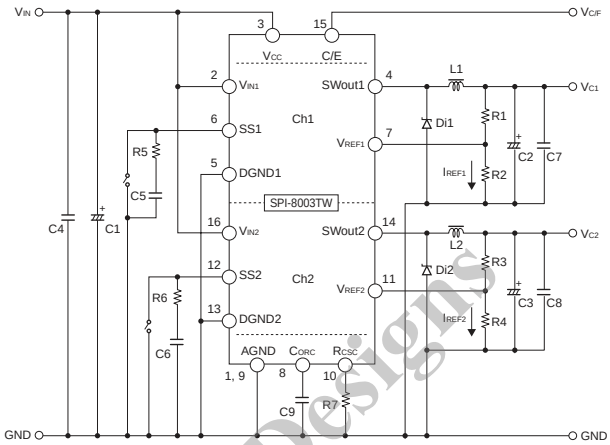




■Typical Connection Diagram



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



C1	: 220 μF/50V	C9	: 100pF/10V
C2, C3	: 470 μF/25V	L1, L2	: 47 μH
C4	: 1 μF/50V	R2, R4	: 1kΩ
C5, C6	: 1 μF/10V	R5, R6	: 1kΩ
C7, C8	: 0.1 μF/50V	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 $SW_{out}1$ and $SW_{out}2$.

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.

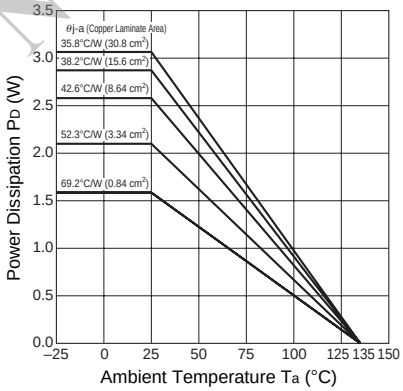
Resistors R1, R2, R3, R4

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

$$R1 = \frac{(V_{O1} - V_{REF1})}{I_{REF1}} = \frac{(V_{O1} - V)}{1\times10^{-3}}\ (\Omega),\ R2 = \frac{V_{REF1}}{I_{REF1}} = \frac{1}{1\times10^{-3}} \fallingdotseq 1\ (K\Omega)$$

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

■T_a-P_D Characteristics



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

V_O : Output Voltage
V_{IN} : Input Voltage
I_O : Output Current
$\eta\chi$: Efficiency (%)
V_F : D_1 Forward Voltage
SJPB-H6⋯0.45V (b=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 D_1 must be considered separately.