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Product Standards

Part No.	AN8015SH
Package Code No.	SSOP010-P-0225A

Analogue LSI Business Unit
Semiconductor Company
Matsushita Electric Industrial Co., Ltd.

Established by	Applied by	Checked by	Prepared by
K.Komichi	M.Hiramatsu	J.Hara	J.Morita
K.Komichi	M.Hiramatsu	J.Hara	J.Morita

2006-08-24	
Established	Revised

Contents

AN8015SH

Single-channel step-down, step-up, or inverting use DC-DC converter control IC

■ Overview

AN8015SH is a single-channel DC-DC converter control IC using the PWM method.

This IC can provide any one output type from among step-down, step-up and inverting output.

Its operating supply voltage range is wide and its consumption current is small. In addition, since it uses the 10-pin surface mounting type package with 0.5 mm pitch, it is suitable for highly efficient miniature potable power supply, especially for a negative output power supply.

■ Features

- Wide operating supply voltage range (3.6 V to 34 V)
- Small consumption current (1.8 mA typical)
- Converter control in a wide output frequency range is possible (2 kHz to 500 kHz).
- Built-in timer latch short-circuit protection circuit (charge current : 1.1 μA typical)
- Incorporating the under-voltage lock-out (U.V.L.O) circuit
- Incorporating a high precision reference voltage circuit (2.46 V (allowance: ±3%))
- Output block is open-collector (darlington) type.
- High absolute maximum rating of output current (100 mA)
- Maximum duty ratio is fixed and has small sample-to-sample variations (90% ±5%)

■ Applications

- LCD displays, digital still cameras, and PDAs

■ Package

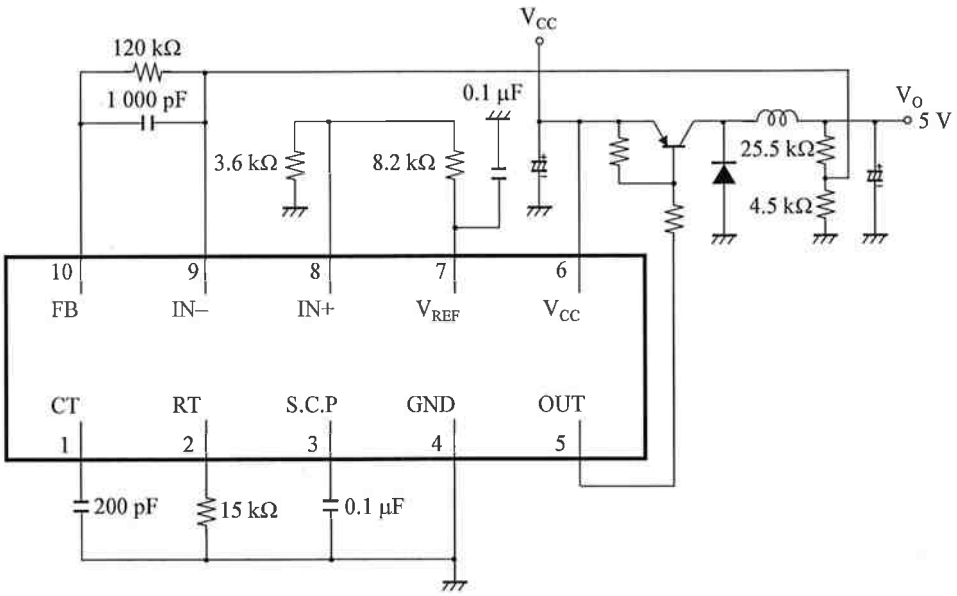
- 10 pin Plastic Shrink Small Outline Package (SSOP Type)

■ Type

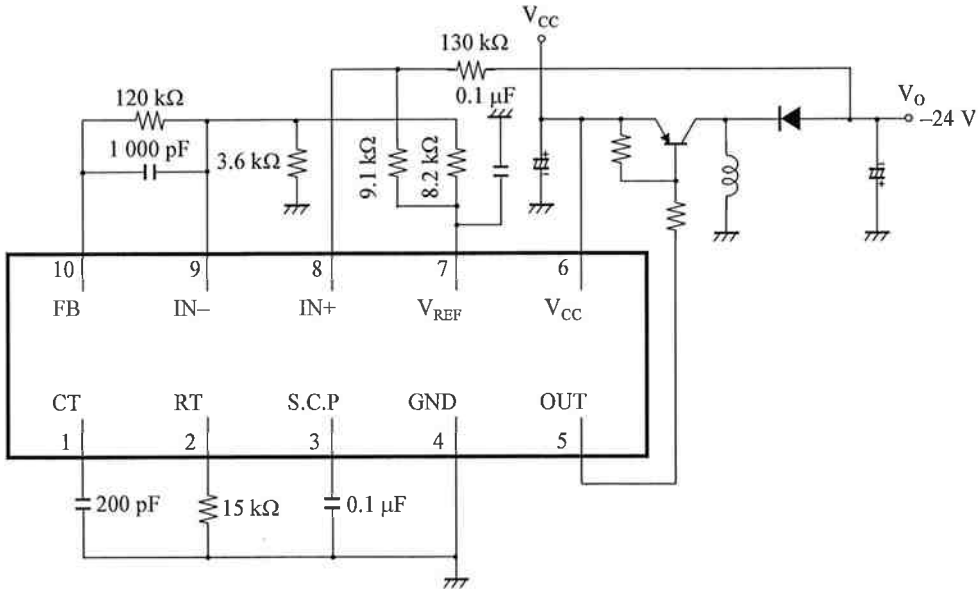
- Silicon Monolithic Bipolar IC

■ Application Circuit Example

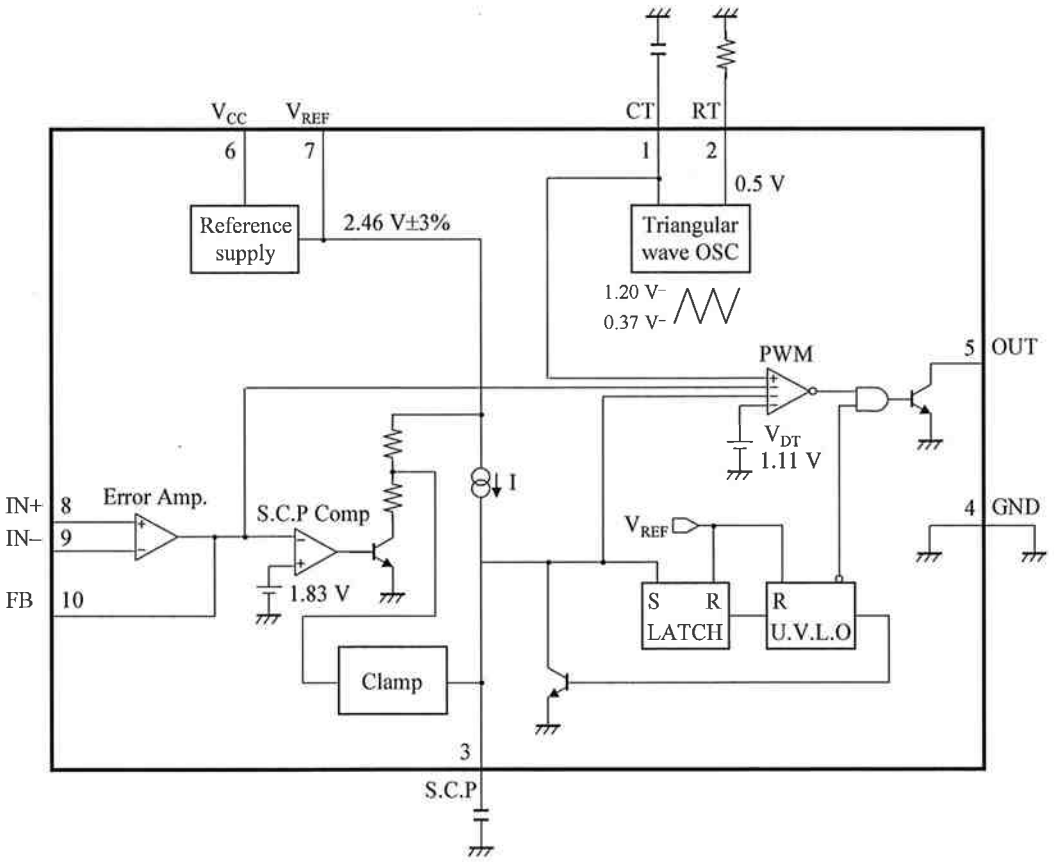
1. Chopper method step-down type



2. Chopper method inverting type



■ Block Diagram



■ Pin Descriptions

Pin No.	Pin name	Type	Description
1	CT	—	Pin for connecting oscillator timing capacitor
2	RT	—	Pin for connecting oscillator timing resistor
3	S.C.P	—	Pin for connection the time constant setting capacitor for short-circuit protection
4	GND	Ground	Grounding pin
5	OUT	Output	Open collector type output pin
6	V_{CC}	Power supply	Power supply voltage application pin
7	V_{REF}	Output	Reference voltage output pin
8	IN+	Input	Error amplifier non-inverted input pin
9	IN–	Input	Error amplifier inverted input pin
10	FB	Output	Output pin of error amplifier

■ Absolute Maximum Ratings

A No.	Parameter	Symbol	Rating	Unit	Notes
1	Supply voltage	V_{CC}	35	V	*1
2	Supply current	I_{CC}	—	mA	—
3	Power dissipation	P_D	115	mW	*2
4	Operating ambient temperature	T_{opr}	−30 to +85	°C	*3
5	Storage temperature	T_{stg}	−55 to +150	°C	*3
6	IN− pin allowable application voltage	V_{IN-}	− 0.3 to V_{REF}	V	—
7	IN+ pin allowable application voltage	V_{IN+}	− 0.3 to V_{REF}	V	—
8	Output pin allowable application voltage	V_{OUT}	35	V	—
9	Collector output current	I_{OUT}	100	mA	—

Notes) *1 : The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

*2 : The power dissipation shown is the value at T_a = 85°C for the independent (unmounted) IC package.
When using this IC, refer to the P_D-T_a diagram of the package standard page 4 and use under the condition not exceeding the allowable value.

*3 : Except for the power dissipation, operating ambient temperature, and storage temperature, all ratings are for T_a = 25°C.

■ Operating supply voltage range

Parameter	Symbol	Range	Unit	Notes
Supply voltage range	V_{CC}	3.6 to 34	V	*

Note) *: The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

■ Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit	Notes
Error amplifier input voltage	V_{IN}	− 0.1	0.8	V	*
Collector output voltage	V_{OUT}	—	34	V	*
Collector output current	I_{OUT}	—	50	mA	*
Timing capacitance	C_T	100	27 000	pF	*
Timing resistance	R_T	5.6	15	kΩ	*
Oscillation frequency	f_{OUT}	2	500	kHz	*
Reference voltage output current	I_{REF}	−3	0	mA	*
Time constant setting capacitance for soft start short-circuit protection	C_{SCP}	1 000	—	pF	*

Note) *: Do not apply current or voltage from external source to any pin not listed above.
In the circuit current, (+) means the current flowing into IC and (−) means the current flowing out of IC.

■ Electrical Characteristics at V_{CC} = 12 V, R_T = 15 kΩ, C_T = 200 pF

Note) T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Test circuits	Conditions	Limits			Unit	Notes
					Min	Typ	Max		
Reference Voltage Block									
1	Reference voltage	V_{REF}	1	I_{REF} = –1 mA	2.386	2.46	2.534	V	
2	Input regulation with input fluctuation	Line	1	V_{CC} = 3.6 to 34 V I_{REF} = –1 mA	—	5	20	mV	
3	Load regulation	Load	1	I_{REF} = – 0.1 to –1 mA	—	2	10	mV	
U.V.L.O. Block									
4	Circuit operation start voltage	V_{UON}	2	—	2.8	3.1	3.4	V	
5	Hysteresis width	V_{HYS}	2	—	100	200	300	mV	
Error Amplifier Block									
6	Input offset voltage	V_{IO}	3	—	–6	—	6	mV	
7	Input bias current	I_B	3	—	–500	–25	—	nA	
8	Common-mode input voltage range	V_{ICR}	3	—	– 0.1	—	0.8	V	
9	High-level output voltage	V_{EH}	4	—	V_{REF} – 0.3	V_{REF} – 0.1	—	V	
10	Low-level output voltage	V_{EL}	4	—	—	0.1	0.3	V	
Output Block									
11	Oscillation frequency	f_{OUT}	5	R_T = 15 kΩ, C_T = 200 pF	175	195	215	kHz	
12	Maximum duty ratio	D_{MAX}	5	R_T = 15 kΩ, C_T = 200 pF	85	90	95	%	
13	Output saturation voltage	V_{OL}	5	I_O = 50 mA, R_T = 15 kΩ	—	0.9	1.2	V	
14	Output leak current	I_{LEAK}	5	V_{CC} = 34 V, when output transistor is off	—	—	10	μA	
Short-circuit Protection Circuit Block									
15	Input threshold voltage	V_{THPC}	6	—	1.73	1.83	1.93	V	
16	Input standby voltage	V_{STBY}	6	—	1.15	1.25	1.35	V	
17	Input latch voltage	V_{IN}	6	—	—	30	120	mV	
18	Charge current	I_{CHG}	6	V_{SCP} = 0 V	–1.32	–1.1	– 0.88	μA	
Whole Device									
19	Total consumption current	I_{CC}	1	R_T = 15 kΩ	—	1.8	2.8	mA	

■ Electrical Characteristics (Reference values for design) at V_{CC} = 12 V, R_T = 15 kΩ, C_T = 200 pF

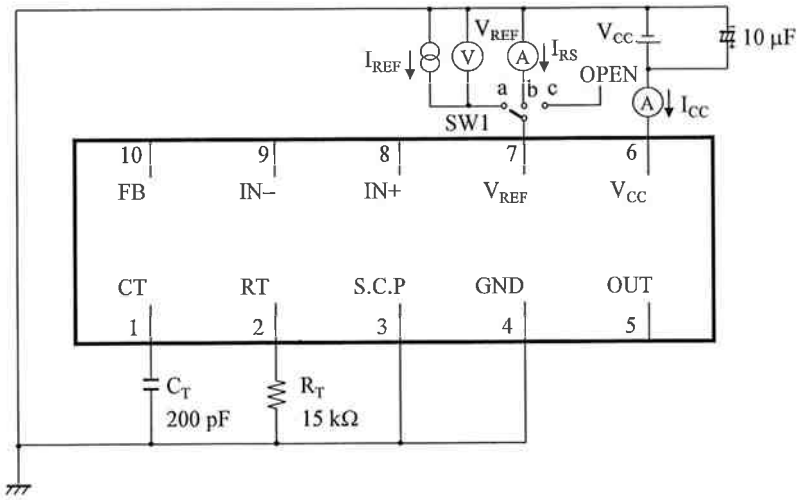
Note) T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Test circuits	Conditions	Reference values			Unit	Notes
					Min	Typ	Max		
Reference Voltage Block									
20	Input regulation with input fluctuation 2	L_{INE2}	1	V_{CC} = 3.6 V to 20 V	—	10 (max)	—	mV	*1
21	Output voltage temperature characteristics 1	V_{TC1}	1	Ta = –30 to 25°C	—	±0.5	—	%	*1
22	Output voltage temperature characteristics 2	V_{TC2}	1	Ta = 25 to 85°C	—	±0.5	—	%	*1
23	Reference short-circuit current	I_{RS}	1	—	—	–20	—	mA	*1
Error Amplifier Block									
24	Output sink current	I_{SINK}	4	V_{FB} = 0.8 V	—	8	—	mA	*1
25	Output source current	I_{SOURCE}	4	V_{FB} = 0.8 V	—	–120	—	µA	*1
26	Open-loop gain	A_V	4	—	—	70	—	dB	*1
27	Common-mode ripple rejection ratio	CMRR	3	—	—	50	—	dB	*1
Output Block									
28	RT pin voltage	V_{RT}	5	—	—	0.5	—	V	*1
29	Maximum oscillation frequency	$f_{OUT(MAX)}$	5	R_T = 5.6 kΩ, C_T = 150 pF	—	500	—	kHz	*1
30	Frequency supply voltage characteristics	f_{dV}	5	f_{OUT} = 200 kHz, V_{CC} = 3.6 V to 34 V	—	±2	—	%	*1
31	Frequency temperature characteristics 1	$f_{dT}1$	5	f_{OUT} = 200 kHz , Ta = –30 to 25°C	—	±3	—	%	*1
32	Frequency temperature characteristics 2	$f_{dT}2$	5	f_{OUT} = 200 kHz , Ta = 25 to 85°C	—	±3	—	%	*1
Short-circuit Protection Circuit Block									
33	Comparator threshold voltage	V_{THL}	6	—	—	1.83	—	V	*1
Whole Device									
34	Total consumption current 2	$I_{CC}2$	1	R_T = 5.6 kΩ, C_T = 150 pF	—	2.5	—	mA	*1

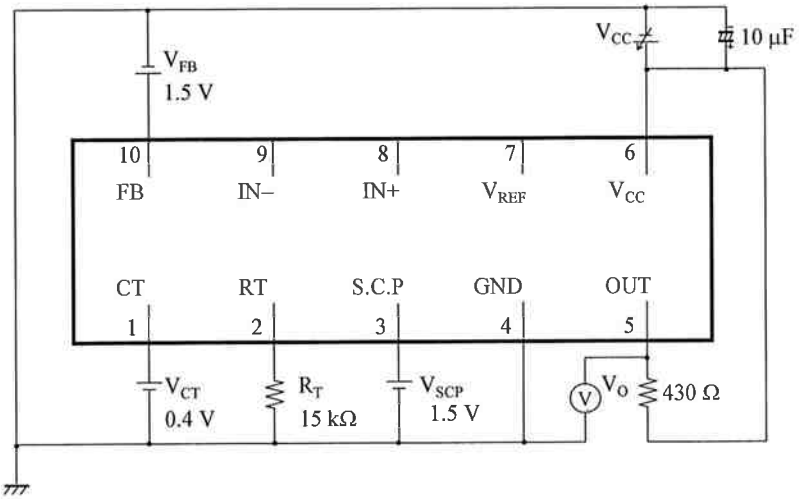
Note) *1: The above characteristics are reference values for design of the IC and are not guaranteed by inspection.
If a problem does occur related to these characteristics, Matsushita will respond in good faith to user concerns.

■ Test Circuit Diagram

1. Test Circuit 1

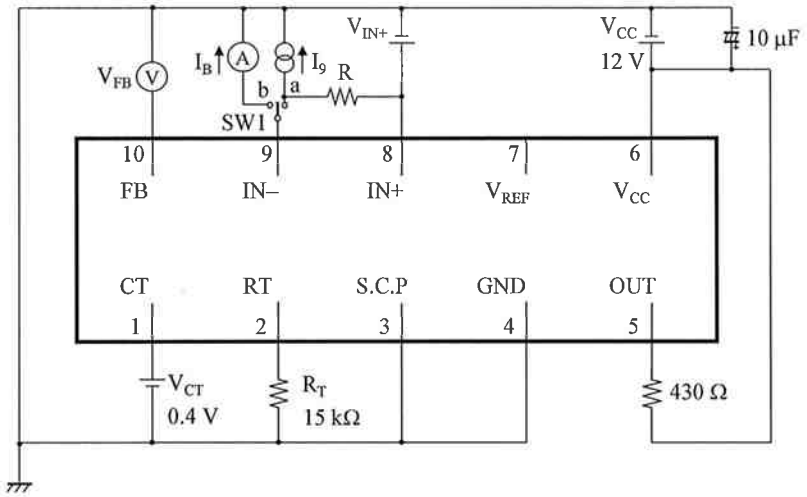


2. Test Circuit 2

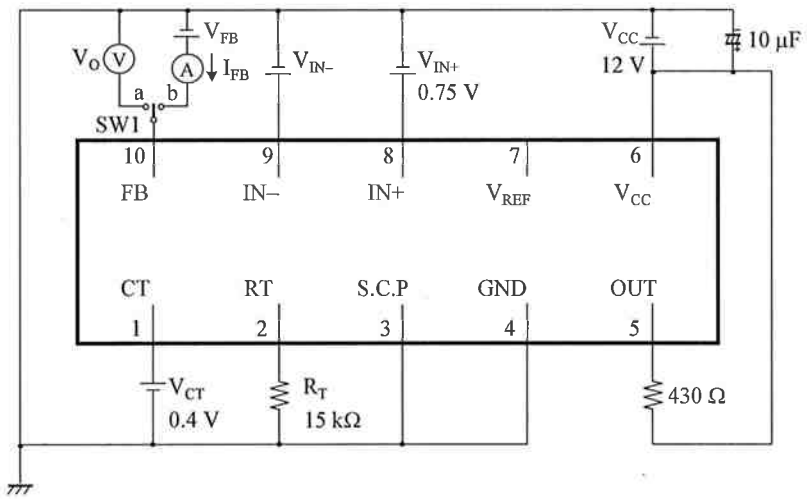


■ Test Circuit Diagram (continued)

3. Test Circuit 3

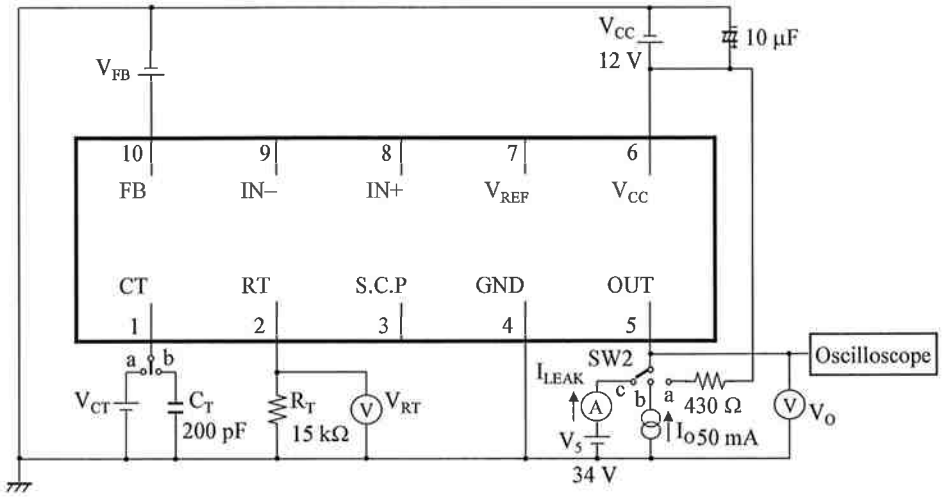


4. Test Circuit 4

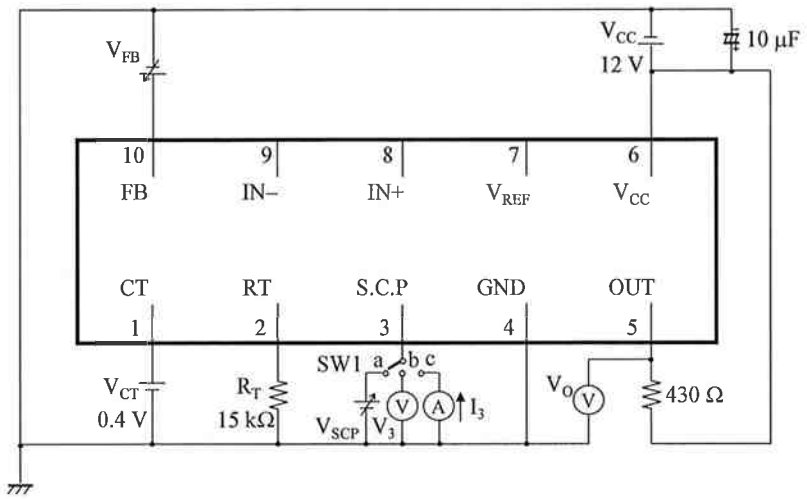


■ Test Circuit Diagram (continued)

5. Test Circuit 5



6. Test Circuit 6

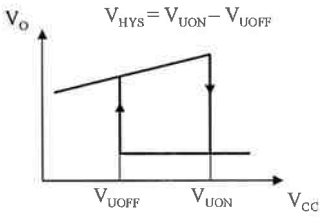


■ Electrical Characteristics Test Procedures

1. Test Circuit1

C No.	Parameter	Conditions	Measuring Method
1	Reference voltage	SW1 = a, V_{CC} = 12 V, I_{REF} = –1 mA	Measure the voltage of V_{REF}.
2	Input regulation with input fluctuation	SW1 = a, V_{CC} = 3.6 V → 34 V, I_{REF} = 0 A	Check the regulation of V_{REF}.
3	Load regulation	SW1 = a, V_{CC} = 12 V, I_{REF} = – 0.1 mA → –1 mA	Check the regulation of V_{REF}.
19	Total consumption current	SW1 = c, V_{CC} = 12 V, RT = 15 kΩ	Measure the current of I_{CC}.
23	Reference short-circuit current	SW1 = b, V_{CC} = 12 V	Measure the current of I_{RS}.

2. Test Circuit2

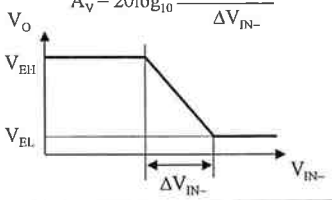
C No.	Parameter	Conditions	Measuring Method
4	Circuit operation start voltage	V_{CT} = 0.4 V, V_{SCP} = 1.5 V, V_{FB} = 1.5 V	Measure the V_{CC} voltage when the V_O changes from High to Low level while increasing the V_{CC} voltage gradually.
5	Hysteresis width	V_{CT} = 0.4 V, V_{SCP} = 1.5 V, V_{FB} = 1.5 V	

3. Test Circuit3

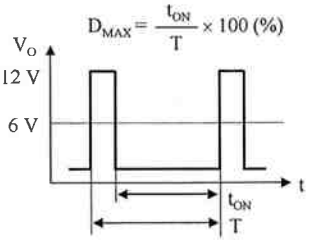
C No.	Parameter	Conditions	Measuring Method
6	Input offset voltage	SW1 = a, V_{CC} = 12 V, V_{IN+} = 0.75 V, V_{CT} = 0.4 V	Measure the I_9 current when the V_{FB} changes while increasing the I_9 current gradually, calculate $V_{IO} = R \times I_9$.
8	Common-mode input voltage range	SW1 = a, V_{CC} = 12 V, V_{CT} = 0.4 V	Check the V_{FB} voltage when V_{IN+} = – 0.1 V or 0.8 V, while changes the I_9 current gradually.
27	Common-mode ripple rejection ratio	SW1 = a, V_{CC} = 12 V, V_{CT} = 0.4 V	Measure the difference of ΔV_{IO} when V_{IN+} = – 0.1 V or 0.8 V, and calculate from the following formula. $CMRR = 20\log_{10}\frac{0.9}{\Delta V_{IO}}$
7	Input bias current	SW1 = b, V_{CC} = 12 V, V_{IN+} = 0.75 V, V_{CT} = 0.4 V	Measure the current of I_B.

■ Electrical Characteristics Test Procedures (continued)

4. Test Circuit4

C No.	Parameter	Conditions	Measuring Method
9	High-level output voltage	SW1 = a, V_{CC} = 12 V, V_{CT} = 0.4 V, V_{IN+} = 0.75 V, V_{IN-} = 0.7 V	Measure the voltage of V_O.
10	Low-level output voltage	SW1 = a, V_{CC} = 12 V, V_{CT} = 0.4 V, V_{IN+} = 0.75 V, V_{IN-} = 0.8 V	Measure the voltage of V_O.
24	Output sink current	SW1 = b, V_{CC} = 12 V, V_{CT} = 0.4 V, V_{IN+} = 0.75 V, V_{IN-} = 0.8 V, V_{FB} = 0.8 V	Measure the current of I_{FB}.
25	Output source current	SW1 = b, V_{CC} = 12 V, V_{CT} = 0.4 V, V_{IN+} = 0.75 V, V_{IN-} = 0.7 V, V_{FB} = 0.8 V	Measure the current of I_{FB}.
26	Open-loop gain	SW1 = a, V_{CC} = 12 V, V_{CT} = 0.4 V	$A_V = 20\log_{10}\frac{V_{EH} - V_{EL}}{\Delta V_{IN-}}$ 

5. Test Circuit5

C No.	Parameter	Conditions	Measuring Method
11	Oscillation frequency	SW1 = b, SW2 = a, V_{CC} = 12 V, V_{FB} = 1.5 V	Oscilloscope waveform $f_{OUT} = \frac{1}{T}$ Hz
12	Maximum duty ratio	SW1 = b, SW2 = a, V_{CC} = 12 V, V_{FB} = 1.5 V	$D_{MAX} = \frac{t_{ON}}{T} \times 100\ (\%)$ 
13	Output saturation voltage	SW1 = a, SW2 = b, V_{CC} = 12 V, V_{FB} = 0.5 V, V_{CT} = 0.4 V, I_O = 50 mA	Measure the voltage of V_O.
14	Output leak current	SW1 = a, SW2 = c, V_{CC} = 12 V, V_{FB} = 0.3 V, V_{CT} = 0.4 V, V_5 = 34 V	Measure the current of I_{LEAK}.
28	RT pin voltage	SW1 = b, SW2 = a, V_{CC} = 12 V, V_{FB} = 1.5 V	Measure the voltage of V_{RT}.

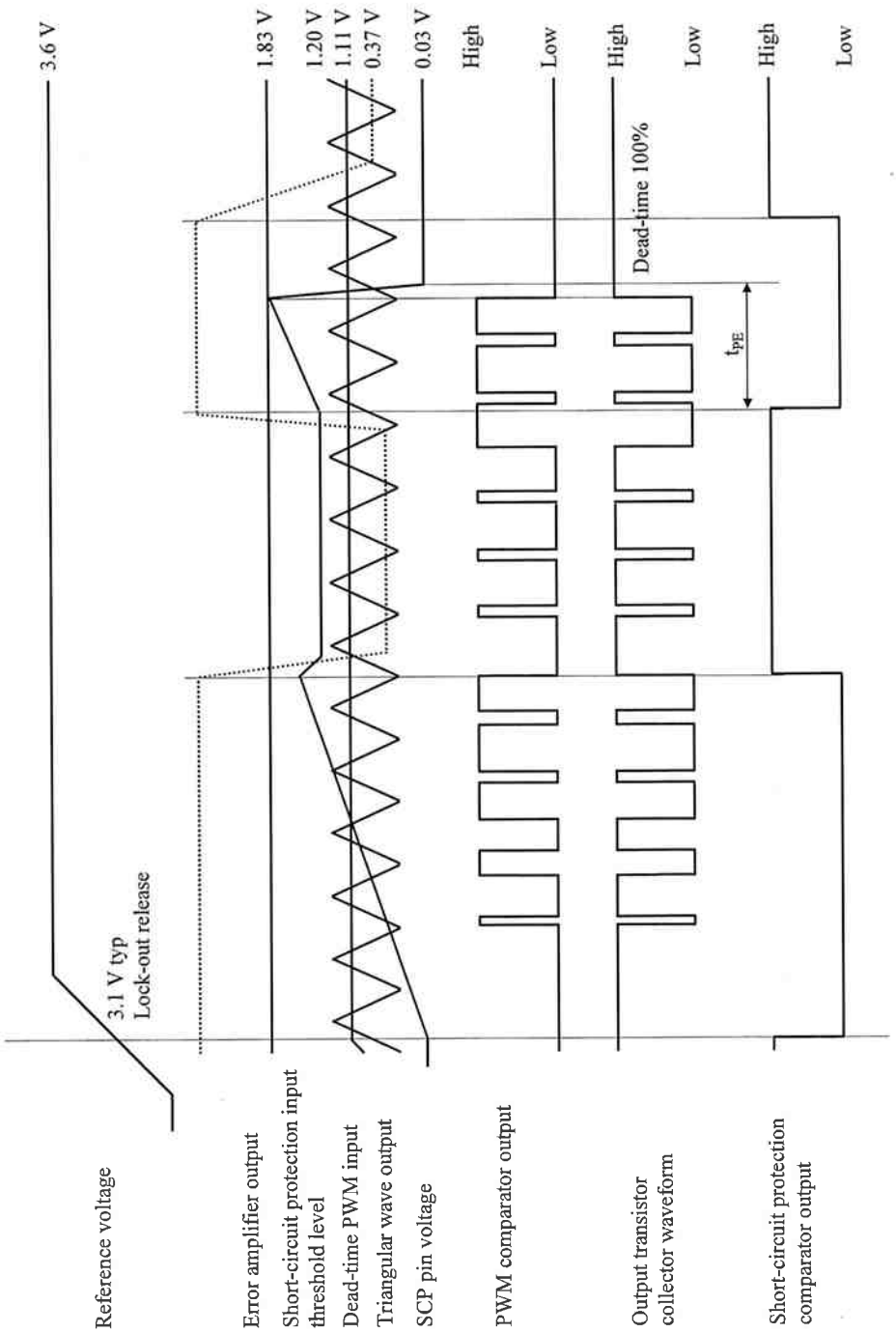
■ Electrical Characteristics Test Procedures (continued)

6. Test Circuit6

C No.	Parameter	Conditions	Measuring Method
15	Input threshold voltage	SW1 = a, V_{CC} = 12 V, V_{CT} = 0.4 V, V_{FB} = 2.1 V	Measure the V_{SCP} voltage when the V_O changes from Low to High level while increasing the V_{SCP} voltage gradually.
16	Input standby voltage	SW1 = b, V_{CC} = 12 V, V_{CT} = 0.4 V, V_{FB} = 1.5 V	Measure the voltage of V_3.
17	Input latch voltage	SW1 = b, V_{CC} = 12 V, V_{CT} = 0.4 V, V_{FB} = 2.1 V	Measure the voltage of V_3.
18	Charge current	SW1 = c, V_{CC} = 12 V, V_{CT} = 0.4 V, V_{FB} = 1.5 V	Measure the current of I_3.
33	Comparator threshold voltage	SW1 = b, V_{CC} = 12 V, V_{CT} = 0.4 V	Measure the V_{FB} voltage when the V_O changes from Low to High level while increasing the V_{FB} voltage gradually.

■ Technical Data

• Timing chart



■ Usage Notes

This IC uses the constant current given by the timing resistor R_T as the bias current of the triangular oscillation block and the PWM comparator for consumption current reduction. The total consumption current is approximately 1.8 mA (typical) when R_T is 15 kΩ, and it increases to approximately 2.5 mA (typical) when R_T is 5.6 kΩ.

It is possible to use the circuit in the recommended operating range of 2 kHz to 500 kHz of the oscillation frequency. However, the timing resistor R_T versus the oscillation frequency should be set within the recommended range shown in figure 1. Also, refer to the figure 2, Timing capacitance-Oscillation frequency for setting the timing capacitance.

For a high frequency use, the overshoot and undershoot amounts increase due to operation delay of the triangular oscillation comparator, and the maximum duty ratio drops. This effect can be alleviated by speeding up through the reduction of the resistor R_T and increase in the circuit current.

Note that this IC can not be used as an IC for slave when the several ICs are operated in parallel synchronous mode.

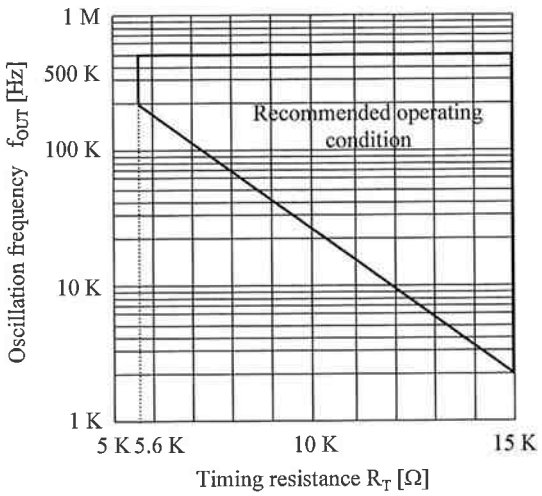


Figure 1. Timing resistance recommended condition

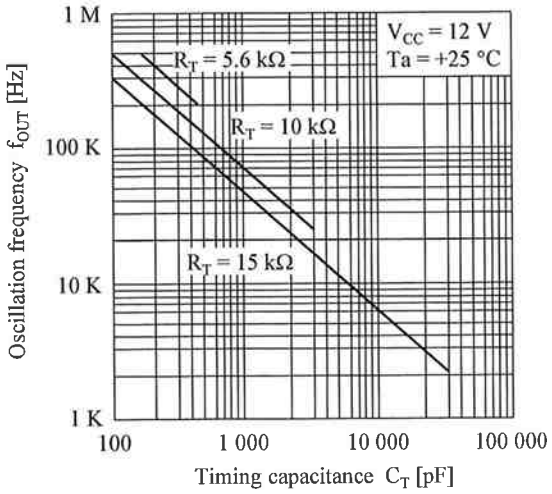


Figure 2. Timing capacitance-Oscillation frequency

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PACKAGE STANDARDS

Package Code	SSOP010-P-0225A

Semiconductor Company
Matsushita Electric Industrial Co., Ltd.

Established by	Applied by	Checked by	Prepared by
K.Komichi	H.Yoshida	M.Okajima	M.Itoh

Established: 2004-01-19
Revised : 2007-02-13

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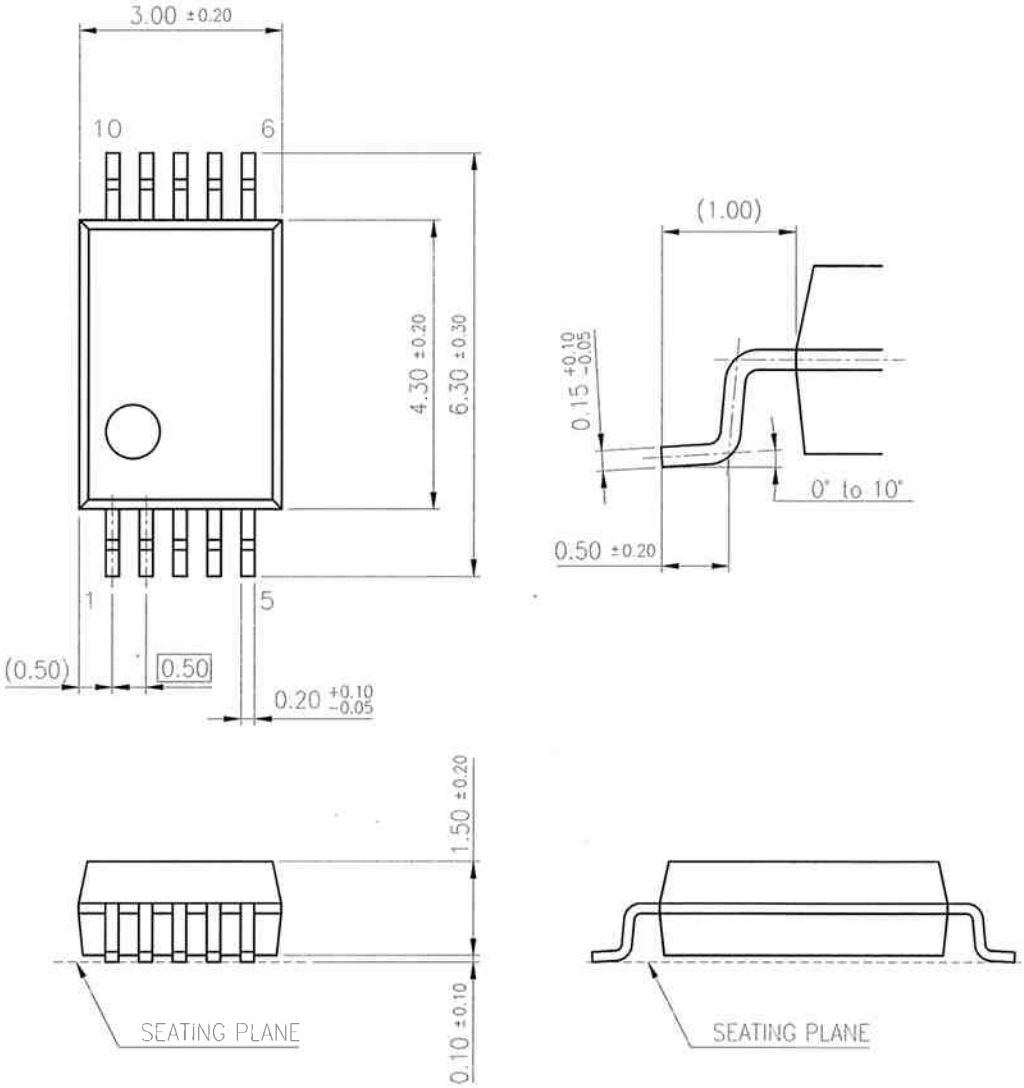
1. Outline Drawing

Unit:mm



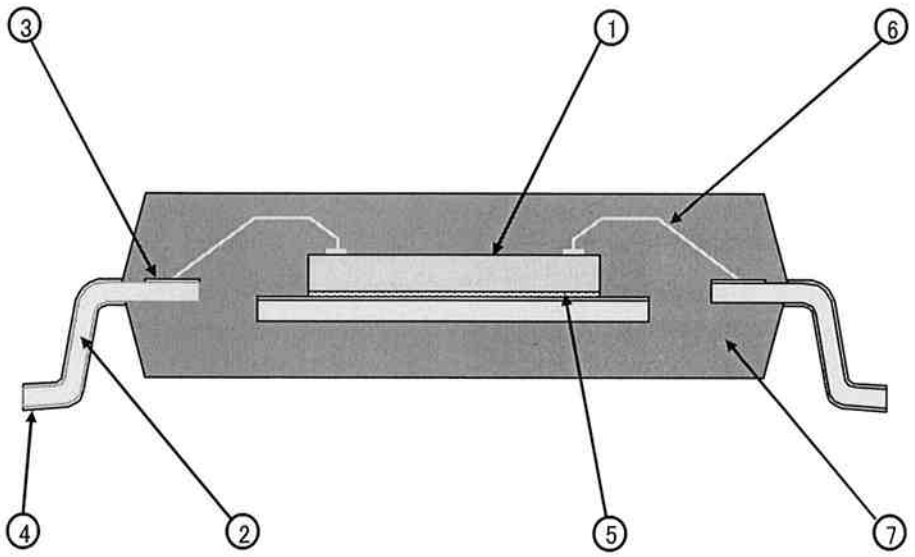
Weight	:	43 mg
Body Material	:	Epoxy Resin
Lead Material	:	Cu Alloy
Lead Finish Method	:	SnBi Plating

Semiconductor Company, Matsushita Electric Industrial Co., Ltd.

Established: 2004-01-19
Revised : 2007-02-13

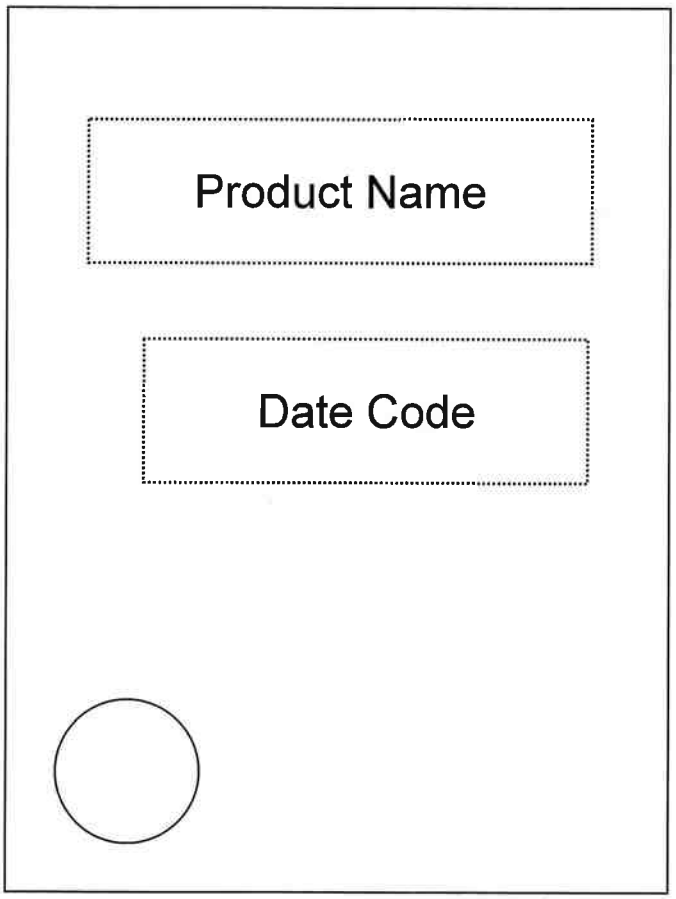
2. Package Structure (Technical Report)

Chip Material		Si	①
Leadframe material		Cu alloy	②
Inner lead surface		Ag plating	③
Outer lead surface		SnBi plating	④
Chip mount	Method	Resin adhesive method	⑤
	Material	Adhesive material	
Wirebond	Method	Thermo-compression bonding	⑥
	Material	Au	
Molding	Method	Multiplunger molding	⑦
	Material	Epoxy resin	



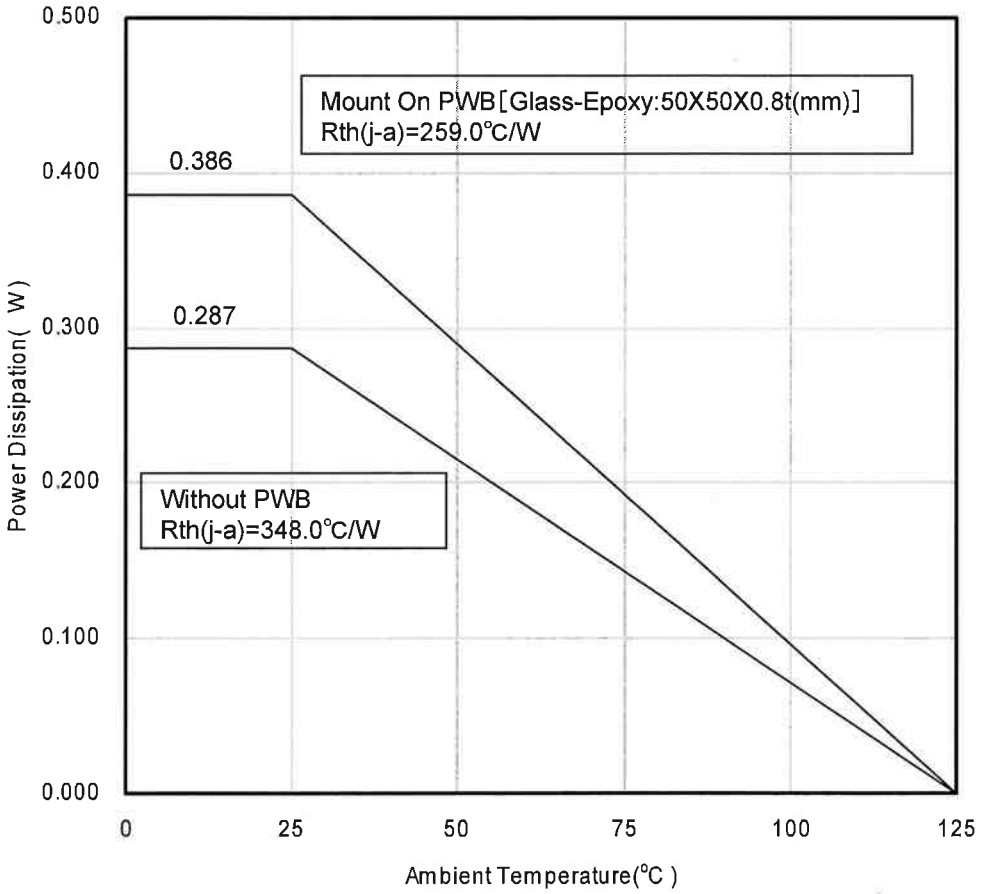
Established: 2004-01-19
Revised : 2007-02-13

3. Mark Drawing



Established: 2004-01-19
Revised : 2007-02-13

4. Power Dissipation (Technical Report)



Established: 2004-01-19
Revised : 2007-02-13

5. Power Dissipation (Supplementary Explanation)

[Experiment environment]

Power Dissipation (Technical Report) is a result in the experiment environment of SEMI standard conformity. (Ambient air temperature (Ta) is 25 degrees C)

[Supplementary information of PWB to be used for measurement]

The supplement of PWB information for Power Dissipation data (Technical Report) are shown below.

Indication	Total Layer	Resin Material
Glass-Epoxy	1-layer	FR-4
4-layer	4-layer	FR-4

[Notes about Power Dissipation (Thermal Resistance)]

Power Dissipation values (Thermal Resistance) depend on the conditions of the surroundings, such as specification of PWB and a mounting condition , and a ambient temperature. (Power Dissipation (Thermal Resistance) is not a fixed value.)

The Power Dissipation value (Technical Report) is the experiment result in specific conditions (evaluation environment of SEMI standard conformity) ,and keep in mind that Power Dissipation values (Thermal resistance) depend on circumference conditions and also change.

[Definition of each temperature and thermal resistance]

Ta : Ambient air temperature

※The temperature of the air is defined at the position where the convection, radiation, etc. don't affect the temperature value, and it's separated from the heating elements.

Tc : It's the temperature near the center of a package surface. The package surface is defined at the opposite side if the PWB.

Tj : Semiconductor element surface temperature (Junction temperature.)

Rth(j-c) : The thermal resistance (difference of temperature of per 1 Watts) between a semiconductor element junction part and the package surface

Rth(c-a) : The thermal resistance (difference of temperature of per 1 Watts) between the package surface and the ambient air

Rth(j-a) : The thermal resistance (difference of temperature of per 1 Watts) between a semiconductor element junction part and the ambient air

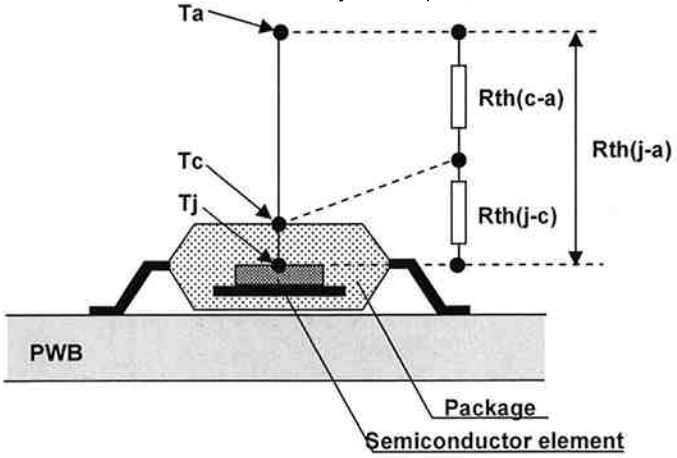


Fig1. Definition image

[Definition formula]

$$Tj=\{Rth(j-c)+Rth(c-a)\}\times P+Ta$$
$$=Rth(j-a)\times P+Ta$$

$$Rth(j-c)=\frac{Tj-Tc}{P}\quad(℃/W)$$

$$Rth(c-a)=\frac{Tc-Ta}{P}\quad(℃/W)$$

$$Rth(j-a)=\frac{Tj-Ta}{P}\quad(℃/W)$$

$$=Rth(j-c)+Rth(c-a)$$

P:power(W)

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