

Code No.: IC3F4738

Total Pages

Page

17

1

# 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

210801500106070

Semiconductor Company, Matsushita Electric Industrial Co., Ltd.

	Product Standards	AN8015SH	
		Total Pages	Page
		17	2

### Contents

■ Overview .....	3
■ Features .....	3
■ Applications .....	3
■ Package .....	3
■ Type .....	3
■ Application Circuit Example .....	4
■ Block Diagram .....	5
■ Pin Descriptions .....	6
■ Absolute Maximum Ratings .....	7
■ Operating Supply Voltage Range .....	7
■ Recommended Operating Conditions .....	7
■ Electrical Characteristics .....	8
■ Electrical Characteristics (Reference values for design) .....	9
■ Test Circuit Diagram .....	10
■ Electrical Characteristics Test Procedures .....	13
■ Technical Data .....	16
■ Usage Notes .....	17

2006-08-24		
Established	Revised	

	<b>Product Standards</b>	<b>AN8015SH</b>	
		Total Pages	Page
		17	3

# 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 portable 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  $\mu$ A typical)
- Incorporating the under-voltage lock-out (U.V.L.O) circuit
- Incorporating a high precision reference voltage circuit (2.46 V (allowance:  $\pm$ 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%  $\pm$ 5%)

## ■ Applications

- LCD displays, digital still cameras, and PDAs

## ■ Package

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

## ■ Type

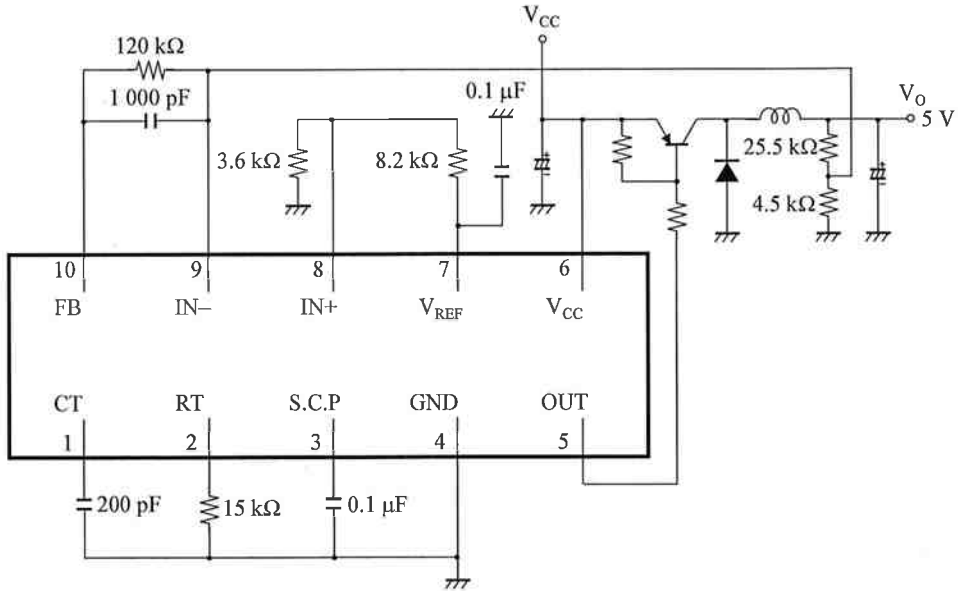
- Silicon Monolithic Bipolar IC

2006-08-24		
Established	Revised	

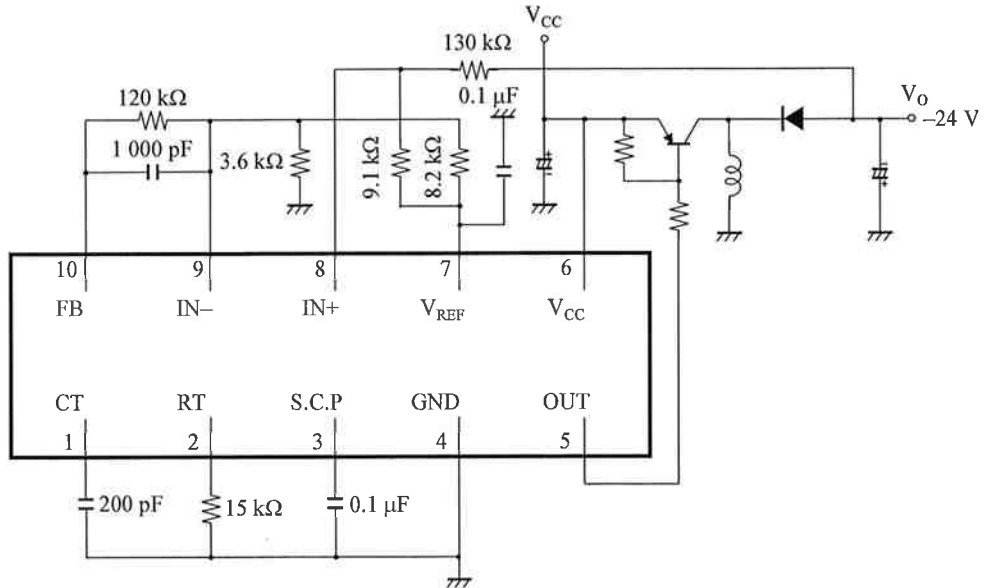
<h1>Product Standards</h1>		AN8015SH	
		Total Pages	Page
		17	4

■ Application Circuit Example

1. Chopper method step-down type



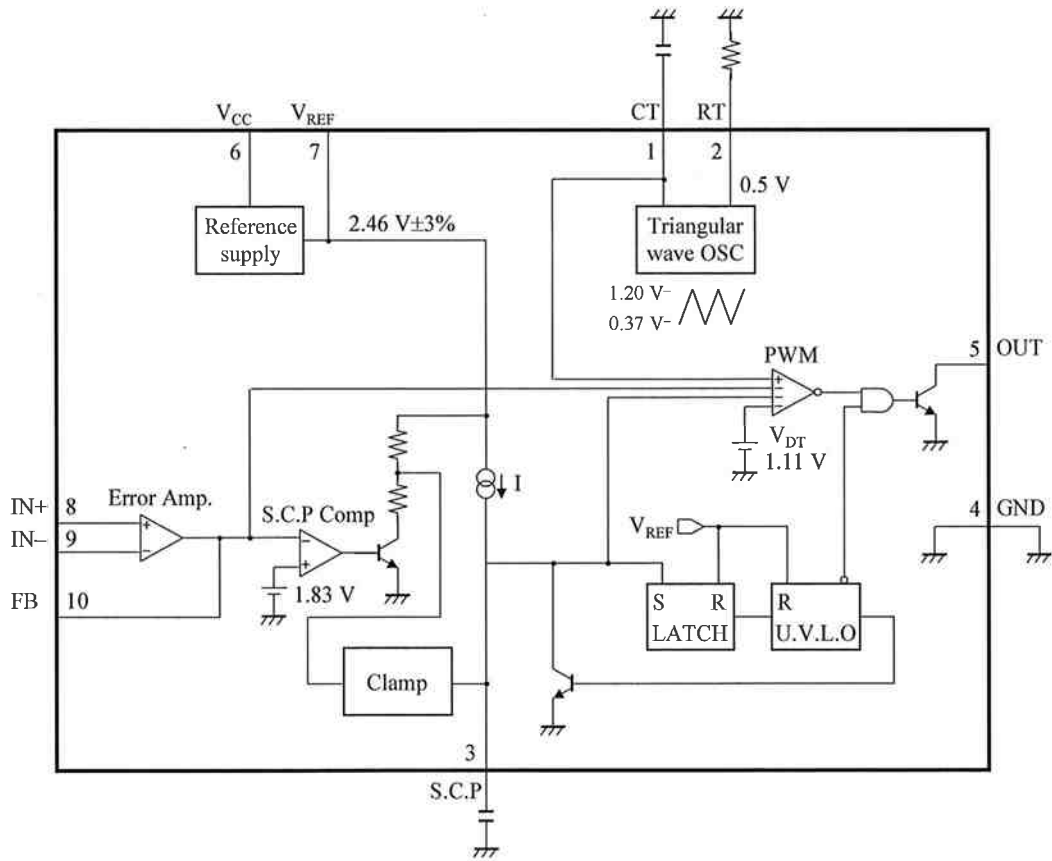
2. Chopper method inverting type



2006-08-24	
Established	Revised

	Product Standards	AN8015SH	
		Total Pages	Page
		17	5

■ Block Diagram



2006-08-24		
Established	Revised	

	<b>Product Standards</b>	<b>AN8015SH</b>	
		Total Pages	Page
		17	6

■ 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 <sub>CC</sub>	Power supply	Power supply voltage application pin
7	V <sub>REF</sub>	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

2006-08-24		
Established	Revised	

		Product Standards		AN8015SH	
				Total Pages	Page
		17	7		

### ■ 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  $T_a = 85^\circ\text{C}$  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  $T_a = 25^\circ\text{C}$ .

### ■ 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	k $\Omega$	*
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.

2006-08-24		
Established	Revised	

		<h1>Product Standards</h1>		<b>AN8015SH</b>	
				Total Pages	Page
				17	8

■ Electrical Characteristics at  $V_{CC} = 12\text{ V}$ ,  $R_T = 15\text{ k}\Omega$ ,  $C_T = 200\text{ pF}$

Note)  $T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$  unless otherwise specified.

B No.	Parameter	Symbol	Test circuits	Conditions	Limits			Unit	Notes
					Min	Typ	Max		
<b>Reference Voltage Block</b>									
1	Reference voltage	$V_{REF}$	1	$I_{REF} = -1\text{ mA}$	2.386	2.46	2.534	V	
2	Input regulation with input fluctuation	Line	1	$V_{CC} = 3.6\text{ to }34\text{ V}$ $I_{REF} = -1\text{ mA}$	—	5	20	mV	
3	Load regulation	Load	1	$I_{REF} = -0.1\text{ to }-1\text{ mA}$	—	2	10	mV	
<b>U.V.L.O. Block</b>									
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	
<b>Error Amplifier Block</b>									
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	
<b>Output Block</b>									
11	Oscillation frequency	$f_{OUT}$	5	$R_T = 15\text{ k}\Omega$ , $C_T = 200\text{ pF}$	175	195	215	kHz	
12	Maximum duty ratio	$D_{MAX}$	5	$R_T = 15\text{ k}\Omega$ , $C_T = 200\text{ pF}$	85	90	95	%	
13	Output saturation voltage	$V_{OL}$	5	$I_O = 50\text{ mA}$ , $R_T = 15\text{ k}\Omega$	—	0.9	1.2	V	
14	Output leak current	$I_{LEAK}$	5	$V_{CC} = 34\text{ V}$ , when output transistor is off	—	—	10	$\mu\text{A}$	
<b>Short-circuit Protection Circuit Block</b>									
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	$V_{SCP} = 0\text{ V}$	-1.32	-1.1	-0.88	$\mu\text{A}$	
<b>Whole Device</b>									
19	Total consumption current	$I_{CC}$	1	$R_T = 15\text{ k}\Omega$	—	1.8	2.8	mA	

2006-08-24		
Established	Revised	



<h1>Product Standards</h1>		<b>AN8015SH</b>	
		Total Pages	Page
		17	9

■ Electrical Characteristics (Reference values for design) at  $V_{CC} = 12\text{ V}$ ,  $R_T = 15\text{ k}\Omega$ ,  $C_T = 200\text{ pF}$

Note)  $T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$  unless otherwise specified.

B No.	Parameter	Symbol	Test circuits	Conditions	Reference values			Unit	Notes
					Min	Typ	Max		
<b>Reference Voltage Block</b>									
20	Input regulation with input fluctuation 2	$L_{INE2}$	1	$V_{CC} = 3.6\text{ V to }20\text{ V}$	—	10 (max)	—	mV	*1
21	Output voltage temperature characteristics 1	$V_{TC1}$	1	$T_a = -30\text{ to }25^\circ\text{C}$	—	$\pm 0.5$	—	%	*1
22	Output voltage temperature characteristics 2	$V_{TC2}$	1	$T_a = 25\text{ to }85^\circ\text{C}$	—	$\pm 0.5$	—	%	*1
23	Reference short-circuit current	$I_{RS}$	1	—	—	-20	—	mA	*1
<b>Error Amplifier Block</b>									
24	Output sink current	$I_{SINK}$	4	$V_{FB} = 0.8\text{ V}$	—	8	—	mA	*1
25	Output source current	$I_{SOURCE}$	4	$V_{FB} = 0.8\text{ V}$	—	-120	—	$\mu\text{A}$	*1
26	Open-loop gain	$A_V$	4	—	—	70	—	dB	*1
27	Common-mode ripple rejection ratio	CMRR	3	—	—	50	—	dB	*1
<b>Output Block</b>									
28	RT pin voltage	$V_{RT}$	5	—	—	0.5	—	V	*1
29	Maximum oscillation frequency	$f_{OUT(MAX)}$	5	$R_T = 5.6\text{ k}\Omega$ , $C_T = 150\text{ pF}$	—	500	—	kHz	*1
30	Frequency supply voltage characteristics	$f_{dV}$	5	$f_{OUT} = 200\text{ kHz}$ , $V_{CC} = 3.6\text{ V to }34\text{ V}$	—	$\pm 2$	—	%	*1
31	Frequency temperature characteristics 1	$f_{dT1}$	5	$f_{OUT} = 200\text{ kHz}$ , $T_a = -30\text{ to }25^\circ\text{C}$	—	$\pm 3$	—	%	*1
32	Frequency temperature characteristics 2	$f_{dT2}$	5	$f_{OUT} = 200\text{ kHz}$ , $T_a = 25\text{ to }85^\circ\text{C}$	—	$\pm 3$	—	%	*1
<b>Short-circuit Protection Circuit Block</b>									
33	Comparator threshold voltage	$V_{THL}$	6	—	—	1.83	—	V	*1
<b>Whole Device</b>									
34	Total consumption current 2	$I_{CC2}$	1	$R_T = 5.6\text{ k}\Omega$ , $C_T = 150\text{ pF}$	—	2.5	—	mA	*1

Note) \*1: The above characteristics are reference values for design of the IC and are not guaranteed by inspection.

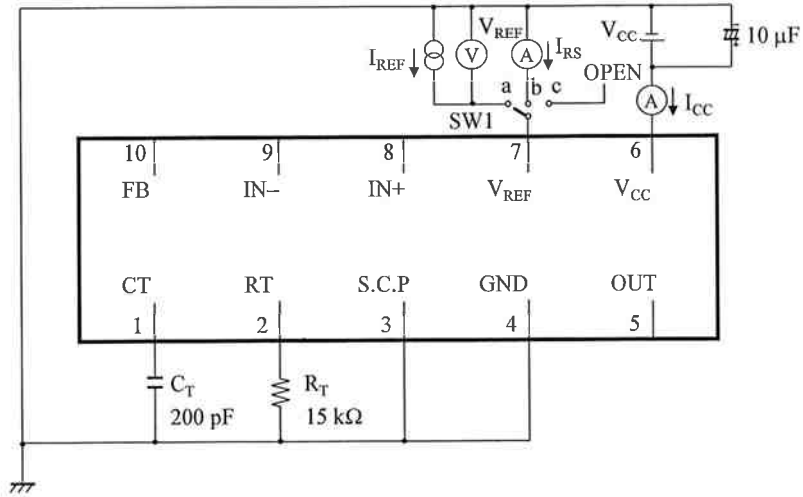
If a problem does occur related to these characteristics, Matsushita will respond in good faith to user concerns.

2006-08-24		
Established	Revised	

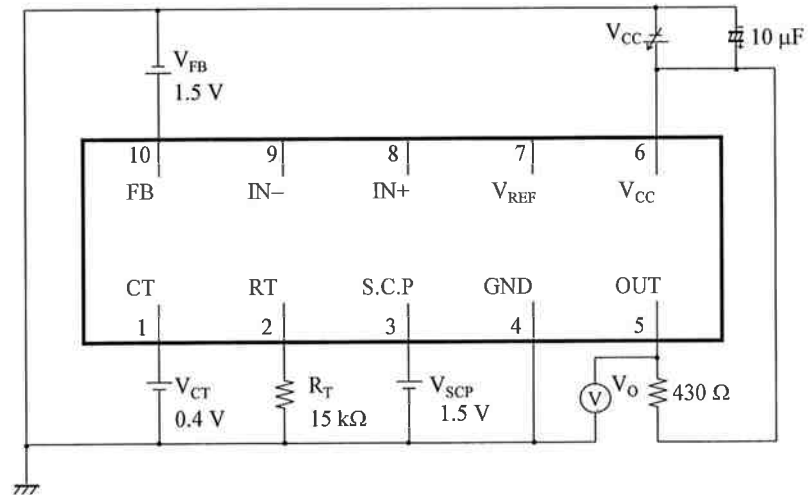
	Product Standards	AN8015SH	
		Total Pages	Page
		17	10

■ Test Circuit Diagram

1. Test Circuit 1



2. Test Circuit 2

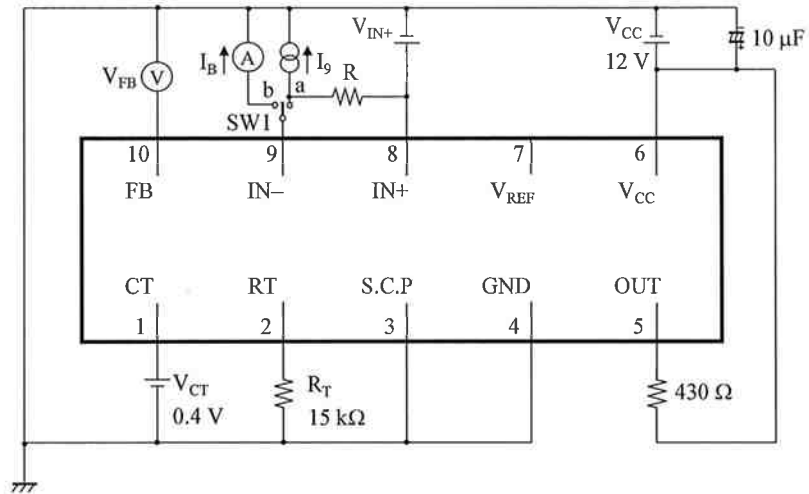


2006-08-24		
Established	Revised	

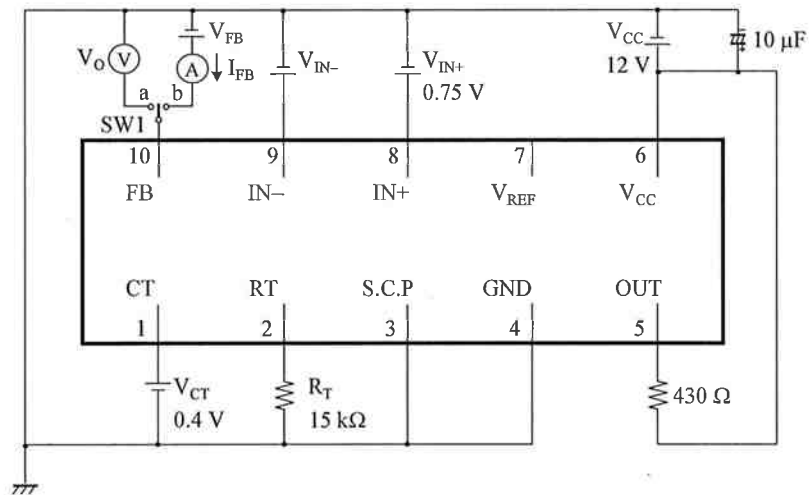
	<h1>Product Standards</h1>	<h2>AN8015SH</h2>	
		Total Pages	Page
		17	11

■ Test Circuit Diagram (continued)

3. Test Circuit 3



4. Test Circuit 4

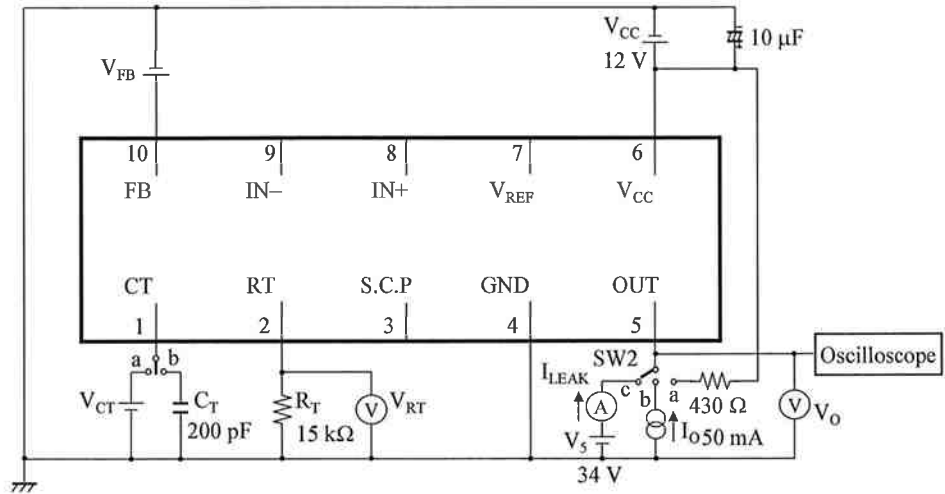


2006-08-24		
Established	Revised	

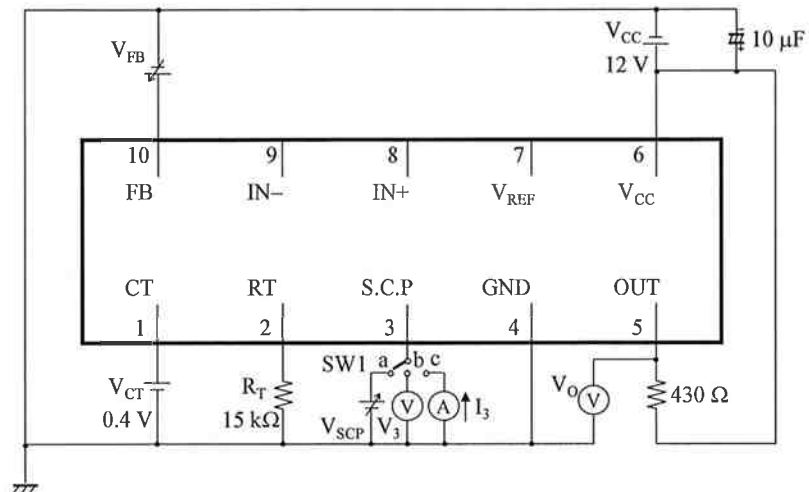
	Product Standards	AN8015SH	
		Total Pages	Page
		17	12

■ Test Circuit Diagram (continued)

5. Test Circuit 5



6. Test Circuit 6



2006-08-24		
Established	Revised	

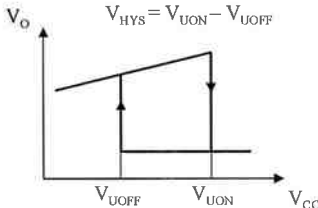
<h1>Product Standards</h1>		<b>AN8015SH</b>	
		Total Pages	Page
		17	13

## ■ Electrical Characteristics Test Procedures

### 1. Test Circuit1

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

### 2. Test Circuit2

C No.	Parameter	Conditions	Measuring Method
4	Circuit operation start voltage	$V_{CT} = 0.4\text{ V}$ , $V_{SCP} = 1.5\text{ V}$ , $V_{FB} = 1.5\text{ V}$	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	$V_{CT} = 0.4\text{ V}$ , $V_{SCP} = 1.5\text{ V}$ , $V_{FB} = 1.5\text{ V}$	

### 3. Test Circuit3

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

2006-08-24		
Established	Revised	

<h1>Product Standards</h1>		<b>AN8015SH</b>	
		Total Pages	Page
		17	14

■ Electrical Characteristics Test Procedures (continued)

4. Test Circuit4

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

5. Test Circuit5

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

2006-08-24		
Established	Revised	

	<b>Product Standards</b>	<b>AN8015SH</b>	
		Total Pages	Page
		17	15

■ Electrical Characteristics Test Procedures (continued)

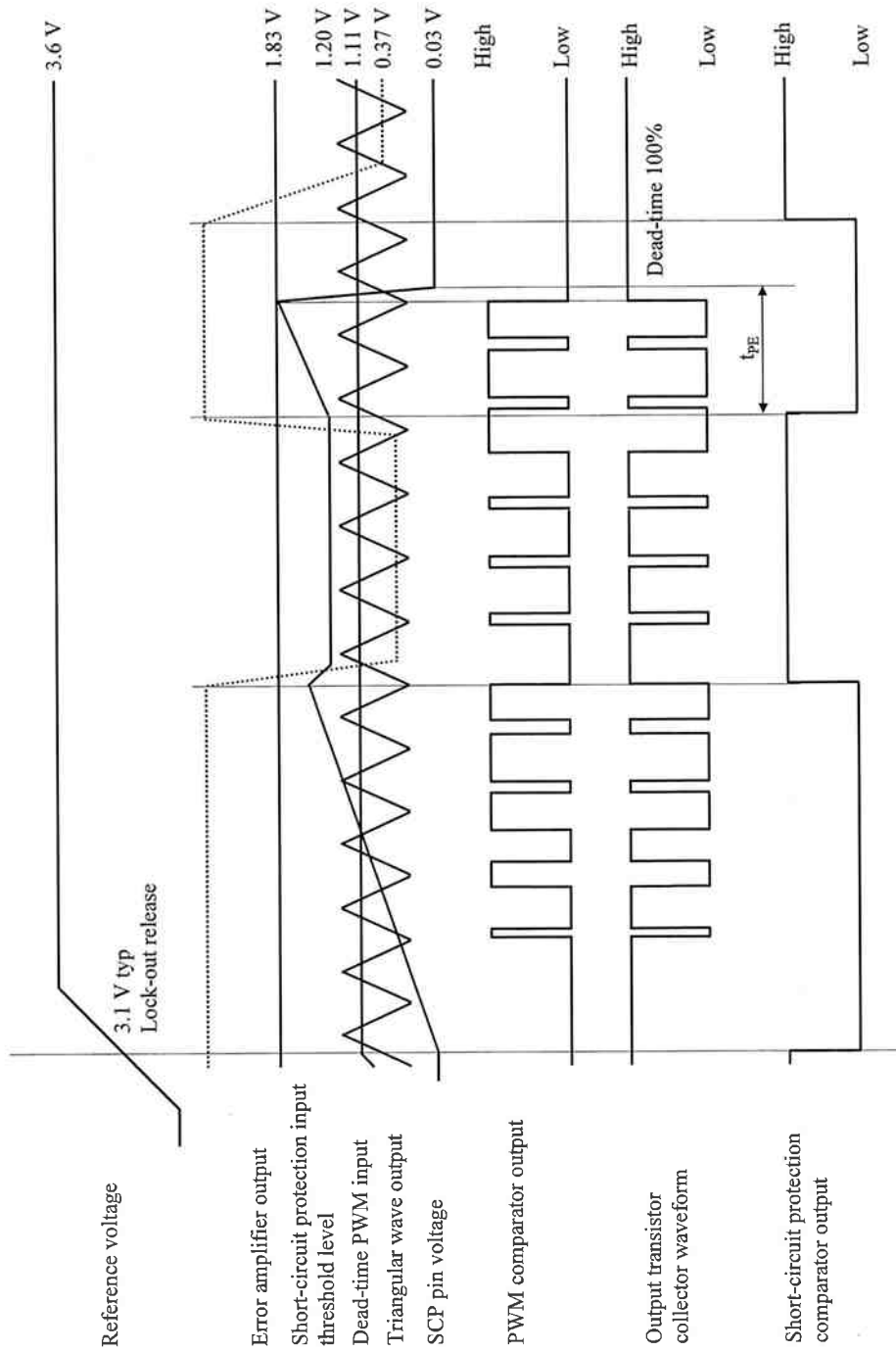
6. Test Circuit6

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

2006-08-24		
Established	Revised	

Product Standards		AN8015SH	
		Total Pages	Page
		17	16

- Technical Data
  - Timing chart



2006-08-24	
Established	Revised

210801501606070

Semiconductor Company, Matsushita Electric Industrial Co., Ltd.



	<h1>Product Standards</h1>	<b>AN8015SH</b>	
		Total Pages	Page
		17	17

■ 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 k $\Omega$ , and it increases to approximately 2.5 mA (typical) when  $R_T$  is 5.6 k $\Omega$ .

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.

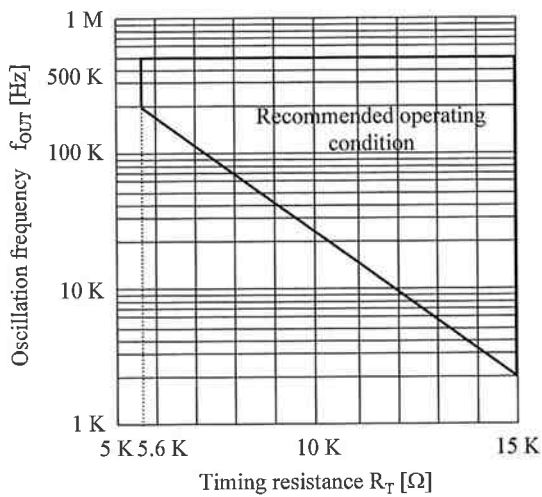


Figure 1. Timing resistance recommended condition

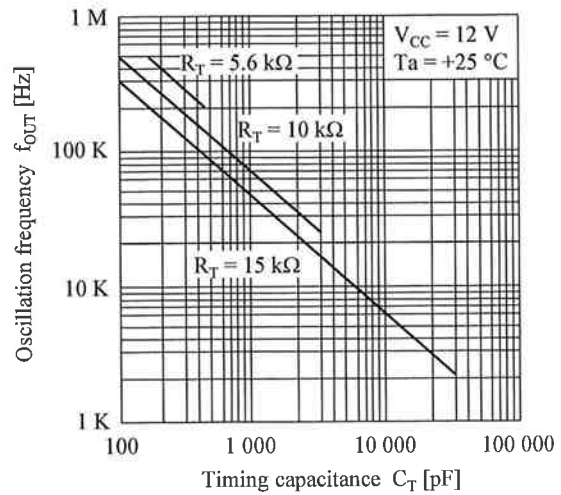


Figure 2. Timing capacitance-Oscillation frequency

2006-08-24		
Established	Revised	

# PACKAGE STANDARDS

Package Code

SSOP010-P-0225A

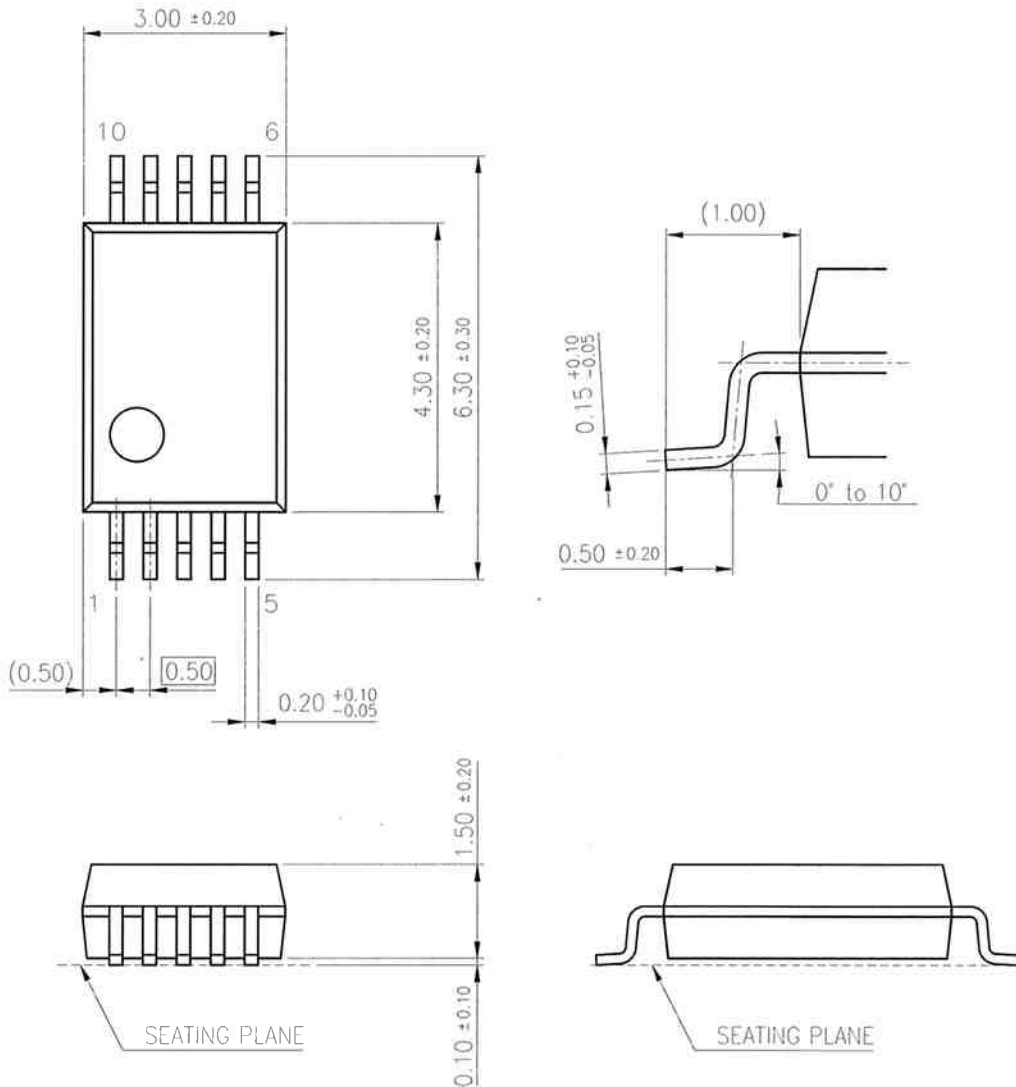
Semiconductor Company  
Matsushita Electric Industrial Co., Ltd.

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

	<b>PACKAGE STANDARDS</b> SSOP010-P-0225A		
		Total Pages	Page
		6	2

1. Outline Drawing

Unit:mm

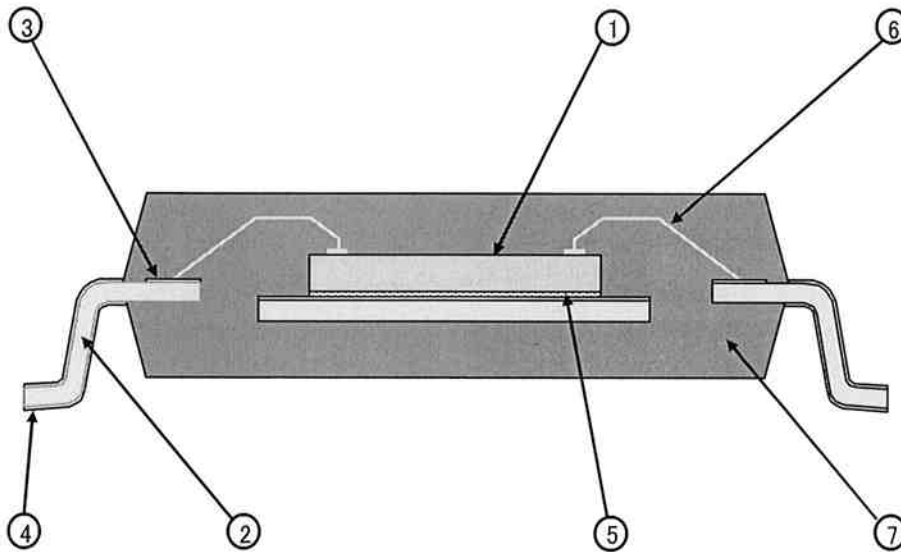


Weight	: 43 mg
Body Material	: Epoxy Resin
Lead Material	: Cu Alloy
Lead Finish Method	: SnBi Plating

	<b>PACKAGE STANDARDS</b> <b>SSOP010-P-0225A</b>		
		Total Pages	Page
		6	3

2. Package Structure (Technical Report)

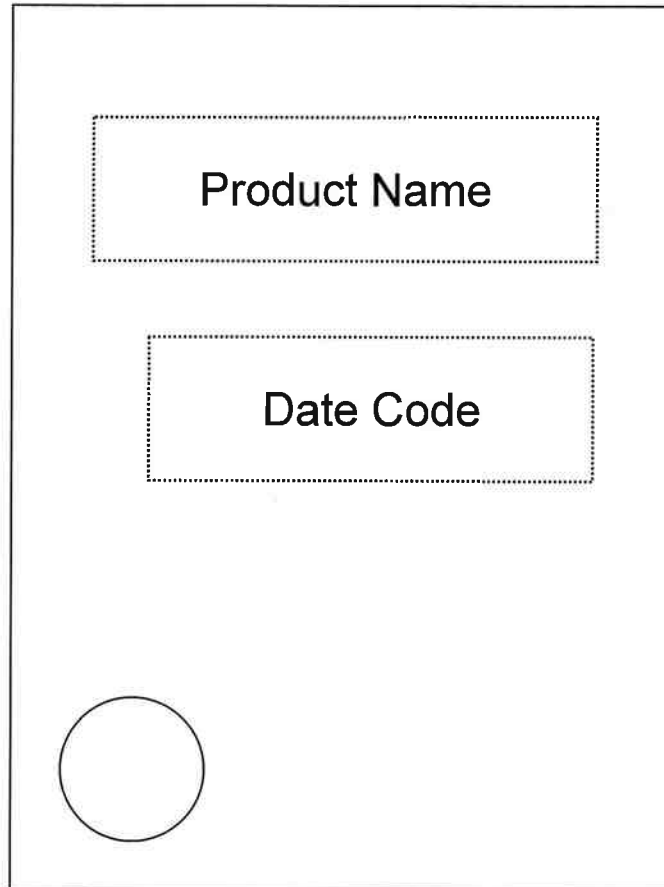
Chip Material		Si	①
Leadframe material		Cu alloy	②
Inner lead surface		Ag plating	③
Outer lead surface		SnBi plating	④
Chip mount	Method	Resin adhesive method	⑤
	Material	Adhesive material	
Wirebond	Method	Thermo-compression bonding	⑥
	Material	Au	
Molding	Method	Multipunger molding	⑦
	Material	Epoxy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



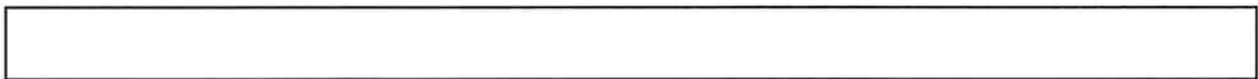
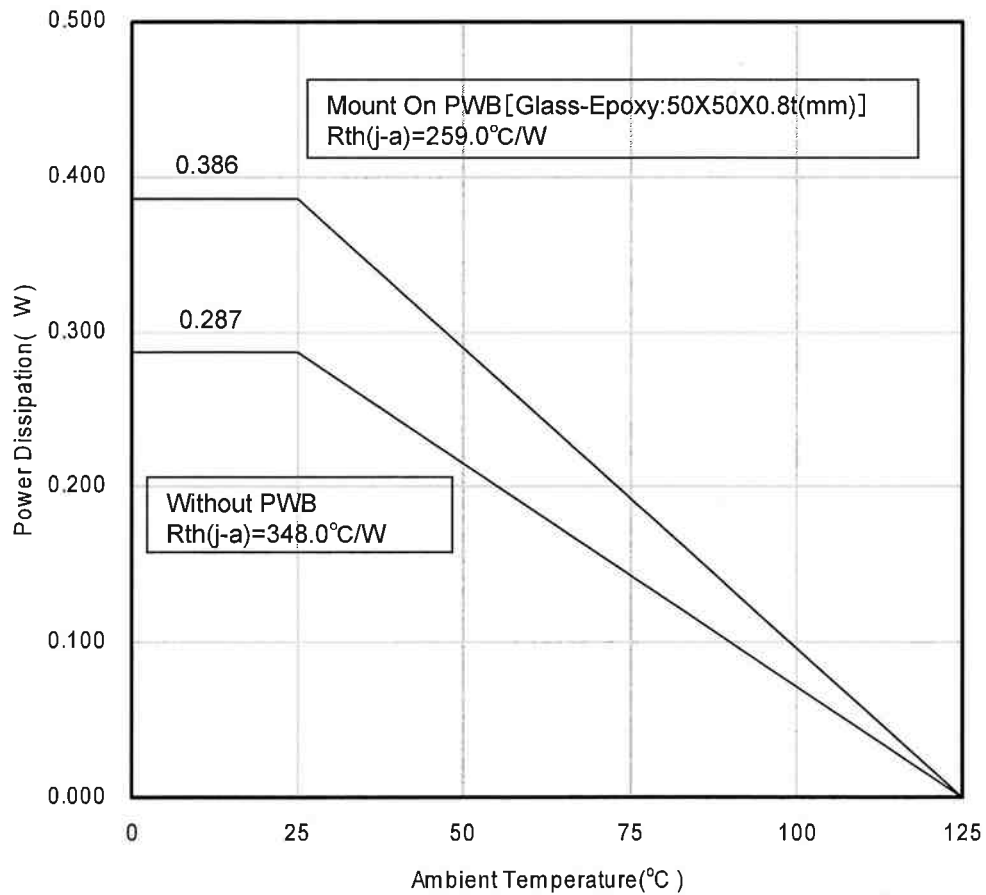
Semiconductor Company, Matsushita Electric Industrial Co., Ltd.

	<b>PACKAGE STANDARDS</b> <b>SSOP010-P-0225A</b>		
		Total Pages	Page
		6	4

3. Mark Drawing



4. Power Dissipation (Technical Report)



### 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

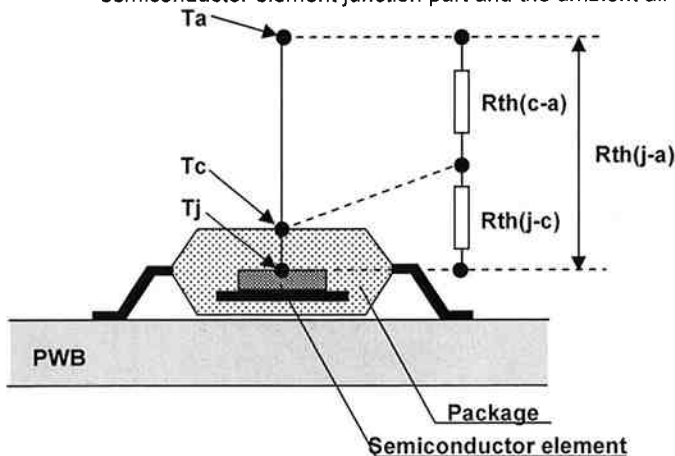


Fig1. Definition image

**[Definition formula]**

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

$$= Rth(j-a) \times P + Ta$$

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

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

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

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

P: power(W)