DATA SHEET

Part No.	AN12946A
Package Code No.	HQFP048-P-0707

Contents

AN12946A

Stereo BTL amplifier IC with built-in MIC amplifier and regulator

■ Overview

AN12946A is a CMOS output power amplifier. The parallel control method is adopted selecting various modes including standby function ON/OFF. Moreover, a power supply for CODEC and the microphone amplifier necessary for notebook PC are built-in.

■ Features

- Maximum power of 1 W (VCC_SP = 5 V, RL = 8 Ω, THD = 10%)
- Standby (STBY) function for speaker amplifier, microphone amplifier and regulator
- RF noise prevention
- Built-in over current protection
- BEEP detector

■ Applications

- Notebook PC

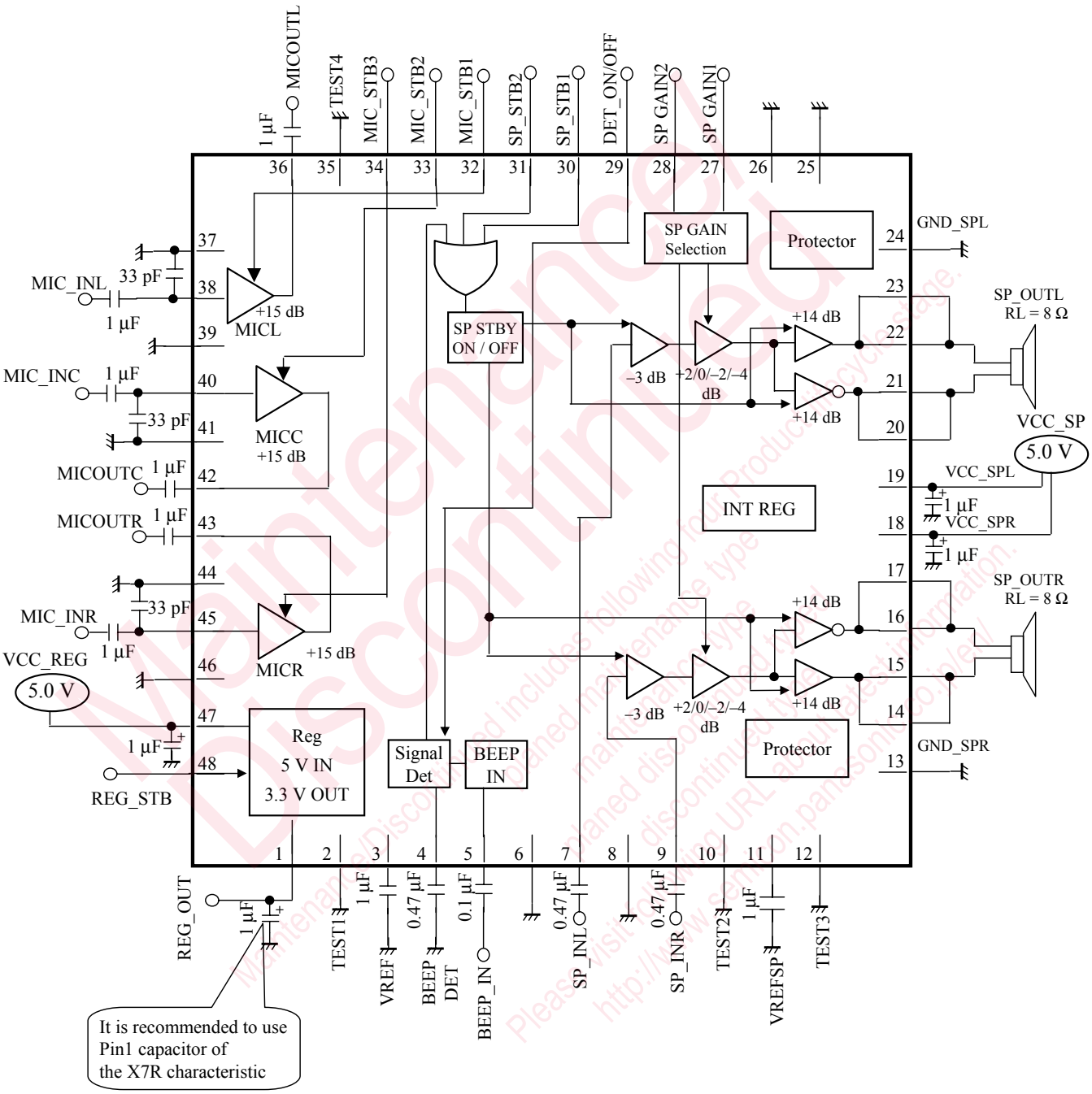
■ Package

- 48 pin plastic quad flat package with heat sink (QFP type)

■ Type

- Silicon monolithic bipolar IC

■ Application Circuit Example (Block Diagram)



Note) 1. This application circuit is shown as an example but does not guarantee the design for mass production set.

2. This block diagram is for explaining functions. The part of the block diagram may be omitted, or it may be simplified.

■ Pin Descriptions

Pin No.	Pin Name	Type	Description
1	REG_OUT	Output	Power supply for codec
2	TEST1	Input	Terminal for testing (please connect to ground)
3	VREF	Input	Terminal of reference voltage
4	BEEPDET	Input	BEEP detect cap
5	BEEP_IN	Input	Beep input
6	GND	Ground	Ground
7	SP_INL	Input	L-channel speaker amplifier input
8	GND	Ground	Ground
9	SP_INR	Input	R-channel speaker amplifier input
10	TEST2	Input	Terminal for testing (please connect to ground)
11	VREFSP	Input	Terminal of reference voltage for SP amp.
12	TEST3	Input	Terminal for testing (please connect to ground)
13	GND_SPR	Ground	Ground for SP R-channel amp system
14	SP_OUTR+	Output	SP amp. R-channel output (+)
15	SP_OUTR+	Output	SP amp. R-channel output (+)
16	SP_OUTR–	Output	SP amp. R-channel output (–)
17	SP_OUTR–	Output	SP amp. R-channel output (–)
18	VCC_SPR	Power supply	Power supply for SP R-channel amp system
19	VCC_SPL	Power supply	Power supply for SP L-channel amp system
20	SP_OUTL–	Output	SP amp. L-channel output (–)
21	SP_OUTL–	Output	SP amp. L-channel output (–)
22	SP_OUTL+	Output	SP amp. L-channel output (+)
23	SP_OUTL+	Output	SP amp. L-channel output (+)
24	GND_SPL	Ground	Ground for SP L-channel amp system
25	N.C.	—	N.C.
26	N.C.	—	N.C.
27	SPGAIN1	Input	Speaker amp gain setting terminal
28	SPGAIN2	Input	Speaker amp gain setting terminal
29	DET_ON/OFF	Input	Beep detector On/Off control
30	SP_STBY1	Input	SP standby On/Off control
31	SP_STBY2	Input	SP standby On/Off control
32	MICL_STBY	Input	L-channel MIC standby On/Off control

■ Pin Descriptions (continued)

Pin No.	Pin Name	Type	Description
33	MICC_STBY	Input	C-channel MIC standby On/Off control
34	MICR_STBY	Input	R-channel MIC standby On/Off control
35	TEST4	Input	Terminal for testing (please connect to ground)
36	MICOUTL	Output	L-channel MIC output
37	GND	Ground	Ground
38	MIC_INL	Input	L-channel MIC input
39	GND	Ground	Ground
40	MIC_INC	Input	C-channel MIC input
41	GND	Ground	Ground
42	MICOUTC	Output	C-channel MIC output
43	MICOUTR	Output	R-channel MIC output
44	GND	Ground	Ground
45	MIC_INR	Output	R-channel MIC input
46	GND	Ground	Ground
47	VCC_REG	Power supply	Power supply for regulator
48	REG_STBY	Input	Regulator standby on/Off control

■ Absolute Maximum Ratings

A No.	Parameter	Symbol	Rating	Unit	Note
1	Supply voltage	VCC_SPL VCC_SPR	5.75	V	*1
		VCC_REG	5.75		
2	Supply current	I_{CC}	—	A	—
3	Power dissipation	P_D	355	mW	*2
4	Operating ambient temperature	T_{opr}	–30 to +85	°C	*3
5	Storage temperature	T_{stg}	–55 to +150	°C	*3

Note) *1: The range under absolute maximum ratings, power dissipation.

*2: Power dissipation shows the value of only package at T_a = 85°C.
When using this IC, refer to the 5. P_D – T_a diagram in the ■ Technical Data and use under the condition not exceeding the allowable value.

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

■ Operating Supply Voltage Range

Parameter	Symbol	Range	Unit	Note
Supply voltage range	VCC_SPL VCC_SPR	4.5 to 5.5	V	—
	VCC_REG	4.5 to 5.5		

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

■ Electrical Characteristics at VCC_SPL = VCC_SPR = VCC_REG = 5.0 V, SP_GAIN = 17 dB, RL = 8 Ω

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

B No.	Parameter	Symbol	Conditions	Limits			Unit	Note
				Min	Typ	Max		
Circuit current								
1	Circuit current 1A at Non-signal (VCC_SP system)	IVCC1A	Non-signal, SP_STB = OFF, REG_STB = ON, MIC_STB = ON, DETECT = OFF	6	15	25	mA	*
2	Circuit current 2A at Non-signal (VCC_REG)	IVCC2A	Non-signal, SP_STB = OFF, REG_STB = OFF, MIC_STB = ON, DETECT = OFF	—	2.0	4	mA	—
3	Circuit current 3A at Non-signal (VCC_SP system)	IVCC3A	Non-signal, SP_STB = ON, REG_STB = ON, MIC_STB = ON, DETECT = ON	—	2.5	5	mA	*
4	Circuit current 4A at Non-signal (VCC_SP system)	IVCC4A	Non-signal, SP_STB = ON, REG_STB = ON, MIC_STB = OFF, ETECT = OFF	—	2.5	5	mA	*
5	Circuit current 1B at Non-signal (VCC_SP system)	IVCC1B	Non-signal, SP_STB = ON, REG_STB = ON, MIC_STB = ON, DETECT = OFF	—	0.1	10	µA	*
6	Circuit current 2B at Non-signal (VCC_REG)	IVCC2B	Non-signal, SP_STB = ON, REG_STB = ON, MIC_STB = ON, DETECT = OFF	—	0.1	10	µA	—
Speaker amplifier characteristics SP_STB = OFF, REG_STB = OFF, MIC_STB = ON								
7	SP reference output level	VSPOL VSPOR	VinL = VinR = –17.0 dBV, f = 1 kHz, DETECT = OFF	–2.0	0	2.0	dBV	—
8	SP reference output distortion	THSPOL THSPOR	VinL = VinR = –17.0 dBV, f = 1 kHz to THD 5th, DETECT = OFF	—	0.05	0.1	%	—
9	SP output noise voltage	VNSPOL VNSPOR	Non-signal A curve filter, DETECT = OFF	—	–79	–73	dBV	—
10	SP maximum rating output	VMSPOL VMSPOR	THD = 10% , f = 1 kHz, DETECT = OFF	0.8	1	—	W	—
11	SP channel balance	CHBS	VinL = VinR = –17.0 dBV, f = 1 kHz, DETECT = OFF	–1.0	0	1.0	dB	—
12	SP cross talk	VCTSPL VCTSPR	VinL or VinR = –17.0 dBV, f = 1 kHz, A curve filter, DETECT = OFF	70	80	—	dB	—
13	SP output level at standby	VSSPOL VSSPOR	VinL = VinR = –17.0 dBV, f = 1 kHz, A curve filter, DETECT = OFF	—	–100	–86	dBV	—
14	SP output DC offset voltage	VDCSPL VDCSPR	Non-signal, DETECT = OFF	—	±0	±35	mV	—

Note) *: Minimum capacitor that achieves proper operation is 0.7 µF and this capacitance must fall within the range of the operating temperature of ±30%. Please check the total range of the operating condition of the capacitor to fulfill the minimum requirement of the above-mentioned before selecting it for your application. Minimum value of ESR is 5 mΩ or more. A capacitor of X7R characteristics has a temperature range of –40°C to +125°C.

■ Electrical Characteristics at VCC_SPL = VCC_SPR = VCC_REG = 5.0 V, SP_GAIN = 17 dB, RL = 8 Ω (continued)

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

B No.	Parameter	Symbol	Conditions	Limits			Unit	Note
				Min	Typ	Max		
Microphone Amplifier Characteristics SP_STB = ON, REG_STB = OFF, MIC_STB = OFF, DETECT = OFF								
15	MIC amp. reference output level	VMPOL VMPOC VMPOR	Vin = –39.0 dBV, f = 1 kHz, 1ch OUT	–25.5	–24.0	–22.5	dBV	—
16	MIC amp. output distortion 1	THMPO1L THMPO1C THMPO1R	Vin = –39.0 dBV, f = 1 kHz, 1ch OUT, to THD 5th	—	0.015	0.045	%	—
17	MIC amp. output distortion 2	THMPO2L THMPO2C THMPO2R	Vin = –22.0 dBV, f = 1 kHz, 1ch OUT, to THD 5th	—	0.08	1	%	—
18	MIC amp. output noise voltage	VNMPOL VNMPOC VNMPOR	Non-signal, 1ch OUT, A curve filter	—	–100	–96	dBV	—
19	MIC amp. channel balance	CHBMP	Vin = –39.0 dBV, f = 1 kHz, L/C/R difference	–1.0	0.0	1.0	dB	—
Linear Regulator Characteristics SP_STB = OFF, REG_STB = OFF, MIC_STB = ON, DETECT = OFF								
20	Output voltage	VOREG	Iout = 1 mA	3.23	3.3	3.37	V	—
21	Line regulation	LINREG	Vin = 4.5 V, 5.5 V, Iout = 1 mA	–0.3	+0.01	+0.3	%/V	—
22	Load regulation 1	LODREG1	Iout = 1 mA, 150 mA	—	0.0034	—	% /mA	—
23	Load regulation 2	LODREG2	Iout = 200 mA	—	1	5	%	—

■ Electrical Characteristics (Reference values for design) at VCC_SPL = VCC_SPR = VCC_REG = 5.0 V, SP_GAIN =17 dB, RL= 8 Ω

Note) T_a = 25°C±2°C unless otherwise specified.
The characteristics listed below 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.

B No.	Parameter	Symbol	Conditions	Limits			Unit	Note
				Min	Typ	Max		
Speaker amplifier characteristics SP_STB = OFF, REG_STB = OFF, MIC_STB = ON								
24	SP ripple rejection	VSPRRL VSPRRR	Vripple = 200 mV[p-p], f = 1 kHz, A curve filter, DETECT = OFF	—	60	—	dB	—
Microphone amplifier characteristics SP_STB = ON, REG_STB = OFF, MIC_STB = OFF, DETECT = OFF								
25	MIC amp. ripple rejection	VMRRL VMRRC VMRRR	Vripple = 200 mV[p-p], f = 1 kHz, 1-ch. OUT, A curve filter	—	60	—	dB	—
Linear regulator characteristics SP_STB = OFF, REG_STB = OFF, MIC_STB = ON, DETECT = OFF								
26	Load regulation 1	LODREG1	Iout = 1 mA, 150 mA	—	0.0034	—	% /mA	—
27	Ripple rejection 1	REGRR1	Vripple = 200 mV[p-p], f = 1 kHz, Iout = 1 mA	—	60	—	dB	—
28	Ripple rejection 2	REGRR2	Vripple = 200 mV[p-p], f = 10 kHz, Iout = 1 mA	—	50	—	dB	—
29	Current limit	IREGLIM	Vout = GND	—	500	—	dB	—
Threshold voltage level								
30	Low level 1 (Pin 29, 30, 31, 32, 33, 34, 48)	VLO1	—	0	—	0.5	V	—
31	High level 1 (Pin 29, 30, 31, 32, 33, 34, 48)	VHI1	—	2.5	—	VCC	V	—
32	Low level 2 (Pin 27, 28)	VLO2	—	0	—	0.5	V	—
33	High level 2 (Pin 27, 28)	VHI2	—	4.0	—	VCC	V	—

■ Technical Data

1. STBY-control

(a) SP_STBY ON/OFF selection

Pin voltage		SP_STBY ON/OFF
Pin 30 (SP_STBY1)	Pin 31 (SP_STBY2)	
Low	Low	ON
Low	High	OFF
High	Low	OFF
High	High	OFF

(b) DETECT ON/OFF selection

Pin voltage	DETECT ON/OFF
Pin 29 (DETECT_ON/OFF)	
Low	OFF
High	ON

(c) MIC_STBY ON/OFF selection

Pin voltage	MIC ON/OFF
Pin 32, 33, 34 (MIC_STBY)	
Low	OFF
High	ON

(d) REG_STBY ON/OFF selection

Pin voltage	REG ON/OFF
Pin 48 (REG_STBY)	
Low	OFF
High	ON

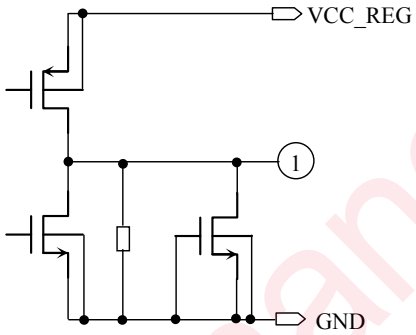
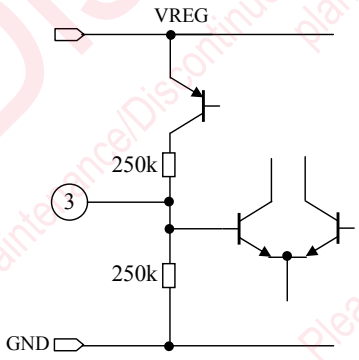
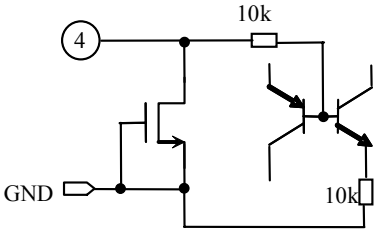
(e) SP gain selection

Pin voltage		SP_GAIN Selection
Pin 27 (SP_GAIN1)	Pin 28 (SP_GAIN2)	
Low	Low	+17 dB
Low	High	+19 dB
High	Low	+15 dB
High	High	+13 dB

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions

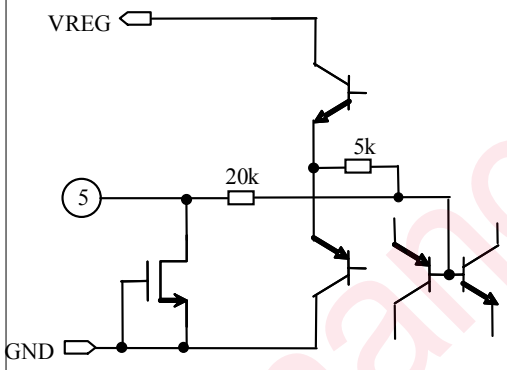
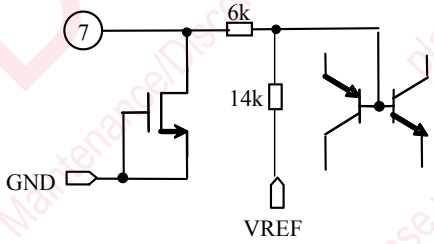
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
1	REG_OUT DC 3.3 V		Output impedance = less than 1 Ω	It is an output terminal of the regulator.
2	TEST1	—	—	Terminal for testing. Please connect to ground.
3	VREF DC 2 V		Input impedance = About 125 kΩ	The reference voltage terminal for DC bias. Please connect an external capacitor to remove any ripples present.
4	BEEPDET DC 2.8 V		Input impedance = About 10 kΩ	It is a capacitor terminal for the BEEP sound detection. The detection speed can be changed by changing the capacitance value.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

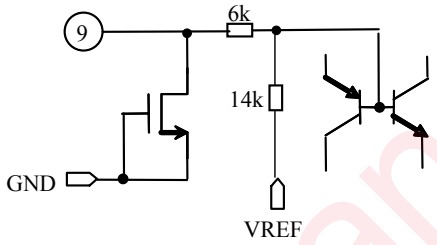
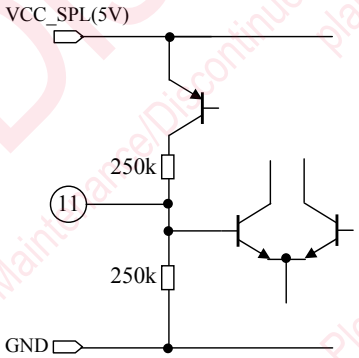
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
5	BEEP_IN  DC 2 V		Input impedance = About 20 kΩ	It is BEEP input terminal. Please insert a capacitor of 0.1 µF in series with the pin.
6	GND	—	—	It is a terminal GND.
7	SP_INL ———— DC 2 V		Input impedance = About 20 kΩ	It is an input terminal of the L-channel speaker amplifier. Please insert a capacitor of 0.47 µF in series with the pin.
8	GND	—	—	It is a terminal GND.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

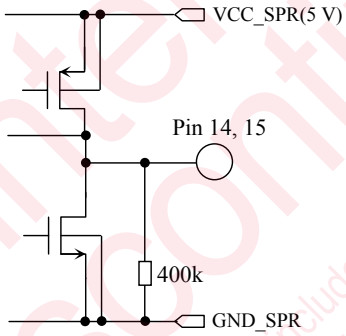
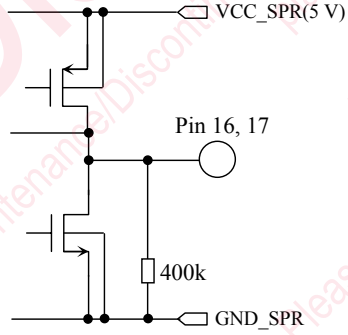
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
9	SP_INR DC 2 V		Input impedance = About 20 kΩ	It is an input terminal of the R-channel speaker amplifier. Please insert a capacitor of 0.47 µF in series with the pin.
10	TEST2	—	—	Terminal for testing. Please connect to ground.
11	VREFSP DC 2.5 V		Input impedance = About 125 kΩ	The reference voltage terminal for DC bias of the output stage of a speaker amplifier system. Please connect an external capacitor to remove any ripples present.
12	TEST3	—	—	Terminal for testing. Please connect to ground.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

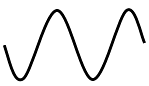
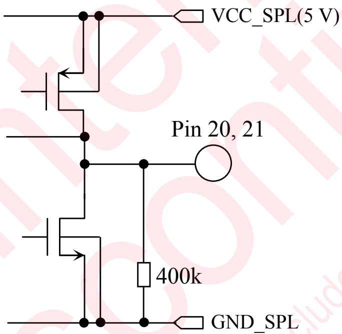
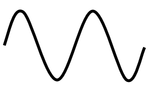
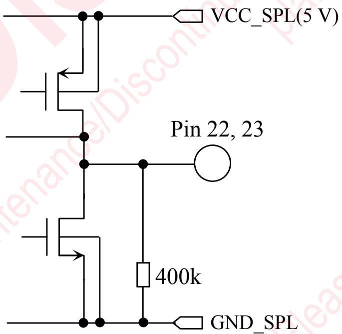
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
13	GND_SPR	—	—	Terminal GND for speaker amplifier of R-channel It is not connected with the substrate in IC. Because of large current flows, it is preferable to separate the terminal GND (Pin 13 and Pin 24) for the speaker amplifier and other terminals GND as much as possible on a printed circuit board (PCB).
14 15	SP_OUTR(+)  DC 2.5 V AC –2 dBV		Output impedance = Equal to or less than 1 Ω	Output terminal of R-channel speaker amplifier. It is BTL output. R-channel positive aspect output pin: Pin 14, Pin 15 R-channel reverse-aspect output pin: Pin 16, Pin 17 To decrease the voltage loss across the wire resistance during large current flows, the output is made into two terminals. Please connect Pin 14, Pin 15, Pin 16, and Pin 17 respectively on the PCB.
16 17	SP_OUTR(–)  DC 2.5 V AC –2 dBV		Output impedance = Equal to or less than 1 Ω	
18	VCC_SPR ———— DC 5 V	—	—	Terminal VCC to supply voltage to speaker amplifier of R-channel. Because of large current flows, it is preferable to separate as much as possible on the VCC system (Pin 18, Pin 19 and Pin 47) on the PCB.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

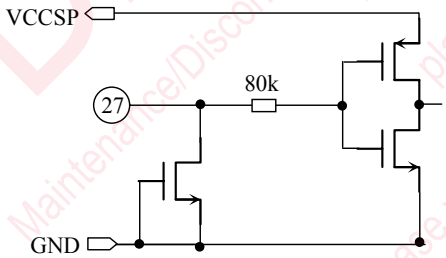
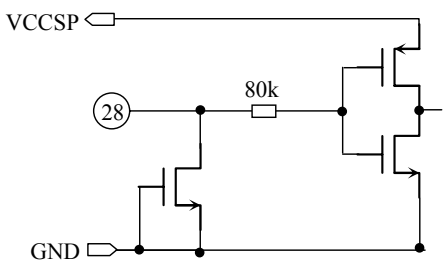
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
19	VCC_SPL ——— DC 5 V	—	—	Terminal VCC to supply voltage to speaker amplifier of L-channel. Because of large current flows, it is preferable to separate as much as possible on the VCC system (Pin 18, Pin 19 and Pin 47) on the PCB.
20 21	SP_OUTL(–)  DC 2.5 V AC –2 dBV		Output impedance = Equal to or less than 1 Ω	Output terminal of L-channel speaker amplifier. It is BTL output. L-channel positive aspect output pin: Pin 22, Pin 23 L-channel reverse-aspect output pin: Pin 20, Pin 21 To decrease the voltage loss across the wire resistance during large current flows, the output is made into two terminals. Please connect Pin 20, Pin 21, Pin 22, and Pin 23 respectively on the PCB.
22 23	SP_OUTL(+)  DC 2.5 V AC –2 dBV		Output impedance = Equal to or less than 1 Ω	
24	GND_SPL	—	—	Terminal GND for speaker amplifier of L-channel. It is not connected with the substrate in IC. Because of large current flows, it is preferable to separate the terminal GND (Pin 13 and Pin 24) for the speaker amplifier and other terminals GND as much as possible on the PCB.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

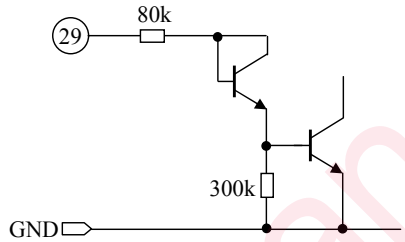
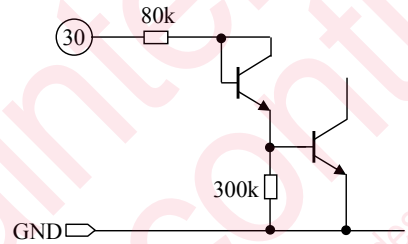
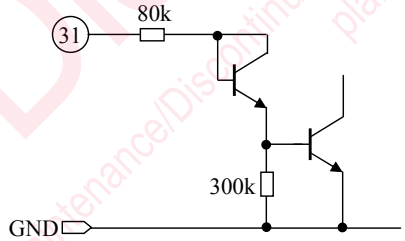
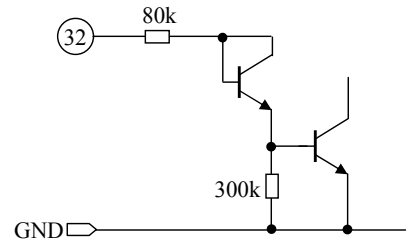
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
25	N.C.	—	—	No wiring.
26	N.C.	—	—	
27	SPGAIN1		Input impedance = Hi-Z	It is a speaker gain setting terminal. Please do not leave it unconnected.
28	SPGAIN2		Input impedance = Hi-Z	Please connect either to 5 V power supply or GND. Refer to the control terminal mode table of Page No.11 for the mode setting.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

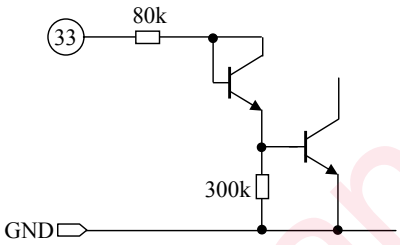
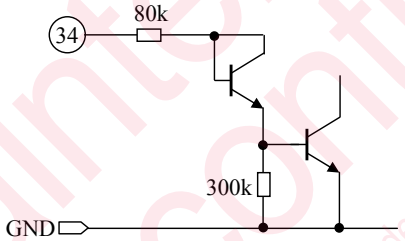
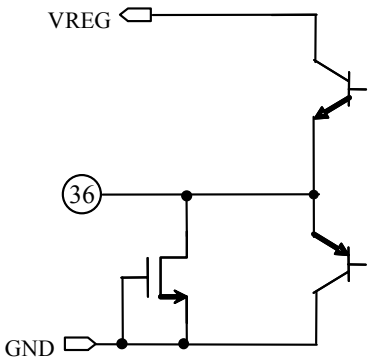
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
29	DET_ON/OFF		Input impedance = About 80 kΩ	It is a control terminal that determines the BEEP detector is in a state of operation or standby. The BEEP sound detection operates at Pin 29 high. When Pin 29 is low, the BEEP sound detection is turned off. Please refer to the control terminal mode table of Page No.11 for the mode setting.
30	SP_STBY1		Input impedance = About 80 kΩ	It is a control terminal that determines the speaker amplifier system is in a state of operation or standby. The speaker amplifier system operates at Pin 30 or Pin 31 high. When Pin 29, Pin 30, Pin 31, Pin 32, Pin 33, Pin 34 and Pin 48 all are low, it completely enters the state of standby, and most circuit currents are 0 in this IC. Please refer to the control terminal mode table of Page No.11 for the mode setting.
31	SP_STBY2		Input impedance = About 80 kΩ	
32	MICL_STBY		Input impedance = About 80 kΩ	It is a control terminal that determines the L-channel microphone amplifier system is in a state of operation or standby. At Pin 32 high, the L-channel. microphone amplifier turns on, and turns off at low. Please refer to the control terminal mode table of Page No.11 for the mode setting.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

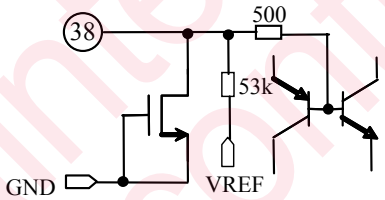
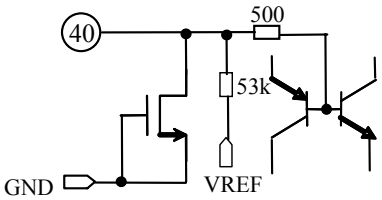
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
33	MICC_STBY		Input impedance = About 80 kΩ	It is a control terminal that determines the C-channel microphone amplifier system is in a state of operation or standby. At Pin 33 high, the C-channel microphone amplifier turns on, and turns off at low. Please refer to the control terminal mode table of Page No.11 for the mode setting.
34	MICR_STBY		Input impedance = About 80 kΩ	It is a control terminal that determines the R-channel microphone amplifier system is in a state of operation or standby. At Pin 34 high, the C-channel microphone amplifier turns on, and turns off at low. Please refer to the control terminal mode table of Page No.11 for the mode setting.
35	TEST4	—	—	Terminal for testing. Please connect to ground.
36	MICOUTL  DC 2 V		Output impedance = Equal to or less than 1 Ω	The output terminal of the microphone amplifier L-channel.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

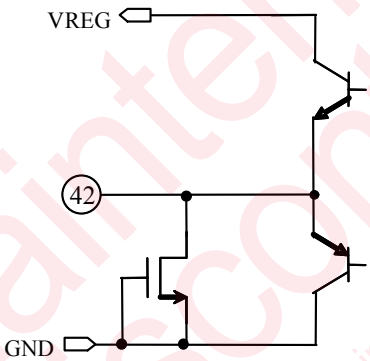
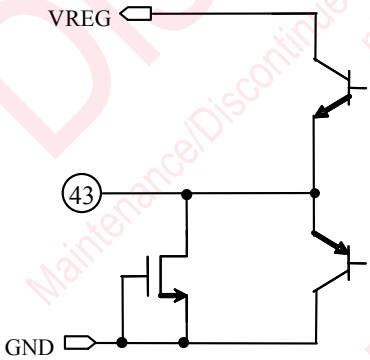
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
37	GND	—	—	It is a terminal GND.
38	MIC_INL ———— DC 2.0 V		Input impedance = About 53 kΩ	The input terminal of the microphone amplifier L-channel. Please insert a capacitor of 1 µF in series with the pin.
39	GND	—	—	It is a terminal GND.
40	MIC_INC ———— DC 2.0 V		Input impedance = About 53 kΩ	The input terminal of microphone amplifier C-channel. Please insert a capacitor of 1 µF in series with the pin.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

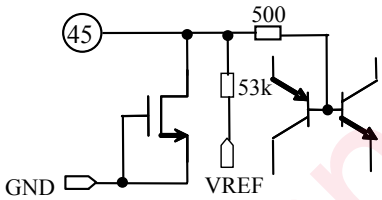
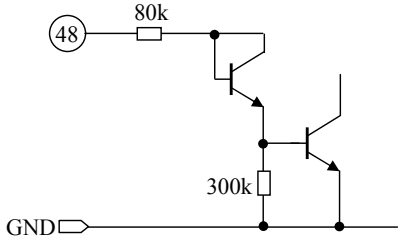
Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
41	GND	—	—	It is a terminal GND.
42	MICOUTC  DC 2 V		Output impedance = Equal to or less than 1 Ω	The output terminal of the microphone amplifier C-channel.
43	MICOUTR  DC 2 V		Output impedance = Equal to or less than 1 Ω	The output terminal of the microphone amplifier R-channel.
44	GND	—	—	It is a terminal GND.

■ Technical Data (continued)

2. I/O block circuit diagrams and pin function descriptions (continued)

Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

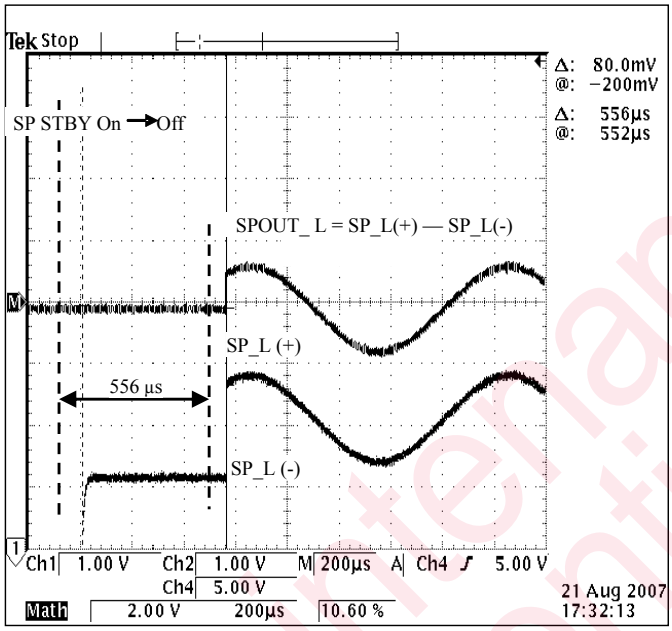
Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
45	MIC_INR ———— DC 2.0 V		Input impedance = About 53 kΩ	The input terminal of the microphone amplifier R-channel. Please insert a capacitor of 1 µF in series with the pin.
46	GND	—	—	It is a terminal GND.
47	VCC_REG	—	—	It is a power supply terminal for regulator.
48	REG_STB		—	It is a control terminal that determines the regulator is in a state of operation or standby. At Pin 48 high, the regulator turns on, and turns off at low. Please refer to the control terminal mode table of Page No.11 for the mode setting.

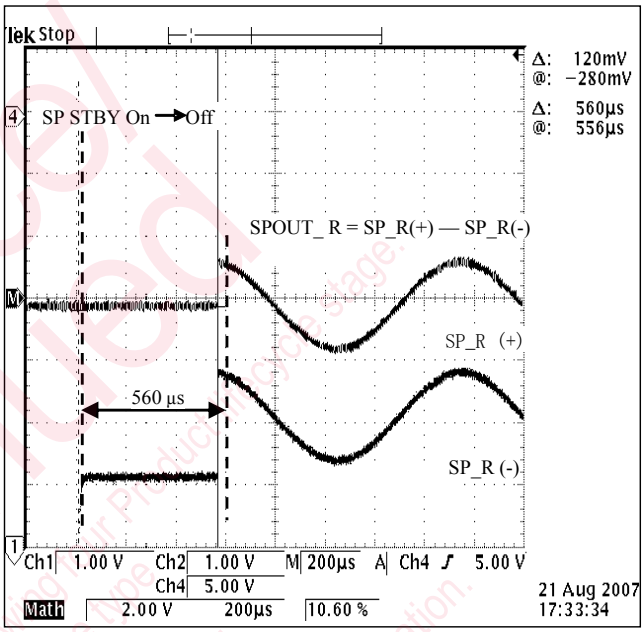
■Technical Data (continued)

3. Turn ON time descriptions

Note) The characteristics listed below are reference values based on the IC design and are not guaranteed.

Condition: Speaker STBY On → Off, REG_STBY Off, MIC_STBY On, VCC_SP = VCC_REG = 5 V, Vin_SP = –17 dBV, RL = 8 Ω





Results (Taken from waveform above)

Delay time taken for standby on → Off (SP O/P L): 556 µs

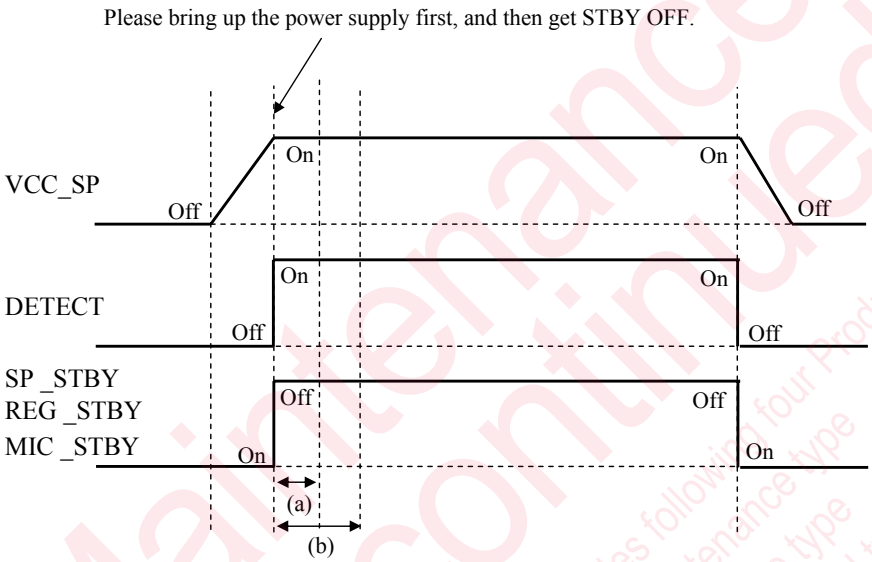
Delay time taken for standby on → Off (SP O/P R): 560 µs

■ Technical Data (continued)

4. The power supply and logic sequence

The timing control of power-ON/OFF and each logic according to the procedure below should be applied for the best pop-noise performance caused during switching.

- The sequence of the power supply and each logic



The basic procedure at the power-on

1) Initially, the power OFF condition: SP_STBY,REG_STBY and MIC_STBY are in the ON condition.
2) Power ON
3) SP_STBY, REG_STBY and MIC_STBY OFF

The basic procedure at the power-off

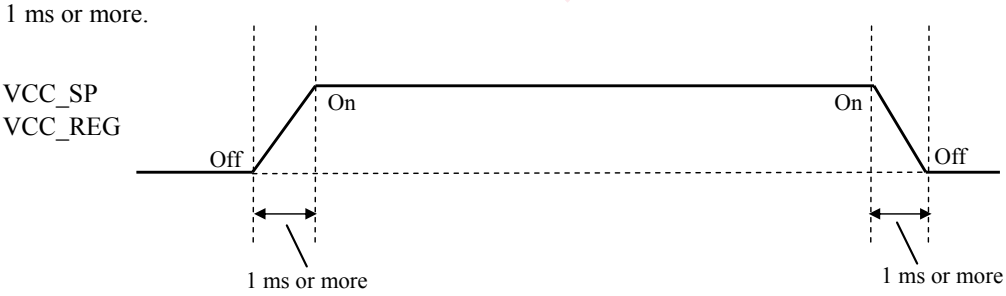
1) Initially, the power ON condition: SP_STBY, REG_STBY and MIC_STBY are in the OFF condition.
2) SP_STBY, REG_STBY and MIC_STBY OFF
3) Power OFF

When there is signal at BEEP_IN, the speaker output signal will only appear 35 ms later after DETECT is turned On. This time is denoted as (a) in the above figure.

When there is Non-signal at BEEP_IN, the speaker output will be muted for 70 ms or less after DETECT is turned On. This is because the anti-pop noise circuit is turned on. This time is denoted as (b) in the above figure.

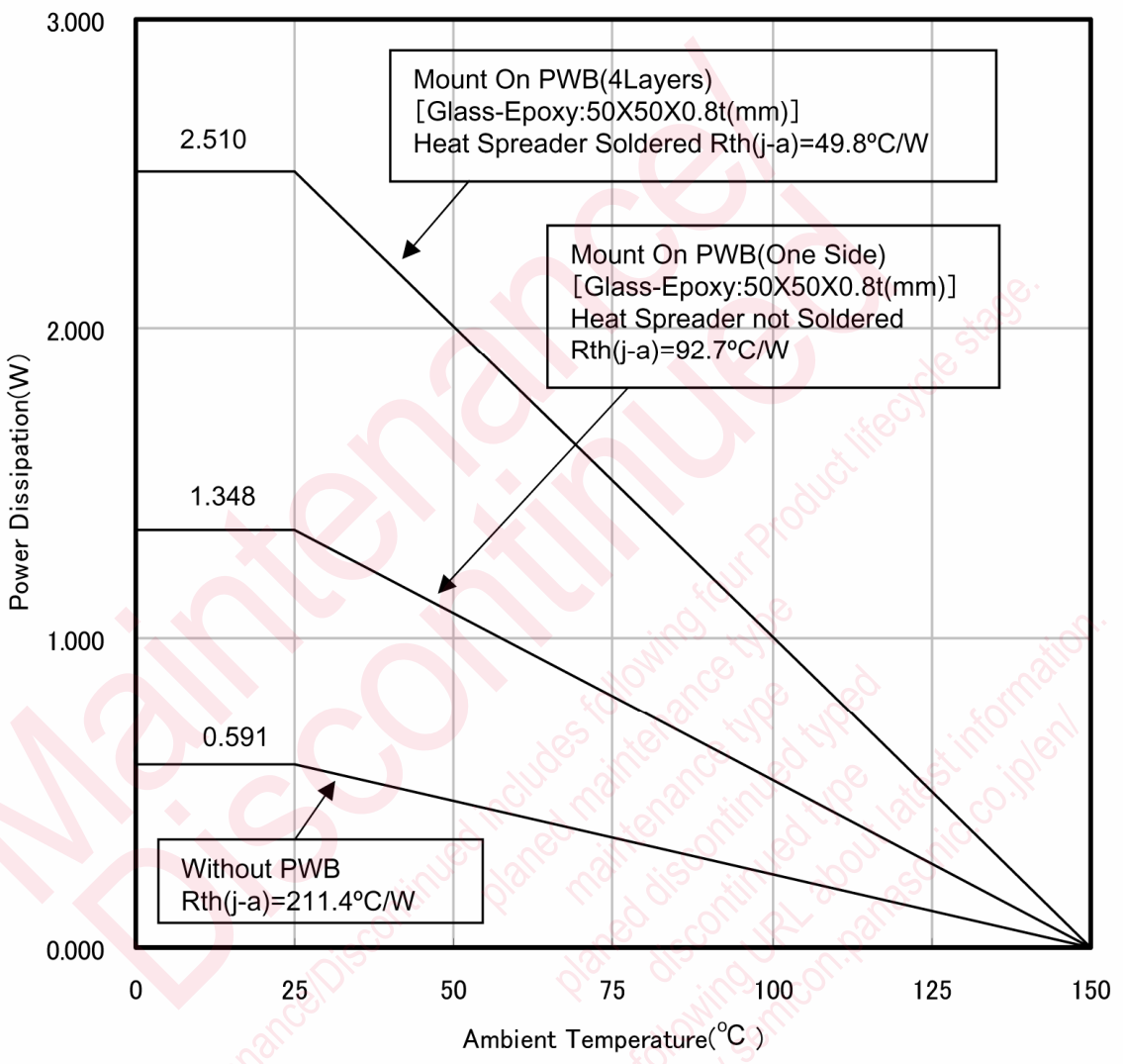
- The sequence of VCC_SP and VCC_REG

There are no sequence for VCC_SP and VCC_REG. However, the rising and falling time of VCC_SP and VCC_REG requires 1 ms or more.



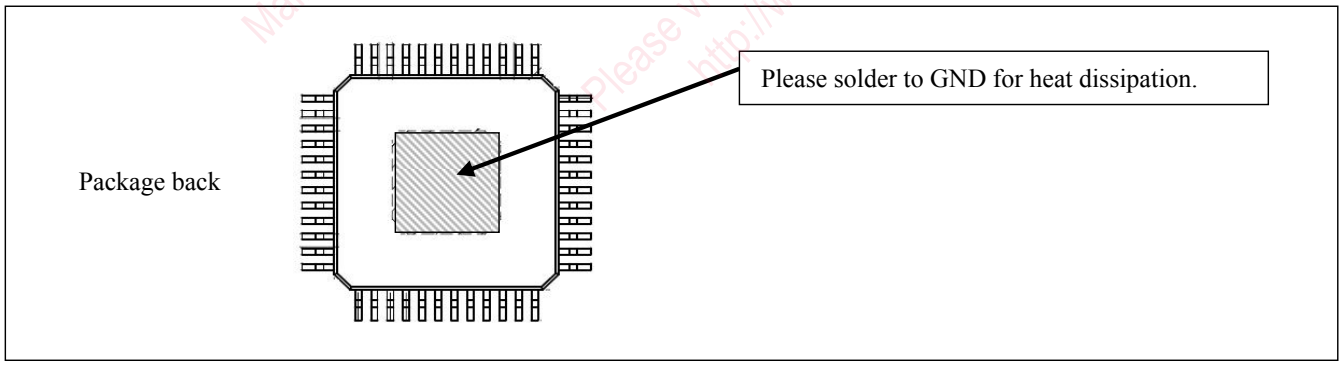
■ Technical Data (continued)

5. P_D — T_a diagram



■ Usage Notes

1. This IC is intended to be used for general electronic equipment [Note book PC].
   Consult our sales staff in advance for information on the following applications:
   - Special applications in which exceptional quality and reliability are required, or if the failure or malfunction of this IC may directly jeopardize life or harm the human body.
   - Any applications other than the standard applications intended.
     (1) Space appliance (such as artificial satellite, and rocket)
     (2) Traffic control equipment (such as for automobile, airplane, train, and ship)
     (3) Medical equipment for life support
     (4) Submarine transponder
     (5) Control equipment for power plant
     (6) Disaster prevention and security device
     (7) Weapon
     (8) Others : Applications of which reliability equivalent to (1) to (7) is required
2. Pay attention to the direction of LSI. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might smoke or ignite.
3. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the ■ Pin Description for the pin configuration.
4. Perform a visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as a solder-bridge between the pins of the semiconductor device. Also, perform a full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the LSI during transportation.
5. Take notice in the use of this product that it might break or occasionally smoke when an abnormal state occurs such as output pin-V_{CC} short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short) .
   And, safety measures such as an installation of fuses are recommended because the extent of the above-mentioned damage and smoke emission will depend on the current capability of the power supply.
6. When using the LSI for new models, verify the safety including the long-term reliability for each product.
7. When the application system is designed by using this LSI, be sure to confirm notes in this book.
   Be sure to read the notes to descriptions and the usage notes in the book.
8. Please carry out the thermal design with sufficient margin such that the power dissipation will not be exceeded, based on the conditions of power supply, load and surrounding temperature.
   Although indicated also in the column of the maximum rating, the maximum rating becomes an instant and the marginal value which must not exceed. It sufficiently evaluates, and I use-wish-do so that it may not exceed certainly.
   Moreover, don't impress neither voltage nor current to PIN which is not indicated. It may be spoilt in both cases.
9. Note of soldering for heat dissipation



Request for your special attention and precautions in using the technical information and semiconductors described in this book

(1) If any of the products or technical information described in this book is to be exported or provided to non-residents, the laws and regulations of the exporting country, especially, those with regard to security export control, must be observed.

(2) The technical information described in this book is intended only to show the main characteristics and application circuit examples of the products, and no license is granted under any intellectual property right or other right owned by our company or any other company. Therefore, no responsibility is assumed by our company as to the infringement upon any such right owned by any other company which may arise as a result of the use of technical information described in this book.

(3) The products described in this book are intended to be used for standard applications or general electronic equipment (such as office equipment, communications equipment, measuring instruments and household appliances).
Consult our sales staff in advance for information on the following applications:
- Special applications (such as for airplanes, aerospace, automobiles, traffic control equipment, combustion equipment, life support systems and safety devices) in which exceptional quality and reliability are required, or if the failure or malfunction of the products may directly jeopardize life or harm the human body.
- Any applications other than the standard applications intended.

(4) The products and product specifications described in this book are subject to change without notice for modification and/or improvement. At the final stage of your design, purchasing, or use of the products, therefore, ask for the most up-to-date Product Standards in advance to make sure that the latest specifications satisfy your requirements.

(5) When designing your equipment, comply with the range of absolute maximum rating and the guaranteed operating conditions (operating power supply voltage and operating environment etc.). Especially, please be careful not to exceed the range of absolute maximum rating on the transient state, such as power-on, power-off and mode-switching. Otherwise, we will not be liable for any defect which may arise later in your equipment.
 Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.

(6) Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process. When using products for which damp-proof packing is required, satisfy the conditions, such as shelf life and the elapsed time since first opening the packages.