

## MSC1157

### Speaker Drive Amplifier

#### GENERAL DESCRIPTION

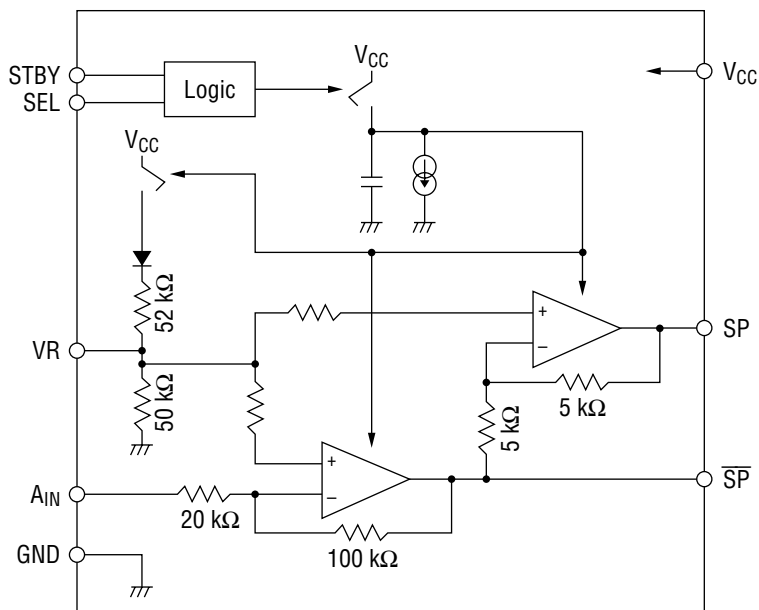
The MSC1157, designed specifically to operate at a low voltage with low current consumption, is a power amplifier developed for driving a speaker for a voice IC.

The voltage gains can be adjusted over a range of up to ten. The differential output can directly drive a speaker without any output coupling capacitors. The MSC 1157, because of its ability to stand by, is ideally suitable for portable equipment applications powered by a battery.

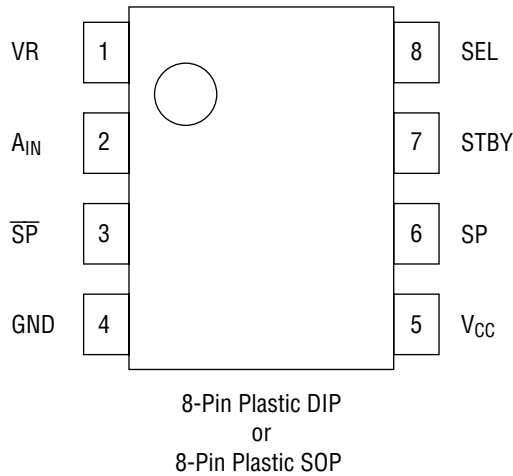
#### FEATURES

- Low voltage operation : 2.0 to 6.0 V (Single power supply)
- Low current dissipation : 1.6mA without load (typ.)
- Standby function : Current dissipation less than 1  $\mu$ A in standby
- High output current : 350mA peak
- Differential outputs : A speaker can be directly connected between differential outputs.
- Adjustable gain : Gain can be adjusted by use of an external resistor.
- Package options:
  - 8-pin plastic DIP (DIP8-P-300-2.54) (Product name : MSC1157RS)
  - 8-pin plastic SOP (SOP8-P-250-1.27-K) (Product name : MSC1157MS-K)
  - Chip

#### BLOCK DIAGRAM



**PIN CONFIGURATION (TOP VIEW)**



**PIN DESCRIPTIONS**

Pin	Symbol	Type	Description																								
5	V <sub>CC</sub>	—	Power supply pin.																								
4	GND	—	Ground pin.																								
2	A <sub>IN</sub>	I	Signal input pin for analog signal inputs, etc.																								
7, 8	STBY, SEL	I	<p>Digital input pins. Setting these pins configures the standby status. See the table below for how to set the pins.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>SEL</th> <th>STBY</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td rowspan="3">0</td> <td>0</td> <td>Operation</td> </tr> <tr> <td>1</td> <td>Standby</td> </tr> <tr> <td>Clock</td> <td>Operation</td> </tr> <tr> <td rowspan="3">1</td> <td>0</td> <td>Standby</td> </tr> <tr> <td>1</td> <td>Operation</td> </tr> <tr> <td>Clock</td> <td>Operation</td> </tr> <tr> <td rowspan="3">Clock</td> <td>0</td> <td>Operation</td> </tr> <tr> <td>1</td> <td>Operation</td> </tr> <tr> <td>Clock</td> <td>Unstable Operation</td> </tr> </tbody> </table> <p>Applying a clock between 32kHz and 4MHz to either the STBY or the SEL pin leads the IC to operation status regardless of the status set at the other pin. Applying clocks to both of the pins at the same time may cause malfunction.</p> <p><u>Refer to the section, RECOMMENDED OPERATING CONDITIONS since clock frequencies are changed by setting the SEL pin.</u></p>	SEL	STBY	Status	0	0	Operation	1	Standby	Clock	Operation	1	0	Standby	1	Operation	Clock	Operation	Clock	0	Operation	1	Operation	Clock	Unstable Operation
SEL	STBY	Status																									
0	0	Operation																									
	1	Standby																									
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	Clock	Operation																									
Clock	0	Operation																									
	1	Operation																									
	Clock	Unstable Operation																									
1	VR	0	<p>Bias output pin for internal circuits. This pin is at GND potential during standby. Connecting a capacitor between VR and the GND pin reduces the pop-up noise at power on and improves the ripple elimination ratio.</p>																								
3	SP-bar	0	Speaker output pin. This pin outputs a negative phase with respect to the input signal.																								
6	SP	0	Speaker output pin. This pin outputs a positive phase with respect to the input signal.																								

## ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating	Unit	Remark
Power Supply Voltage	$V_{CC}$	$T_a=25^\circ\text{C}$	-0.3 to +6.5	V	$V_{CC}$
Input Voltage	$V_{IN}$	$T_a=25^\circ\text{C}$	-0.3 to $V_{CC}+0.3$	V	STBY $A_{IN}$ , SEL
Maximum Output Current	$I_{OMAX}$	$T_a=25^\circ\text{C}$	(*1) $\pm 400$	mA	SP, $\overline{SP}$
Power Dissipation	$P_D$	$T_a=25^\circ\text{C}$	470	mW	DIP type
			400	mW	SOP type
Junction Temperature	$T_{jMAX}$	—	125	$^\circ\text{C}$	Chip
Storage Temperature	$T_{STG}$	—	-55 to +150	$^\circ\text{C}$	

\*1 Avoid shorting the output pins (SP and  $\overline{SP}$ ) to  $V_{CC}$  or GND because the IC may be damaged.

## RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Min.	Max.	Unit
Power Supply Voltage	$V_{CC}$	—	2.0	6.0	V
Load Impedance (*2)	$R_L$	—	8.0	—	$\Omega$
Peak Load Current	$I_{O-P}$	—	—	350	mA
"H" Input Voltage	$V_{IH}$	For STBY and SEL pins	0.7 $V_{CC}$	—	V
"L" Input Voltage	$V_{IL}$		—	0.3 $V_{CC}$	V
STBY Operating Frequency (*3)	$f_{STBY}$	SEL = "L" At clock input $V_{CC} \geq 2.4\text{ V}$	32 k	4.096 M	Hz
		SEL = "H" At clock input $V_{CC} \geq 2.4\text{ V}$	32 k	1 M	
Operating Temperature	$T_{op}$	—	-20	+70	$^\circ\text{C}$

\*2 A speaker of 8  $\Omega$  (standard) or more should be used.

\*3 The input of clocks may cause a little noise in output waveforms.

It is recommended to input the DC voltage to improve voice quality.

**ELECTRICAL CHARACTERISTICS**

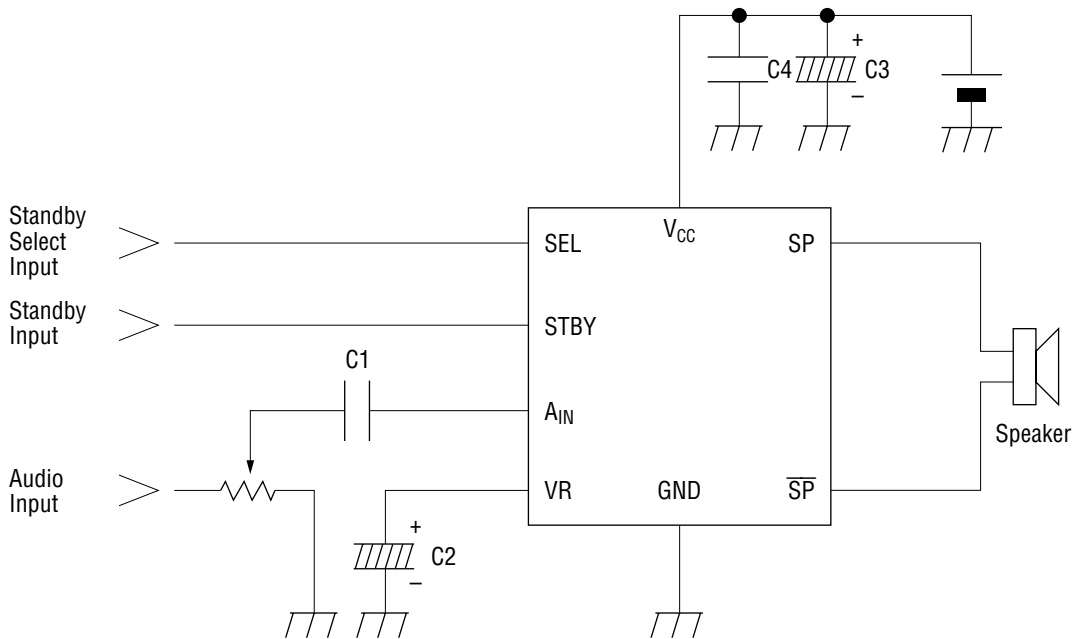
Unless otherwise specified, Ta=25°C, VCC=2 to 6 V

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	
A <sub>IN</sub> Input Resistance	R <sub>IN</sub>	—	14	20	26	kΩ	
Voltage Gain	A <sub>V1</sub>	A <sub>IN</sub> →SP	13.44	14	14.49	dB	
	A <sub>V2</sub>	SP→SP	-1.94	0	+1.58		
	A <sub>V3</sub>	A <sub>IN</sub> →(Between SP-SP)	19.46	20	20.51		
Output Power	P <sub>OUT1</sub>	V <sub>CC</sub> =3 V, f=1 kHz R <sub>L</sub> =8 Ω, THD≥10%	100	178	—	mW	
	P <sub>OUT2</sub>	V <sub>CC</sub> =6 V, f=1 kHz R <sub>L</sub> =32 Ω, THD≥10%	300	440	—	mW	
Total Harmonic Distortion	THD1	V <sub>CC</sub> =3 V, R <sub>L</sub> =8 Ω f=1 kHz, P <sub>OUT</sub> =45 mW	—	1.2	—	%	
	THD2	V <sub>CC</sub> =6 V, R <sub>L</sub> =32 Ω f=1 kHz, P <sub>OUT</sub> =125 mW	—	0.37	—	%	
Ripple Elimination Ratio	RR	f=1 kHz, C2=4.7 μF	30	43	—	dB	
Output DC Voltage (*4)	V <sub>O</sub>	In no signal state	V <sub>CC</sub> =2 V	0.53	0.65	0.77	V
			V <sub>CC</sub> =6 V	2.49	2.61	2.73	
Output Offset Voltage	ΔV <sub>O</sub>	Between SP-SP	—	—	±30	mV	
Output "H" Voltage	V <sub>OH</sub>	A <sub>IN</sub> =V <sub>CC</sub> or GND I <sub>OUT</sub> =-100 mA	V <sub>CC</sub> -1.15	V <sub>CC</sub> -1.04	—	V	
Output "L" Voltage	V <sub>OL</sub>	A <sub>IN</sub> =V <sub>CC</sub> or GND I <sub>OUT</sub> =100 mA	—	0.17	0.3	V	
STBY, SEL Input Current	I <sub>IH</sub>	V <sub>I</sub> =V <sub>CC</sub>	—	—	±0.1	μA	
	I <sub>IL</sub>	V <sub>I</sub> =GND	—	—	±0.1	μA	
VR Equivalent Resistance	R <sub>VR</sub>	—	18	25	32	kΩ	
Circuit Current During Operation	I <sub>CC</sub>	V <sub>CC</sub> =6 V, R <sub>L</sub> =∞	1.1	1.6	2.4	mA	
Circuit Current During Standby	I <sub>CCS</sub>	—	—	—	1.0	μA	

\*4 The typical value of the output voltage in no signal state is determined from the following equation.

$$V_O = (V_{CC} - 0.67) \frac{50 \text{ k}\Omega}{50 \text{ k}\Omega + 52 \text{ k}\Omega}$$

APPLICATION CIRCUIT



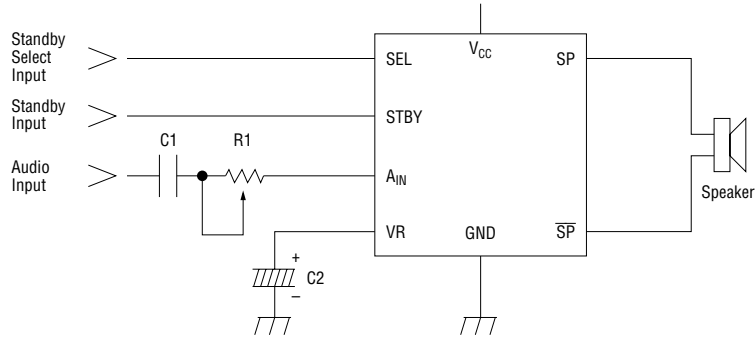
- If parasitic capacitance of 60pF or more exists between GND and the speaker output pin  $\overline{SP}$  or  $\overline{SP}$ , oscillation may occur. Implement the circuit mount design so as to be less than 60pF.
- C1 is the AC coupling capacitor. Cutoff frequency  $f_c$  on the low frequency side is determined by the following equation. Choose a value of C1 according to the bandwidth.

$$f_c = \frac{1}{2 \times \pi \times C1 \times 20k} \text{ (Hz)}$$

- Choose a value of C2 that is 80 to 100 times as large as that of C1.
- When the standby function is not used, connect the pins STBY and SEL to  $V_{CC}$  or GND.
- It is recommended that the capacitor C4 (approximately 0.1 $\mu$ F) having better high frequency characteristics and the capacitor C3 (approximately 10 $\mu$ F) be placed between the pins  $V_{CC}$  and GND.

## GAIN ADJUSTMENT

### 1. Gain Adjustment Using Input Resistance (This approach allows gain adjustment with fewer external components)



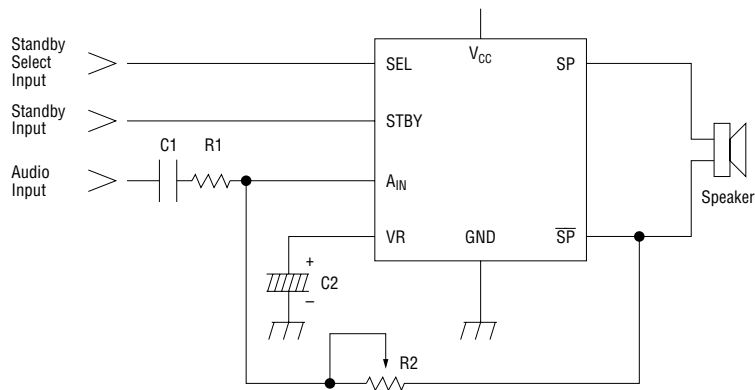
- Cutoff frequency  $f_c$  on the low frequency side is determined from the equation:

$$f_c \doteq \frac{1}{2 \times \pi \times C1 \times (R1 + 20k)} \text{ (Hz)}$$

- Voltage gain  $A_{V1}$  is determined from the equation:

$$A_{V1} \doteq \frac{100k}{R1 + 20k} \text{ (V/V)}$$

### 2. Gain Adjustment Using Feedback Resistance (This approach has the advantage over the above approach (less noise approach), but the number of components is increased)



- Cutoff frequency  $f_c$  on the low frequency side is determined from the equation:

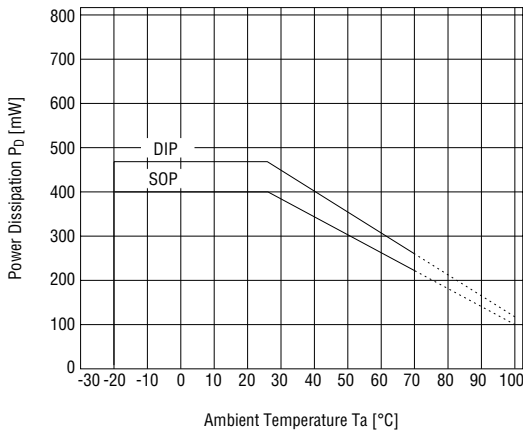
$$f_c \doteq \frac{1}{2 \times \pi \times C1 \times Z_{in}} \text{ (Hz)} \quad Z_{in} \doteq R1 + \frac{R2 \times 20k}{R2 + 120k} \text{ (\Omega)}$$

- Voltage gain  $A_{V1}$  is determined from the equation:

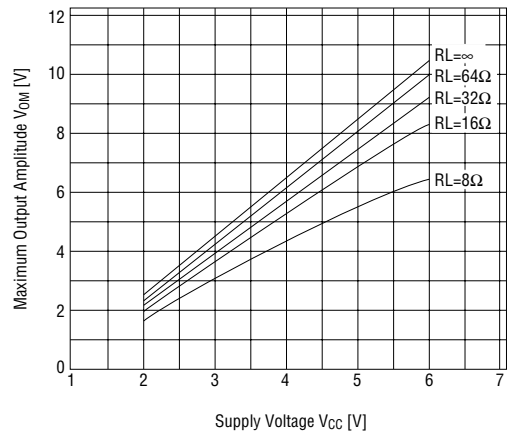
$$A_{V1} \doteq \frac{5}{1 + \frac{R1}{20k} + \frac{6 \times R1}{R2}} \text{ (V/V)}$$

### OPERATING CHARACTERISTICS

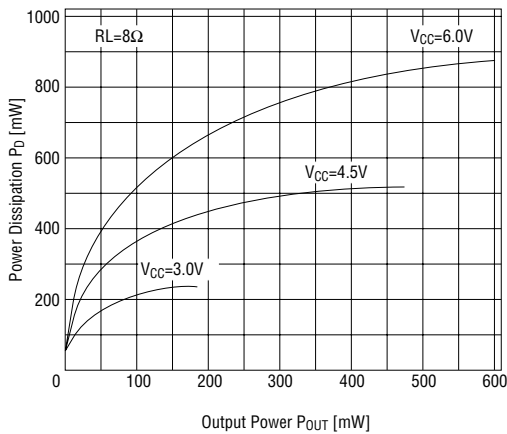
Power Dissipation vs. Ambient Temperature



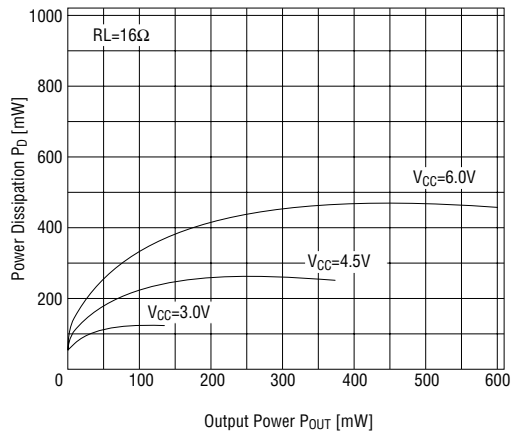
Maximum Output Amplitude vs. Voltage Supply



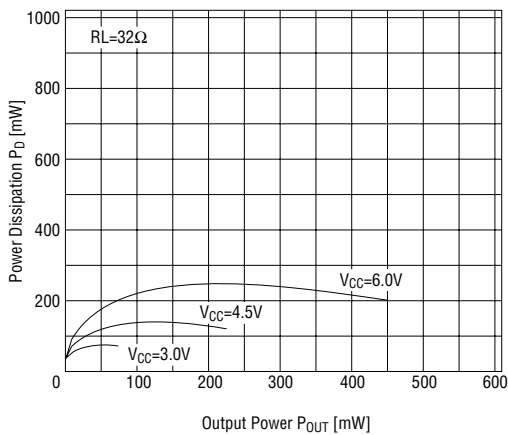
Power Dissipation vs. Output Power



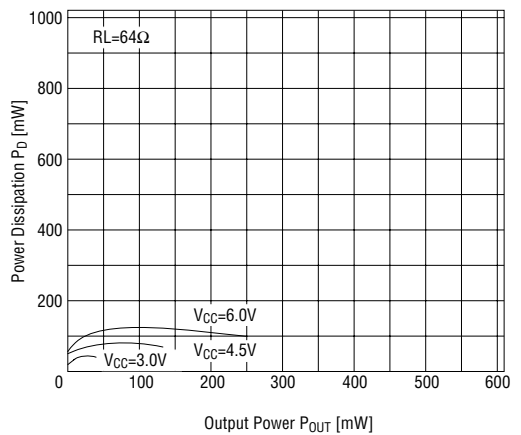
Power Dissipation vs. Output Power



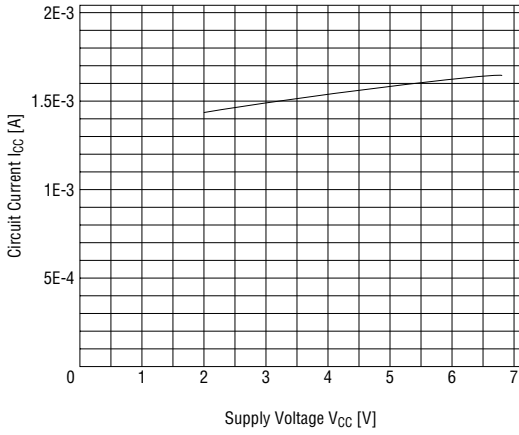
Power Dissipation vs. Output Power



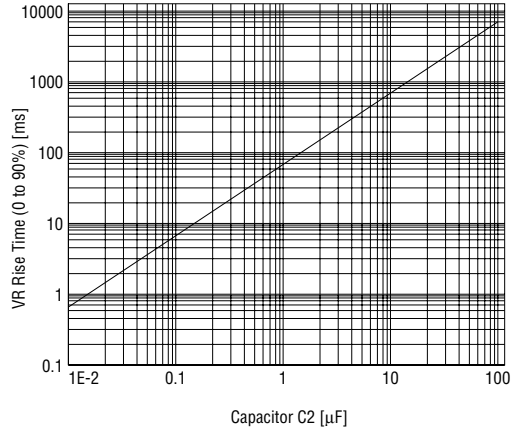
Power Dissipation vs. Output Power



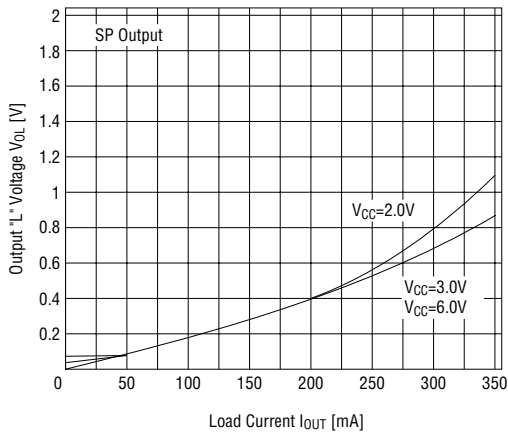
Circuit Current vs. Voltage Supply



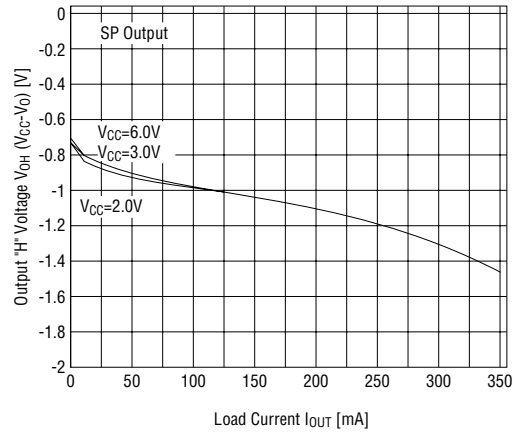
VR Rise Time vs. Capacitor Value (C2)



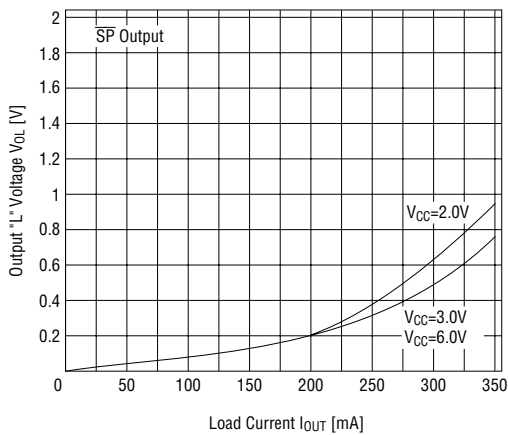
Output Voltage vs. Load Current



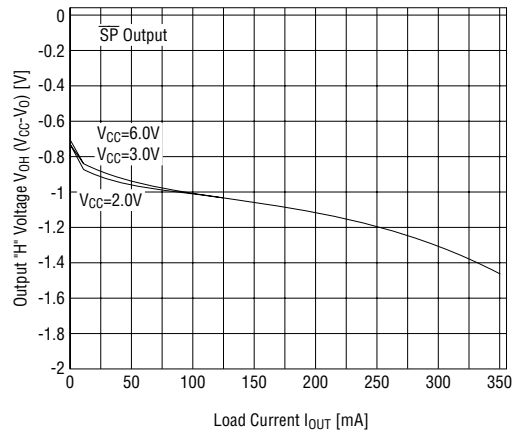
Output Voltage vs. Load Current



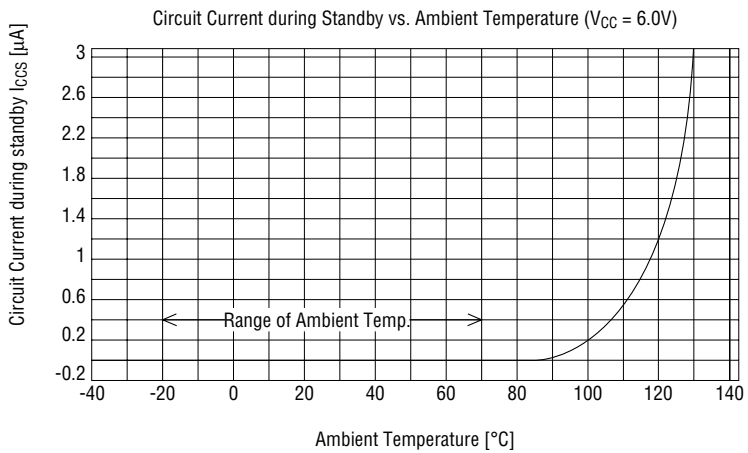
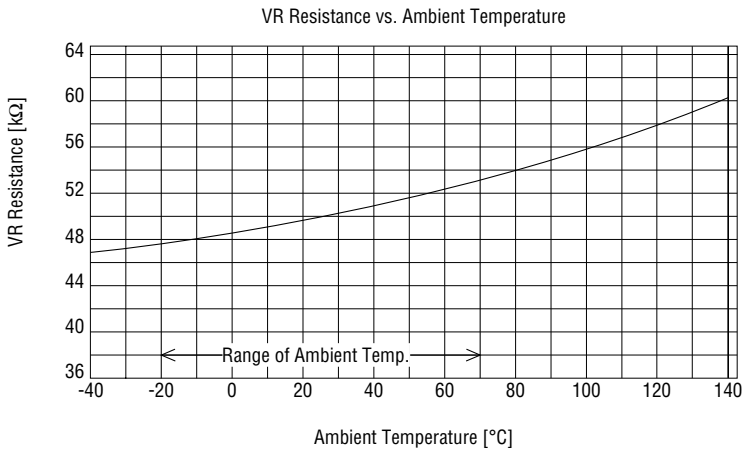
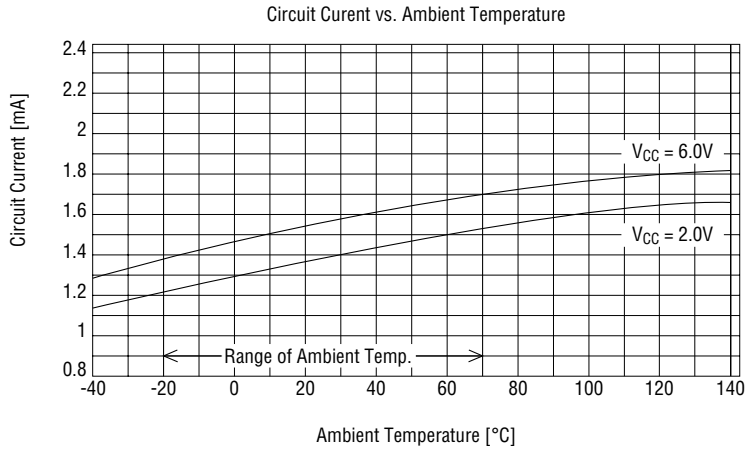
Output Voltage vs. Load Current

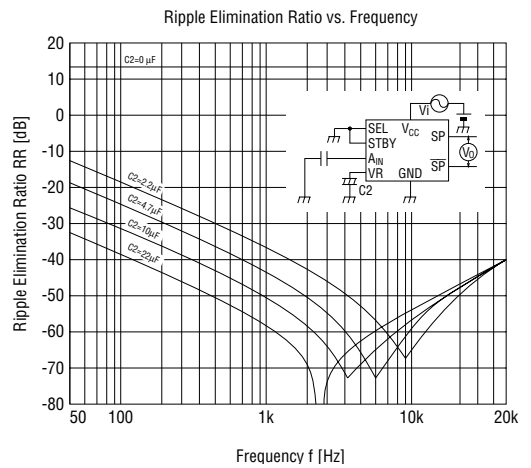
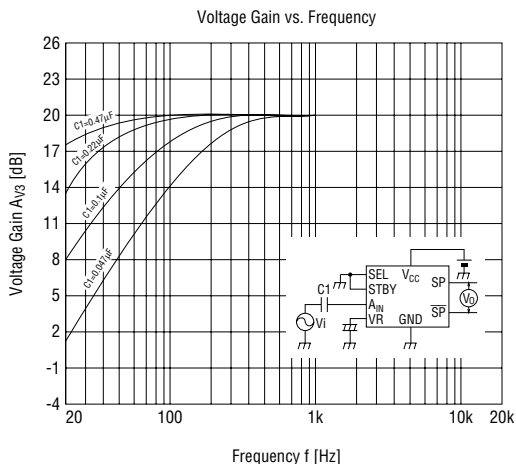
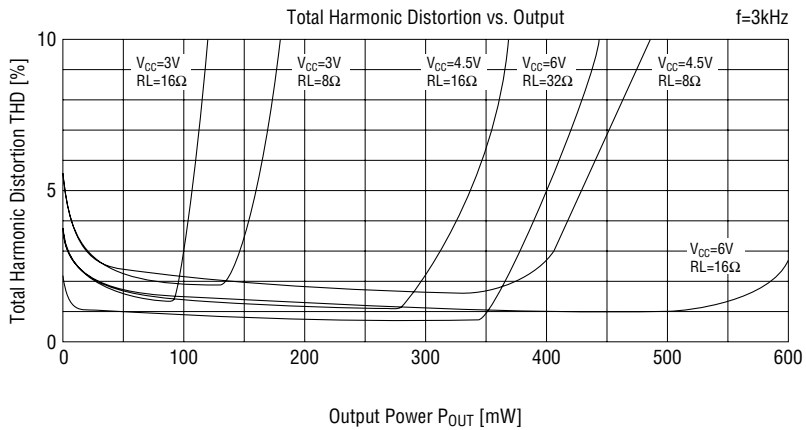
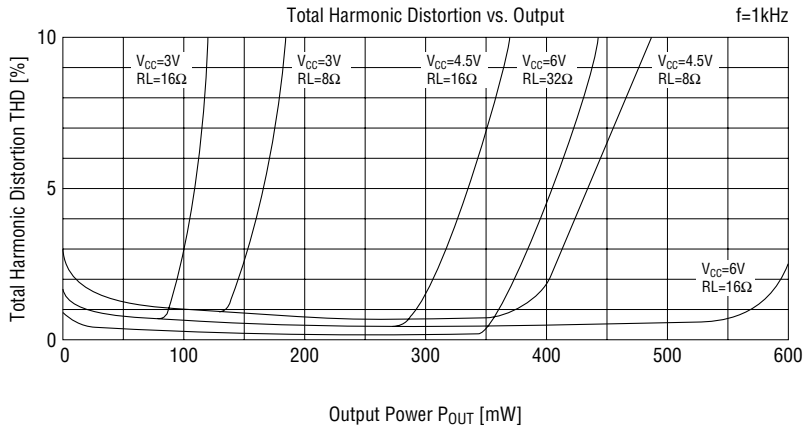


Output Voltage vs. Load Current





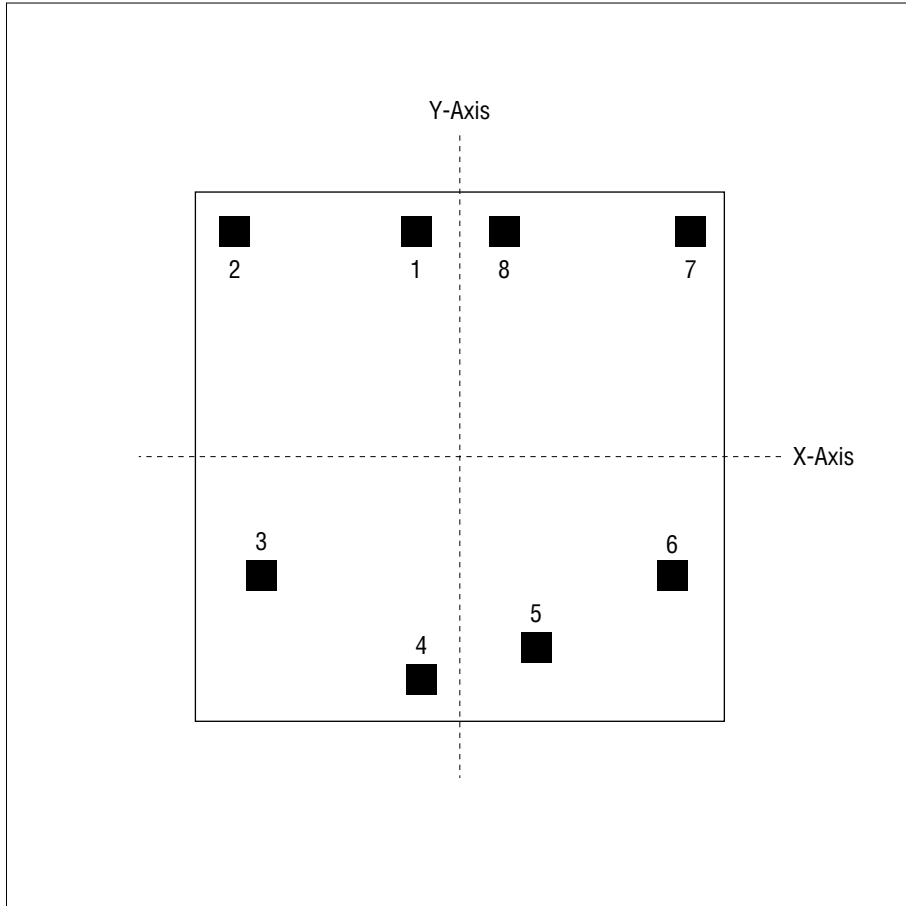




**PAD CONFIGURATION**

**Pad Layout**

Chip size : X=2.3mm, Y=2.4mm  
 Chip thickness : 350±30µm  
 Pad size (PV aperture) : 110×110µm  
 Substrate potential : GND  
 Pad location diagram



**Pad Coordinates**

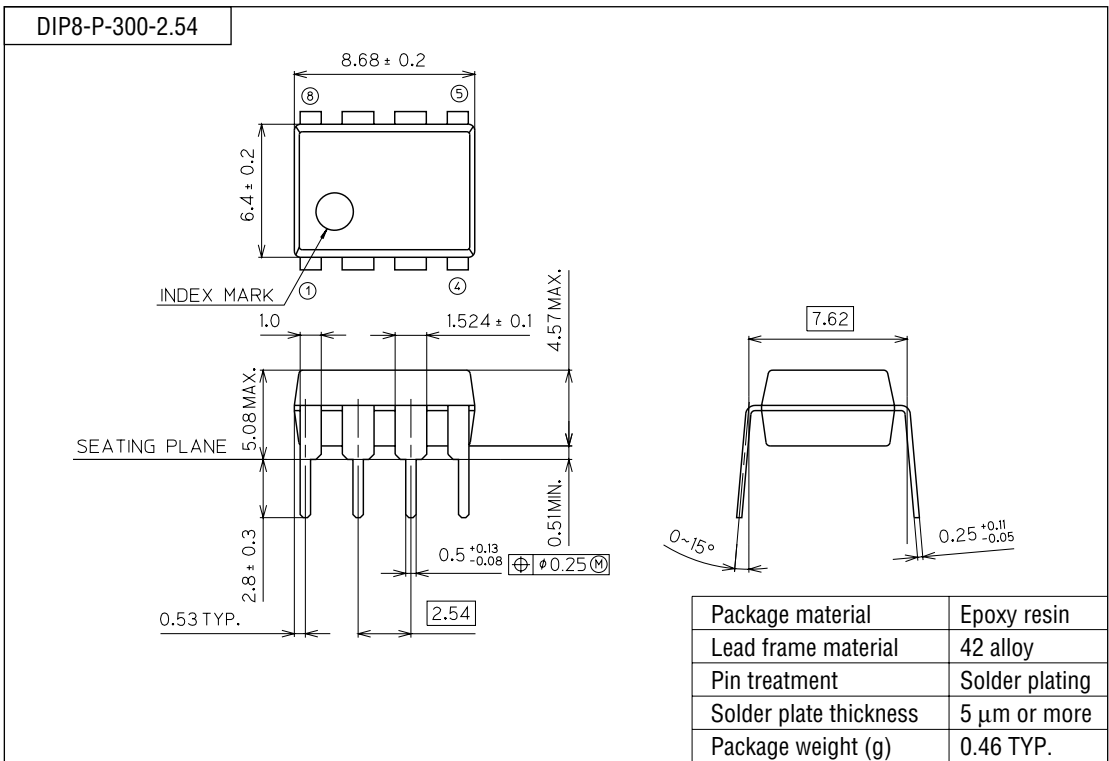
(Chip center is located at X=0 and Y=0.)

(Unit: µm)

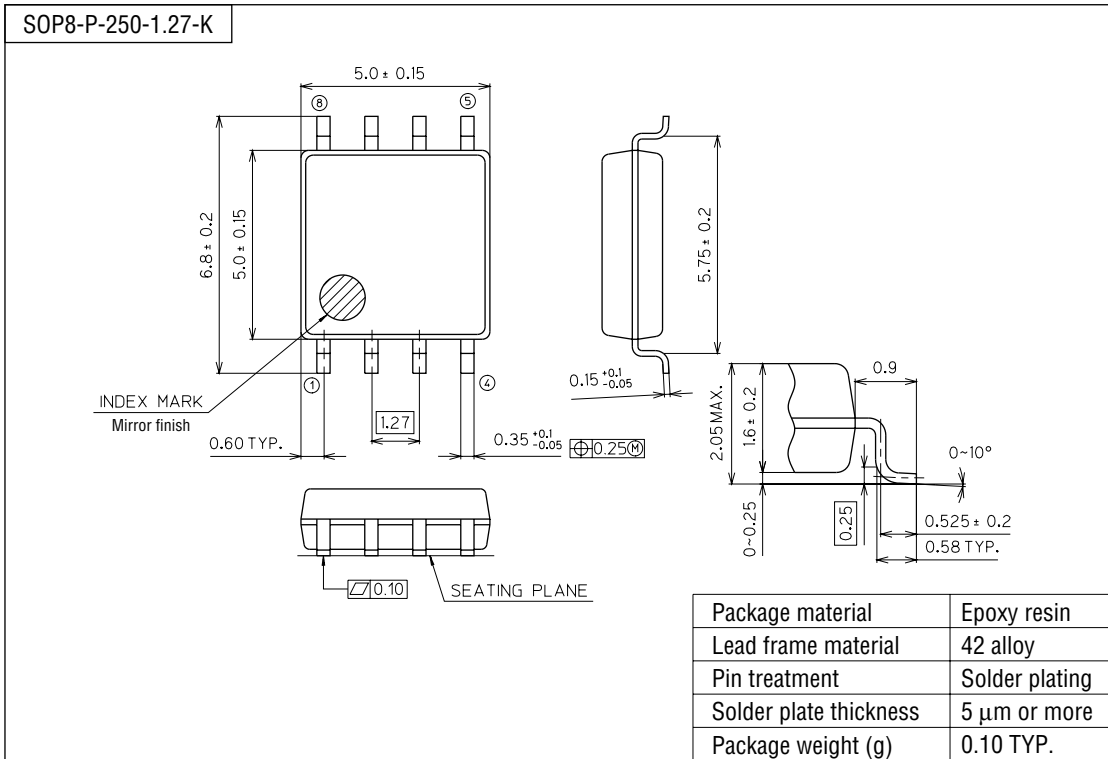
Pad No.	Pad Name	X-AXIS	Y-AXIS
1	VR	-133	1035
2	A <sub>IN</sub>	-985	1035
3	SP	-950	-263
4	GND	-180	-1027
5	V <sub>CC</sub>	240	-914
6	SP	950	-263
7	STBY	985	1035
8	SEL	159	1035

PACKAGE DIMENSIONS

(Unit : mm)



(Unit : mm)



Notes for Mounting the Surface Mount Type Package

The SOP, QFP, TSOP, TQFP, LQFP, SOJ, QFJ (PLCC), SHP, and BGA are surface mount type packages, which are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact Oki’s responsible sales person on the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

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