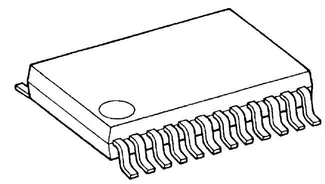
TOSHIBA Bipolar Linear IC Silicon Monolithic

TA2152FNG

Low Current Consumption Headphone Amplifier (for 1.5-V/3-V Use)

The TA2152FNG is a headphone amplifier of low current consumption type developed for portable digital audio.

It is especially suitable for portable CD players, portable MD players etc.



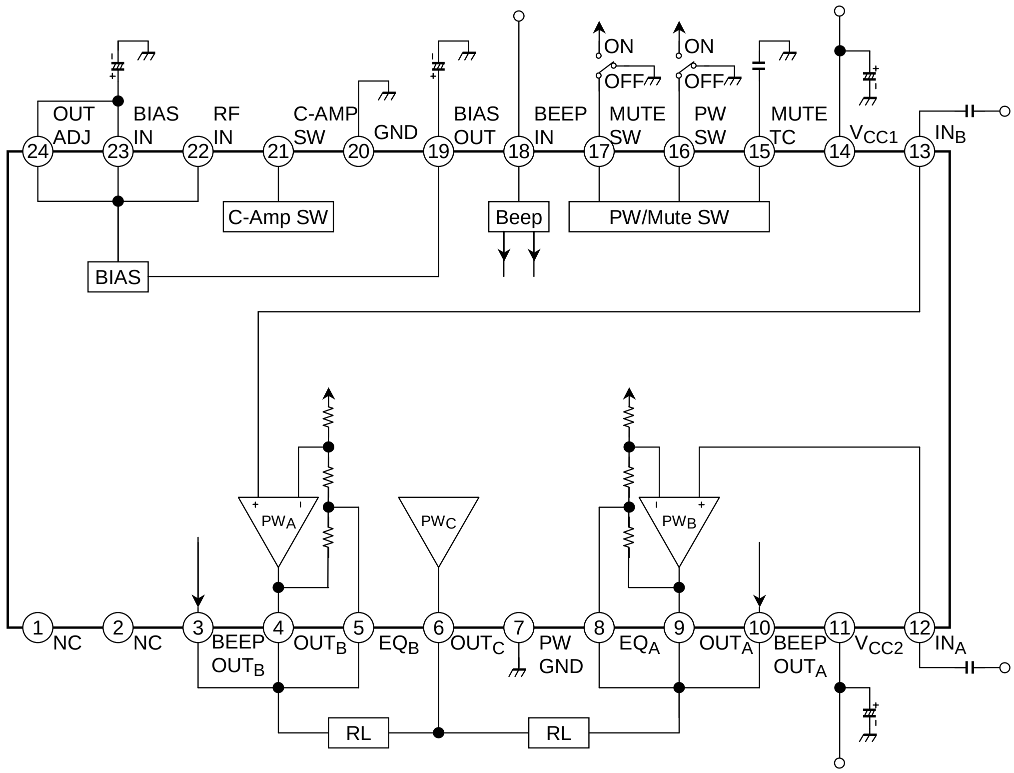
SSOP24-P-300-0.65A

Weight: 0.14 g (typ.)

Features

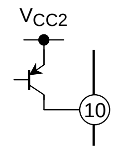
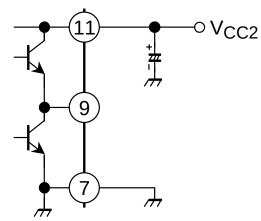
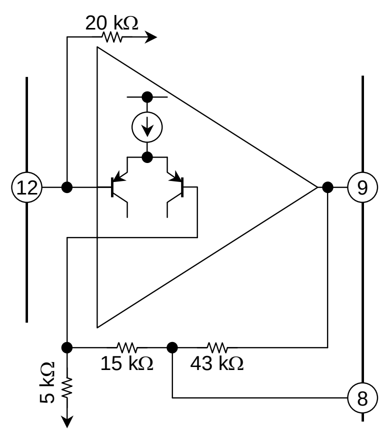
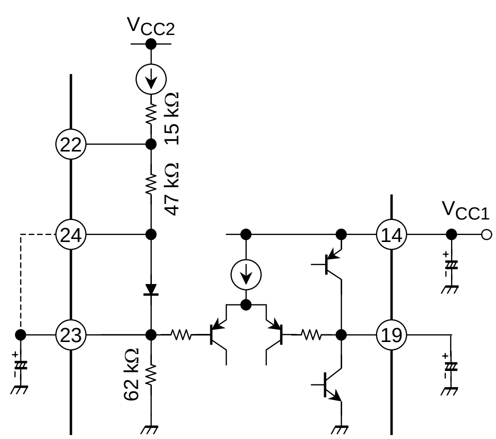
- Low current consumption
  - The power drive stage can be driven using a single battery. As a result, overall current consumption is low.
  - Built-in center amplifier switch
    For the output-coupling type, the consumption current has been decreased still further.
  - Current value (V_{CC1} = 2.4 V, V_{CC2} = 1.2 V, f = 1 kHz, R_L = 16 Ω, Ta = 25°C, typ.)
    - Output-coupling type
      - No Signal: I_{CC} (V_{CC1}) = 0.4 mA, I_{CC} (V_{CC2}) = 0.3 mA
      - 0.1 mW × 2 ch: I_{CC} (V_{CC1}) = 0.5 mA, I_{CC} (V_{CC2}) = 2.2 mA
      - 0.5 mW × 2 ch: I_{CC} (V_{CC1}) = 0.5 mA, I_{CC} (V_{CC2}) = 5.0 mA
    - OCL type
      - No Signal: I_{CC} (V_{CC1}) = 0.7 mA, I_{CC} (V_{CC2}) = 0.7 mA
      - 0.1 mW × 2 ch: I_{CC} (V_{CC1}) = 0.7 mA, I_{CC} (V_{CC2}) = 4.5 mA
      - 0.5 mW × 2 ch: I_{CC} (V_{CC1}) = 0.8 mA, I_{CC} (V_{CC2}) = 10.0 mA
- Output power: P_o = 8 mW (typ.)
  (V_{CC1} = 2.4 V, V_{CC2} = 1.2 V, f = 1 kHz, R_L = 16 Ω, THD = 10%, Ta = 25°C)
- Built-in beep function
- Built-in low-pass compensation (output-coupling type)
- Built-in mute switch
- Built-in power switch
- Operating supply voltage range (Ta = 25°C)
  $V_{CC1\ (opr)}$ = 1.8 V~4.5 V
  $V_{CC2\ (opr)}$ = 0.9 V~4.5 V

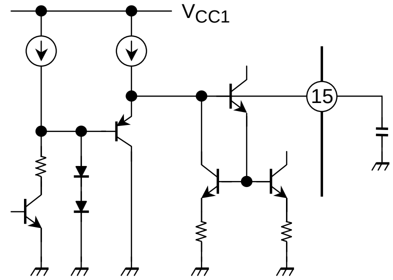
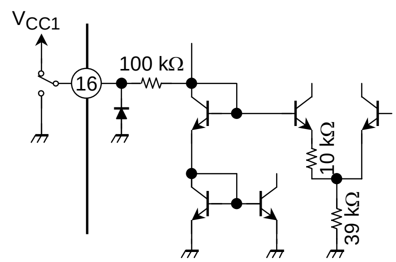
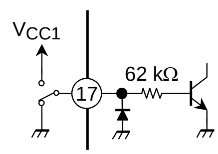
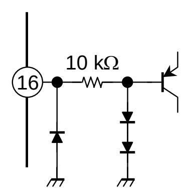
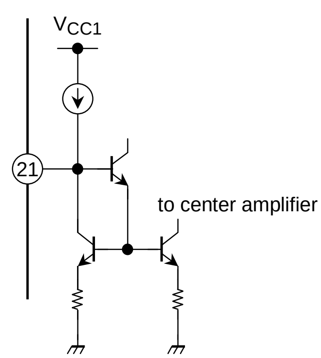
Block Diagram (of OCL Application)



Pin Descriptions

Pin Voltage: Typical pin voltage for test circuit when no input signal is applied (V_{CC1} = 2.4 V, V_{CC2} = 1.2 V, Ta = 25°C)

<table>
<tr><th colspan="2">Pin</th><th rowspan="2">Function</th><th rowspan="2">Internal Circuit</th><th rowspan="2">Pin Voltage (V)</th></tr>
<tr><th>No.</th><th>Name</th></tr>
<tr><td>1</td><td>NC</td><td rowspan="2">Not connected</td><td rowspan="2">—</td><td rowspan="2">—</td></tr>
<tr><td>2</td><td>NC</td></tr>
<tr><td>3</td><td>BEEP OUT_B</td><td rowspan="2">Outputs for beep signal</td><td rowspan="2">
</td><td rowspan="2">—</td></tr>
<tr><td>10</td><td>BEEP OUT_A</td></tr>
<tr><td>4</td><td>OUT_B</td><td rowspan="3">Outputs from power amplifier</td><td rowspan="5">
</td><td rowspan="3">0.6</td></tr>
<tr><td>6</td><td>OUT_C</td></tr>
<tr><td>9</td><td>OUT_A</td></tr>
<tr><td>7</td><td>PW GND</td><td>GND for power drive stage</td><td>0</td></tr>
<tr><td>11</td><td>V_{CC2}</td><td>V_{CC} for power drive stage</td><td>1.2</td></tr>
<tr><td>5</td><td>EQ_B</td><td rowspan="2">Low-pass compensation pins</td><td rowspan="4">
</td><td rowspan="2">0.6</td></tr>
<tr><td>8</td><td>EQ_A</td></tr>
<tr><td>12</td><td>IN_A</td><td rowspan="2">Inputs to power amplifier</td><td rowspan="2">0.6</td></tr>
<tr><td>13</td><td>IN_B</td></tr>
<tr><td>14</td><td>V_{CC1}</td><td>V_{CC} for everything other than power drive stage</td><td rowspan="5">
</td><td>2.4</td></tr>
<tr><td>19</td><td>BIAS OUT</td><td>Bias circuit output</td><td>0.6</td></tr>
<tr><td>22</td><td>RF IN</td><td>Ripple filter input</td><td>1.1</td></tr>
<tr><td>23</td><td>BIAS IN</td><td>Bias circuit output</td><td>0.6</td></tr>
<tr><td>24</td><td>OUT ADJ</td><td>DC output voltage adjustment
Either connect this pin or leave it open depending on the level of V_{CC2}.
If the power supply of a 1.5 V system is applied to V_{CC2}. connect this pin to BIAS IN (pin 23).
If the power supply of a 3 V system is applied to V_{CC2}, leave this pin open.</td><td>0.6</td></tr>
</table>

<table>
<tr><th colspan="2">Pin</th><th rowspan="2">Function</th><th rowspan="2">Internal Circuit</th><th rowspan="2">Pin Voltage (V)</th></tr>
<tr><th>No.</th><th>Name</th></tr>
<tr><td>15</td><td>MUTE TC</td><td>Mute smoothing
Reduces popping noises during switching.</td><td></td><td>—</td></tr>
<tr><td>16</td><td>PW SW</td><td>Power switch
IC ON :H level
IC OFF :L level
Refer to application note (6)</td><td></td><td>—</td></tr>
<tr><td>17</td><td>MUTE SW</td><td>Mute switch
Mute OFF: L level
Mute ON: H level
Refer to application note (6)</td><td></td><td>—</td></tr>
<tr><td>18</td><td>BEEP IN</td><td>Beep signal input
If the beep function is not used, this pin should be connected to GND.</td><td></td><td>—</td></tr>
<tr><td>20</td><td>GND</td><td>GND for everything other than power drive stage</td><td>—</td><td>0</td></tr>
<tr><td>21</td><td>C-AMP SW</td><td>Center amplifier switch
C-Cup type: GND
OCL type: Open</td><td></td><td>—</td></tr>
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Application Notes

(1) Beep function

In Power Mute Mode, the beep signal from the microcomputer or other controlling device is input on the BEEP IN pin (pin 18). This signal is output as a current which flows to the load via the BEEP output pin (pin 3/10). The beep level is set to $V_O = -50$dBV ($R_L = 16\ \Omega$ (typ.)). For the beep signal timing, please refer to Figure 1.

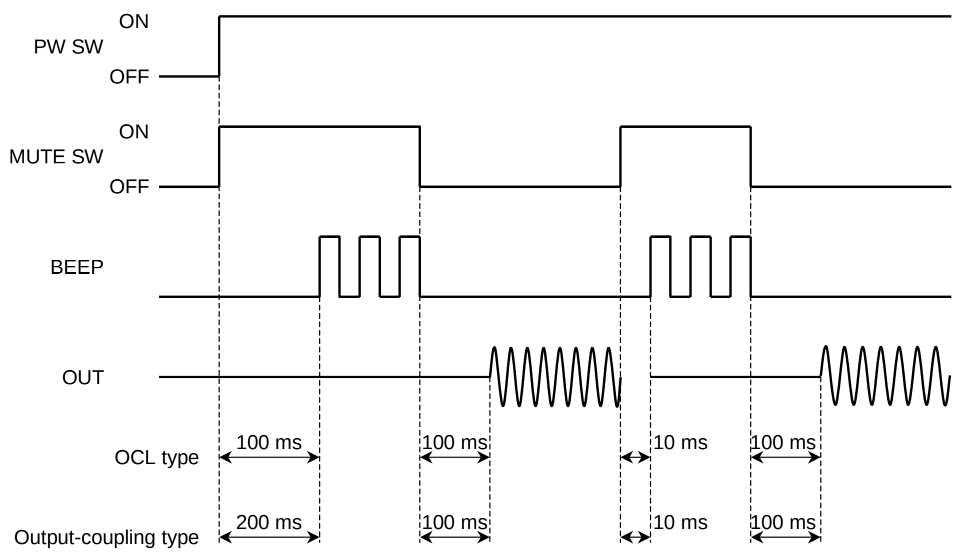


Figure 1 Timing chart for beep and output signals

(2) Low-cut compensation

For output-coupling type, the low-frequency range can be decreased using an output-coupling capacitor and a load ($f_c = 45$ Hz at C = 220 μF, R = 16 Ω). However, since the capacitor is connected between the IC's output pin (pin 4/9) and EQ pin (pin 5/8), the low-frequency gain of the power amplifier increases, enabling low-cut compensation to be performed. For the response of capacitors of different values, please refer to Figure 2.

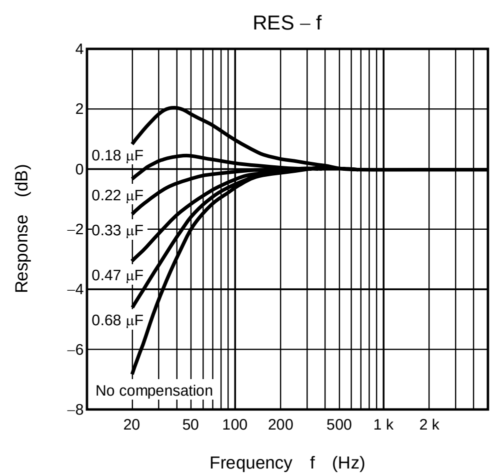


Figure 2 Capacitor response

(3) Adjustment of DC output voltage

Please perform the OUT ADJ pin (pin 24) as follows by the power supply of V_{CC1} and V_{CC2}.

- If a boost voltage is applied to V_{CC1}, V_{CC2} is connected to a battery and the difference between V_{CC1} and V_{CC2} is greater than or equal to 0.7 V, short pins 23 and 24 together. In this case the DC output voltage will be $\frac{V_{CC2}}{2}$.

- If the difference between V_{CC1} and V_{CC2} is less than 0.7 V, or if V_{CC1} and V_{CC2} are connected to the same power supply, leave pin 24 open.

  In these cases the DC output voltage will be $\frac{V_{CC2} - 0.7\ V}{2}$.

However, when the voltage level of V_{CC2} is high, the DC output voltage is will be set to approximately 1.4 V.

(4) RF IN pin

The ripple rejection ratio can by improved by connecting a capacitor to this pin. Connection of a capacitor is recommended, particularly for output-coupling type.

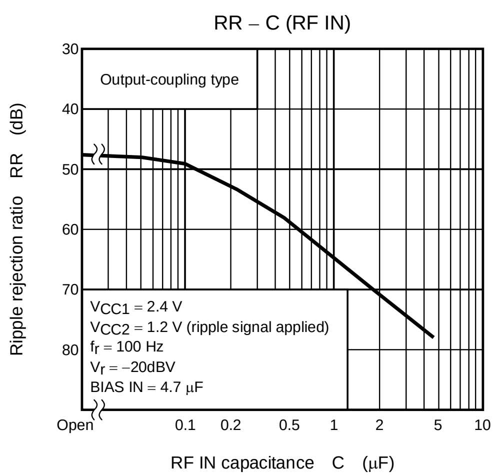


Figure 3 Improvement of ripple rejection ratio

(5) Output application of power amplifier

For output-coupling type the center amplifier is not used with the result that current consumption is low. Please set the C-AMP SW pin (pin 21) accordingly.

Output-coupling type: Pin 21 is connected to GND.
OCL type: Pin 21 is open.

(6) Switching pins

(a) PW SW

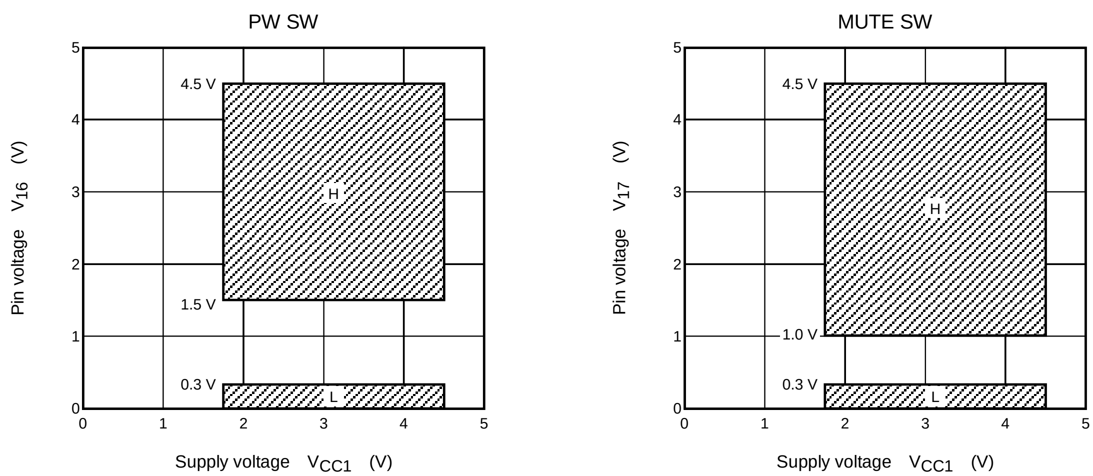
The device is ON when this pin is set to High. To prevent the IC being turned ON by external noise, it is necessary to connect an external pull-down resistor to the PW SW pin. The pin is highly sensitive.

(b) MUTE SW

If the MUTE SW pin is fixed to High, current will flow through the pin, even when the PW SW pin is in OFF Mode. To prevent the IC being turned ON by external noise, it is necessary to connect an external pull-down resistor.

The pop noise heard when the MUTE SW switch is turned ON or OFF can be reduced by connecting an external capacitor to the MUTE TC pin.

(c) Switch sensitivity (Ta = 25°C)



	PW SW
H level	IC ON
L level	IC OFF

	MUTE SW
H level	Mute ON
L level	Mute OFF

Figure 4 Switch sensitivity

(7) Miscellaneous

The following capacitors must have excellent temperature and frequency characteristics.

- Capacitor between V_{CC1} (pin 14) and GND (pin 20)
- Capacitor between V_{CC2} (pin 11) and PW GND (pin 7)
- Capacitor between BIAS IN (pin 23) and GND (pin 20)
- Capacitor between BIAS OUT (pin 19) and GND (pin 20)
- Capacitor between RF IN (pin 22) and GND (pin 20)

Absolute Maximum Ratings (Ta = 25°C)

Characteristic	Symbol	Rating	Unit
Supply voltage 1	V_{CC1}	4.5	V
Supply voltage 2	V_{CC2}	4.5	
Output current	$I_{o\ (peak)}$	100	mA
Power dissipation	P_D (Note)	500	mW
Operating temperature	T_{opr}	−25~75	°C
Storage temperature	T_{stg}	−55~150	°C

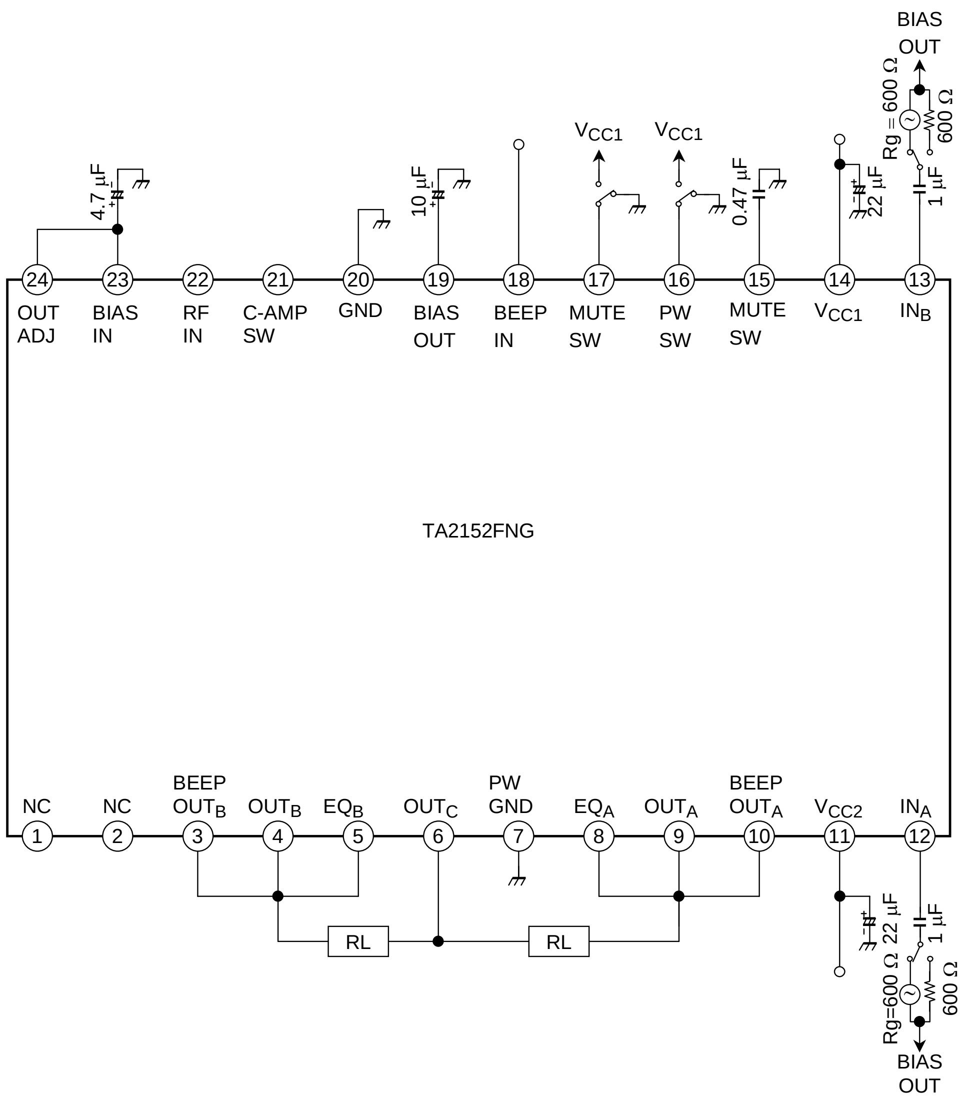
Note: Derated by 4 mW/°C above Ta = 25°C

Electrical Characteristics

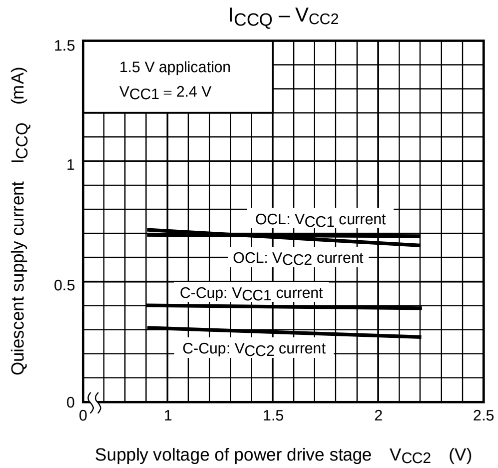
(Unless otherwise specified V_{CC1} = 2.4 V, V_{CC2} = 1.2 V, Rg = 600 Ω, R_L = 16 Ω, f = 1 kHz, Ta = 25°C, SW1: a, SW2: b, SW3: a)

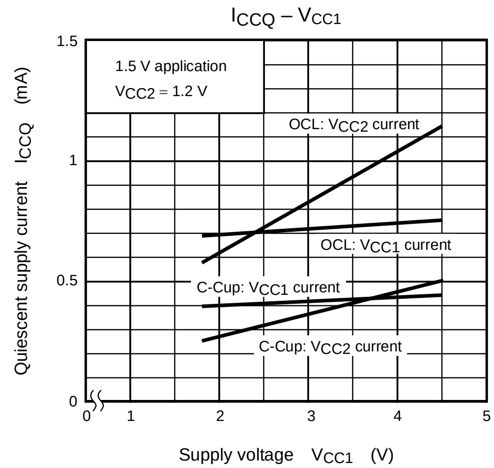
Characteristic	Symbol	Test Conditions	Min	Typ.	Max	Unit
Quiescent supply current	I_{CCQ1}	IC OFF (V_{CC1}), SW1: b	—	0.1	5	μA
	I_{CCQ2}	IC OFF (V_{CC2}), SW1: b	—	0.1	5	
	I_{CCQ3}	OCL, Mute ON (V_{CC1}), SW2: a	—	400	600	
	I_{CCQ4}	OCL, Mute ON (V_{CC2}), SW2: a	—	650	1400	
	I_{CCQ5}	C-Cup, Mute ON (V_{CC1}), SW2: a	—	170	250	
	I_{CCQ6}	C-Cup, Mute ON (V_{CC2}), SW2: a	—	85	170	
	I_{CCQ7}	OCL, no signal (V_{CC1})	—	0.7	1.1	mA
	I_{CCQ8}	OCL, no signal (V_{CC2})	—	0.7	1.5	
	I_{CCQ9}	C-Cup, no signal (V_{CC1})	—	0.4	0.6	
	I_{CCQ10}	C-Cup, no signal (V_{CC2})	—	0.3	0.6	
Power supply current during drive	I_{CC1}	OCL, 0.5 mW × 2 ch (V_{CC1})	—	0.8	—	mA
	I_{CC2}	OCL, 0.5 mW × 2 ch (V_{CC2})	—	10.0	—	
	I_{CC3}	C-Cup, 0.5 mW × 2 ch (V_{CC1})	—	0.5	—	
	I_{CC4}	C-Cup, 0.5 mW × 2 ch (V_{CC2})	—	5.0	—	
Voltage gain	G_V	V_o = −22dBV	9.5	11.5	13.5	dB
Channel balance	CB	V_o = −22dBV	−1.5	0	1.5	
Output power	P_o	THD = 10%	5	8	—	mW
Total harmonic distortion	THD	P_o = 1 mW	—	0.1	1.0	%
Output noise voltage	V_{no}	Rg = 600 Ω, Filter: IHF-A, SW3: b	—	−100	−96	dBV
Crosstalk	CT	V_o = −22 dBV	−25	−35	—	dB
Ripple rejection ratio 1	RR1	Inflow to V_{CC1}, SW3: b f_r = 100 Hz, V_r = −20 dBV	−65	−85	—	
Ripple rejection ratio 2	RR2	Inflow to V_{CC2}, SW3: b f_r = 100 Hz, V_r = −20 dBV	−85	−100	—	
Muting attenuation	ATT	V_o = −12dBV	−100	−115	—	
Beep sound output voltage	$V_{BEEP\ (OUT)}$	$V_{BEEP\ (IN)}$ = 2 $V_{p\text{-}p}$	−55	−50	−45	dBV
PW SW ON current	I16	V_{CC1} = 1.8 V, V_{CC2} = 0.9 V	5	—	—	μA
PW SW OFF voltage	V16	V_{CC1} = 1.8 V, V_{CC2} = 0.9 V	0	—	0.3	V
Mute SW ON current	I17	V_{CC1} = 1.8 V, V_{CC2} = 0.9 V	5	—	—	μA
Mute SW OFF voltage	V17	V_{CC1} = 1.8 V, V_{CC2} = 0.9 V	0	—	0.3	V

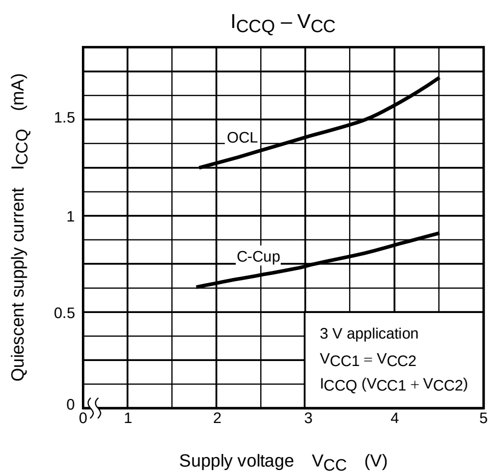
Test Circuit

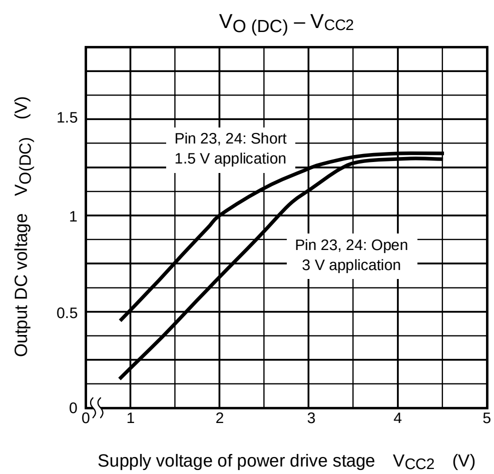


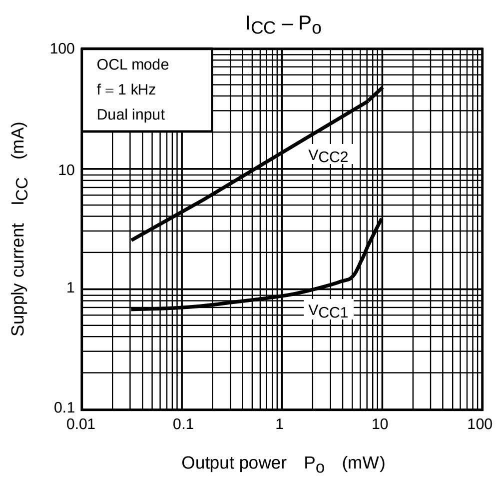
Characteristic Curves (unless otherwise specified, $V_{CC1} = 2.4$ V, $V_{CC2} = 1.2$ V, $R_g = 600\ \Omega$, $R_L = 16\ \Omega$, f = 1 kHz, Ta = 25°C)

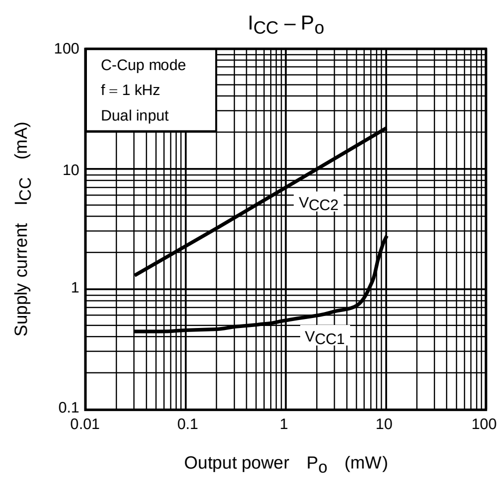


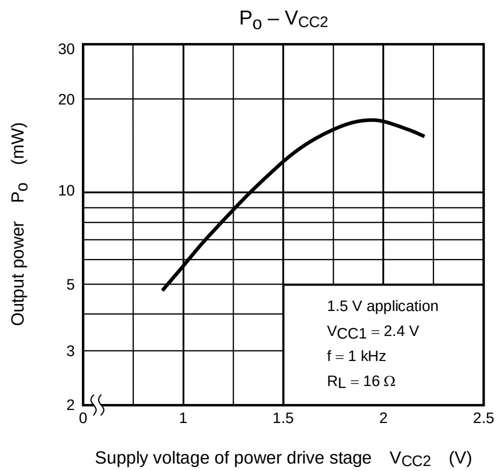


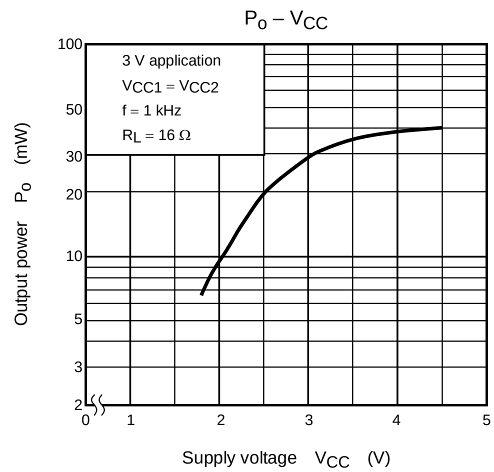


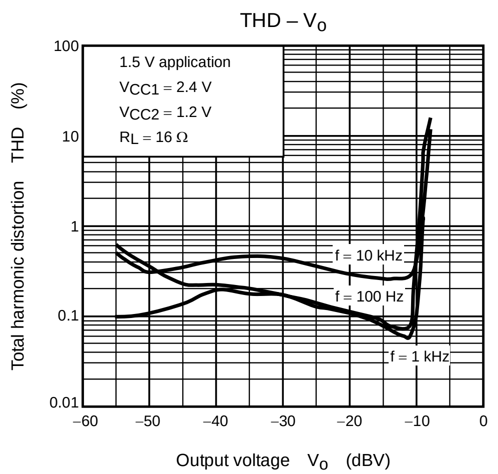


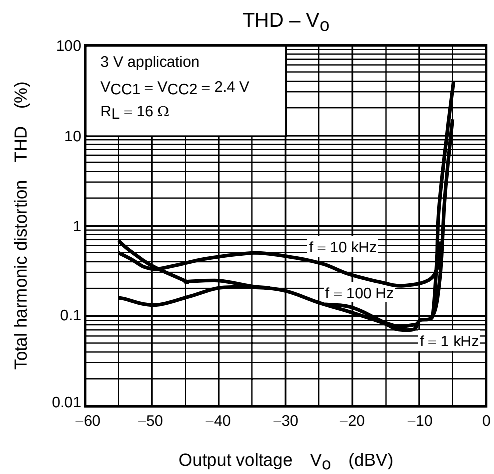


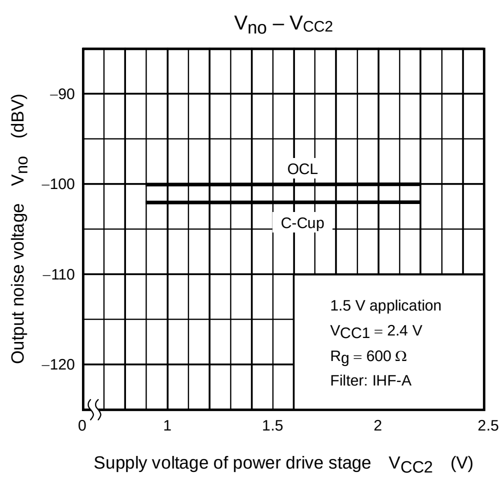


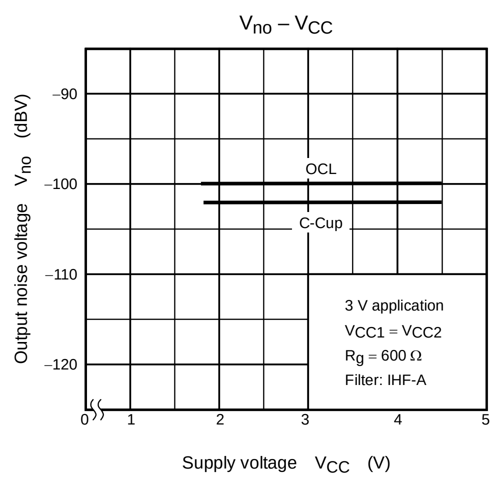

Po – VCC2
Output power Po (mW)
Supply voltage of power drive stage VCC2 (V)
1.5 V application
VCC1 = 2.4 V
f = 1 kHz
RL = 16 Ω

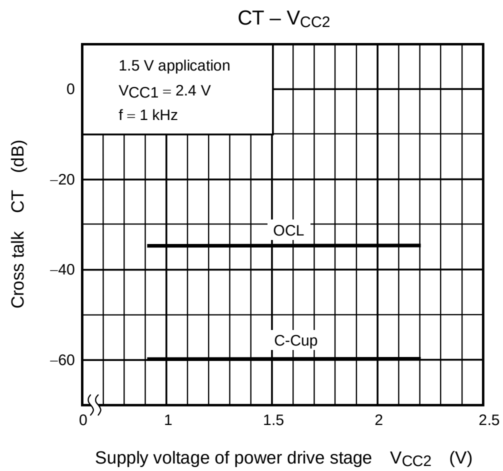

Po – VCC
Output power Po (mW)
Supply voltage VCC (V)
3 V application
VCC1 = VCC2
f = 1 kHz
RL = 16 Ω

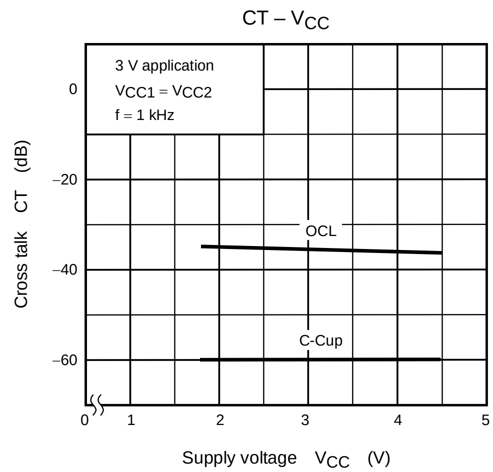

THD – Vo
Total harmonic distortion THD (%)
Output voltage Vo (dBV)
1.5 V application
VCC1 = 2.4 V
VCC2 = 1.2 V
RL = 16 Ω
f = 10 kHz
f = 100 Hz
f = 1 kHz

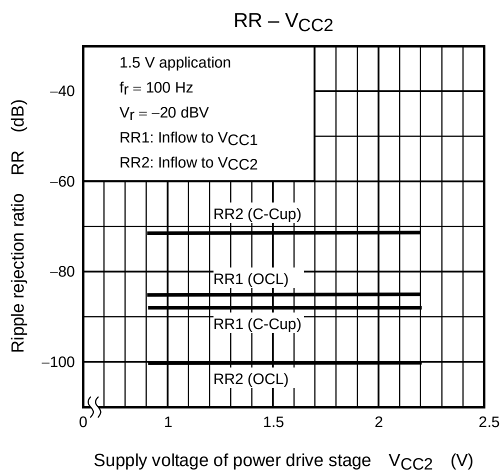

THD – Vo
Total harmonic distortion THD (%)
Output voltage Vo (dBV)
3 V application
VCC1 = VCC2 = 2.4 V
RL = 16 Ω
f = 10 kHz
f = 100 Hz
f = 1 kHz

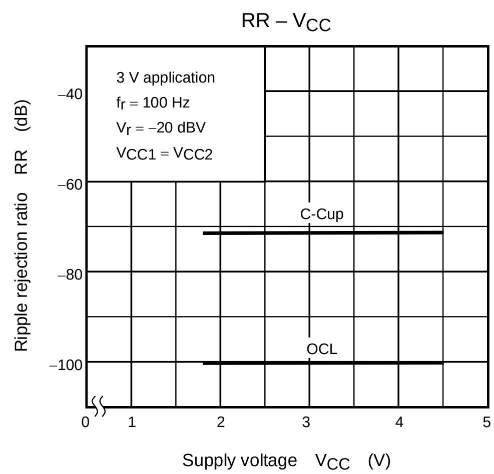

Vno – VCC2
Output noise voltage Vno (dBV)
Supply voltage of power drive stage VCC2 (V)
OCL
C-Cup
1.5 V application
VCC1 = 2.4 V
Rg = 600 Ω
Filter: IHF-A

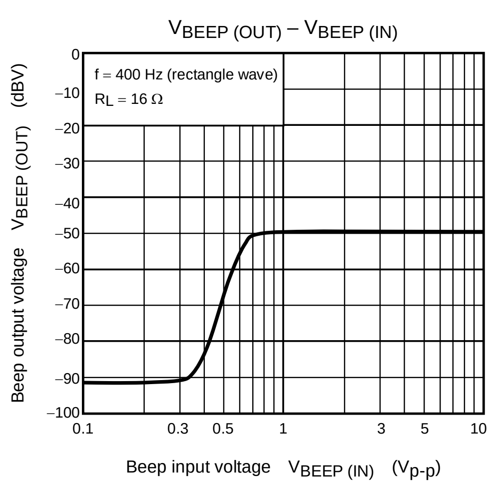

Vno – VCC
Output noise voltage Vno (dBV)
Supply voltage VCC (V)
OCL
C-Cup
3 V application
VCC1 = VCC2
Rg = 600 Ω
Filter: IHF-A

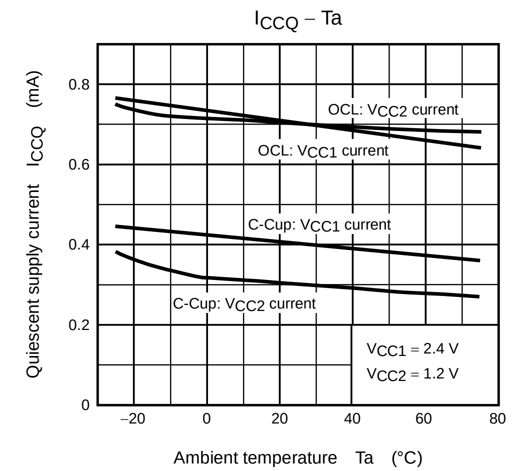

CT – VCC2
1.5 V application
VCC1 = 2.4 V
f = 1 kHz
OCL
C-Cup
Cross talk CT (dB)
Supply voltage of power drive stage VCC2 (V)

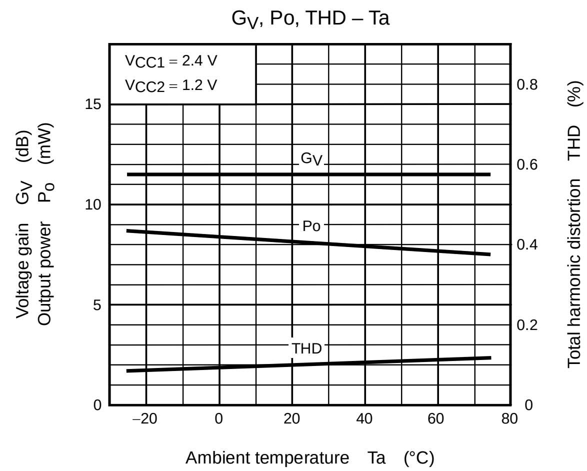

CT – VCC
3 V application
VCC1 = VCC2
f = 1 kHz
OCL
C-Cup
Cross talk CT (dB)
Supply voltage VCC (V)

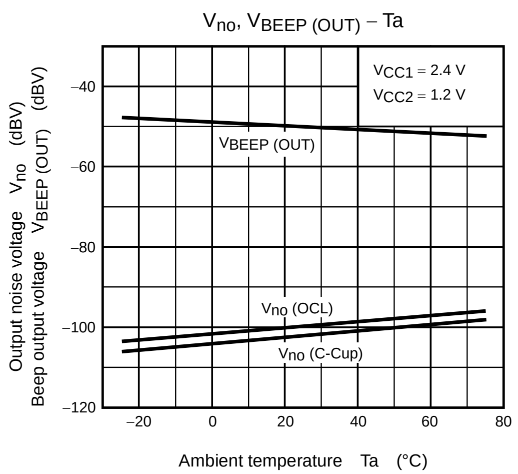

RR – VCC2
1.5 V application
fr = 100 Hz
Vr = −20 dBV
RR1: Inflow to VCC1
RR2: Inflow to VCC2
RR2 (C-Cup)
RR1 (OCL)
RR1 (C-Cup)
RR2 (OCL)
Ripple rejection ratio RR (dB)
Supply voltage of power drive stage VCC2 (V)

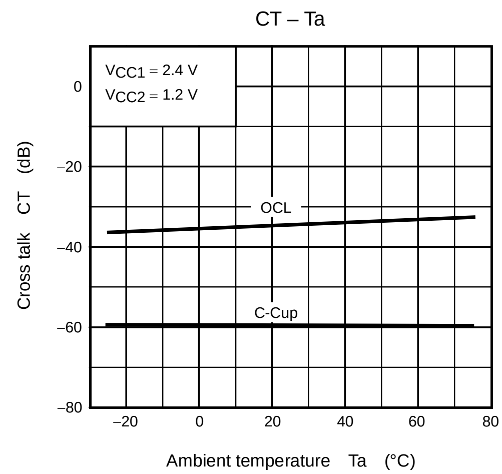

RR – VCC
3 V application
fr = 100 Hz
Vr = −20 dBV
VCC1 = VCC2
C-Cup
OCL
Ripple rejection ratio RR (dB)
Supply voltage VCC (V)

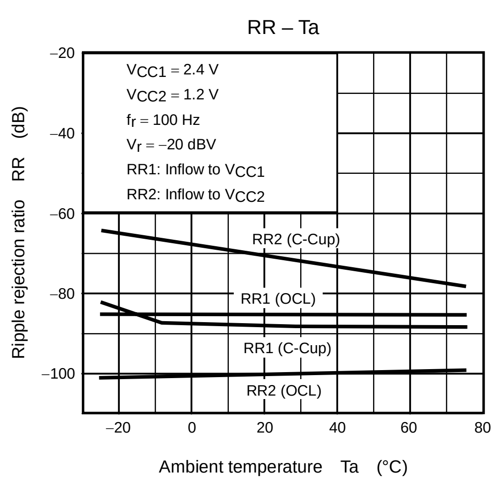

VBEEP (OUT) – VBEEP (IN)
f = 400 Hz (rectangle wave)
RL = 16 Ω
Beep output voltage VBEEP (OUT) (dBV)
Beep input voltage VBEEP (IN) (Vp-p)

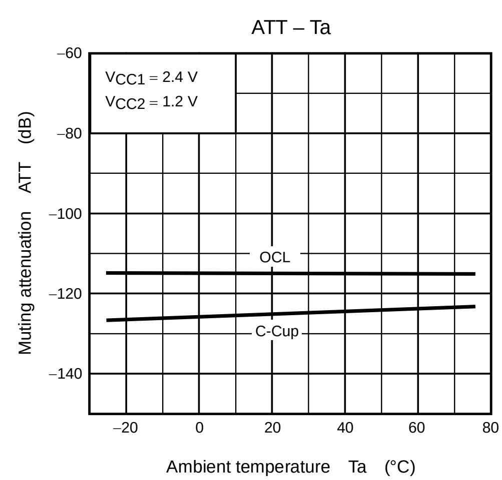

ICCQ – Ta
Quiescent supply current ICCQ (mA)
OCL: VCC2 current
OCL: VCC1 current
C-Cup: VCC1 current
C-Cup: VCC2 current
VCC1 = 2.4 V
VCC2 = 1.2 V
0.8
0.6
0.4
0.2
0
−20
0
20
40
60
80
Ambient temperature Ta (°C)


GV, Po, THD – Ta
VCC1 = 2.4 V
VCC2 = 1.2 V
Voltage gain GV (dB)
Output power Po (mW)
Total harmonic distortion THD (%)
GV
Po
THD
15
10
5
0
0.8
0.6
0.4
0.2
0
−20
0
20
40
60
80
Ambient temperature Ta (°C)

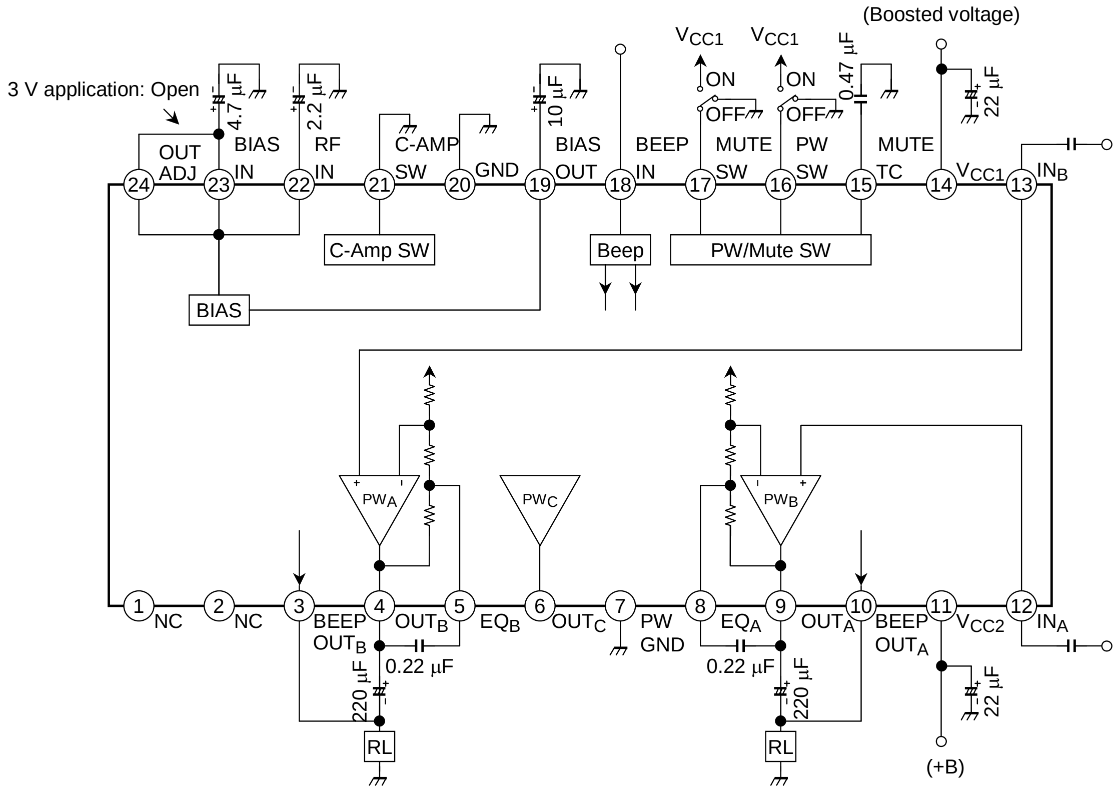

Vno, VBEEP (OUT) – Ta
VCC1 = 2.4 V
VCC2 = 1.2 V
Output noise voltage Vno (dBV)
Beep output voltage VBEEP (OUT) (dBV)
VBEEP (OUT)
Vno (OCL)
Vno (C-Cup)
−40
−60
−80
−100
−120
−20
0
20
40
60
80
Ambient temperature Ta (°C)


CT – Ta
VCC1 = 2.4 V
VCC2 = 1.2 V
Cross talk CT (dB)
OCL
C-Cup
0
−20
−40
−60
−80
−20
0
20
40
60
80
Ambient temperature Ta (°C)

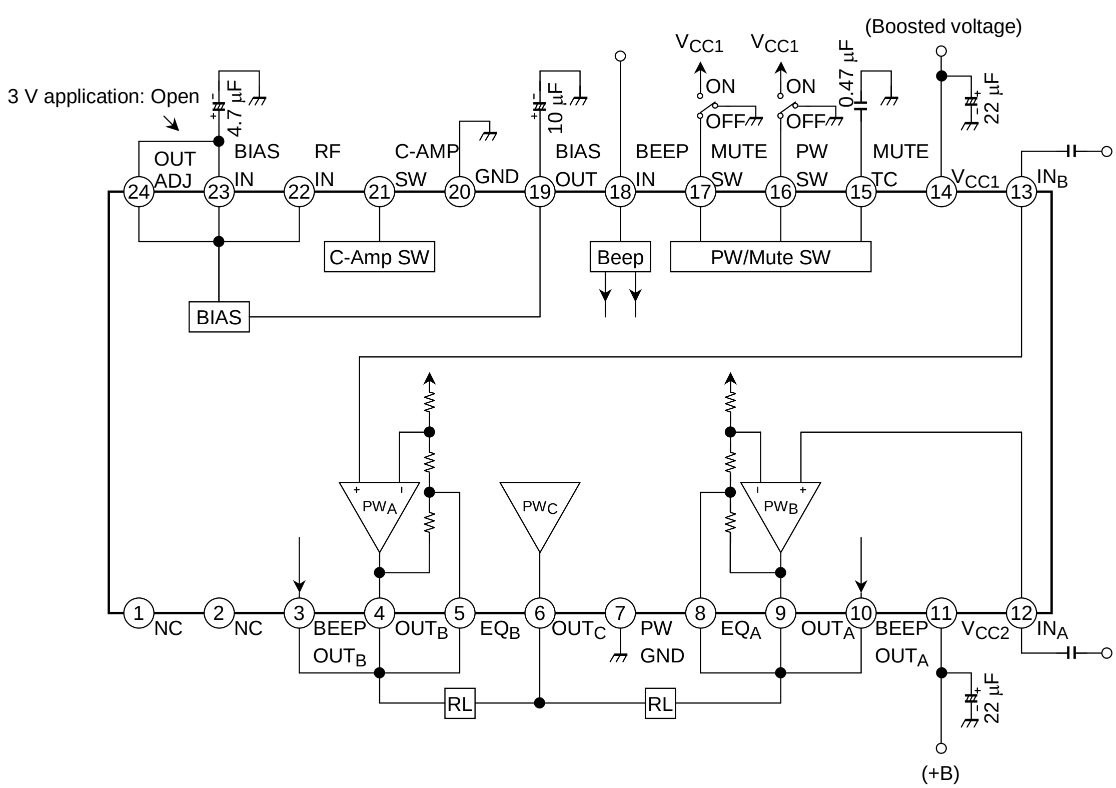

RR – Ta
VCC1 = 2.4 V
VCC2 = 1.2 V
fr = 100 Hz
Vr = −20 dBV
RR1: Inflow to VCC1
RR2: Inflow to VCC2
Ripple rejection ratio RR (dB)
RR2 (C-Cup)
RR1 (OCL)
RR1 (C-Cup)
RR2 (OCL)
−20
−40
−60
−80
−100
−20
0
20
40
60
80
Ambient temperature Ta (°C)


ATT – Ta
VCC1 = 2.4 V
VCC2 = 1.2 V
Muting attenuation ATT (dB)
OCL
C-Cup
−60
−80
−100
−120
−140
−20
0
20
40
60
80
Ambient temperature Ta (°C)

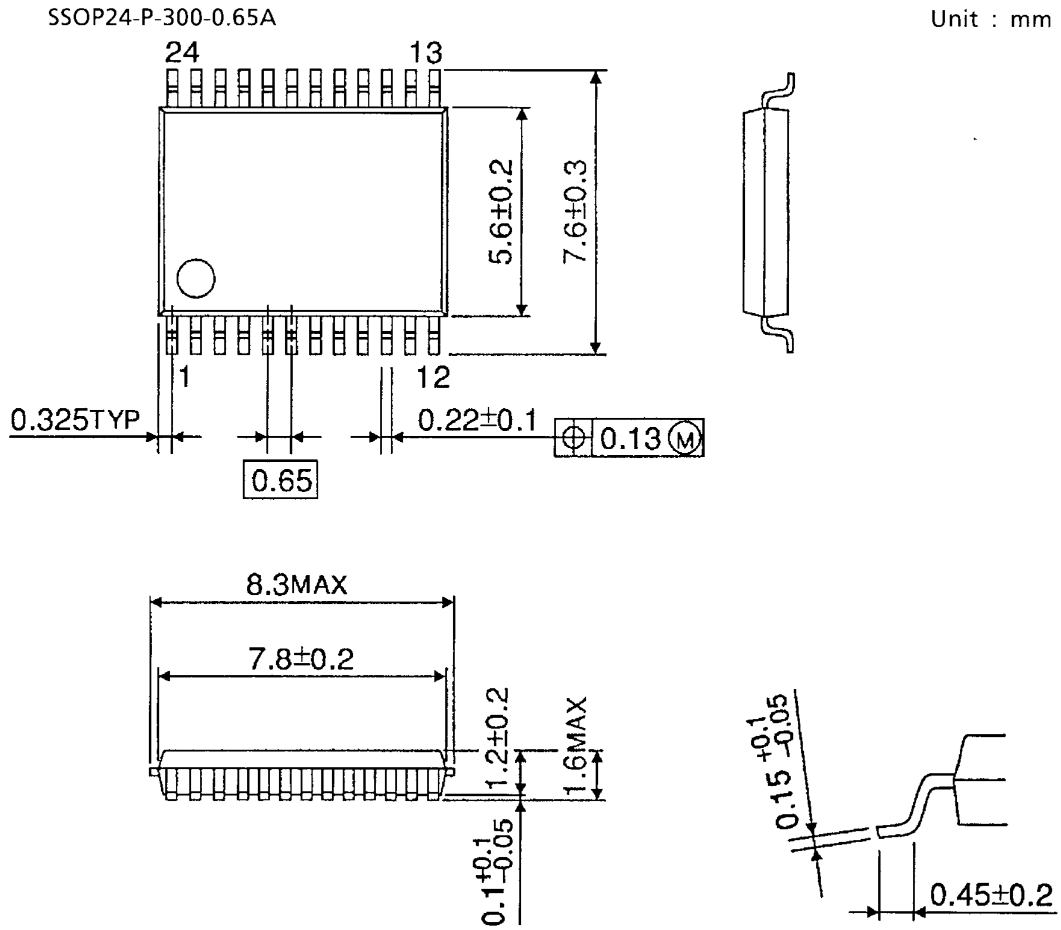
Application Circuit 1 (1.5 V Output Coupling Type)



Application Circuit 2 (1.5 V OCL Type)



Package Dimensions



Weight: 0.14 g (typ.)

About solderability, following conditions were confirmed

- Solderability

  (1) Use of Sn-63Pb solder Bath
  - · solder bath temperature = 230°C
  - · dipping time = 5 seconds
  - · the number of times = once
  - · use of R-type flux

  (2) Use of Sn-3.0Ag-0.5Cu solder Bath
  - · solder bath temperature = 245°C
  - · dipping time = 5 seconds
  - · the number of times = once
  - · use of R-type flux