Ordering number : ENA2040

# LA4814JA

**Monolithic Linear IC**

# 2-Channel Power Amplifier

ON Semiconductor®

http://onsemi.com

## Overview

The LA4814JA buili-in the power amplifier circuit capable of low-voltage (2.7V and up) operation and has additionally a standby function to reduce the current drain. It is a power amplifier IC optimal for speaker drive used in battery-driven portable equipment and other such products.

## Applications

Mini radio cassette players/recorders, portable radios, transceivers and other portable audio devices

## Features

- On-chip 2-channel power amplifier
  Output power 1 = 350mW typ. ($V_{CC}$ = 5.0V, $R_L$ = 4Ω, THD = 10%)
  Output power 2 = 150mW typ. ($V_{CC}$ = 3.6V, $R_L$ = 4Ω, THD = 10%)
- Enables monaural BTL output system by changing externally connected components
  Output power 3 = 700mW typ. ($V_{CC}$ = 5.0V, $R_L$ = 8Ω, THD = 10%)
  Output power 4 = 320mW typ. ($V_{CC}$ = 3.6V, $R_L$ = 8Ω, THD = 10%)
- Low-voltage operation possible
  $V_{CC}$ =2.7V and up
- Standby function
  Current drain at standby = 0.1μA typ. ($V_{CC}$ = 5V)
- Voltage gain setting possible
  Voltage gain = 3 to 20dB
- Second amplifier stop control function
  Reducing the pop noise at startup (in BTL mode)

Semiconductor Components Industries, LLC, 2013

# Specifications

## Maximum Ratings at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Maximum supply voltage | $V_{CC}$ max | | 8 | V |
| Allowable power dissipation | Pd max | * | 1.3 | W |
| Maximum junction temperature | Tj max | | 150 | °C |
| Operating temperature | Topr | | -40 to +85 | °C |
| Storage temperature | Tstg | | -40 to +150 | °C |

* Mounted on Our evaluation board : Double-sided board with dimensions of 60mm × 60mm × 1.6mm

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

## Operating Conditions at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Recommended supply voltage | $V_{CC}$ | | 5 | V |
| Recommended load resistance | RL | Single ended mode | 4 to 32 | Ω |
| | | BTL mode | 8 to 32 | Ω |
| Operating supply voltage range | $V_{CC}$ op | Single ended mode, $R_L$ = 6 to 32Ω | 2.7 to 7 | V |
| | | Single ended mode, $R_L$ = 4 to 6Ω | 2.7 to 5.5 | V |
| | | BTL mode, $R_L$ = 16 to 32Ω | 2.7 to 7 | V |
| | | BTL mode, $R_L$ = 8 to 16Ω | 2.7 to 5.5 | V |

* Determine the supply voltage to be used with due consideration of allowable power dissipation.

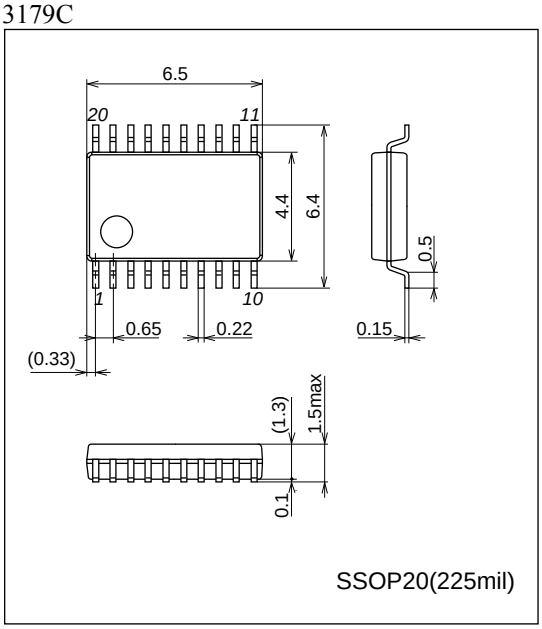
## Electrical Characteristics at Ta = 25°C, $V_{CC}$ = 5.0V, $R_L$ = 4Ω, fin = 1kHz

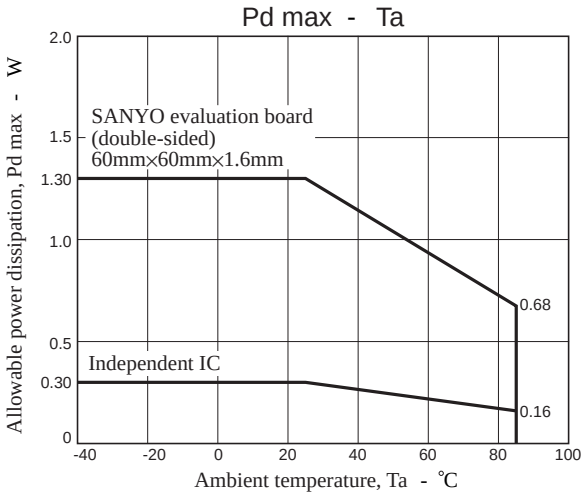
| Parameter | Symbol | Conditions | Ratings | | | Unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Quiescent current drain | $I_{CCOP}$ | No signal | | 8.6 | 15 | mA |
| Standby current drain | ISTBY | No signal, V8 = Low | | 0.1 | 10 | μA |
| Maximum output power | POMAX | THD = 10% | 220 | 350 | | mW |
| BTL maximum output power | POMXB | BTL mode, $R_L$ = 8Ω, THD = 10% | | 700 | | mW |
| Voltage gain | VG | $V_{IN}$ = -30dBV | 8.2 | 9.7 | 11.2 | dB |
| Voltage gain use range | VGU | | 3 | | 20 | dB |
| Channel balance | CHB | $V_{IN}$ = -30dBV | -2 | 0 | 2 | dB |
| Total harmonic distortion | THD | $V_{IN}$ = -30dBV | | 0.35 | 1 | % |
| Output noise voltage | VNOUT | Rg = 620Ω, 20 to 20kHz | | 15 | 50 | μVrms |
| Channel separation | CHSEP | VOUT = -10dBV, 20 to 20kHz | -70 | -81 | | dBV |
| Ripple rejection ratio | SVRR | Rg = 620Ω, fr = 100Hz, Vr = -20dBV | | 53 | | dB |
| Output DC offset voltage | VOF | Rg = 620Ω, V3-V12, in BTL mode | -30 | 0 | 30 | mV |
| Reference voltage | VREF | | | 2.2 | | V |
| Pin 8 control HIGH voltage | V8H | (Power amplifier operation mode) | 1.6 | | $V_{CC}$ | V |
| Pin 8 control LOW voltage | V8L | (Power amplifier standby mode) | 0 | | 0.3 | V |
| Pin 9 control HIGH voltage | V9H | (Second amplifier standby mode) | 1.6 | | $V_{CC}$ | V |
| Pin 9 control LOW voltage | V9L | (Second amplifier operation mode) | 0 | | 0.3 | V |

## Package Dimensions

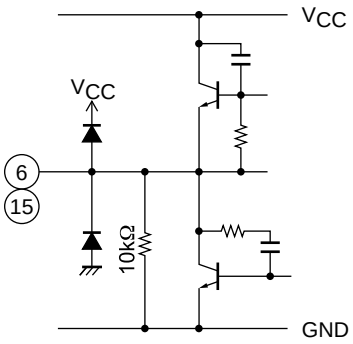
unit : mm (typ)

3179C




## Pin Functions

| Pin No. | Pin Name | Pin Voltage $V_{CC}$ = 5V | Description | Equivalent Circuit |
|---|---|---|---|---|
| 1 | NC | - | No connect | |
| 2 | NC | - | No connect | |
| 3 | NC | - | No connect | |
| 4 | GND | 0 | Ground pin | |
| 5 | NC | - | No connect | |
| 6<br>15 | OUT1<br>OUT2 | 2.2 | Power amplifier output pin |  |
| 7 | NC | - | No connect | |



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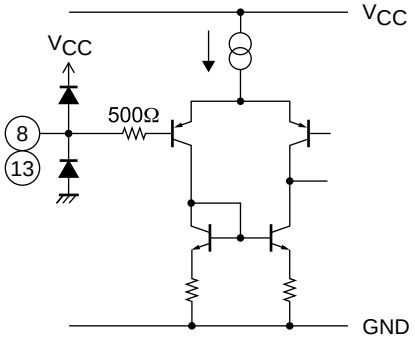
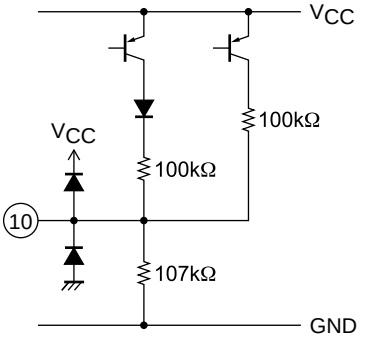
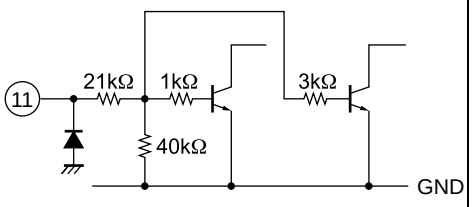
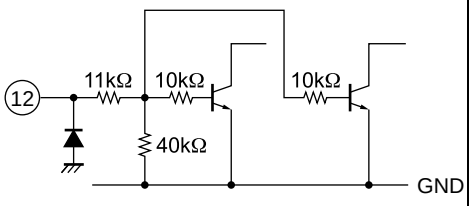
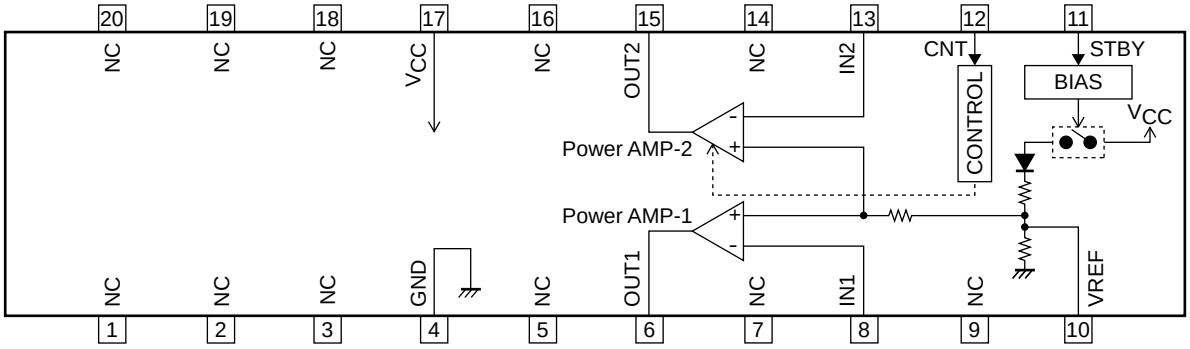
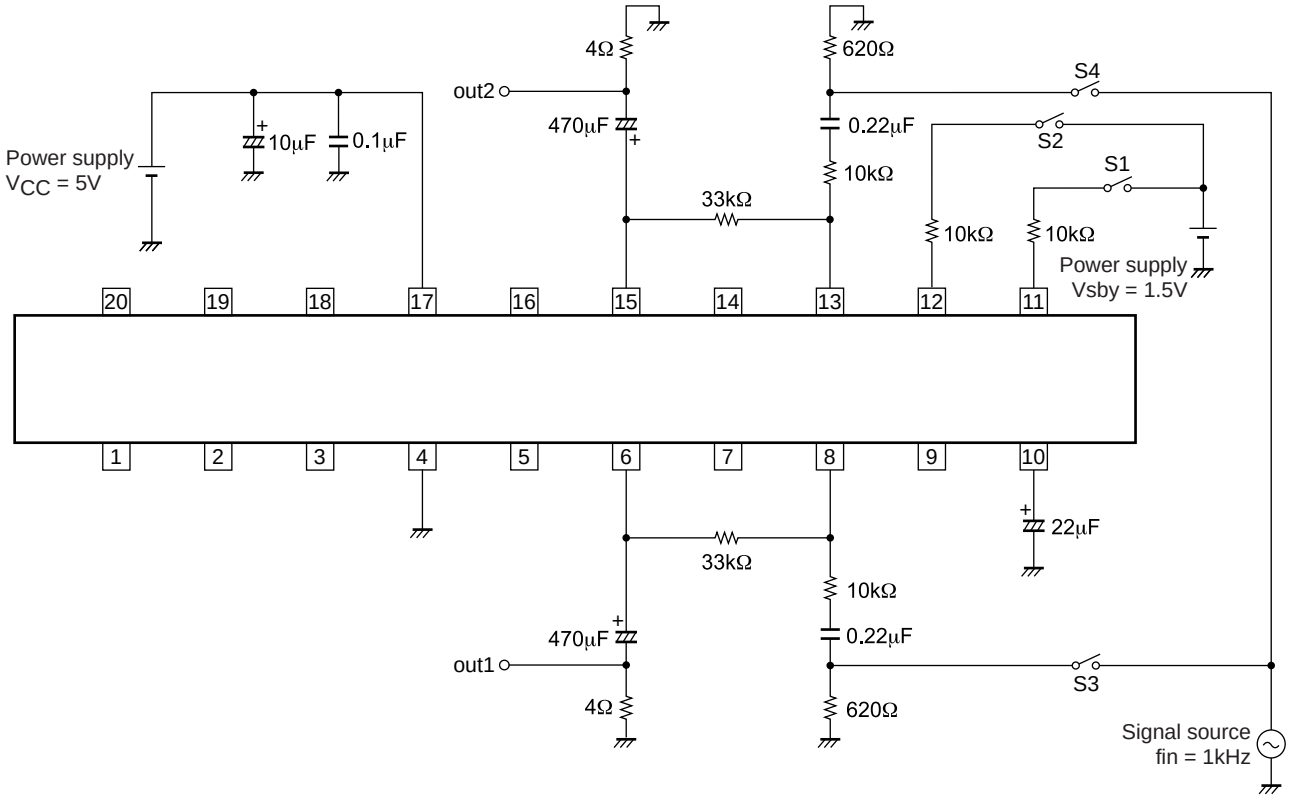
| Pin No. | Pin Name | Pin Voltage $V_{CC}$ = 5V | Description | Equivalent Circuit |
|---|---|---|---|---|
| 8<br>13 | IN1<br>IN2 | 2.2 | Input pin |  |
| 9 | NC | - | No connect | |
| 10 | VREF | 2.2 | Ripple filter pin<br>(For connection of capacitor for filter) |  |
| 11 | STBY | - | Standby pin<br>Standby mode at 0V to 0.3V<br>Operation mode at 1.6V to $V_{CC}$ |  |
| 12 | CNT | - | Second amplifier stop control pin<br>Second amplifier operation at 0V to 0.3V<br>Second amplifier stop at 1.6V to $V_{CC}$ |  |
| 14 | NC | - | No connect | |
| 16 | NC | - | No connect | |
| 17 | $V_{CC}$ | 5 | Power supply pin | |
| 18 | NC | - | No connect | |
| 19 | NC | - | No connect | |
| 20 | NC | - | No connect | |

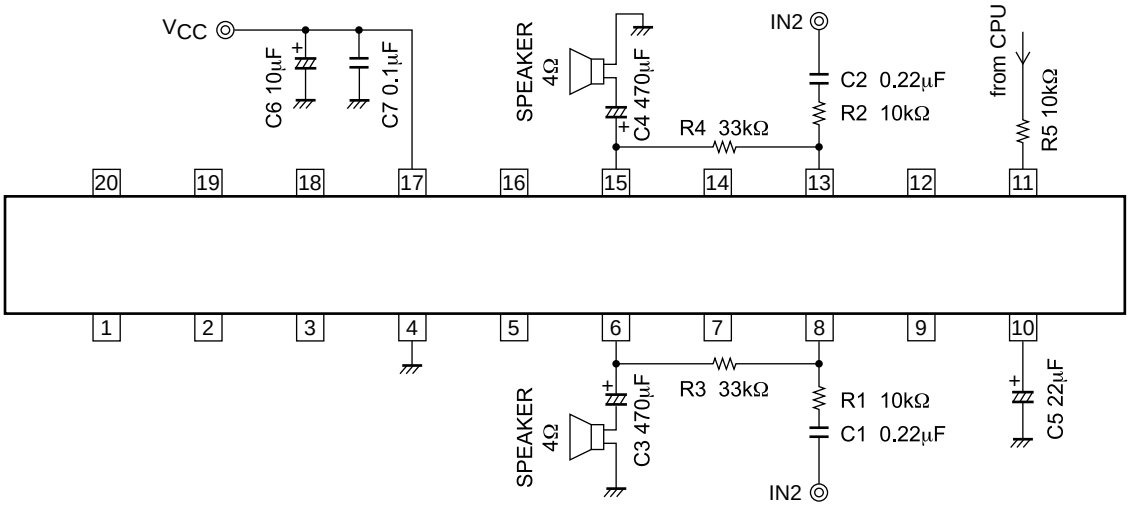
## Block Diagram



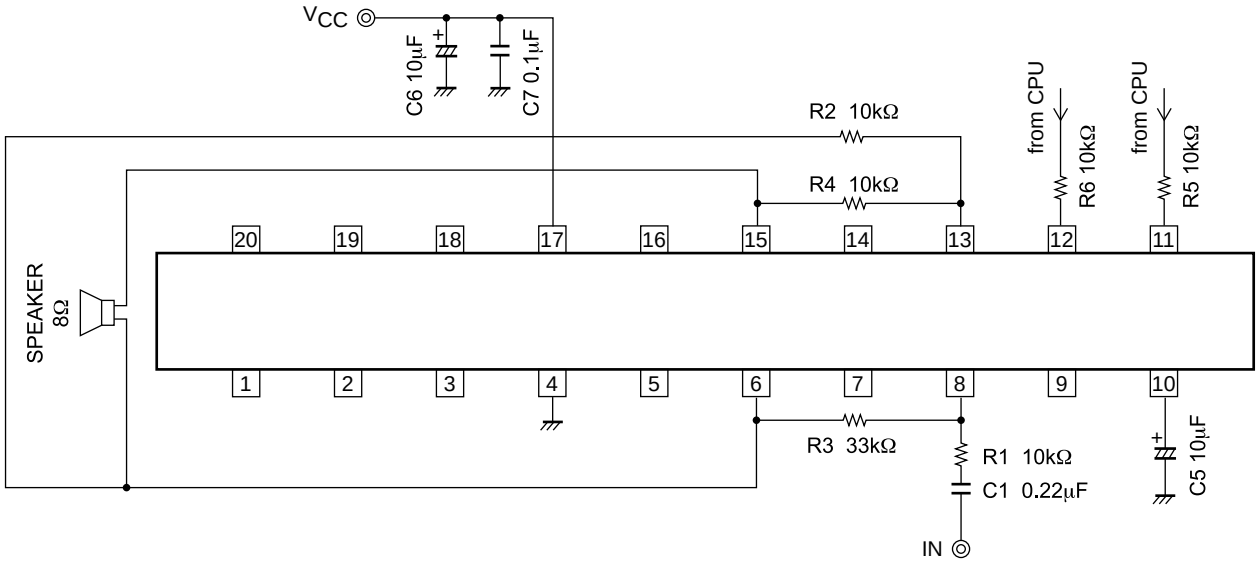

## Test Circuit



## Application Circuit Example 1. (2-channel single ended mode)




## Application Circuit Example 2. (monaural BTL mode)



## Cautions for Use

1. Input coupling capacitors (C1, C2)

C1 and C2 are input coupling capacitors that are used to cut DC voltage. However, the input coupling capacitor C1 (C2) and input resistor R1 (R2) make up the high-pass filter, attenuating the bass frequency. Therefore, the capacitance value must be selected with due consideration of the cut-off frequency.

The cut-off frequency is expressed by the following formula :

$$fc = 1/2\,\pi \times R1 \times C1\ (= 1/2\,\pi \times R2 \times C2)$$

Note with care that this capacitance value affects the pop noise at startup. To increase this capacitance value, it is necessary to increase the capacitance value of pin 10 capacitor (C5) to soften the startup characteristics.

2. Pin 10 capacitor (C5)

This capacitor C5 is designed for the ripple filter. Its purpose is to make up a low-pass filter with a 100kΩ internal resistor for reducing the ripple component of the power supply and improve the ripple rejection ratio.

Inside the IC, the startup characteristics of the pin 10 voltage are used to drive the automatic pop noise reduction circuit, and care must be taken with the pop noise when the C5 capacitance value is to be set lower.

However, when the IC is used in BTL mode, the automatic pop noise reduction function mentioned above has no effect. Instead, a pop noise reduction method that utilizes the second amplifier control function is used so that the capacitance value must be determined while factoring in the ripple rejection ratio or startup time.

Recommended capacitance value : Min. 22μF (in 2-channel mode)
10μF (in mono BTL mode)

3. Bypass capacitor (C7)

The purpose of the bypass capacitor C7 is to reject the high-frequency components that cannot be rejected by the power supply capacitor (chemical capacitor C6). Place the capacitor as near to the IC as possible, and use a ceramic capacitor with excellent high-frequency characteristics.

4. Standby function

The standby function serves to place the IC in standby mode to minimize the current drain.

a) When using the standby function (when using microcomputer control)

By applying the following voltages to the standby pin (pin 11), the mode changeover can be performed between standby and operation.

Operation mode ⋯ V11 ≥ 1.6V
Standby mode ⋯ V11 ≤ 0.3V

However, set the resistance of resistor R5 inserted in series in such a way that the condition in the following formula is met.

$$R5 \leq 24.6 \times (Vstby - 1.6)\ k\Omega$$

The pin 11 inrush current is expressed by the following formula:

$$I11 = (40 \times Vstby - 26.3)/(1+0.04 \times R5)\ \mu A$$

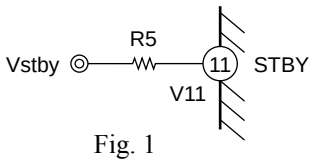


Fig. 1

b) When not using the standby function (microcomputer control is not possible)

By applying a voltage from the power supply (pin 17) to the standby pin (pin 11), the IC can be turned on without the control of the microcomputer when the power is turned on.

In order to reduce the pop noise when the IC is turned off, it is recommended that resistor R5 be inserted as shown in Fig.2. The resistance value indicated below is recommended for the inserted resistor R5.

$V_{CC}$ = 5.0V : R5 = 82kΩ
$V_{CC}$ = 3.6V : R5 = 47kΩ
$V_{CC}$ = 3.0V : R5 = 33kΩ

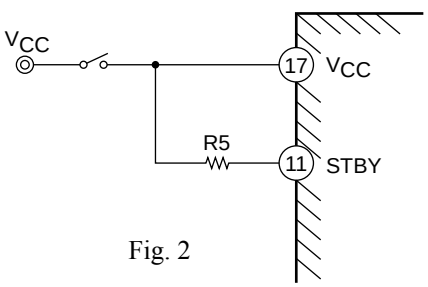


Fig. 2

5.Second amplifier control function (only when BTL mode is used)

The second amplifier control function is a function to reduce the startup pop-noise in BTL mode. The pop noise can be reduced by first turning on the IC while the second amplifier is stopped, then after the potential inside the IC gets stabilized, turning on the second amplifier.

The values shown below are recommended for the control time.

| C5 [μF] | 2.2 | 3.3 | 4.7 | 10 |
|---|---|---|---|---|
| Twu [ms] | 200 | 250 | 300 | 500 |

* Twu : Time after releasing standby to second amplifier turn-on

a) When using microcomputer control

The second amplifier can be controlled by applying the following voltages to pin 12.

Second amplifier operation mode ⋯ V12 ≤ 0.3V

Second amplifier stop mode ⋯ V12 ≥ 1.6V

However, set the resistance value of the resistor R6 inserted in series in such a way that the condition in the following formula is met.

$R6 \leq 16.2 \times (Vcnt - 1.6)\ k\Omega$

The pin 12 injected current is expressed by the following formula :

$I12 = (57.6 \times Vcnt - 31.7)/(1+0.058 \times R6)\ \mu A$

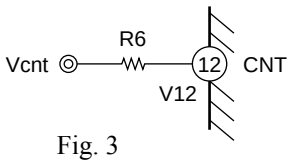



Fig. 3

b) When microcomputer control is not possible

When the microcomputer cannot be used, the second amplifier can be controlled by adding the external components as shown in Fig. 4.

| | $V_{CC}$ (V) | | |
|---|---|---|---|
| | 5 | 3.6 | 3 |
| R7 (kΩ) | 10 | 6.8 | 6.8 |
| R9 (kΩ) | 120 | 68 | 56 |
| C8 (μF) | 100 | 100 | 100 |

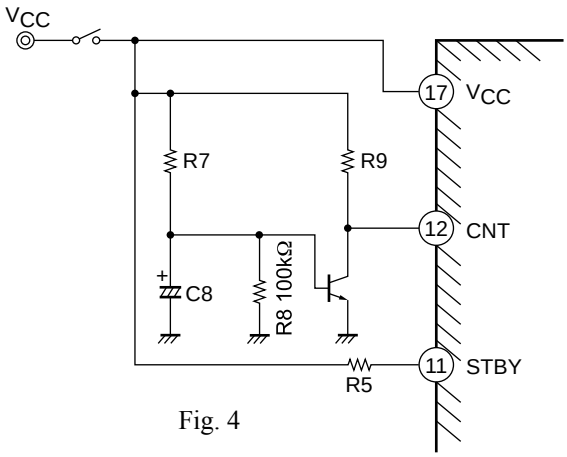



Fig. 4

6.Shorting between pins

When power is applied with pins left short-circuited, electrical deterioration or damage may result.

Therefore, check before power application if pins are short-circuited with solder, etc. during mounting of IC.

7.Load shorting

If the load is left short-circuited for a long period of time, electrical deterioration or damage may occur.

Never allow the load to short-circuit.

8.Maximum rating

When IC is used near the maximum rating, there is a possibility that the maximum rating may be exceeded even under the smallest change of conditions, resulting in failure. Take sufficient margin for variation of supply voltage and use IC within a range where the maximum rating will never be exceeded.

9. Turn-off transient response characteristics

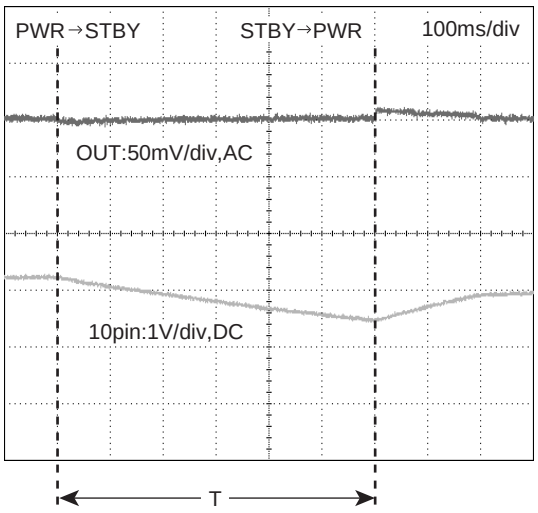
If the IC is turned off and then turned back on while there is a potential difference between the pin 10 (reference voltage, plus input pin) and pins 8 and 15 (minus input pins), a louder pop noise than the one normally generated when power is switched on will be emitted. Therefore, in order to minimize the turn-on pop noise, smoothen the discharge of the input and output capacitors, and bring the potential of pin 10 and pins 8 and 15 to approximately the same level, then turn on the IC.

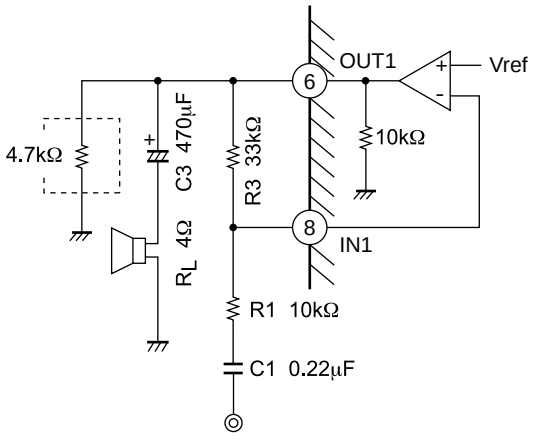
a) Single ended mode

When the continuous changeover of mode between standby and operation is necessary, it is recommended to insert a resistor between the output pins (pins 6 and 15) and ground to accelerate the turn-off transient response characteristic. The value shown below is recommended for the resistor used for discharge. In order to reduce pop noise, it is recommended that time necessary for turning the IC back on is greater than the following value.

Recommended discharge resistor : R = 4.7kΩ

(Recommended turn-on time : T = 600ms)



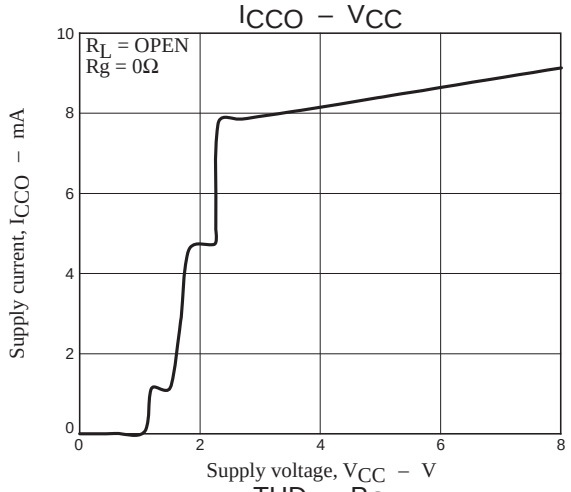



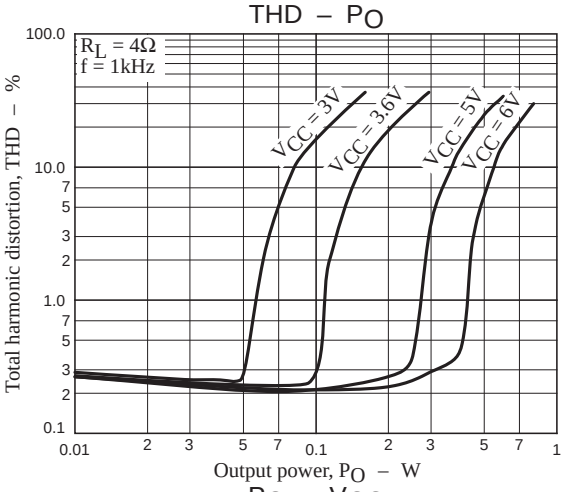

b) BTL mode

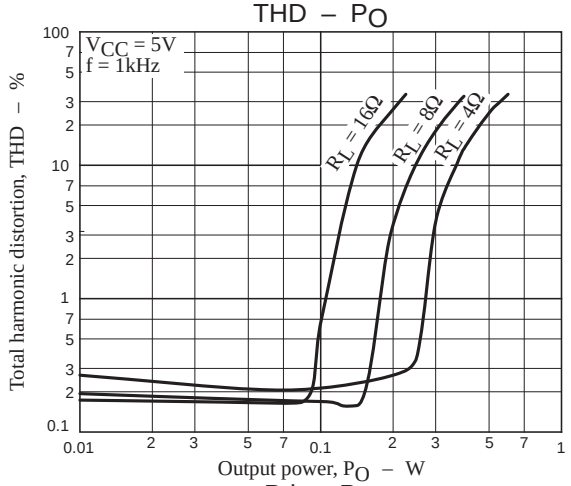
When the continuous changeover of mode between standby and operation is performed, it is recommended that the second amplifier control function be used to reduce the turn-on pop noise. If this function is used, the pop noise level can be reduced regardless of the time taken for the IC to turn on after it is turned off.

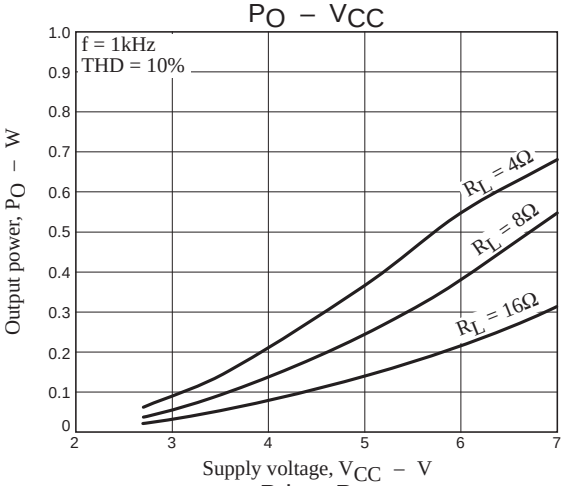
For details on the time taken for the second amplifier to turn on after the IC is turned on, refer to Section 5 “Second amplifier control function.”

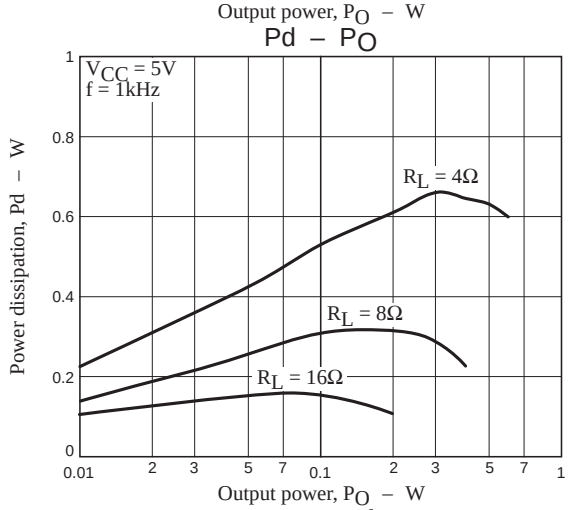
## General characteristics Single ended mode

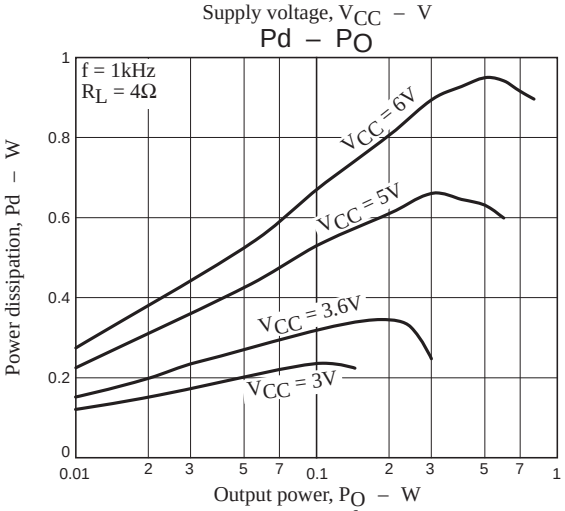


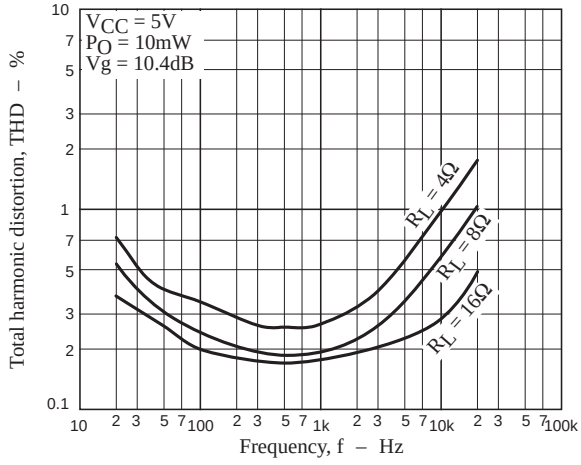



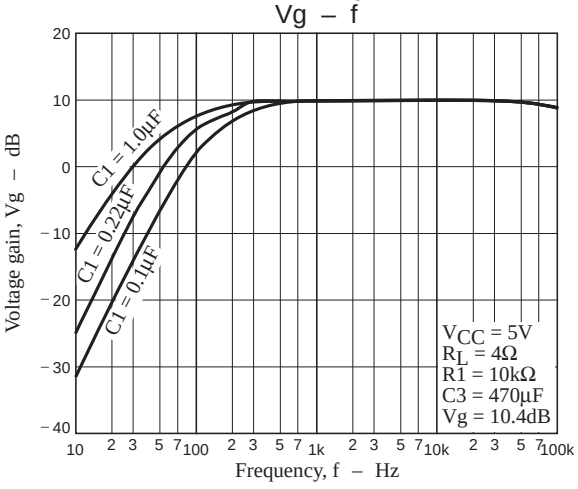



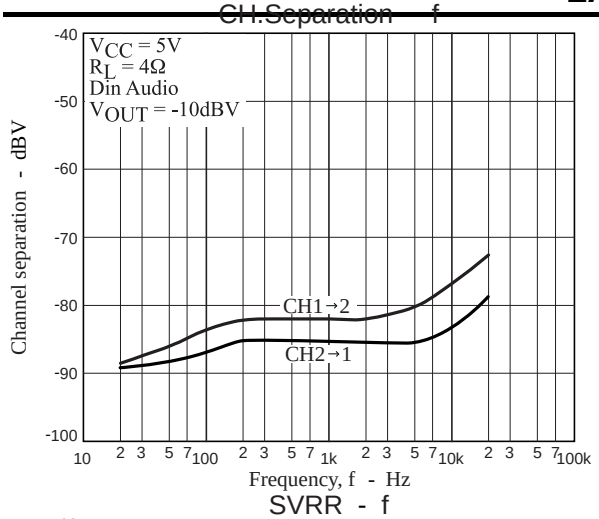



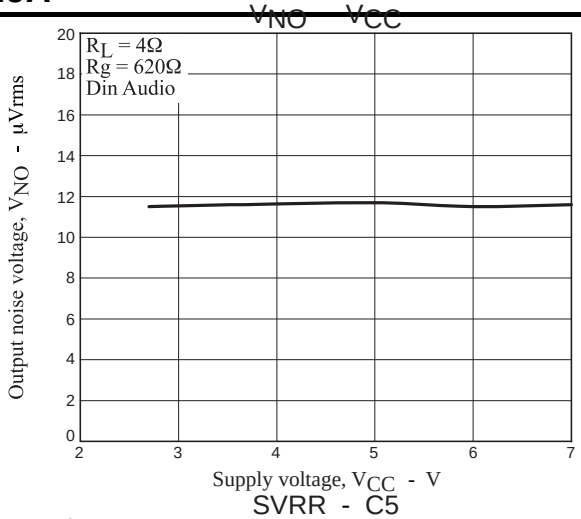



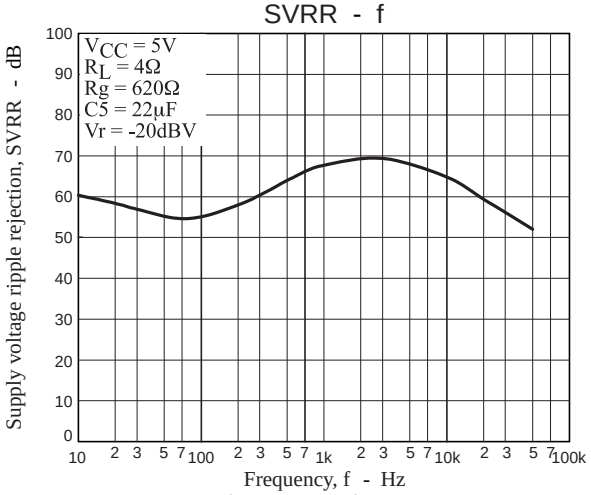
CH.Separation - f



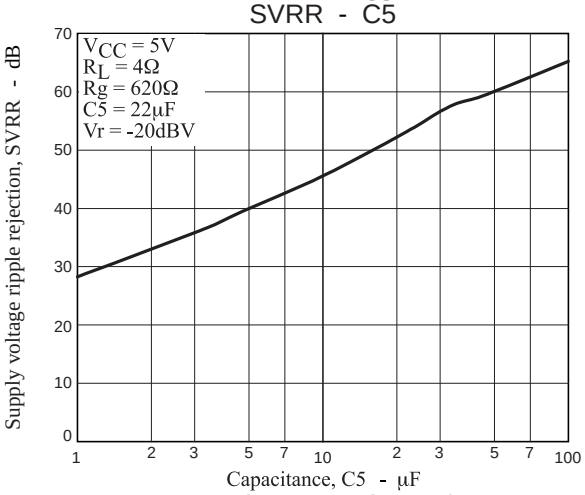

$V_{NO}$ - $V_{CC}$



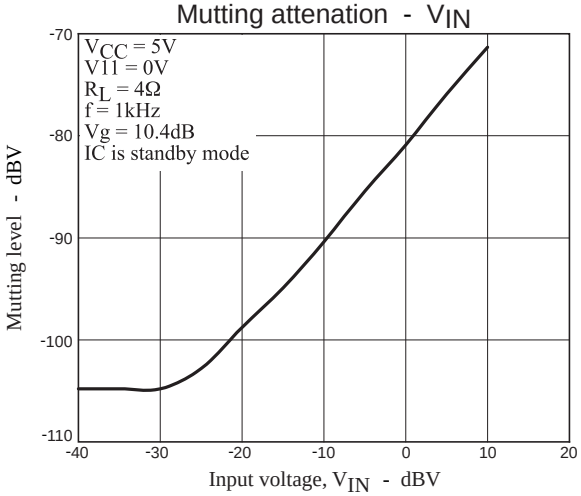

SVRR - f



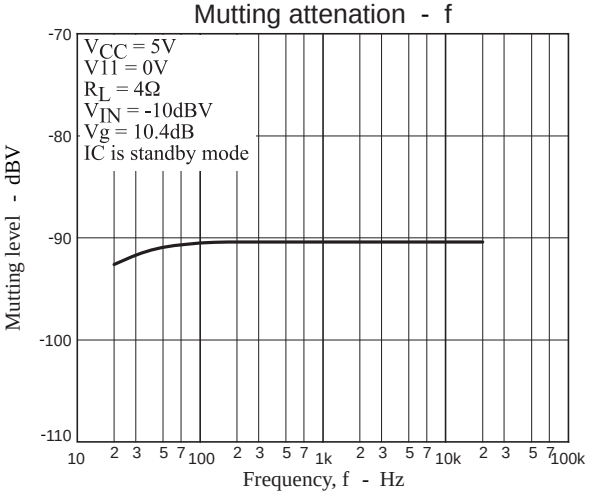

SVRR - C5




Mutting attenation - $V_{IN}$

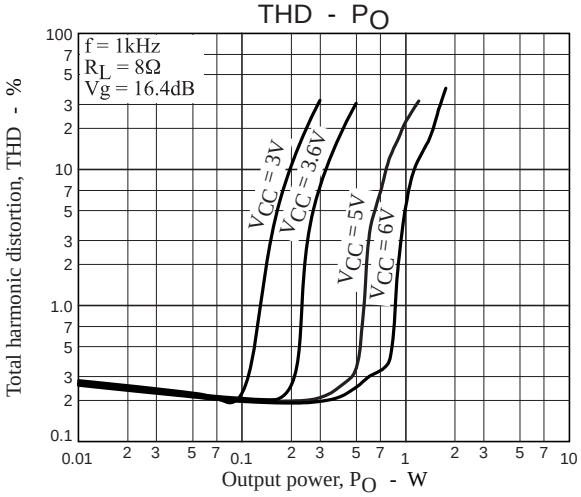



Mutting attenation - f

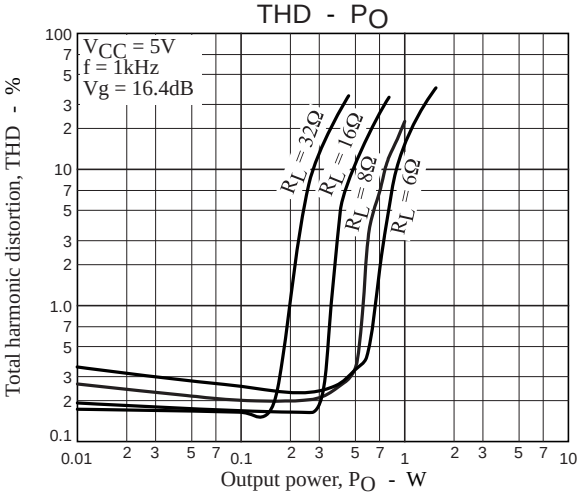



## General characteristics BTL mode

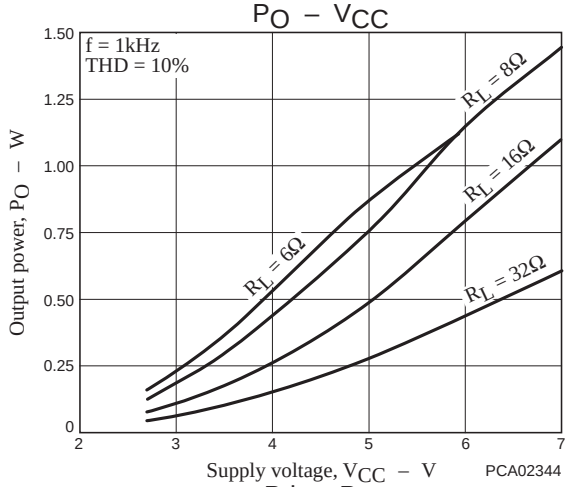
THD - $P_O$



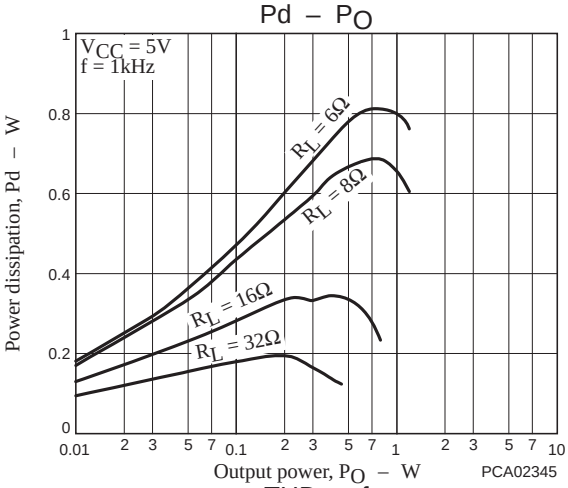

THD - $P_O$



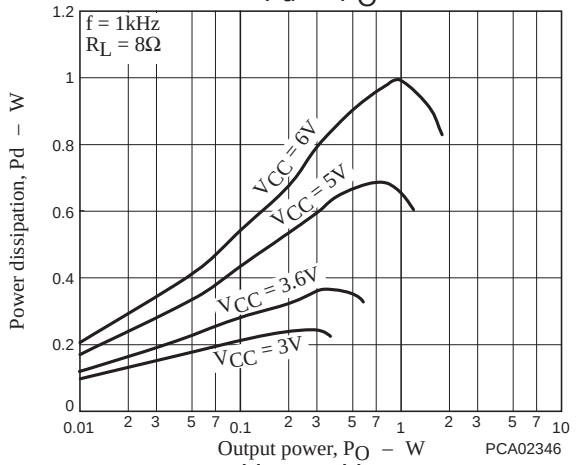
$P_O - V_{CC}$



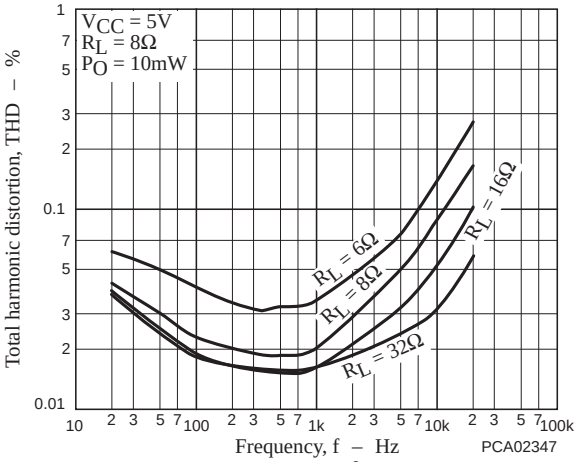

Pd – $P_O$



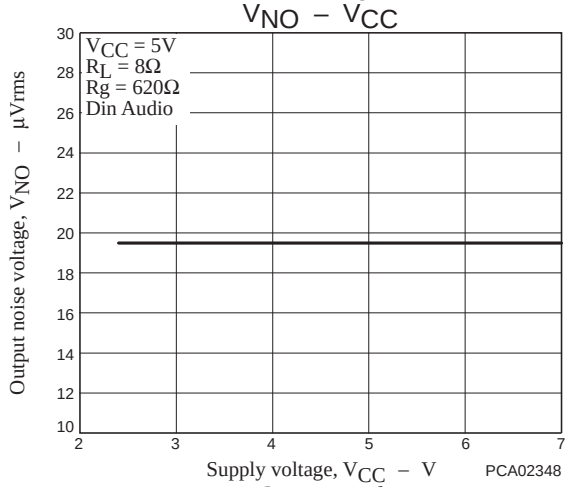

Pd – $P_O$



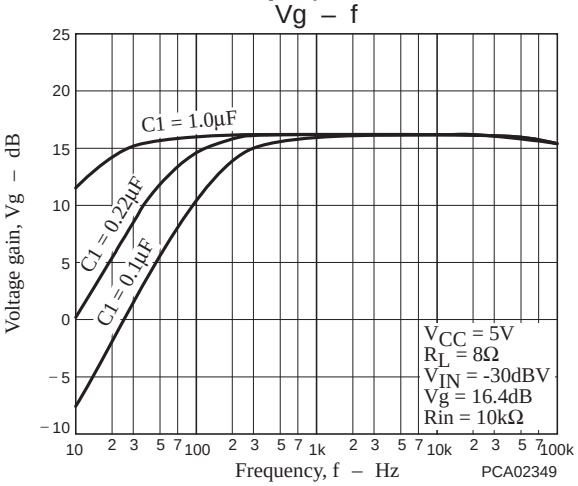

THD – f



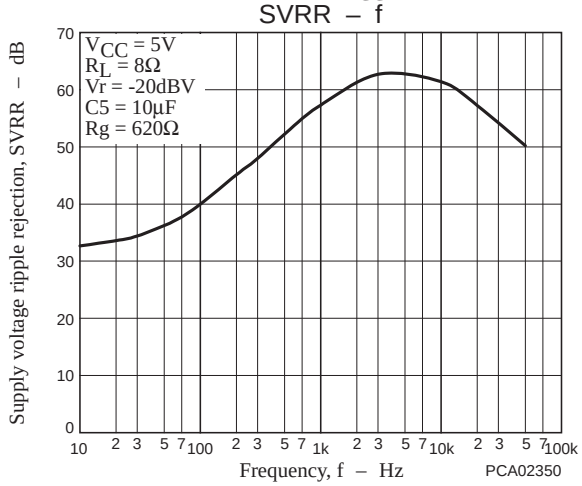

$V_{NO} - V_{CC}$



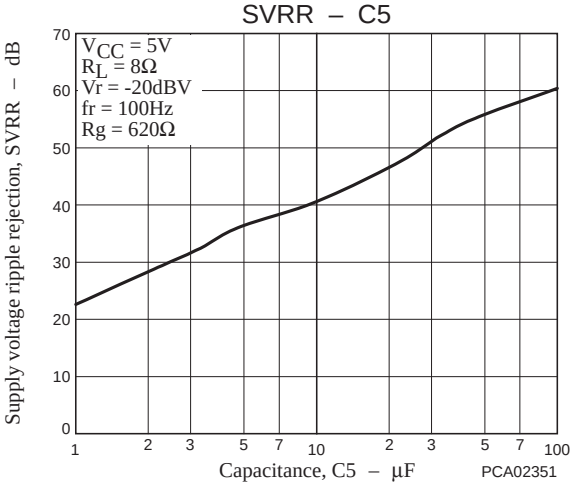

Vg – f



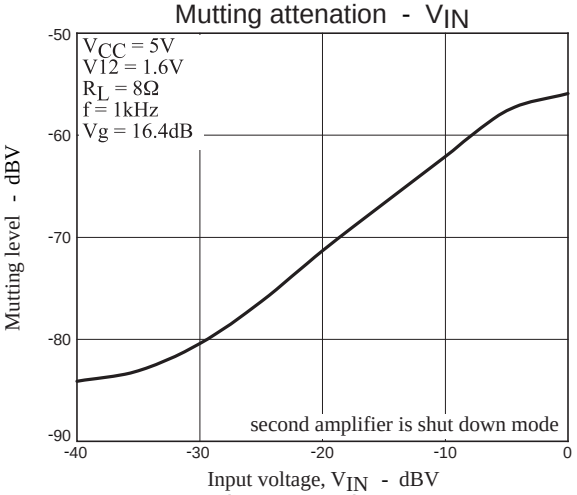

SVRR – f



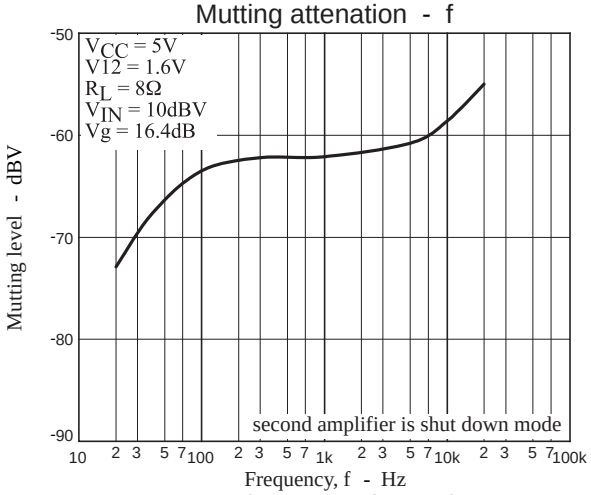

SVRR – C5



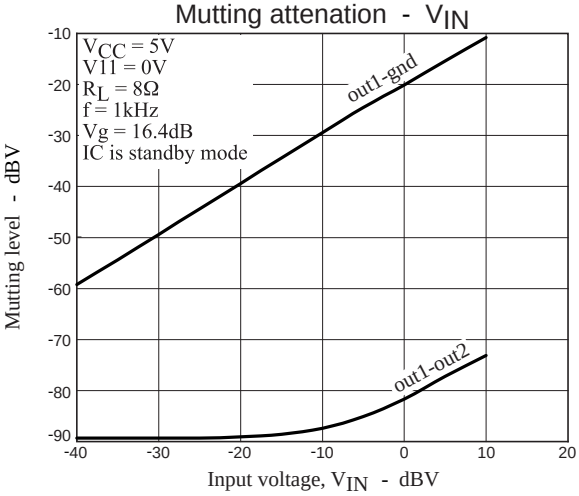
Mutting attenation - $V_{IN}$



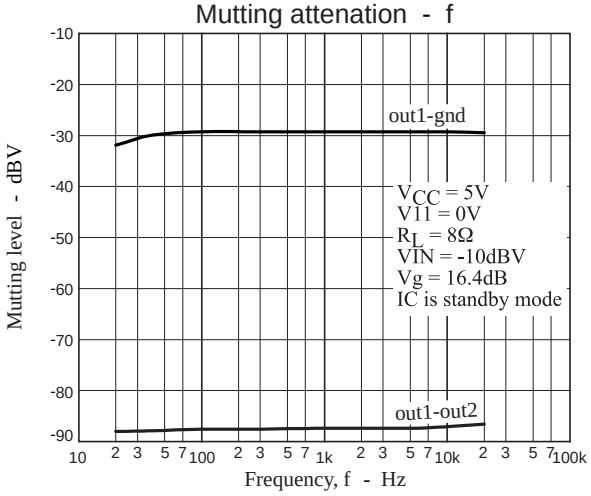

Mutting attenation - f




Mutting attenation - $V_{IN}$

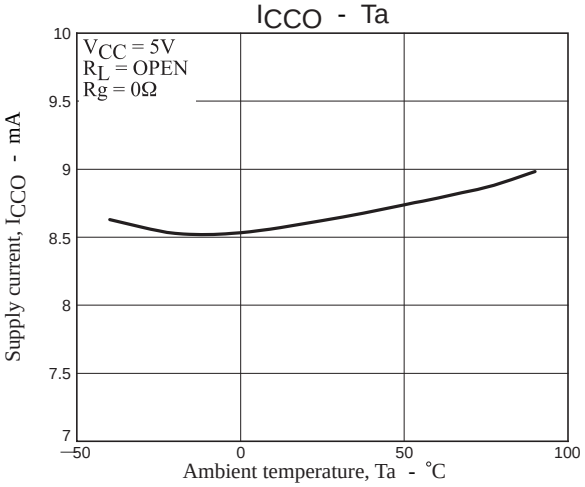



Mutting attenation - f

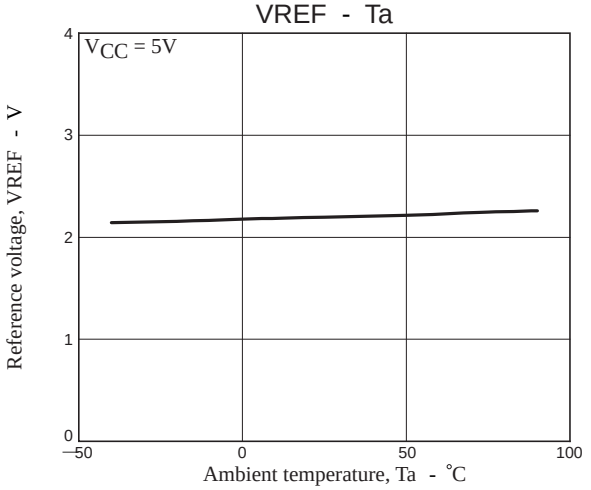



## Temperature characteristics

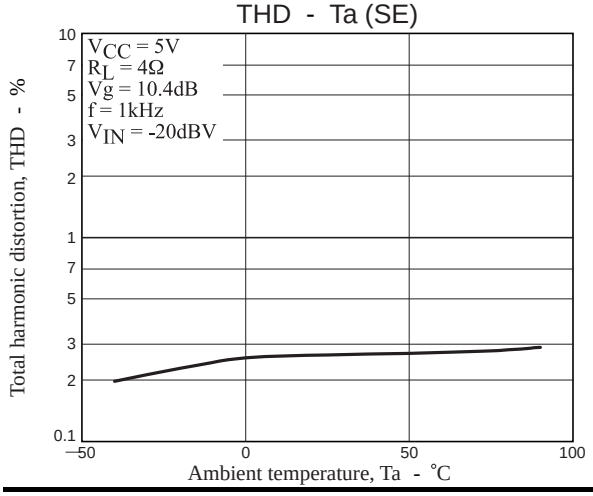
$I_{CCO}$ - Ta



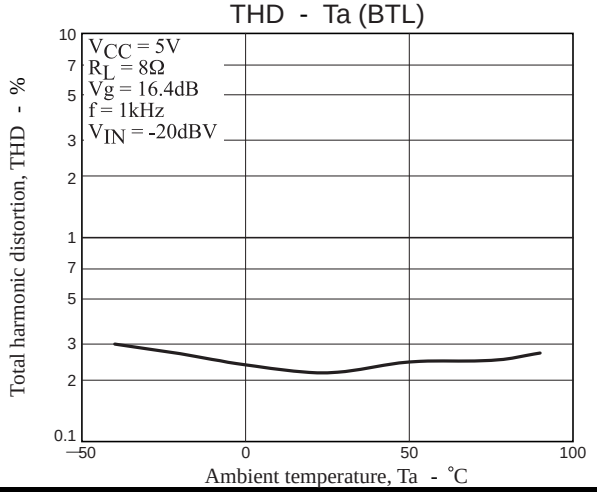

VREF - Ta

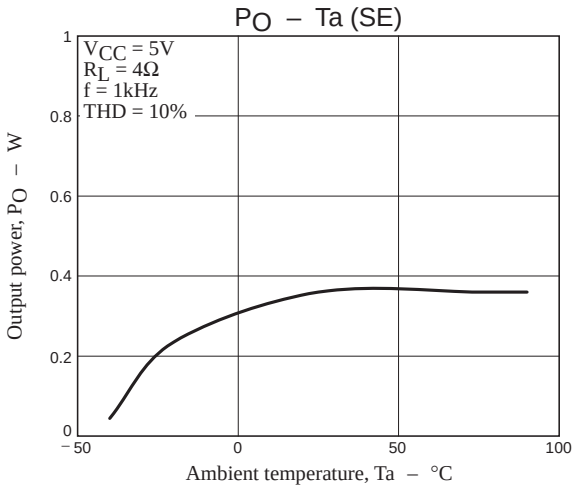


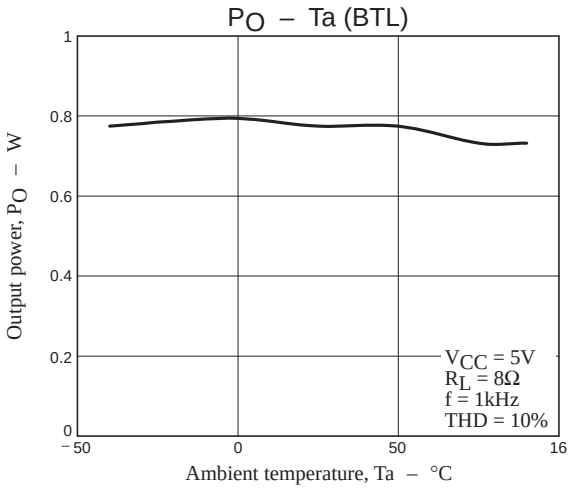

THD - Ta (SE)

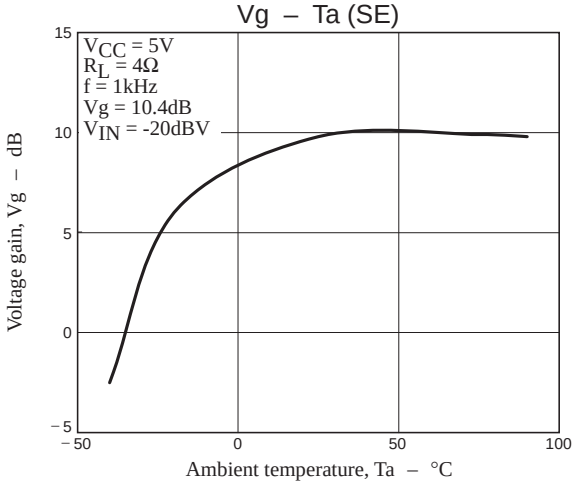


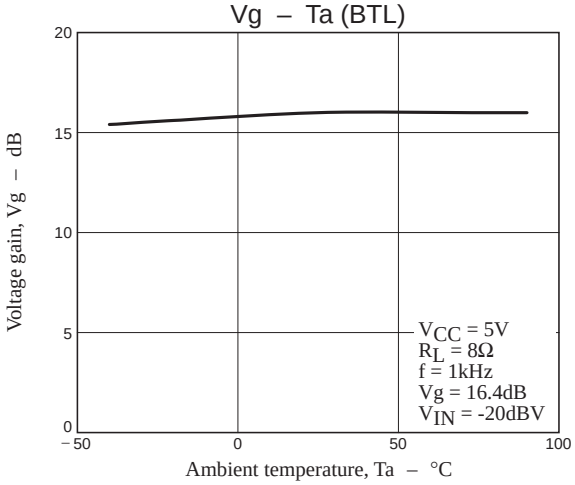

THD - Ta (BTL)




PO – Ta (SE)
VCC = 5V
RL = 4Ω
f = 1kHz
THD = 10%
Output power, PO – W
1
0.8
0.6
0.4
0.2
0
–50
0
50
100
Ambient temperature, Ta – °C

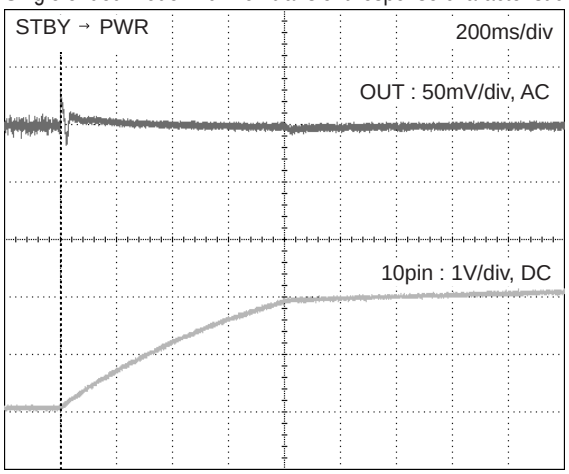

PO – Ta (BTL)
VCC = 5V
RL = 8Ω
f = 1kHz
THD = 10%
Output power, PO – W
1
0.8
0.6
0.4
0.2
0
–50
0
50
16
Ambient temperature, Ta – °C


Vg – Ta (SE)
VCC = 5V
RL = 4Ω
f = 1kHz
Vg = 10.4dB
VIN = -20dBV
Voltage gain, Vg – dB
15
10
5
0
–5
–50
0
50
100
Ambient temperature, Ta – °C

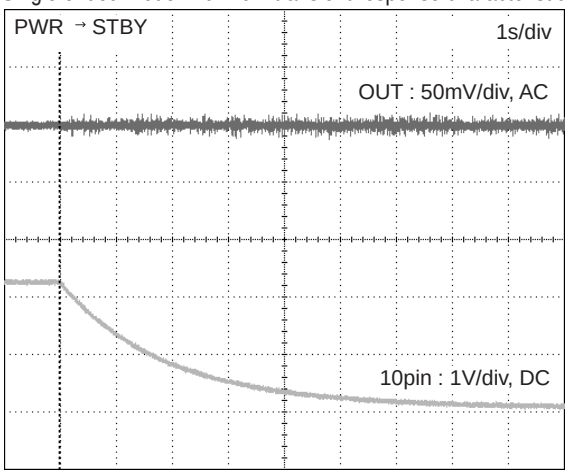

Vg – Ta (BTL)
VCC = 5V
RL = 8Ω
f = 1kHz
Vg = 16.4dB
VIN = -20dBV
Voltage gain, Vg – dB
20
15
10
5
0
–50
0
50
100
Ambient temperature, Ta – °C

Pop noise

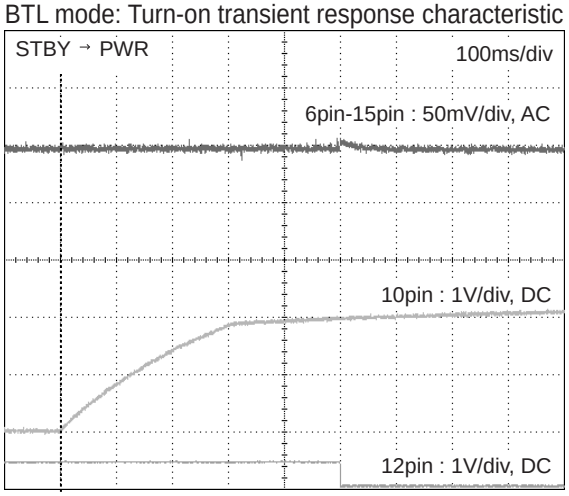
Single ended mode : Turn-on transient response characteristic



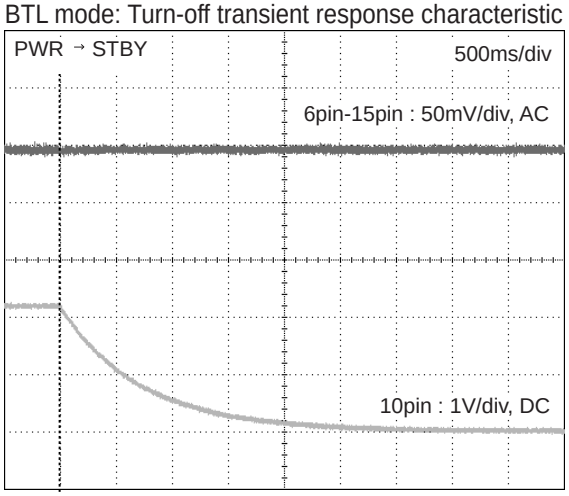

Single ended mode : Turn-off transient response characteristic




BTL mode: Turn-on transient response characteristic

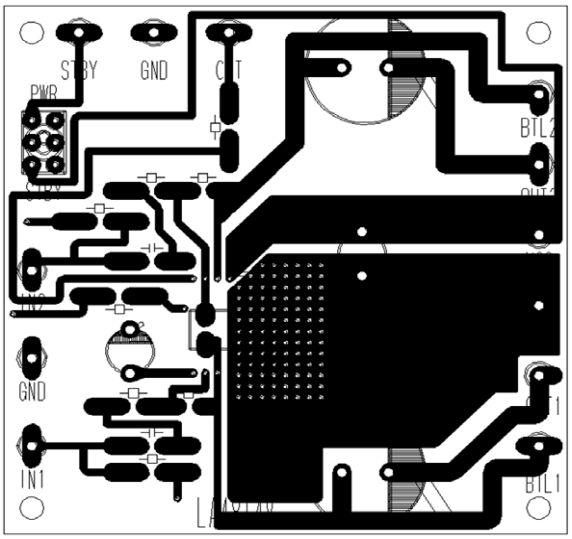



BTL mode: Turn-off transient response characteristic

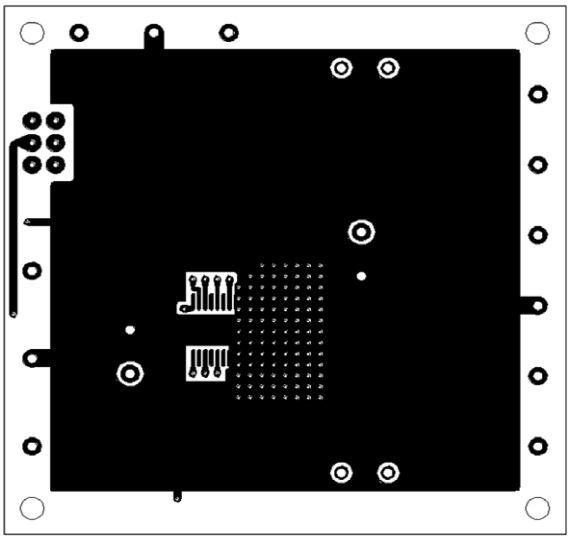


## Evaluation board

1. Double-sided board
   Size : 60mm×60mm×1.6mm




Top Layer



Bottom Layer

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