## *2.5W/CH@5V Power Limited Stereo Filter-less Class-D Audio Amplifier with Headphone Driver*

### Features

- Supply voltage range: 3.0 V to 5.5 V
- 2.5W power limit function
- 10mA static operation current
- <1uA shutdown current
- 64 step DC volume control from -60dB to +24dB
- Overload and thermal protection
- Loudspeaker Output power @ 1% THD+N
  - 1.4W/CH into 8$\Omega$ loudspeaker
  - 2.45W/CH into 4$\Omega$ loudspeaker
- Headphone Output power @ 1% THD+N
  - 65mW/CH into 32$\Omega$ loudspeaker

### Applications

- Monitor audio
- Portable multimedia devices
- Mobile phone

### Description

The AD52656 is a stereo, filter-less class-D audio amplifier with 2.5W power limit and class-AB headphone driver. Operating with 5.0V power supply, it delivers 2.45W/CH power into 4$\Omega$ loudspeaker within 1% THD+N or 65mW/CH power into 32$\Omega$ headphone within 1% THD+N
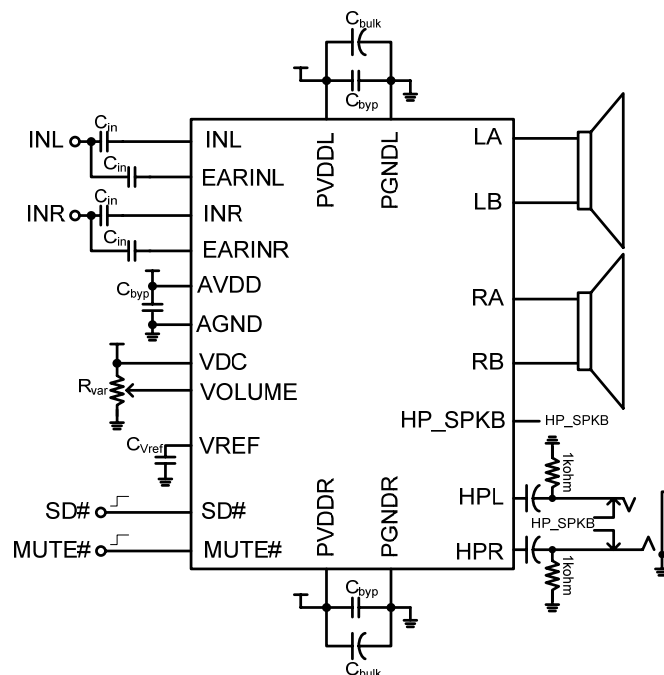
The AD52656 has not only a 64-step DC volume controller, but also a 2.5W power limiter, which implement with an automatic gain controller (AGC).

The AD52656 is packaged as SSOP-24(150mil) is a stereo audio amplifier with high efficiency, which leads to longer battery life, less heat sink, smaller board size, lower system cost, and suitable for the notebook, and portable multimedia devices.
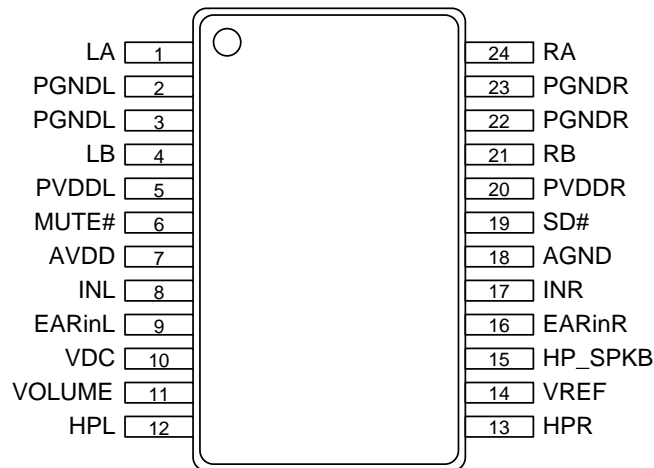
### Ordering Information

| Product ID | Package | Packing | Comments |
|---|---|---|---|
| AD52656-ST24NAT | SSOP-24L 150mil | 56 Units / Tube 100 Tubes / Small BOX | Green |
| AD52656-ST24NAR | SSOP-24L 150mil | 3K Units/ Reel | Green |

### Typical Application Circuit

## Pin Assignments



| | LA | 1 | | 24 | RA |
|---|---|---|---|---|---|
| | PGNDL | 2 | | 23 | PGNDR |
| | PGNDL | 3 | | 22 | PGNDR |
| | LB | 4 | | 21 | RB |
| | PVDDL | 5 | | 20 | PVDDR |
| | MUTE# | 6 | | 19 | SD# |
| | AVDD | 7 | | 18 | AGND |
| | INL | 8 | | 17 | INR |
| | EARinL | 9 | | 16 | EARinR |
| | VDC | 10 | | 15 | HP_SPKB |
| | VOLUME | 11 | | 14 | VREF |
| | HPL | 12 | | 13 | HPR |

## Pin Description

| | NAME | TYP | DESCRIPTION | CHARACTERISTIC |
|---|---|---|---|---|
| 1 | LA | O | Speaker driver_Left (+) | |
| 2 | PGNDL | G | Power ground_Left | |
| 3 | PGNDL | G | Power ground_Left | |
| 4 | LB | O | Speaker driver_Left (-) | |
| 5 | PVDDL | P | Power supply_Left | |
| 6 | MUTE# | I | Mute (low active) | Internal pull-up |
| 7 | AVDD | P | Analog power supply | |
| 8 | INL | I | Single-ended audio input_Left for SPK | |
| 9 | EARinL | I | Single-ended audio input_Left for HP | |
| 10 | VDC | I | Full scale level for gain control section | Internal pull-up |
| 11 | VOLUME | I | Volume level setting by DC voltage | Internal pull-up |
| 12 | HPL | O | Headphone driver_Left | |
| 13 | HPR | O | Headphone driver_Right | |
| 14 | VREF | I | AVDD/2 reference voltage | |
| 15 | HP_SPKB | I. | HP or SPK mode selection (1:HP;0:SPK) | Internal pull-down |
| 16 | EARinR | I | Single-ended audio input_Right for HP | |
| 17 | INR | I | Single-ended audio input_Right for SPK | |
| 18 | AGND | G | Analog power ground | |
| 19 | SD# | I | Shutdown (low active) | Internal pull-up |
| 20 | PVDDR | P | Power supply_Right | |
| 21 | RB | O | Speaker driver_Right (-) | |
| 22 | PGNDR | G | Power ground_Right | |
| 23 | PGNDR | G | Power ground_Right | |
| 24 | RA | O | Speaker driver_Right (+) | |

## Functional Block Diagram
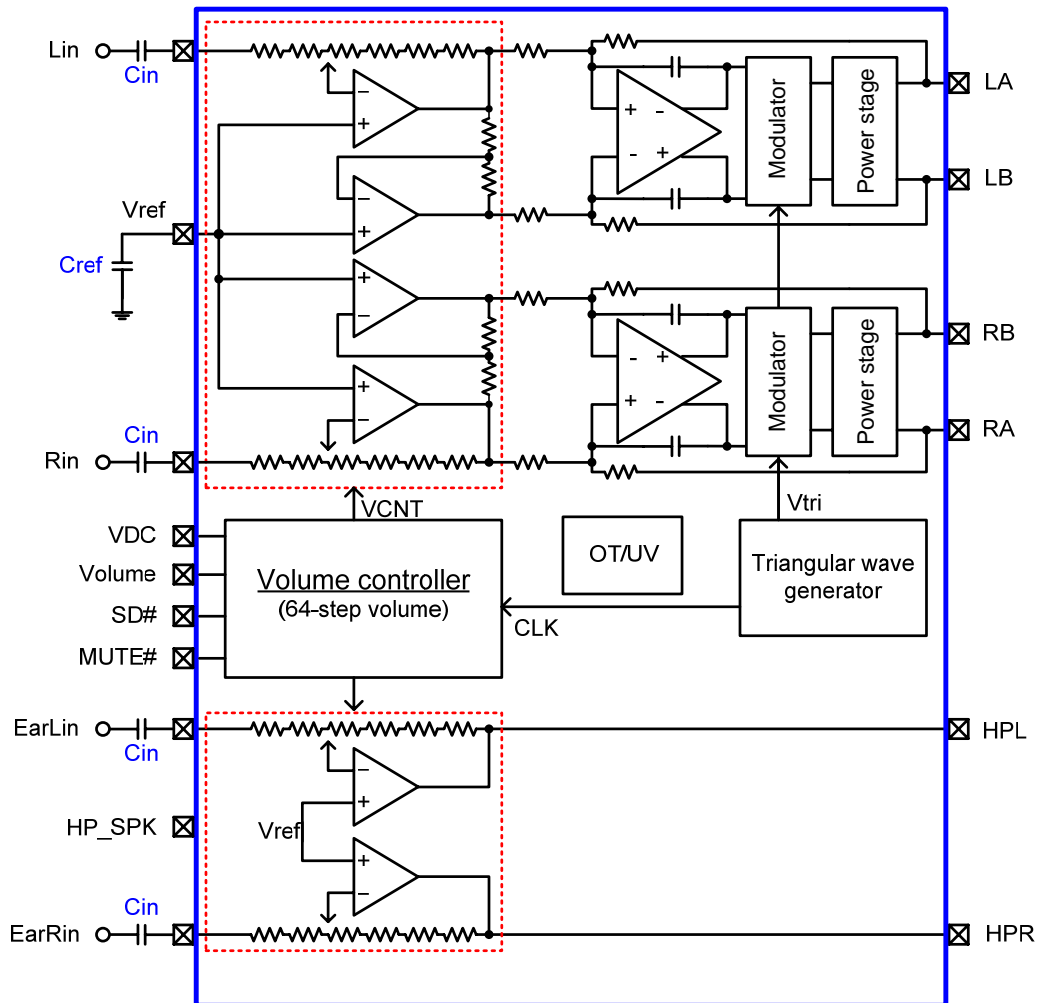


## Available Package

| Package Type | Device No. | $\theta_{ja}$(℃/W) | $\theta_{jc}$(℃/W) |
|---|---|---|---|
| SSOP-24 | AD52656 | 90 | 17 |

*Note 1:* $\theta_{ja}$ *is measured on a room temperature ($T_A$=25℃), natural convection environment test board, which is constructed with a thermally efficient, 2-layers PCB. The measurement is tested using the JEDEC51-3 thermal measurement standard.*

*Note 2:* $\theta_{jc}$ *represents the heat resistance for the heat flow between the chip and the package's top surface.*

## Marking Information

**AD52656**

**Line 1 : LOGO**

**Line 2 : Product no.**

**Line 3 : Tracking Code**

**Line 4 : Date Code**

*ESMT*
AD52656
Tracking Code
Date Code
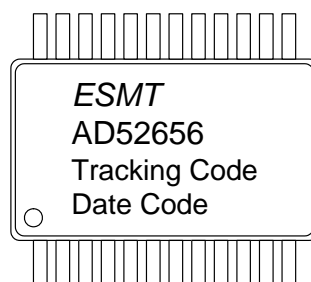
## Absolute Maximum Ratings

| SYMBOL | PARAMETER | MIN | MAX | UNIT |
|---|---|---|---|---|
| AVDD | Power supply for lower power analog circuits | 3.0 | 6.0 | V |
| PVDDL(R) | Power supply for loudspeaker driver | 3.0 | 6.0 | V |
| | Input voltage | -0.3 | AVDD | V |
| $T_{stg}$ | Storage temperature | -65 | 150 | $^o$C |
| $T_j$ | Junction temperature | -40 | 150 | $^o$C |

## Recommended Operating Conditions

| SYMBOL | PARAMETER | TYP | UNIT |
|---|---|---|---|
| AVDD | Power supply for lower power analog cells | 3.0~5.5 | V |
| PVDDL(R) | Power supply for Driver Stage | 3.0~5.5 | V |
| $V_{IH}$ | High-Level Input Voltage | 1.2 | V |
| $V_{IL}$ | Low-Level Input Voltage | 0.4 | V |
| $T_a$ | Ambient Operating Temperature | -40~85 | $^o$C |

## General Electrical Characteristics

| SYMBOL | PARAMETER | CONDITION | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Supply current during Shut-down mode | AVDD=PVDDR(L)=VDD=5.0V, SD#=0.4V | | | 1 | $\mu$A |
| $I_{Q,SPK}$ | Supply current during SPEAKER mode | AVDD=PVDDR(L)=VDD=5.0V, SD#=MUTE#=5.0V, HP_SPKB=0V | | 10 | 15 | mA |
| $I_{Q,HP}$ | Supply current during HEADPHONE mode | AVDD=PVDDR(L)=VDD=5.0V, SD#=MUTE#=HP_SPKB=5.0V | | 2 | | mA |
| $I_{MUTE, SPK}$ | Supply current during MUTE mode | AVDD=PVDDR(L)=VDD=5.0V, SD#=5.0V, MUTE#=0.4V, HP_SPKB=0V | | 2.5 | 4 | mA |
| $I_{MUTE, HP}$ | Supply current during MUTE mode | AVDD=PVDDR(L)=VDD=5.0V, SD#=5.0V, MUTE#=0.4V, HP_SPKB=5.0V | | 2 | | mA |
| $V_{offset}$ | Output offset voltage | Input ac grounded | | 10 | 50 | mV |
| | Junction temperature for driver shutdown | | | 160 | | $^o$C |
| | Temperature hysteresis for recovery from shutdown | | | 125 | | $^o$C |
| $f_{sw}$ | Switching frequency | AVDD=3.0V~5.0V | 200 | 250 | 330 | kHz |
| $I_{SC}$ | Loudspeaker short-circuit detect resistance | PVDDR(L)=5V | | 2.2 | | A |

## Electrical Characteristics and Specifications of Loudspeaker Driver

● AVDD=PVDDL=PVDDR=VDD, Gain= 2V/V, Load=8Ω, $f_{in}$=1 kHz, $T_A$=25°C (unless otherwise noted)

| SYMBOL | PARAMETER | CONDITION | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $P_O$ | RMS Output Power per Channel | VDD=5.0V | THD+N = 1% | | 1.4 | | W |
| | | VDD=3.6V | THD+N = 1% | | 0.7 | | W |
| | | VDD=3.0V | THD+N = 1% | | 0.45 | | W |
| THD+N | Total Harmonic Distortion plus Noise | VDD=5.0V, Po=1.0W | | | 0.1 | | % |
| | | VDD=3.6V, Po=0.5W | | | 0.2 | | % |
| | | VDD=3.0V, Po=0.3W | | | 0.5 | | % |
| SNR | Signal to Noise Ratio | VDD=5.0V, Po=1.0W | | | 96 | | dB |
| PSRR | Power Supply Rejection Ratio | VDD=5.0V, Gain=6dB, $V_{ripple}$=200mVpp, Inputs ac grounded with Ci=470nF f=1kHz | | | -55 | | dB |
| Crosstalk | Crosstalk | VDD=5.0V, $f_{in}$=1kHz | | | -100 | | dB |
| $V_n$ | Output integrated noise (A-weighted) | VDD=5.0V $f_{in}$=20Hz ~ 20kHz | | | 80 | | μV |

● AVDD=PVDDL=PVDDR=VDD Gain= 2V/V, Load=4Ω, $f_{in}$=1 kHz, $T_A$=25°C (unless otherwise noted)

| SYMBOL | PARAMETER | CONDITION | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $P_O$ | RMS Output Power per Channel | VDD=5.0V | THD+N = 1% | | 2.45 | | W |
| | | VDD=3.6V | THD+N = 1% | | 1.2 | | W |
| | | VDD=3.0V | THD+N = 1% | | 0.8 | | W |
| THD+N | Total Harmonic Distortion plus Noise | VDD=5.0V, Po=2.0W | | | 0.2 | | % |
| | | VDD=3.6V, Po=1.0W | | | 0.3 | | % |
| | | VDD=3.0V, Po=0.6W | | | 0.6 | | % |
| SNR | Signal to Noise Ratio | VDD=5.0V, Po=1.8W | | | 96 | | dB |
| PSRR | Power Supply Rejection Ratio | VDD=5.0V, Gain=6dB, $V_{ripple}$=200mVpp, Inputs ac grounded with Ci=470nF f=1kHz | | | -55 | | dB |
| Crosstalk | Crosstalk | VDD=5.0V, $f_{in}$=1kHz | | | -100 | | dB |
| $V_n$ | Output integrated noise (A-weighted) | VDD=5.0V $f_{in}$=20Hz ~ 20kHz | | | 80 | | μV |

## Typical Characteristics of Loudspeaker Driver
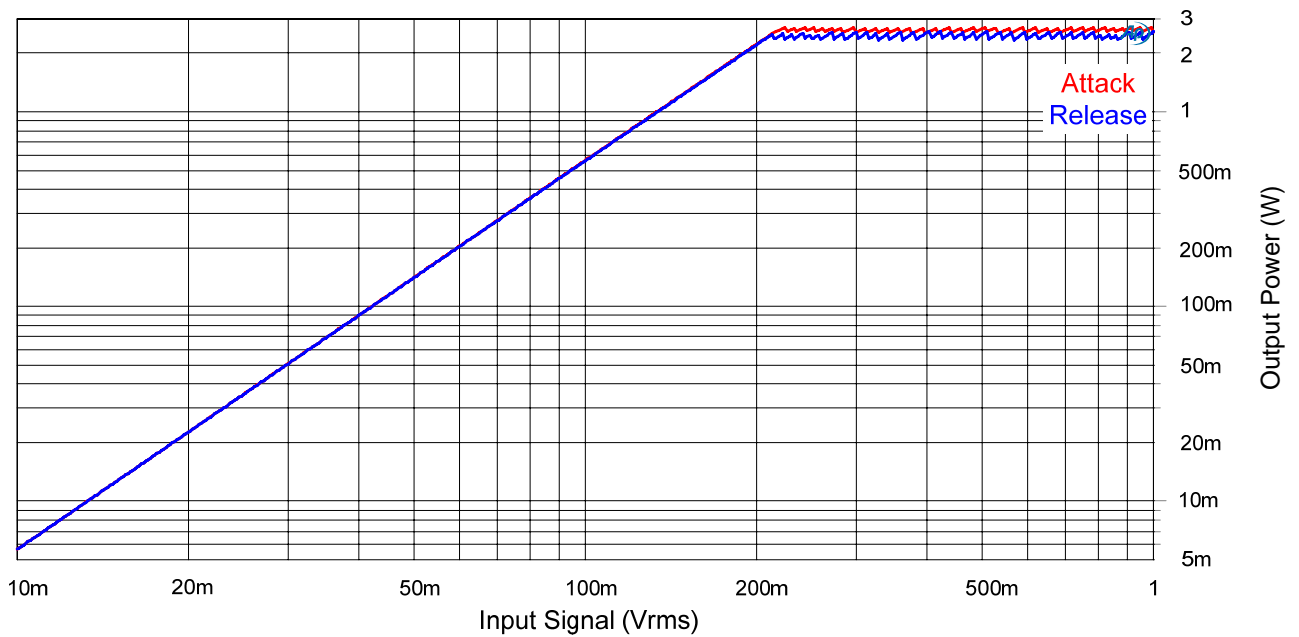
● Input Signal vs. Output Power (5.0V, +24dB, 8Ω)
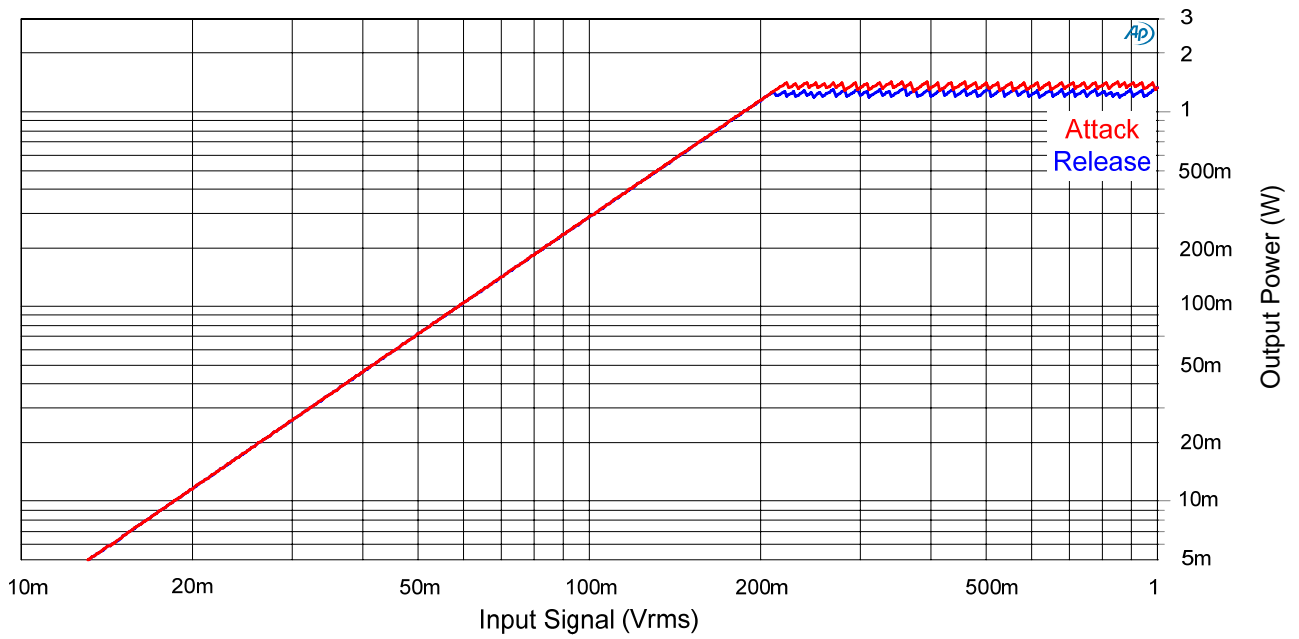


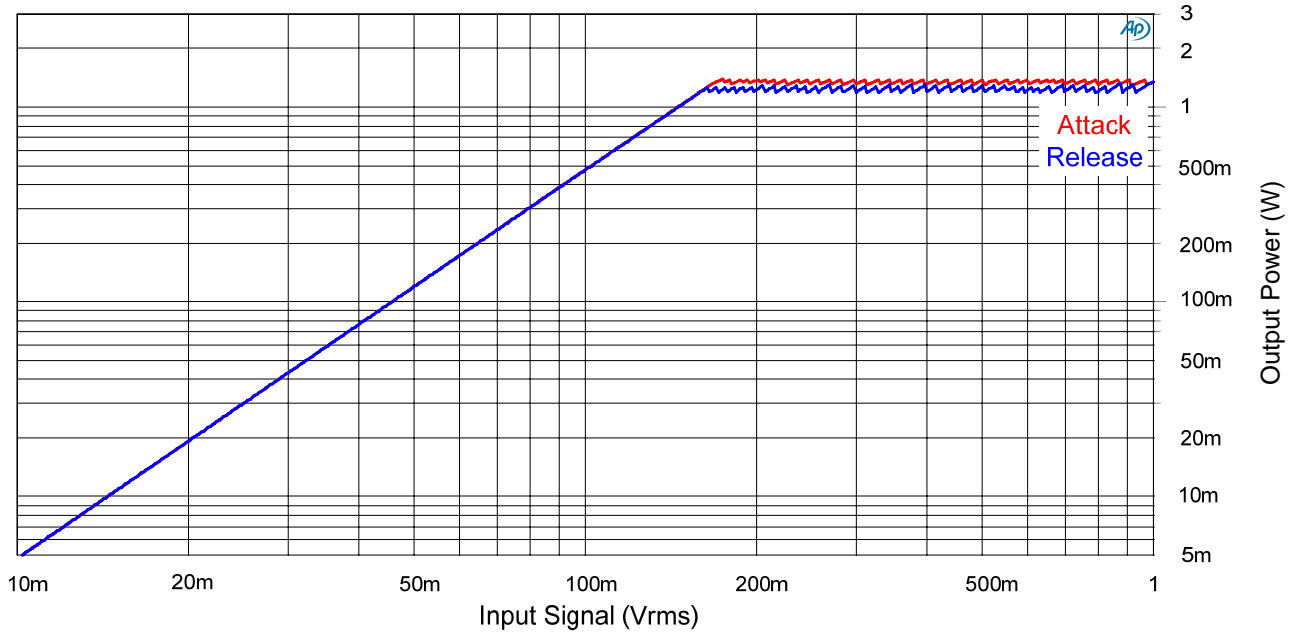● Input Signal vs. Output Power (3.6V, +24dB, 8Ω)
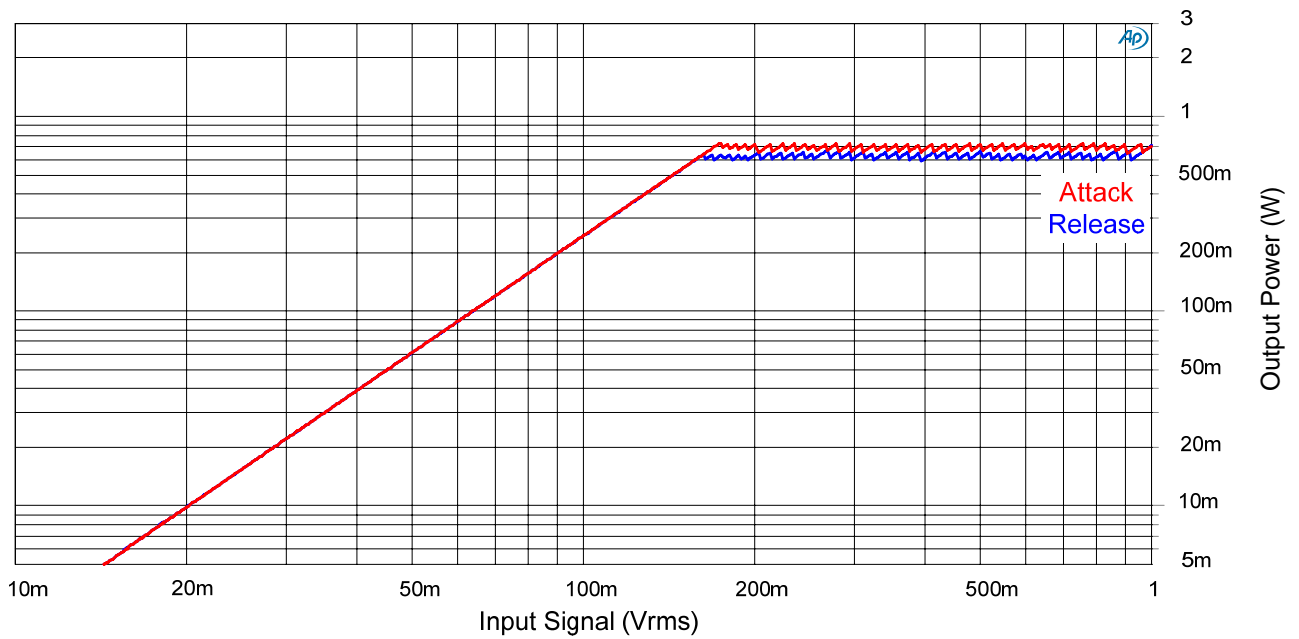
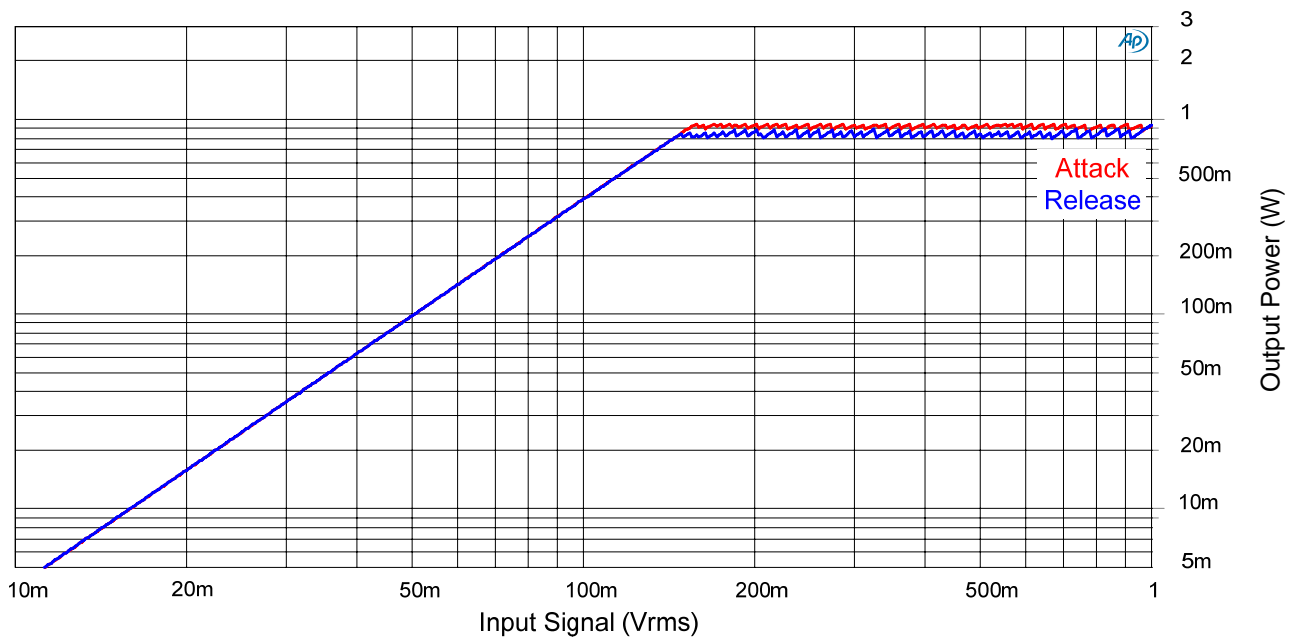● Input Signal vs. Output Power (3.0V, +24dB, 8Ω)
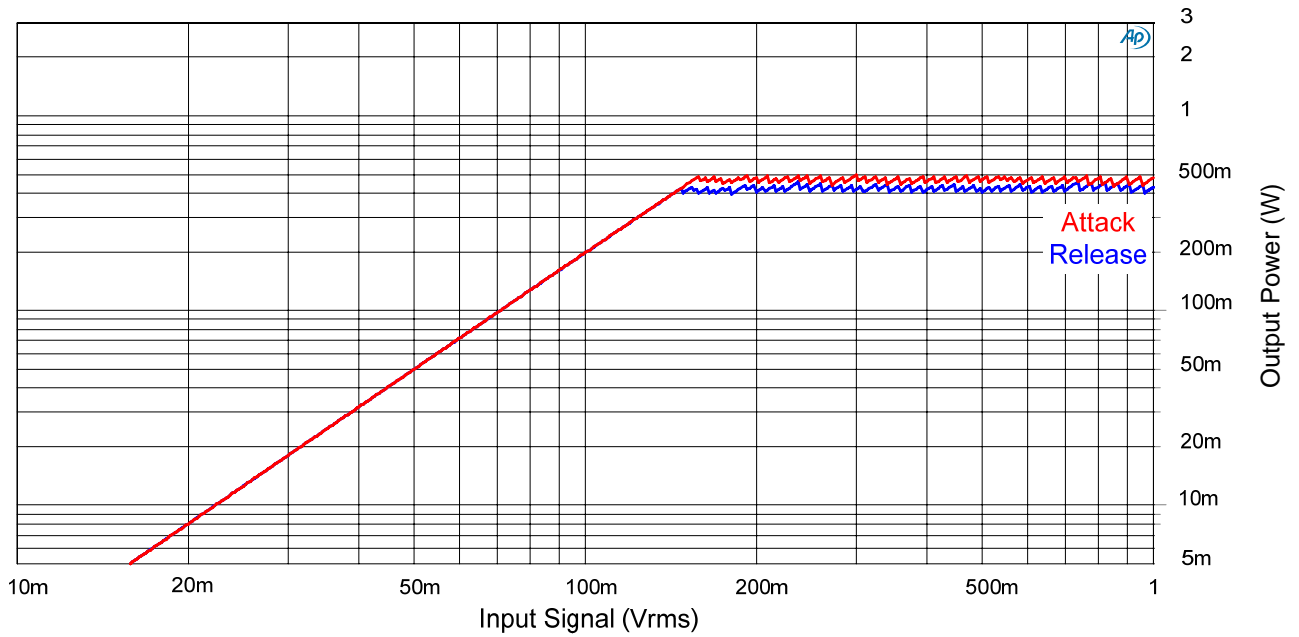


● Input Signal vs. Output Power (5.0V, +24dB, 4Ω)

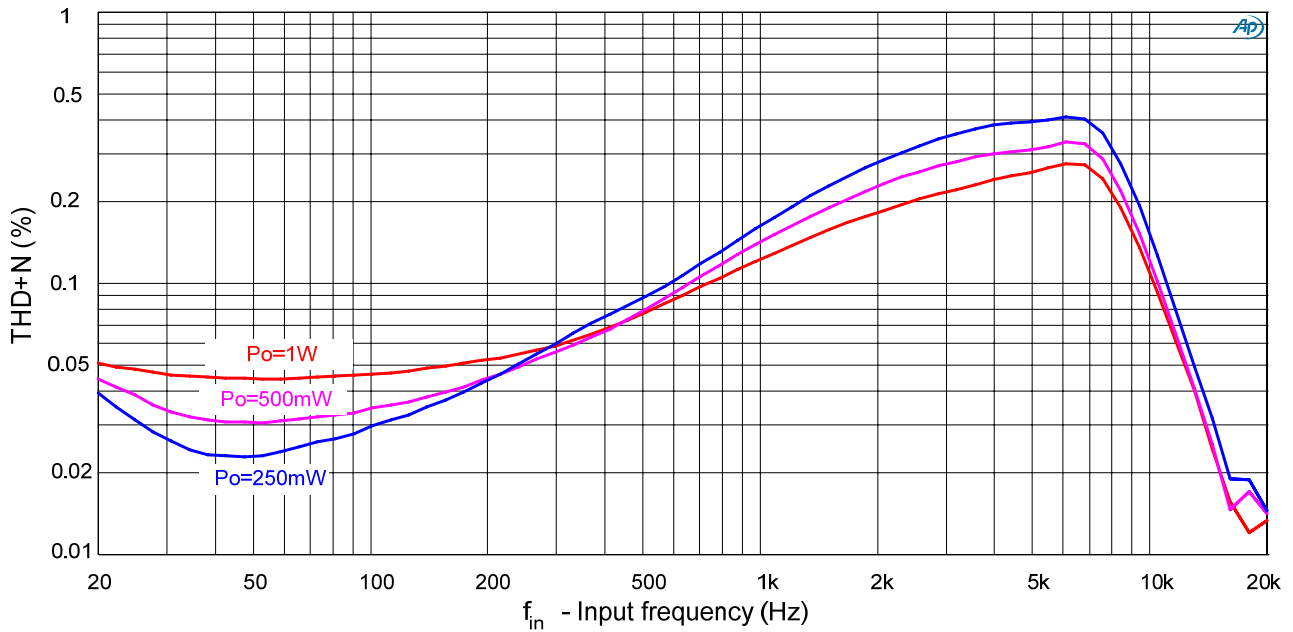● Input Signal vs. Output Power (3.6V, +24dB, 4Ω)



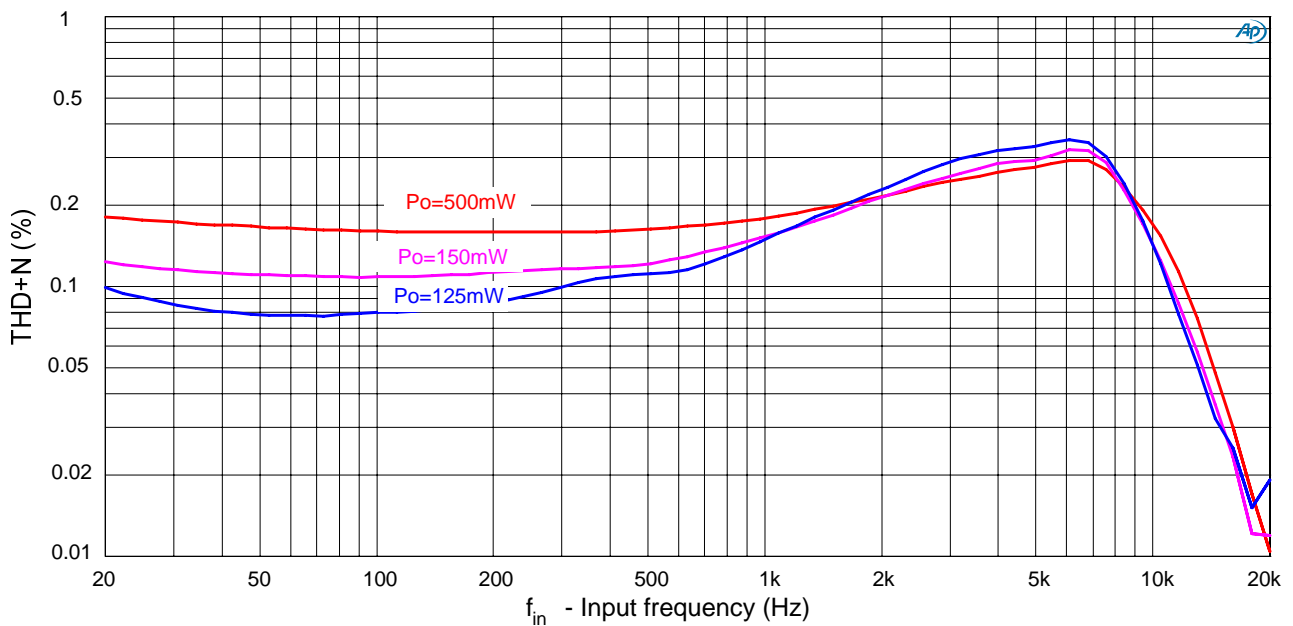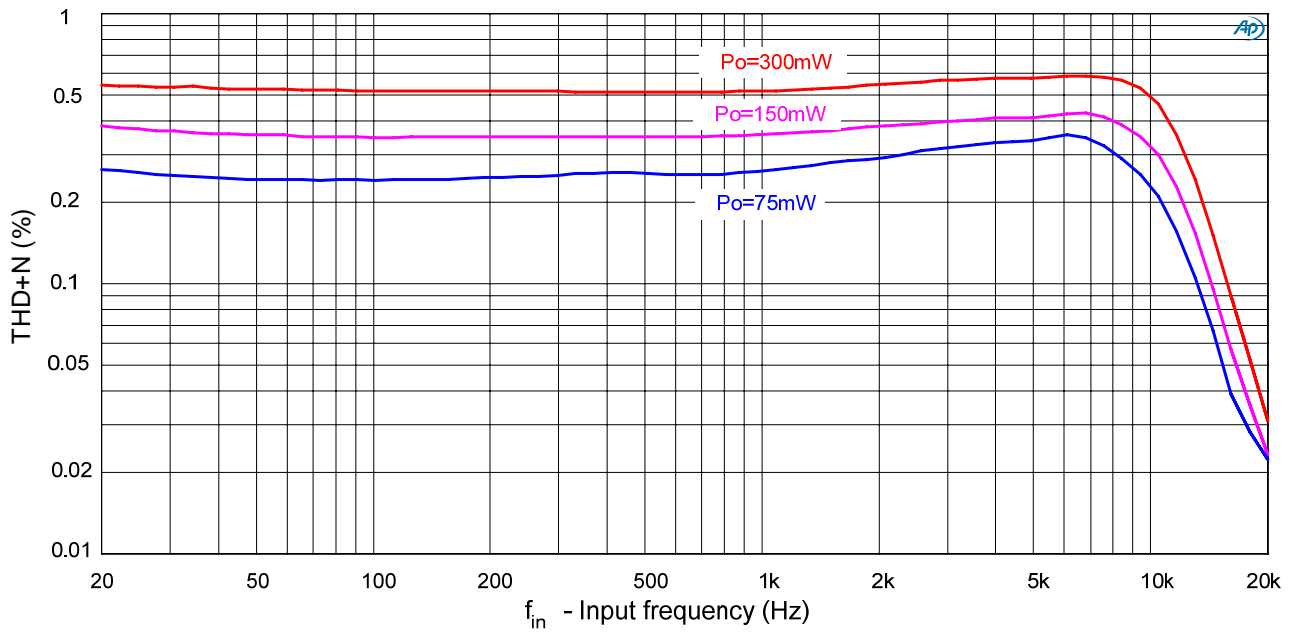● Input Signal vs. Output Power (3.0V, +24dB, 4Ω)

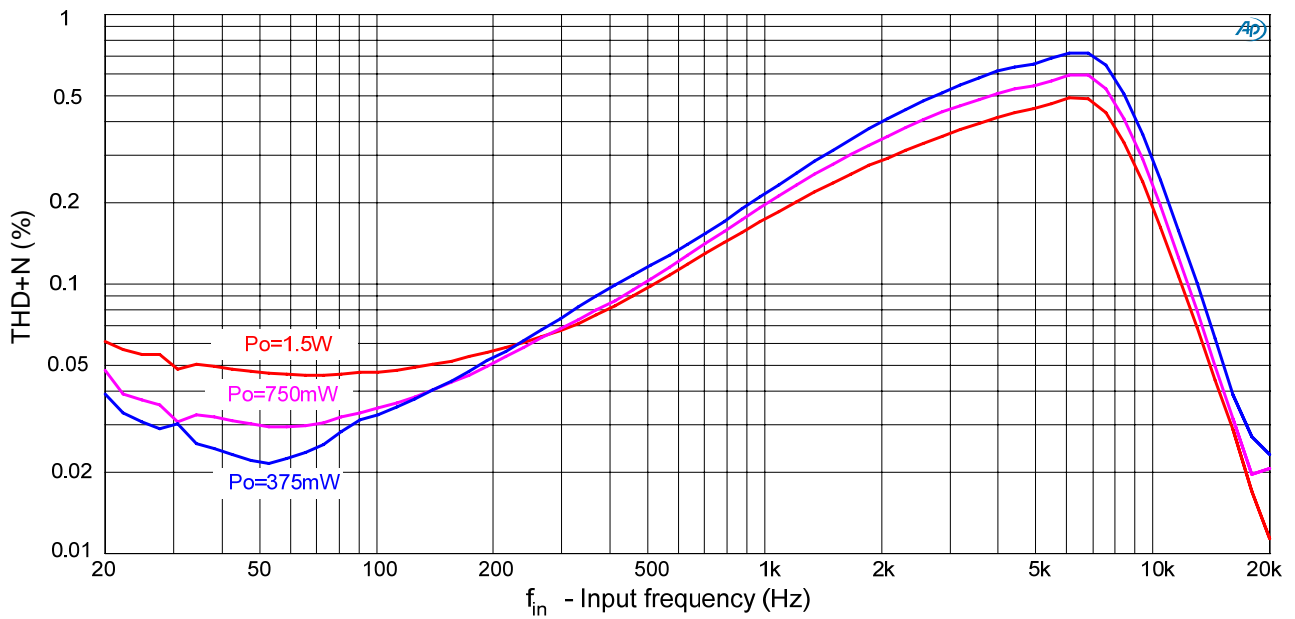● Total Harmonic Distortion + Noise (THD+N) vs. Signal Frequency (5.0V, 8Ω)



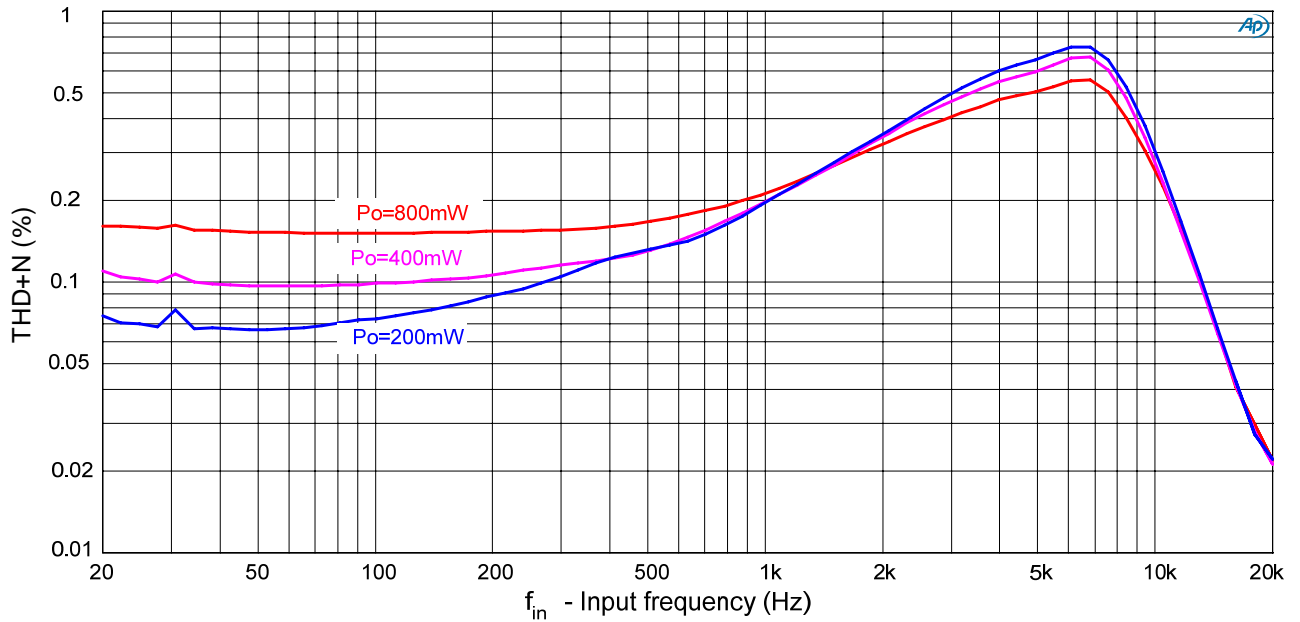● Total Harmonic Distortion + Noise (THD+N) vs. Signal Frequency (3.6V, 8Ω)

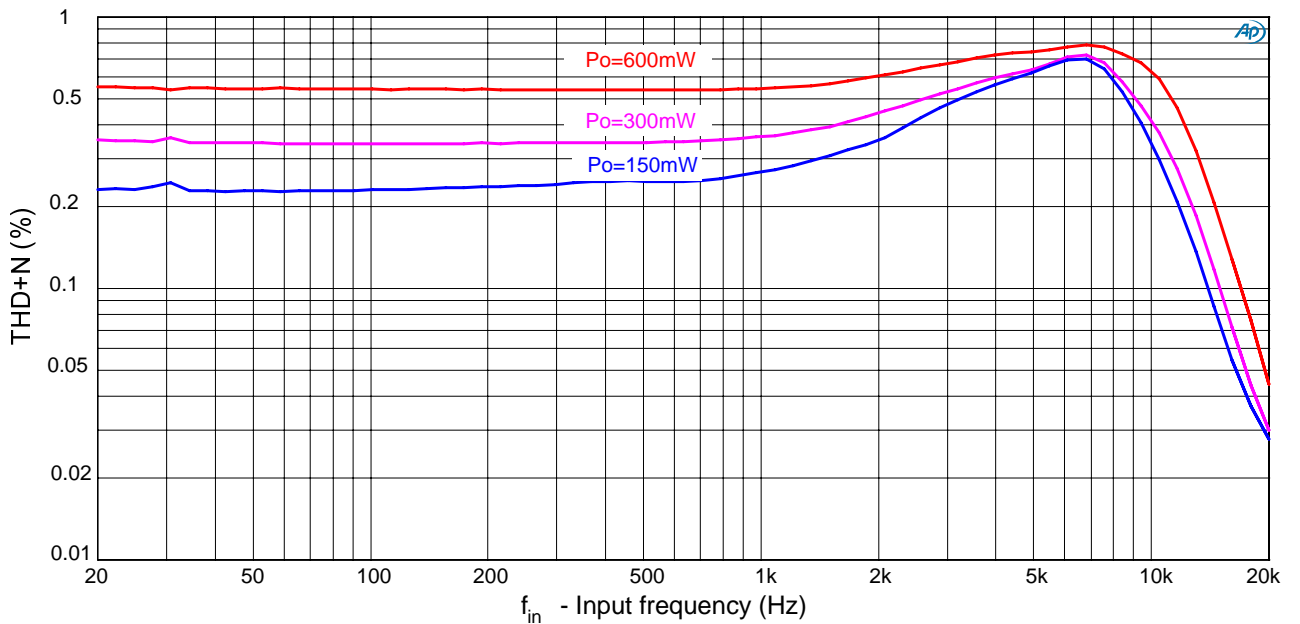● Total Harmonic Distortion + Noise (THD+N) vs. Signal Frequency (3.0V, 8Ω)



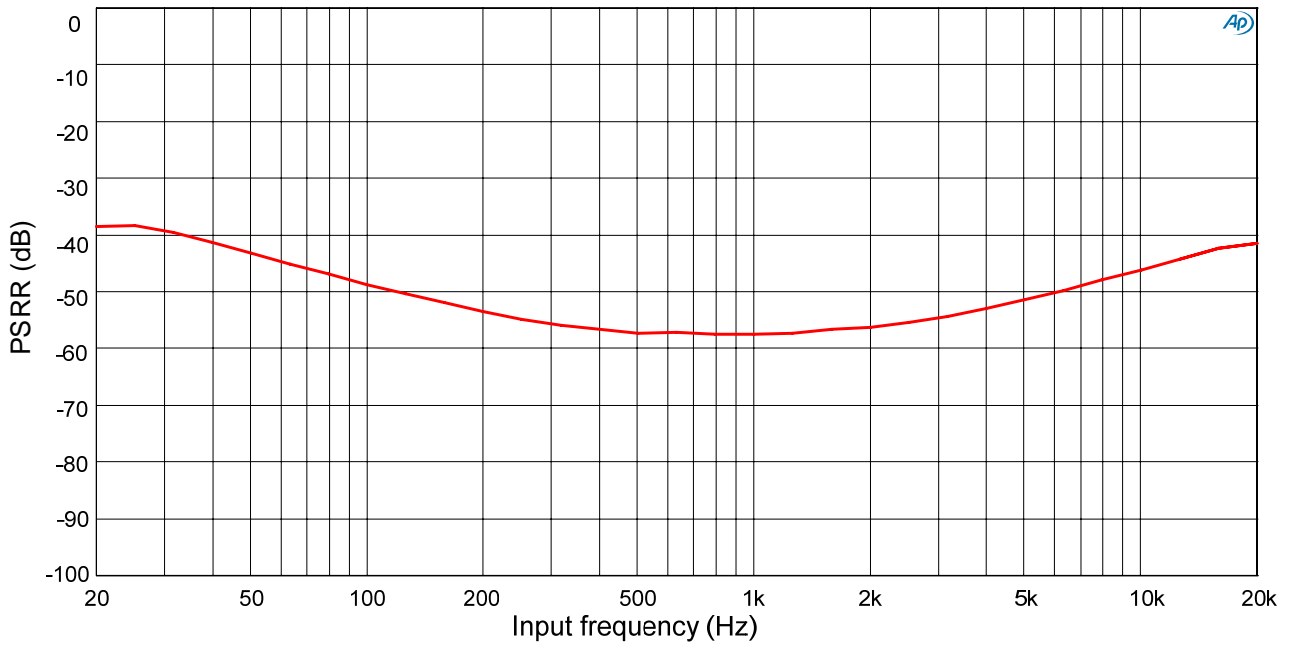● Total Harmonic Distortion + Noise (THD+N) vs. Signal Frequency (5.0V, 4Ω)

● Total Harmonic Distortion + Noise (THD+N) vs. Signal Frequency (3.6V, 4Ω)
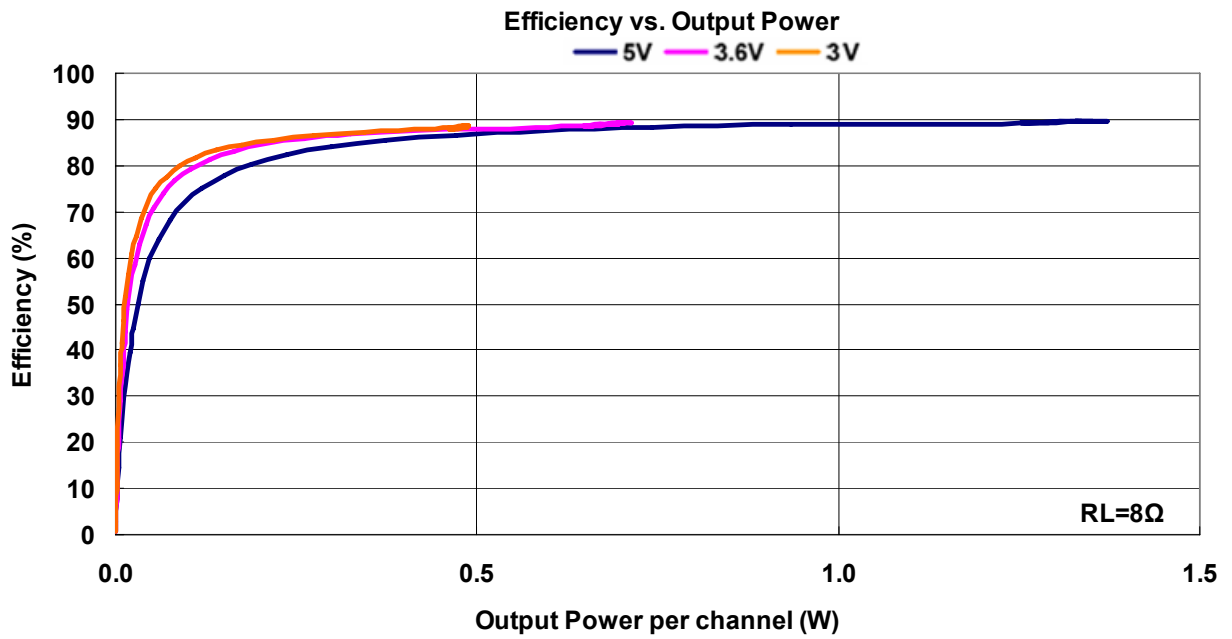


● Total Harmonic Distortion + Noise (THD+N) vs. Signal Frequency (3.0V, 4Ω)
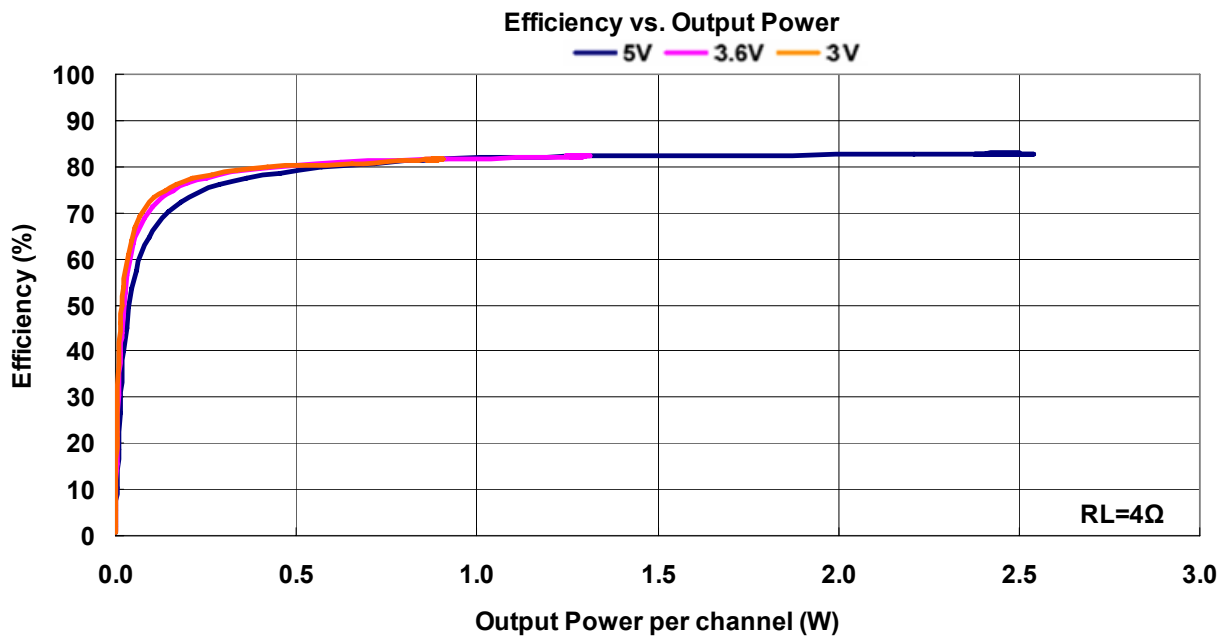
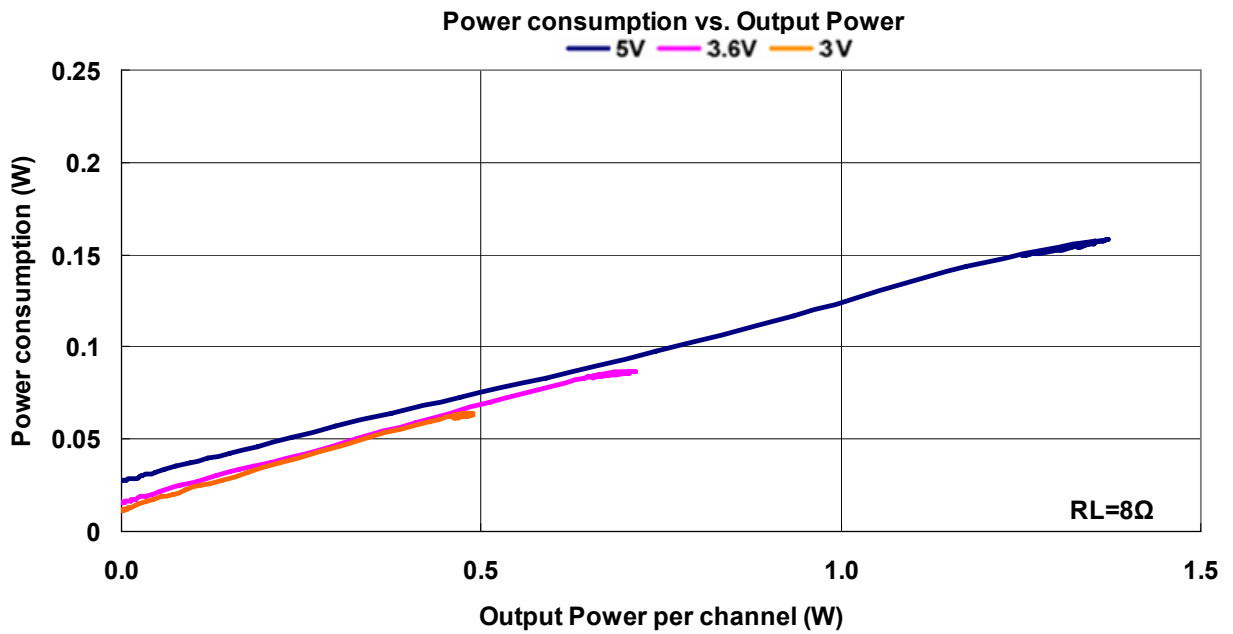● Power Supply Rejection Ratio vs. Frequency (5V, +6dB)

● Efficiency vs. Output Power (8Ω)



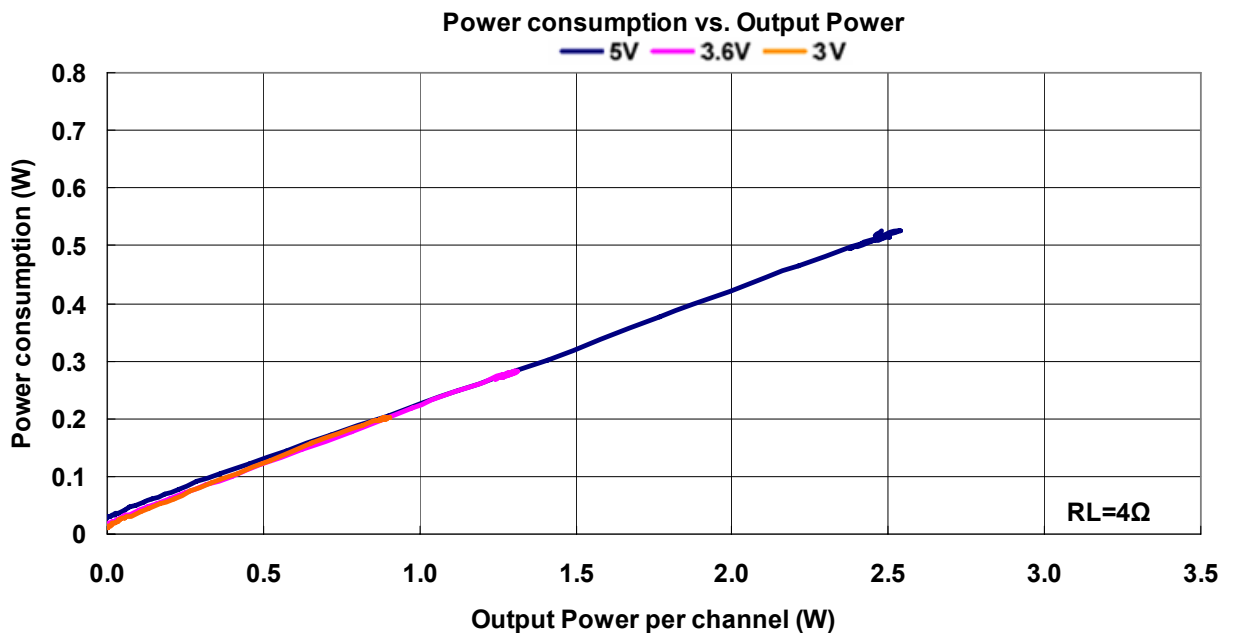● Efficiency vs. Output Power (4Ω)

● Power Consumption vs. Output Power (8Ω)

**Power consumption vs. Output Power**

5V ⎯⎯ 3.6V ⎯⎯ 3 V



RL=8Ω

● Power Consumption vs. Output Power (4Ω)

**Power consumption vs. Output Power**

5V ⎯⎯ 3.6V ⎯⎯ 3 V



RL=4Ω

## Electrical Characteristics and Specifications of headphone driver

● AVDD=PVDDL=PVDDR=VDD, Gain= Max, Load=32Ω, $f_{in}$=1 kHz, $T_A$=25°C (unless otherwise noted)

| SYMBOL | PARAMETER | CONDITION | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $P_O$ | RMS Output Power per Channel | VDD=5.0V | THD+N = 10 % | | 85 | | mW |
| | | | THD+N = 1 % | | 65 | | mW |
| | | VDD=3.6V | THD+N = 10 % | | 45 | | mW |
| | | | THD+N = 1 % | | 30 | | mW |
| | | VDD=3.0V | THD+N = 10 % | | 30 | | mW |
| | | | THD+N = 1 % | | 22 | | mW |
| THD+N | Total Harmonic Distortion plus Noise | VDD=5.0V, Po=50mW | | | 0.02 | | % |
| | | VDD=3.6V, Po=25mW | | | 0.02 | | % |
| | | VDD=3.0V, Po=18mW | | | 0.02 | | % |
| SNR | Signal to Noise Ratio | VDD=5.0V, Po=1.8mW | | | 96 | | dB |
| PSRR | Power Supply Rejection Ratio | VDD=5.0V, Gain=Max, Ci=0.47uF, Cref=1uF, $V_{ripple}$=200mVpp, inputs ac grounded, f=1kHz | | | -90 | | dB |
| Crosstalk | Crosstalk | VDD=5V, $f_{in}$=1kHz | | | -100 | | dB |
| $V_n$ | Output integrated noise (A-weighted) | VDD=5.0V $f_{in}$=20Hz ~ 20kHz | | | 40 | | μV |

## Typical Characteristics of of headphone driver

● Total Harmonic Distortion + Noise (THD+N) vs. Output Power (+3.5dB, 16Ω)
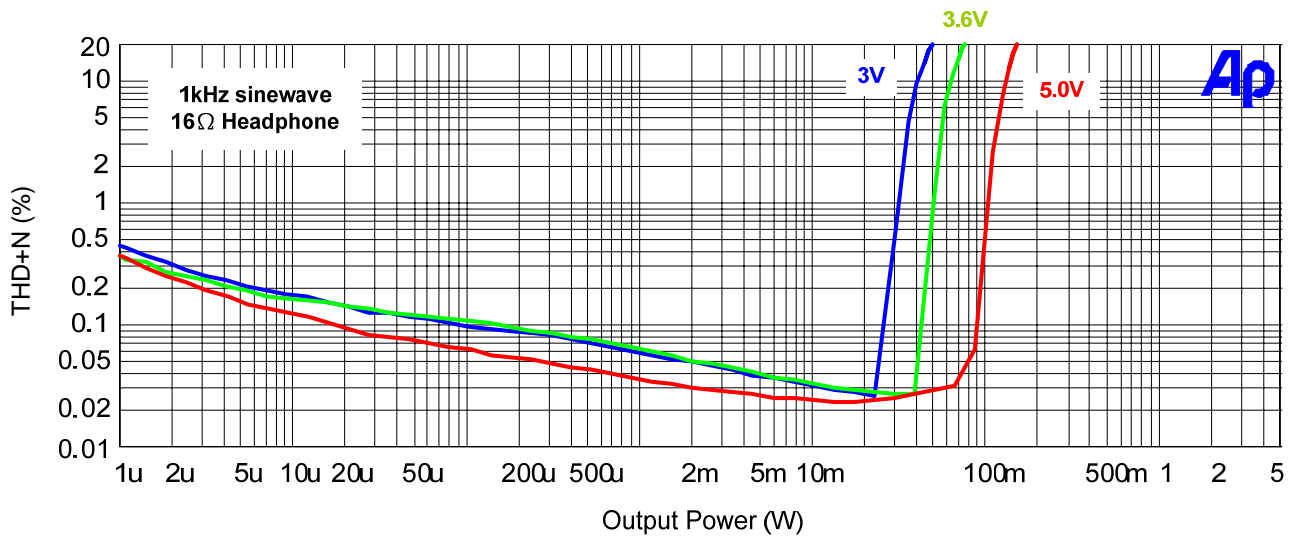


● Total Harmonic Distortion + Noise (THD+N) vs. Output Power (+3.5dB, 32Ω)
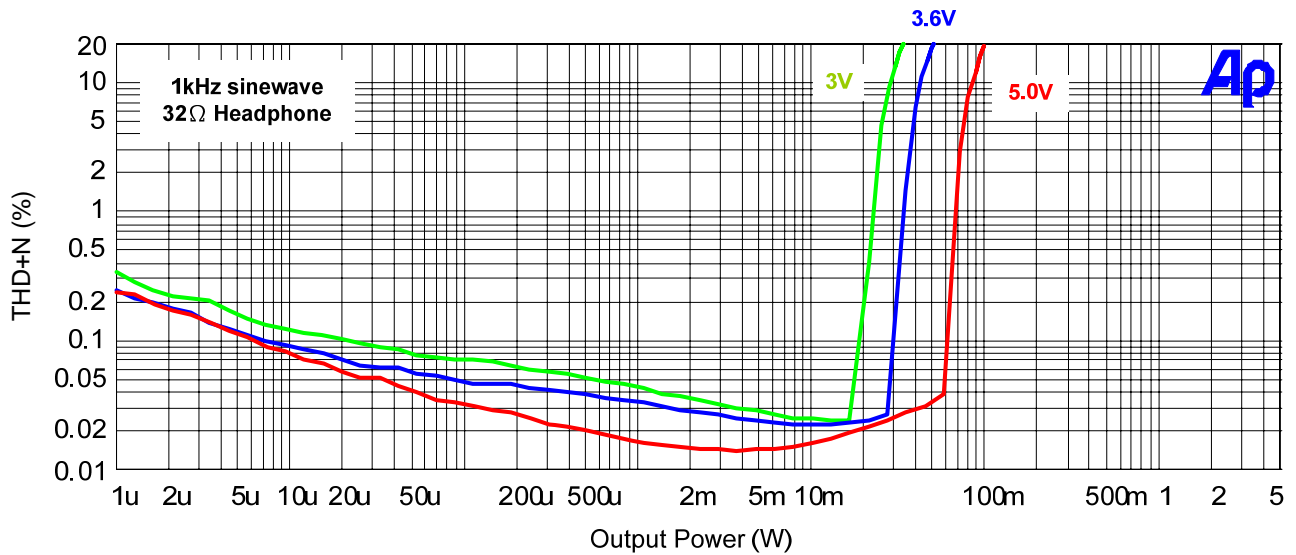
## Operation Descriptions

- ● Volume control

  AD52656 has built-in a 64-steps DC volume controller, and the volume level is set by the VOLUME DC voltage to VDC ratio. To avoid volume level oscillation from one to adjacent one, the hysteresis voltage between the nearby volume levels is designed in AD52656. For example, the volume level changes from LEVEL14 to LEVEL15 when DC voltage applied on VOLUME increases to 25.0 − (25.0 − 21.8) / 4 = 24.2(%) of VDC. And, the volume level drops from LEVEL15 to LEVEL14 when DC voltage applied on VOLUME decreases to 20.4 + (23.6 − 20.4) / 4 = 21.2(%) of VDC. More volume levels, gains, and its DC voltage ratio applied on VOLUME are listed in following table.

| Level | SPK Gain(dB) | HP Gain(dB) | Volume (% of VDC) | Level | SPK Gain(dB) | HP Gain(dB) | Volume (% of VDC) | Level | SPK Gain(dB) | HP Gain(dB) | Volume (% of VDC) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | -60 | -94.6 | 0.0 ~ 4.2 | 22 | 7.8 | -16.3 | 31.6 ~ 34.6 | 43 | 16.1 | -3.3 | 61.0 ~ 63.8 |
| 1 | -40 | -56.0 | 1.9 ~ 5.6 | 23 | 8.1 | -15.7 | 33.0 ~ 36.0 | 44 | 16.5 | -2.8 | 62.4 ~ 65.2 |
| 2 | -34 | -50.2 | 3.8 ~ 7.0 | 24 | 8.5 | -15.0 | 34.4 ~ 37.4 | 45 | 16.9 | -2.3 | 63.8 ~ 66.6 |
| 3 | -28 | -40.7 | 5.2 ~ 8.4 | 25 | 8.9 | -14.2 | 35.8 ~ 38.8 | 46 | 17.3 | -1.8 | 65.2 ~ 68.0 |
| 4 | -22 | -36.8 | 6.6 ~ 9.8 | 26 | 9.3 | -13.4 | 37.2 ~ 40.2 | 47 | 17.7 | -1.4 | 66.6 ~ 69.4 |
| 5 | -16 | -34.2 | 8.0 ~ 11.2 | 27 | 9.7 | -12.6 | 38.6 ~ 41.6 | 48 | 18.1 | -0.9 | 68.0 ~ 70.8 |
| 6 | -10 | -32.1 | 9.4 ~ 12.4 | 28 | 10.1 | -11.8 | 40.0 ~ 43.0 | 49 | 18.5 | -0.5 | 69.4 ~ 72.2 |
| 7 | -7.5 | -30.4 | 10.8 ~ 13.8 | 29 | 10.5 | -11.1 | 41.4 ~ 44.4 | 50 | 18.9 | 0.0 | 70.8 ~ 73.6 |
| 8 | -4.9 | -28.1 | 12.2 ~ 15.2 | 30 | 10.9 | -10.5 | 42.8 ~ 45.8 | 51 | 19.3 | 0.5 | 72.2 ~ 75.0 |
| 9 | -2.4 | -27.0 | 13.6 ~ 16.6 | 31 | 11.3 | -9.8 | 44.2 ~ 47.2 | 52 | 19.7 | 0.9 | 73.6 ~ 76.4 |
| 10 | 0.1 | -25.9 | 15.0 ~ 18.0 | 32 | 11.7 | -9.2 | 45.6 ~ 48.6 | 53 | 20.1 | 1.2 | 75.0 ~ 77.8 |
| 11 | 1.6 | -24.8 | 16.2 ~ 19.4 | 33 | 12.1 | -8.6 | 47.0 ~ 50.0 | 54 | 20.5 | 1.5 | 76.4 ~ 79.2 |
| 12 | 3.2 | -23.8 | 17.6 ~ 20.8 | 34 | 12.5 | -8.0 | 48.4 ~ 51.4 | 55 | 20.9 | 1.8 | 77.8 ~ 80.6 |
| 13 | 4.1 | -22.9 | 19.0 ~ 22.2 | 35 | 12.9 | -7.4 | 49.8 ~ 52.8 | 56 | 21.3 | 2.1 | 79.2 ~ 82.0 |
| 14 | 4.6 | -22.1 | 20.4 ~ 23.6 | 36 | 13.3 | -6.8 | 51.2 ~ 54.2 | 57 | 21.7 | 2.5 | 80.6 ~ 83.4 |
| 15 | 5 | -21.4 | 21.8 ~ 25.0 | 37 | 13.7 | -6.3 | 52.6 ~ 55.6 | 58 | 22.1 | 2.8 | 82.2 ~ 84.8 |
| 16 | 5.4 | -20.6 | 23.2 ~ 26.4 | 38 | 14.1 | -5.8 | 54.0 ~ 57.0 | 59 | 22.5 | 3.1 | 83.6 ~ 86.2 |
| 17 | 5.8 | -20.0 | 24.6 ~ 27.8 | 39 | 14.5 | -5.2 | 55.4 ~ 58.4 | 60 | 22.9 | 3.2 | 85.0 ~ 87.6 |
| 18 | 6.2 | -19.3 | 26.0 ~ 29.2 | 40 | 14.9 | -4.7 | 56.8 ~ 59.8 | 61 | 23.3 | 3.4 | 86.4 ~ 89.0 |
| 19 | 6.6 | -18.5 | 27.4 ~ 30.6 | 41 | 15.3 | -4.2 | 58.2 ~ 61.2 | 62 | 23.7 | 3.6 | 87.8 ~ 90.2 |
| 20 | 7 | -17.7 | 28.8 ~ 31.8 | 42 | 15.7 | -3.7 | 59.6 ~ 62.4 | 63 | 24 | 3.8 | > 90.2 |
| 21 | 7.4 | -17.0 | 30.2 ~ 33.2 | | | | | | | | |
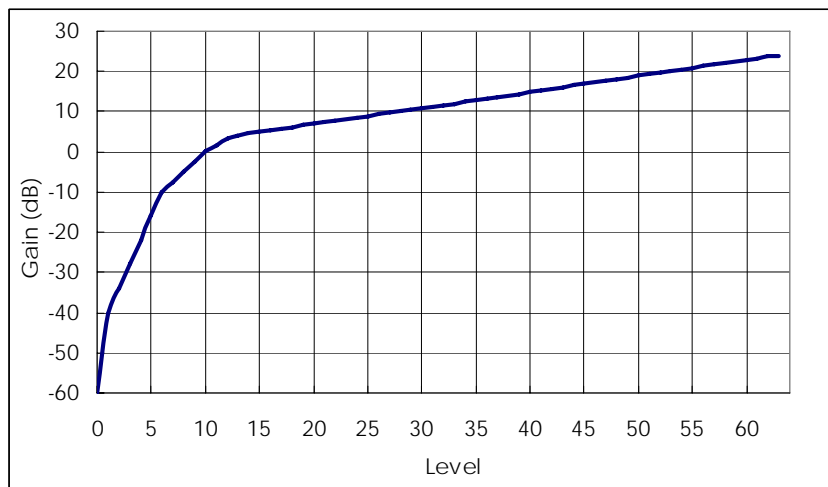
● Power limit

The power limit circuit built-in AD52656 is used to keep the power amplifier performs high quality audio into speakers and to prevent the speakers from damage when higher volume level is selected.

● Self-protection circuits (typical values are used below.)

AD52656 has built-in over-temperature, overload and voltage detectors.

(i)  If the internal junction temperature is higher than 160°C, the outputs of loudspeaker drivers will be disabled and at low state. The temperature hysteresis for AD52656 to return to normal operation is about 35°C. The variation of protected temperature is around 10%.

(ii) AD52656 has built-in overload protection for both right and left channel. To protect loudspeaker drivers from over-current damage when the wires of loudspeaker are shorted to one another, GND or VDD, circuits for the detection of output loading are built in the AD52656. For normal operation, loudspeaker resistance is larger than 3.2Ω is required. Otherwise, overload detectors may activate. Once one of right and left channel is overloaded, both loudspeaker drivers will be disabled. And, AD52656 will be recovery from overload fault by toggling SD# down to low and back to high after removing the short.

●Shut-down control (SD#)

During shutdown mode, means SD#=0, AD52656 ceases all internal circuits To avoid annoying pop during power on/off, well SD# control, like with a power ready signal, is suggested. And, due to its internal pull-up, there is no pop if let the SD# floating.

● Mute control (MUTE#)

Like SD# mode, AD52656 ceases output driver, but keep part of internal circuit still working. That could provide quick disable and enable power amplifier.

● Headphone and speaker switching

The AD52656 is a stereo class-D audio amplifier with stereo class-AB headphone driver. By setting HP_SPKB pin, AD52656 can switch between loudspeaker and headphone mode. When HP_SPKB pin is pulled high, AD52656 is in headphone mode and loudspeaker drivers are off. When HP_SPKB is low, AD52656 is in loudspeaker mode and headphone drivers are off. There is an internal pull-down design on HP_SPKB pin. With the internal pull-down design, mode switching between headphone and loudspeaker will be automatic when headphone is plugged in or pulled out the headphone jack.

## **Application information**

● Input capacitors ($C_{in}$)

The performance at low frequency (bass) is affected by the corner frequency ($f_c$) of the high-pass filter composed of input resistors ($R_{in}$) and input capacitors ($C_{in}$), determined in equation (a). And, the resistance of input resistors is different at different volume gain. But there is 20% variation in input resistance from 20% process variation in actual resistance of the input resistors. Typically, a 0.47$\mu$F or 1$\mu$F ceramic capacitor is suggested.

$$f_c = \frac{1}{2\pi R_{in} C_{in}} \ (Hz) \ \cdots\cdots\cdots (a)$$

| Loudspeaker | |
|---|---|
| Gain (dB) | Rin (ohm) |
| 24 | 42k |
| 18 | 73k |
| 12 | 115k |
| 6 | 160k |

| Headphone | |
|---|---|
| Gain (dB) | Rin (ohm) |
| 3.5 | 65k |
| -6 | 108k |
| -12 | 128k |
| -18 | 144k |

● Capacitor on Vref ($C_{Vref}$)

In order to reduce low-frequency noise produced by power supply, the capacitor ($C_{Vref}$) on Vref, which is the mid-rail voltage of AVDD, is necessary. It is also good for PSRR. And, to have less annoying pop, the recommended $C_{Vref}$ is the same with Cin.

● Decoupling capacitor ($C_{byp}$ and $C_{bulk}$)

Because of the power loss on the trace, which is between the device and decoupling capacitor, the decoupling capacitor should be placed as close to the device PVDDL (PVDDR) and PGNDL (PGNDR) to reduce any parasitic resistor or inductor between them. And, a low ESR ceramic capacitor ($C_{byp}$), typically 1$\mu$F, is suggested for high frequency transients and as close to AD52656 as possible. For filtering audio band noise signal, a 10$\mu$F or greater capacitor ($C_{bulk}$) (tantalum or electrolytic type) is suggested.

● Headphone DC decoupling capacitors ($C_{hp}$)

The DC decoupling capacitors ($C_{hp}$) between headphone and HPL/HPR pins are used to remove the DC voltage on the headphone from HPL/HPR. The high pass filter, which is composed of the headphone resistance and the DC decoupling capacitor, attenuates the low frequency audio performance. For 16$\Omega$ headphone, the electrolytic or tantalum capacitor with 100$\mu$F or greater is suggested. The relationship between $f_{hc}$, $R_{hp}$ and $C_{hp}$ is shown in the below equation (b).

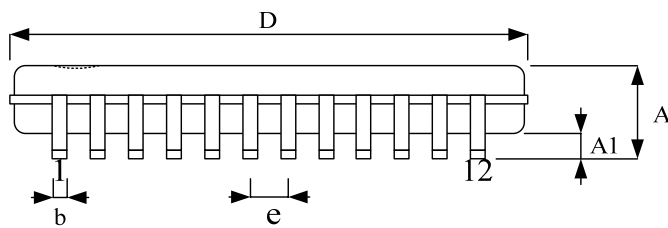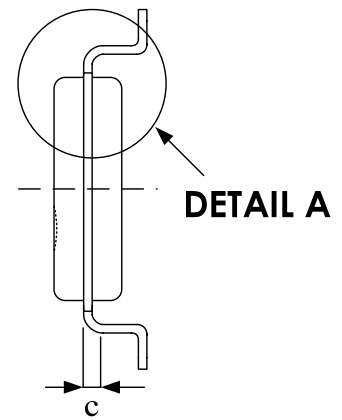$$f_{hc} = \frac{1}{2\pi R_{hp} C_{hp}} \ (Hz) \ \cdots\cdots\cdots (b)$$
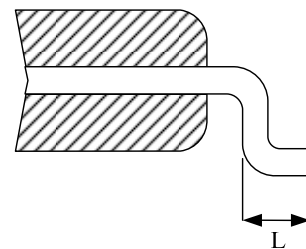
## Package Dimensions

● **SSOP 24 (150mil)**
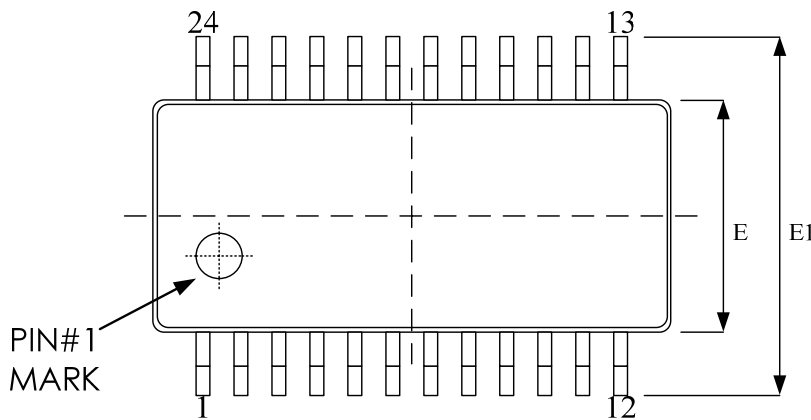
**TOP VIEW**

**SIDE VIEW**

**DETAIL A**

| Symbol | Dimension in mm | |
|--------|------|------|
| | Min | Max |
| A | 1.35 | 1.75 |
| A1 | 0.10 | 0.25 |
| b | 0.20 | 0.31 |
| c | 0.18 | 0.25 |
| D | 8.53 | 8.74 |
| E | 3.80 | 4.00 |
| E1 | 5.80 | 6.20 |
| e | 0.635 BSC | |
| L | 0.38 | 1.27 |

## Revision History

| Revision | Date | Description |
|---|---|---|
| 0.1 | 2014.07.22 | Original |
| 1.0 | 2015.04.01 | 1. Modify package dimensions<br>2. Remove preliminary word and modify version to 1.0 |
| 1.1 | 2015.04.15 | Add ordering packing information |
| 1.2 | 2015.05.19 | 1. Change operating voltage from 3.0~5.0V to 3.0~5.5V.<br>2. Change AMR voltage from 5.5V to 6.0V |
| 1.3 | 2016.02.05 | 1. Replace $T_a$ (Ambient Operating Temperature) by $T_j$ (Junction temperature) in Absolute Maximum Ratings.<br>2. Change Ambient operating temperature from 0~70$^o$C to -40~85$^o$C.<br>3. Modify the Description and Volume Table of Volume Control |

## Important Notice