DATA SHEET

# GPY0031A
# GPY0032A

## 2.0W Audio Power Amplifier

Mar. 14, 2014

Version 1.5

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# AUDIO DRIVER

## 1. GENERAL DESCRIPTION

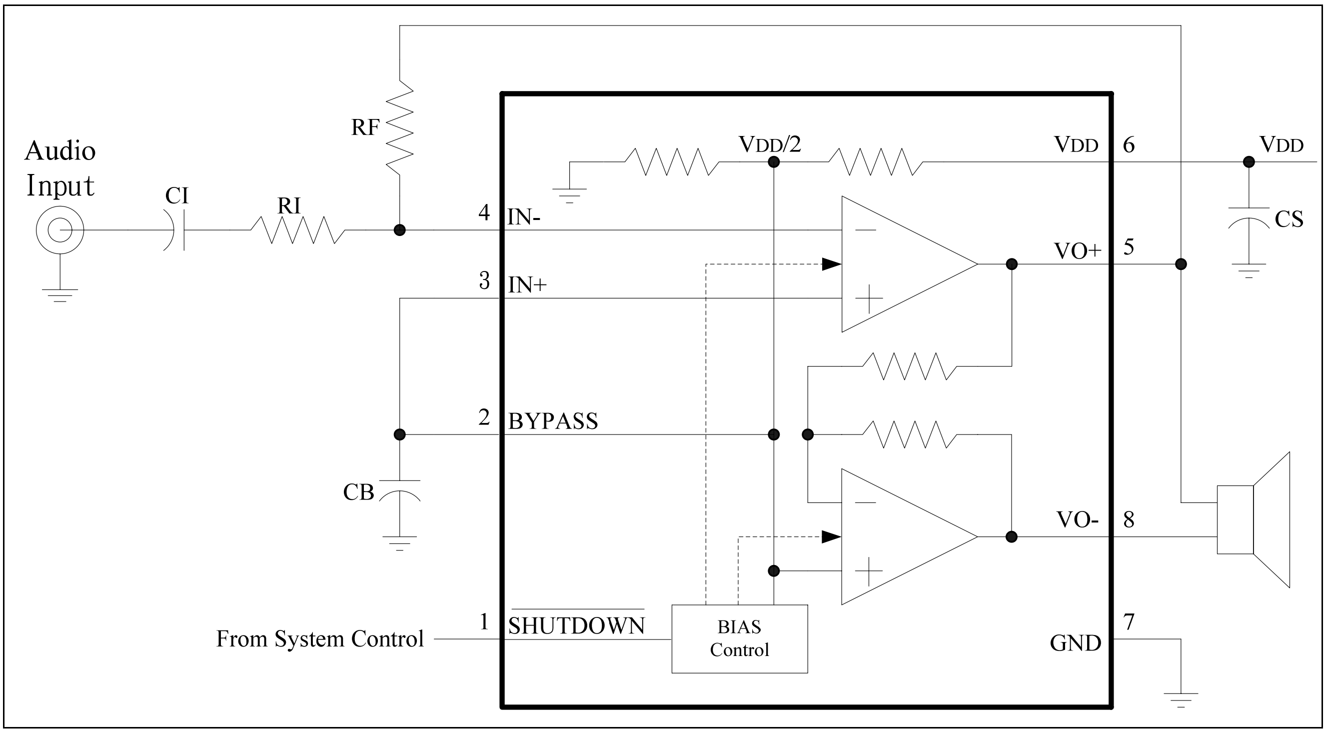
The GPY0031A (a bridge-tied load (BTL) and GPY0032A (a BTL or singled-ended (SE)), are audio amplifiers, designed especially for low-voltage applications which normally require internal speaker. Operating on 5V power supply, GPY0031A / 32A is able to deliver 2.0W of successive average power into 4Ω load at less than 10% of THD+N throughout voice band frequencies and embedded the de-pop circuit to minimize the turn-on and turn-off pop noise. Normally, it is applied for GPC series, GPF series, GPL series and other GENERALPLUS products. The GPY0031A / 32A are easily to be used in various applications and products.

## 2. FEATURES

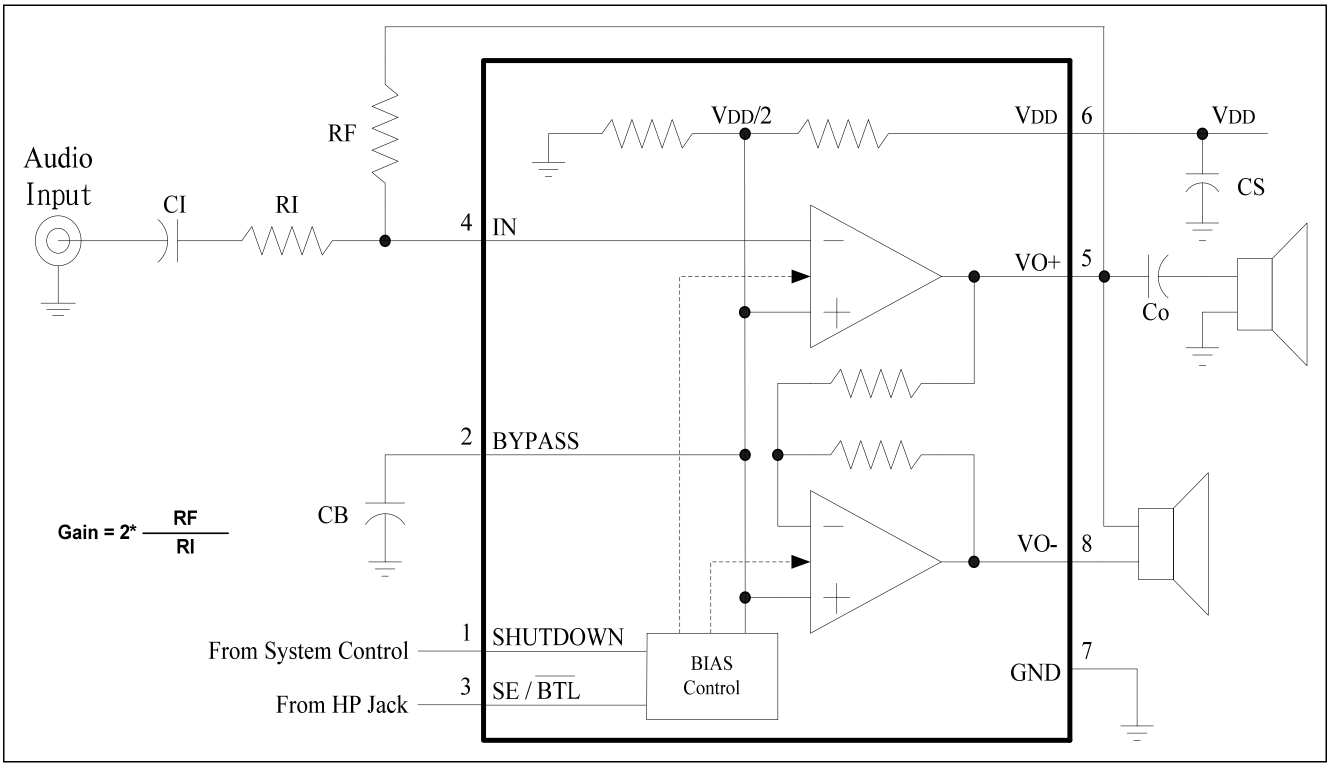
- Wide Operation Range: 2.0V – 6.8V
- Bridge-Tied Load (BTL) (For GPY0031A)
- Bridge-Tied Load (BTL) or Single-Ended (SE) Modes Operation (For GPY0032A)
- Low Distortion: THD+N = 0.15% (Typ.)
  (For VDD = 5.0V, $R_L$ = 4.0Ω & $P_{out}$ = 630mW)
- High Output Power: $P_{OUT}$ = 1.6W
  (For VDD = 5.0V, THD+N =1.0%, f =1.0KHz & $R_L$ = 4Ω)
- Low Shutdown Current: 1.0μA
- Minimize the turn-on and turn-off pop noise
- Thermal Shutdown Protection
- Over Current Protection

## 3. BLOCK DIAGRAM

**GPY0031A:**



**GPY0032A:**


Audio
Input
CI
RI
RF
4
IN
VDD/2
VDD
6
VDD
CS
VO+
5
Co
2
BYPASS
CB
Gain = 2* RF / RI
VO-
8
1
SHUTDOWN
From System Control
3
SE / BTL
From HP Jack
BIAS
Control
GND
7

## 4. SIGNAL DESCRIPTIONS

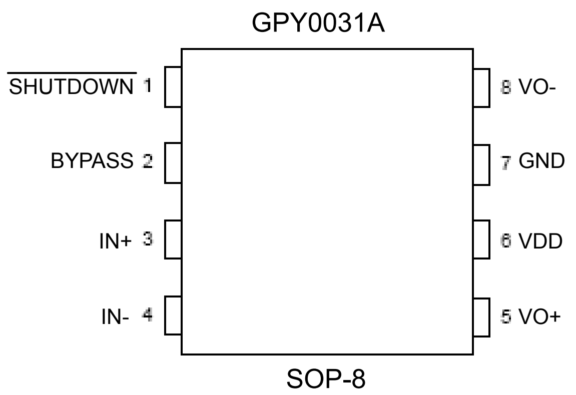
**GPY0031A:**

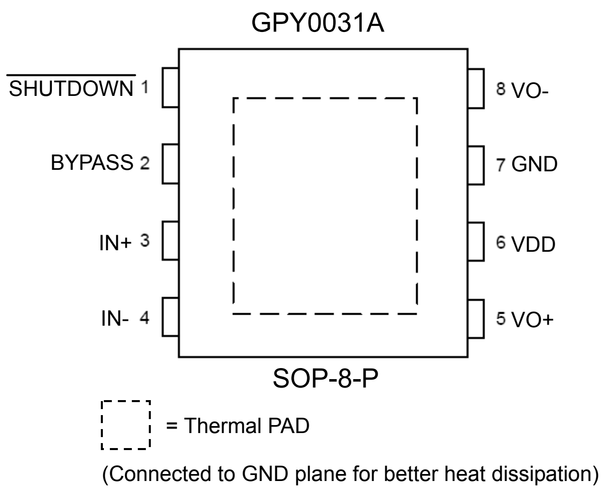
| Mnemonic | PIN No. | Type | Description | Electrical Characteristics |
|---|---|---|---|---|
| $\overline{\text{SHUTDOWN}}$ | 1 | I | Shutdown mode control signal input. Active Low. | - |
| BYPASS | 2 | I | BYPASS is internal mid-supply bias. This pin should be connected to a 0.1uF ~ 2.2uF capacitor. | VDD/2 |
| IN+ | 3 | I | IN+ is non-inverting input | - |
| IN- | 4 | I | IN- is inverting input | - |
| VO+ | 5 | O | VO+ is positive BTL output | - |
| VDD | 6 | I | Power VDD | 2.0V – 6.8V |
| GND | 7 | I | Power Ground | - |
| VO- | 8 | O | VO- is negative BTL output | - |

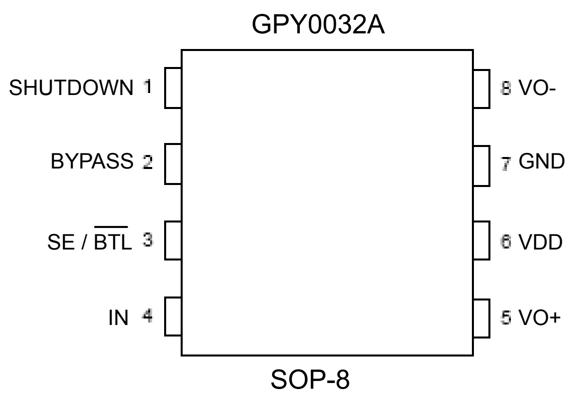
**GPY0032A:**

| Mnemonic | PIN No. | Type | Description | Electrical Characteristics |
|---|---|---|---|---|
| SHUTDOWN | 1 | I | Shutdown mode control signal input. Active High. | - |
| BYPASS | 2 | I | BYPASS is internal mid-supply bias. This pin should be connected to a 0.1uF ~ 2.2uF capacitor. | VDD/2 |
| SE / $\overline{\text{BTL}}$ | 3 | I | When SE / $\overline{\text{BTL}}$ is held low, GPY0032A is in BTL mode. When SE/ $\overline{\text{BTL}}$ is high, GPY0032A is in SE mode. | - |
| IN | 4 | I | Audio input | - |
| VO+ | 5 | O | VO+ is positive output for BTL mode and SE mode | - |
| VDD | 6 | I | Power VDD | 2.0V – 6.8V |
| GND | 7 | I | Power Ground | - |
| VO- | 8 | O | VO- is negative BTL output | - |

#### 4.1. Package Pin Assignment



## 5. ELECTRICAL SPECIFICATIONS

### 5.1. Absolute Maximum Ratings

| Characteristics | Symbol | Rating |
|---|---|---|
| DC Supply Voltage | $V_+$ | < 7.0V |
| Input Voltage Range | $V_{IN}$ | -0.5V to V+ + 0.5V |
| Operating free-air Temperature Range | $T_A$ | -40℃ to + 85℃ |
| Operating junction Temperature Range | $T_J$ | -40℃ to + 150℃ |
| Storage Temperature | $T_{STO}$ | -50℃ to + 150℃ |

**Note:** Stresses beyond those given in the Absolute Maximum Rating table may cause operational errors or damage to the device. For normal operational conditions see AC/DC Electrical Characteristics.

### 5.2. Thermal Characteristics

| Characteristics | Symbol | Value | Unit |
|---|---|---|---|
| SOP-8 Package Thermal Resistance | $R_{THJA}$ | 150 | ℃/W |
| SOP-8-P Package Thermal Resistance | $R_{THJA}$ | 60 | ℃/W |

### 5.3. DC Characteristics ($V_{DD}$=5.0V, $T_A$ = 25°C unless otherwise specified)

**GPY0031A:**

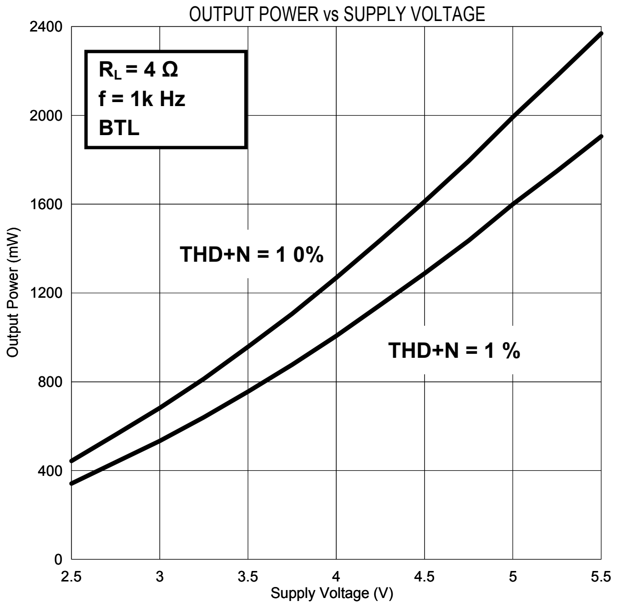
| Item | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Operation Voltage | Temperature = 25℃ | $V_{DD}$ | 2.00 | - | 6.8 | V |
| | Temperature = -20℃ | $V_{DD}$ | 2.15 | - | 6.8 | V |
| | Temperature = -40℃ | $V_{DD}$ | 2.25 | - | 6.8 | V |
| Shutdown Current | $\overline{\text{SHUTDOWN}}$=GND | $I_{STBY}$ | - | 0.1 | 1.0 | uA |
| Operating Current | $V_{DD}$ = 5.0V, $\overline{\text{SHUTDOWN}}$ =$V_{DD}$, No Load | $I_{DD}$ | - | 4.0 | - | mA |
| Reference Voltage | $V_{DD}$ = 5.0V, $\overline{\text{SHUTDOWN}}$ =$V_{DD}$ | $V_{REF}$ | - | $V_{DD}$ /2 | - | V |
| Total Harmonic Distortion + Noise | $V_{DD}$ = 5.0V, $R_L$ = 4.0Ω, $P_{OUT}$ = 630mW | THD+N | - | 0.15 | - | % |
| | $V_{DD}$ = 5.0V, $R_L$ = 8.0Ω, $P_{OUT}$ = 630mW | THD+N | - | 0.15 | - | % |
| Output Power | $V_{DD}$ = 5.0V, THD+N = 1%, f = 1.0KHz & $R_L$ = 4.0Ω | $P_{OUT}$ | - | 1600 | - | mW |
| | $V_{DD}$ = 5.0V, THD+N = 1%, f = 1.0KHz & $R_L$ = 8.0Ω | $P_{OUT}$ | - | 1150 | - | mW |
| | $V_{DD}$ = 5.0V, THD+N = 10%, f = 1.0KHz & $R_L$ = 4.0Ω | $P_{OUT}$ | - | 2000 | - | mW |
| | $V_{DD}$ = 5.0V, THD+N = 10%, f = 1.0KHz & $R_L$ = 8.0Ω | $P_{OUT}$ | - | 1400 | - | mW |
| Output Offset Voltage | $V_{IN}$=0V | $V_{OS}$ | - | - | 30 | mV |
| Power Rejection Ratio | f = 1kHz | PSRR | - | 70 | - | dB |
| Enable Time | $V_{DD}$ = 5.0V, CI=0.47μF, CB=1.0μF | $T_{ON}$ | - | 70 | - | ms |
| Shutdown Time | $V_{DD}$ = 5.0V, CI=0.47μF, CB=1.0μF | $T_{OFF}$ | - | 70 | - | ms |
| Current Limitation | $V_{DD}$ = 5.0V, CI=0.47μF, CB=1.0μF | $I_{LMT}$ | - | 850 | - | mA |

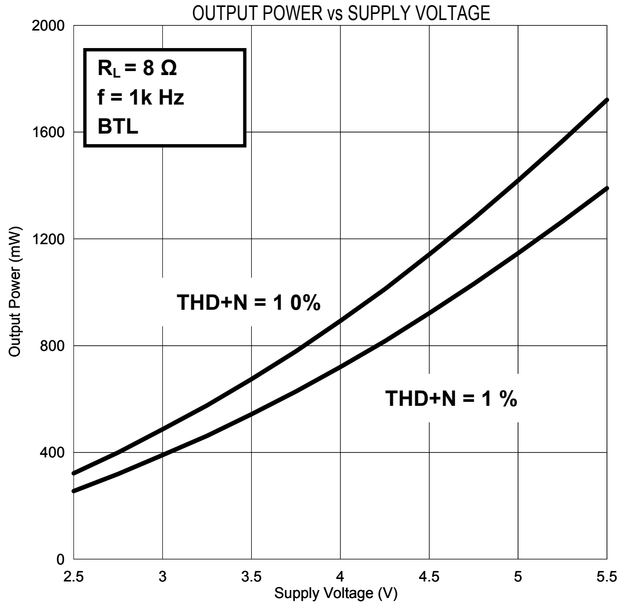
**GPY0032A:**

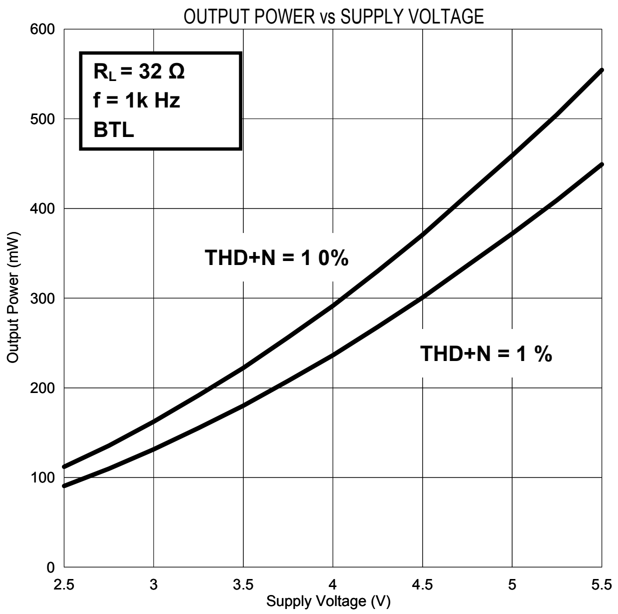
| Item | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Operation Voltage | Temperature = 25°C | $V_{DD}$ | 2.00 | - | 6.8 | V |
| | Temperature = -20°C | $V_{DD}$ | 2.15 | - | 6.8 | V |
| | Temperature = -40°C | $V_{DD}$ | 2.25 | - | 6.8 | V |
| Shutdown Current | SHUTDOWN=VDD | $I_{STBY}$ | - | 0.1 | 1.0 | uA |
| Operating Current | $V_{DD}$ = 5.0V, SHUTDOWN =GND, No Load | $I_{DD}$ | - | 4.0 | - | mA |
| Reference Voltage | $V_{DD}$ = 5.0V, SHUTDOWN =GND | $V_{REF}$ | - | $V_{DD}$ /2 | - | V |
| Total Harmonic Distortion + Noise | $V_{DD}$ = 5.0V, $R_L$ = 4.0Ω, $P_{OUT}$ = 630mW | THD+N | - | 0.15 | - | % |
| | $V_{DD}$ = 5.0V, $R_L$ = 8.0Ω, $P_{OUT}$ = 630mW | THD+N | - | 0.15 | - | % |
| Output Power | $V_{DD}$ = 5.0V, THD+N = 1%, f = 1.0KHz & $R_L$ = 4.0Ω | $P_{OUT}$ | - | 1600 | - | mW |
| | $V_{DD}$ = 5.0V, THD+N = 1%, f = 1.0KHz & $R_L$ = 8.0Ω | $P_{OUT}$ | - | 1150 | - | mW |
| | $V_{DD}$ = 5.0V, THD+N = 10%, f = 1.0KHz & $R_L$ = 4.0Ω | $P_{OUT}$ | - | 2000 | - | mW |
| | $V_{DD}$ = 5.0V, THD+N = 10%, f = 1.0KHz & $R_L$ = 8.0Ω | $P_{OUT}$ | - | 1400 | - | mW |
| Output Offset Voltage | $V_{IN}$=0V | $V_{OS}$ | - | - | 30 | mV |
| Power Rejection Ratio | f = 1kHz | PSRR | - | 70 | - | dB |
| Enable Time | $V_{DD}$ = 5.0V, SE / $\overline{BTL}$ = GND, CB=1.0μF | $T_{ON}$ | - | 70 | - | ms |
| | $V_{DD}$ = 5.0V, SE / $\overline{BTL}$ = $V_{DD}$, CB=1.0μF | | - | 200 | - | ms |
| Shutdown Time | $V_{DD}$ = 5.0V, SE / $\overline{BTL}$=GND, CB=1.0μF | $T_{OFF}$ | - | 70 | - | ms |
| | $V_{DD}$ = 5.0V, SE / $\overline{BTL}$ = $V_{DD}$, CB=1.0μF | | - | 200 | - | ms |
| Current Limitation | $V_{DD}$ = 5.0V, CI=0.47μF, CB=1.0μF | $I_{LMT}$ | - | 850 | - | mA |

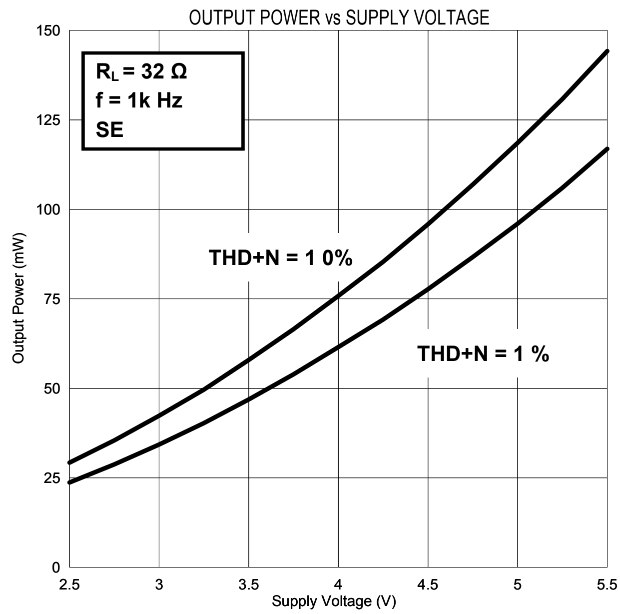
### 5.4. Typical Performance Characteristics

### 5.4.1. Output power vs. supply voltage

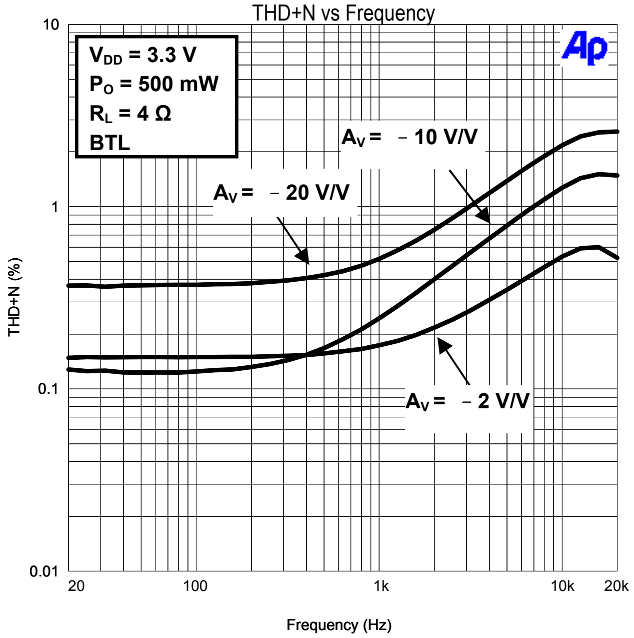


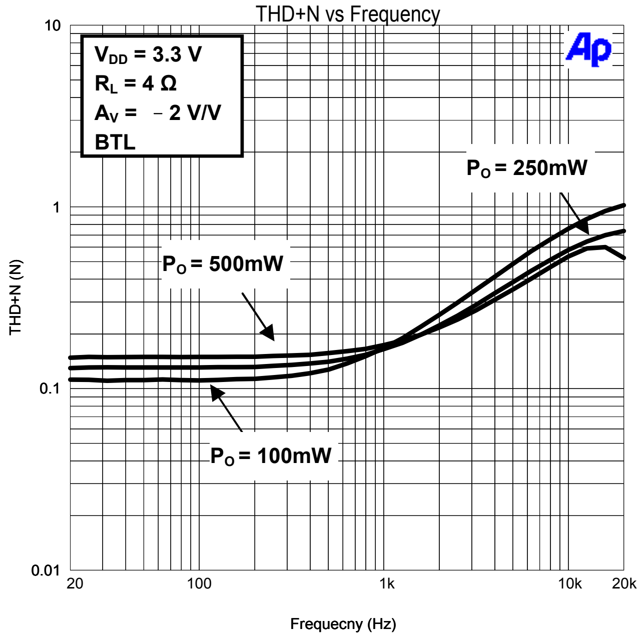



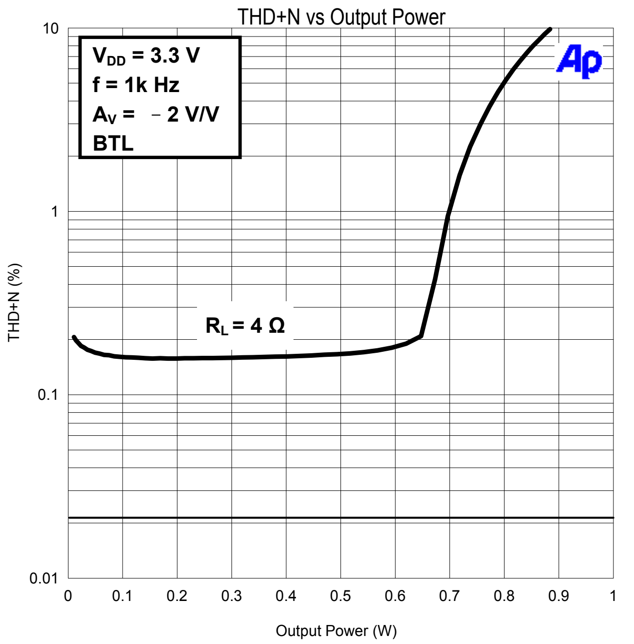



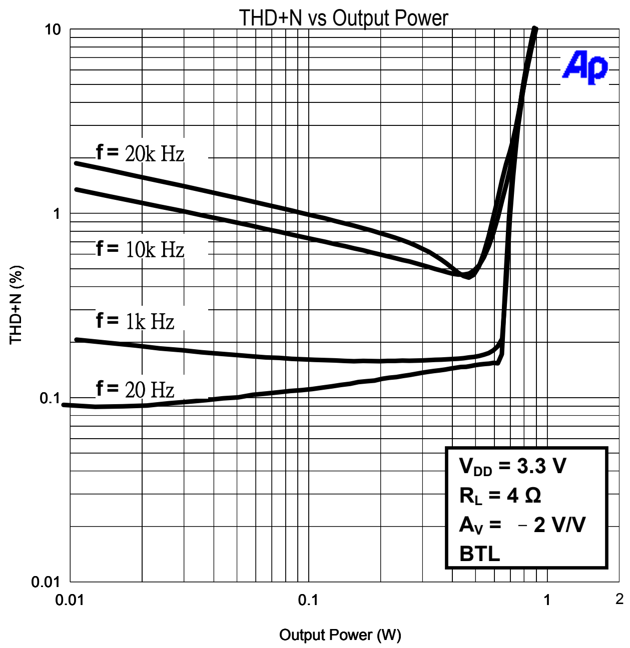



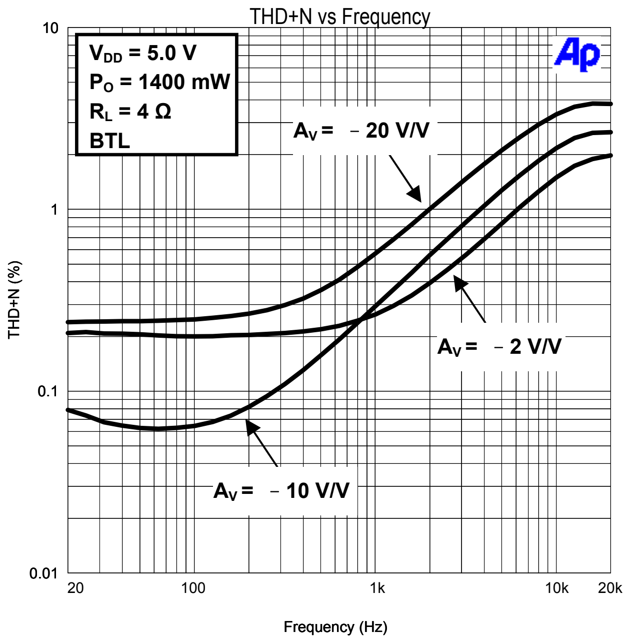
#### 5.4.2. THD+N

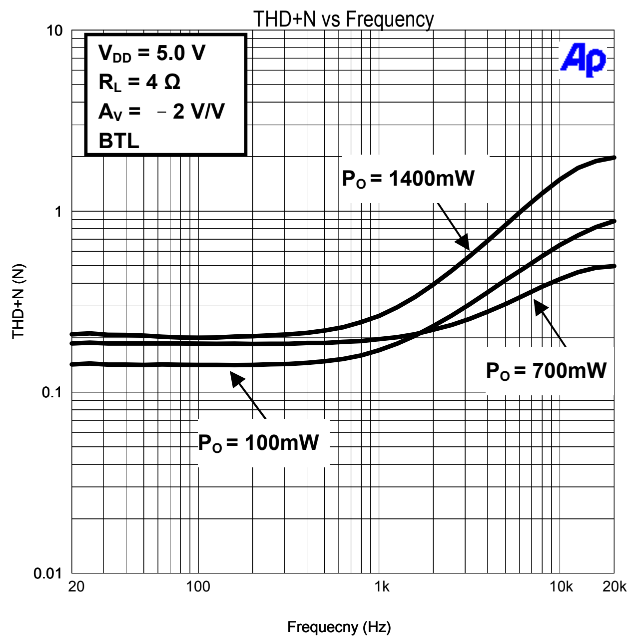

THD+N vs Frequency
$V_{DD}$ = 3.3 V
$P_O$ = 500 mW
$R_L$ = 4 Ω
BTL
$A_V$ = －10 V/V
$A_V$ = －20 V/V
$A_V$ = －2 V/V
THD+N (%)
Frequency (Hz)
10
1
0.1
0.01
20
100
1k
10k
20k

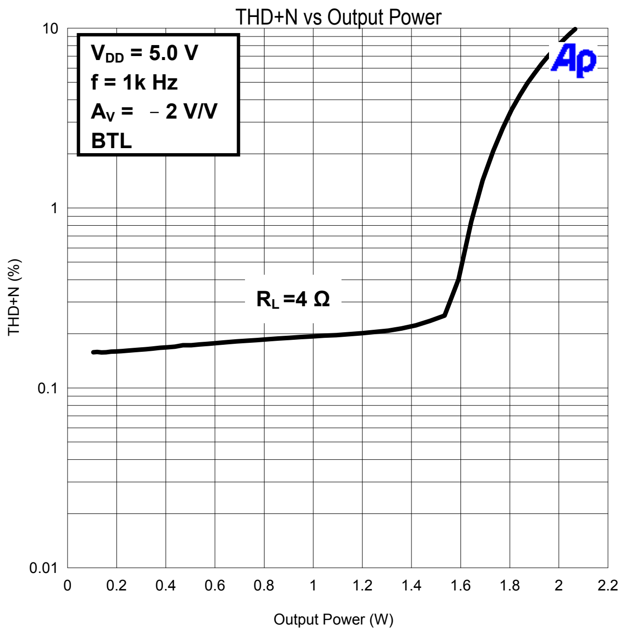

THD+N vs Frequency
$V_{DD}$ = 3.3 V
$R_L$ = 4 Ω
$A_V$ = －2 V/V
BTL
$P_O$ = 250mW
$P_O$ = 500mW
$P_O$ = 100mW
THD+N (N)
Frequecny (Hz)
10
1
0.1
0.01
20
100
1k
10k
20k

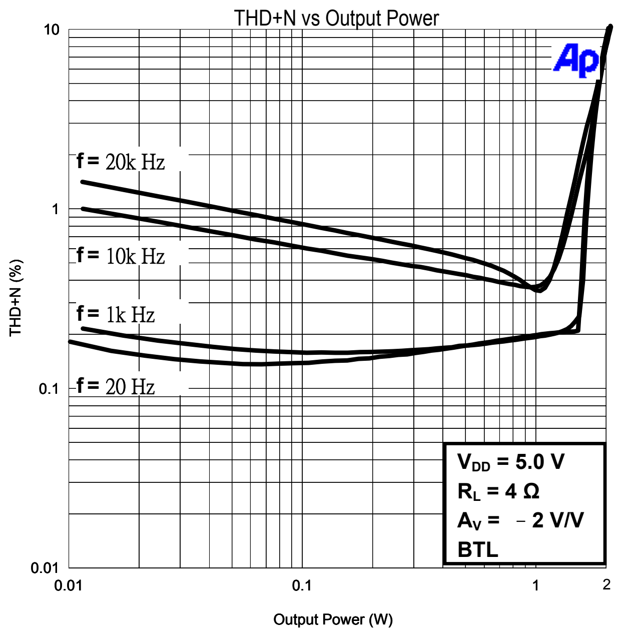

THD+N vs Output Power
$V_{DD}$ = 3.3 V
f = 1k Hz
$A_V$ = －2 V/V
BTL
$R_L$ = 4 Ω
THD+N (%)
Output Power (W)
10
1
0.1
0.01
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

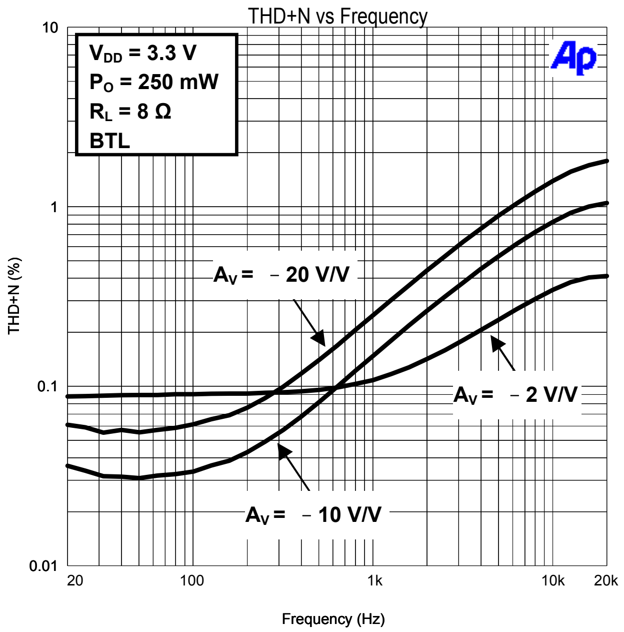

THD+N vs Output Power
f = 20k Hz
f = 10k Hz
f = 1k Hz
f = 20 Hz
$V_{DD}$ = 3.3 V
$R_L$ = 4 Ω
$A_V$ = －2 V/V
BTL
THD+N (%)
Output Power (W)
10
1
0.1
0.01
0.01
0.1
1
2

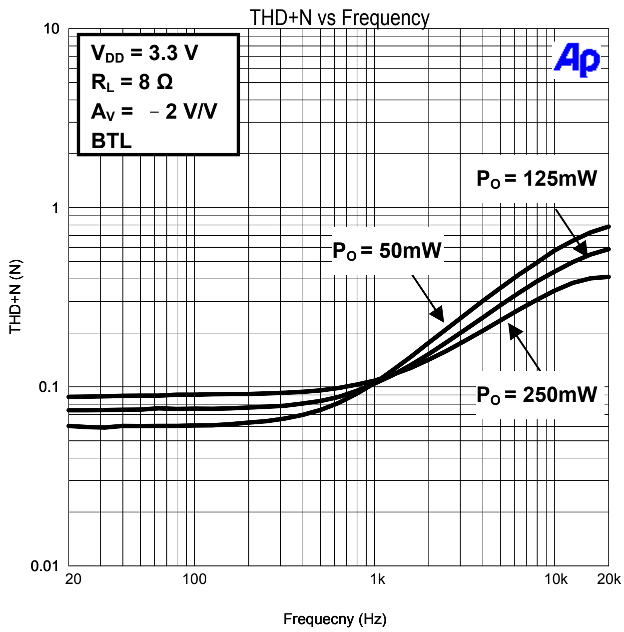

THD+N vs Frequency
VDD = 5.0 V
PO = 1400 mW
RL = 4 Ω
BTL
AV = －20 V/V
AV = －2 V/V
AV = －10 V/V
THD+N (%)
Frequency (Hz)
10
1
0.1
0.01
20
100
1k
10k
20k

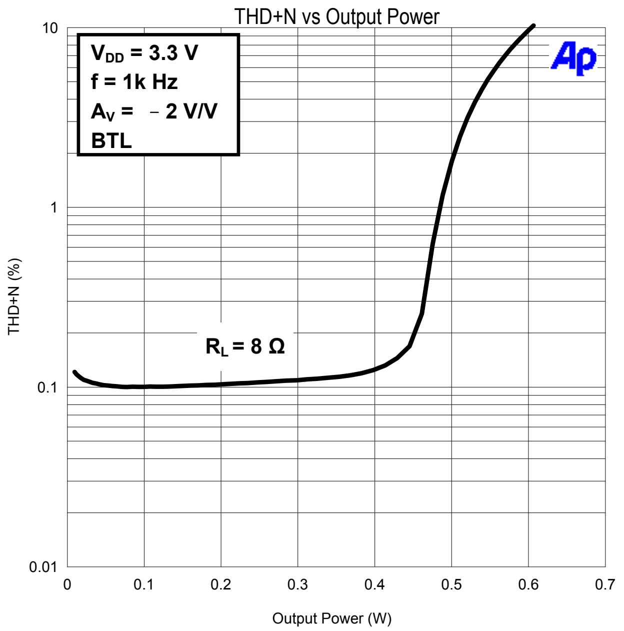

THD+N vs Frequency
VDD = 5.0 V
RL = 4 Ω
AV = －2 V/V
BTL
PO = 1400mW
PO = 700mW
PO = 100mW
THD+N (N)
Frequecny (Hz)
10
1
0.1
0.01
20
100
1k
10k
20k

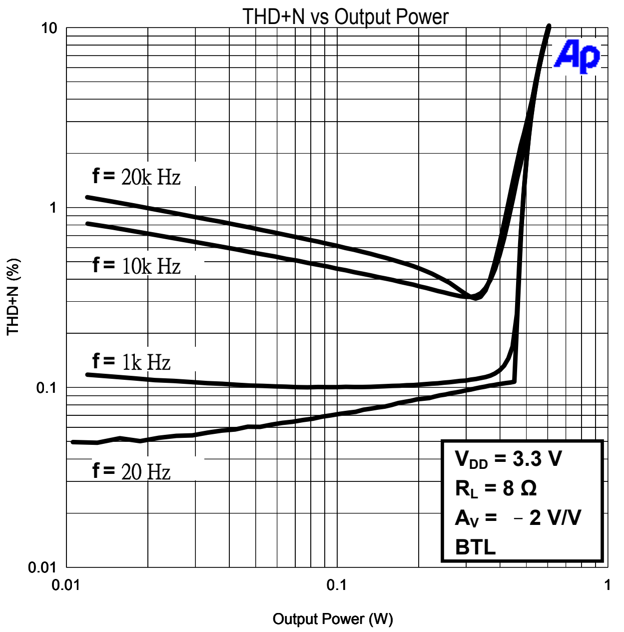

THD+N vs Output Power
VDD = 5.0 V
f = 1k Hz
AV = －2 V/V
BTL
RL =4 Ω
THD+N (%)
Output Power (W)
10
1
0.1
0.01
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2

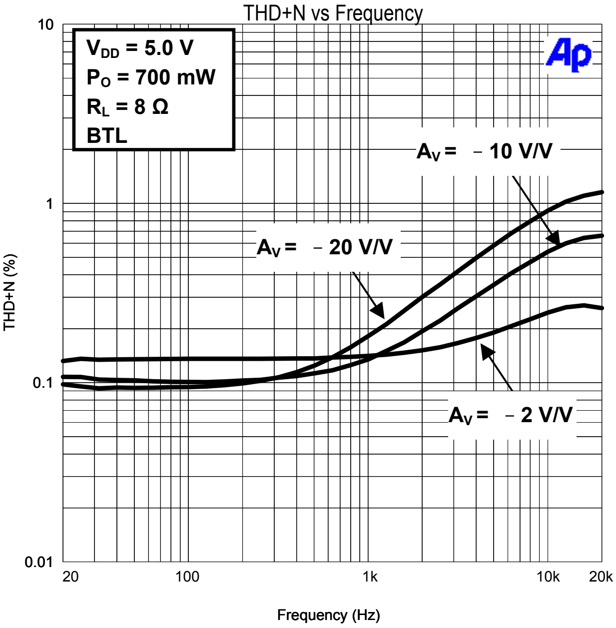

THD+N vs Output Power
f = 20k Hz
f = 10k Hz
f = 1k Hz
f = 20 Hz
VDD = 5.0 V
RL = 4 Ω
AV = －2 V/V
BTL
THD+N (%)
Output Power (W)
10
1
0.1
0.01
0.01
0.1
1
2

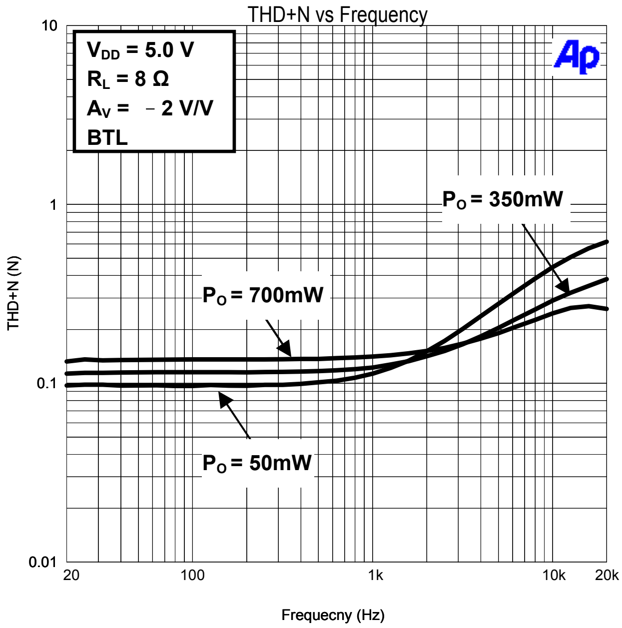

THD+N vs Frequency
VDD = 3.3 V
PO = 250 mW
RL = 8 Ω
BTL
AV = －20 V/V
AV = －2 V/V
AV = －10 V/V
THD+N (%)
Frequency (Hz)

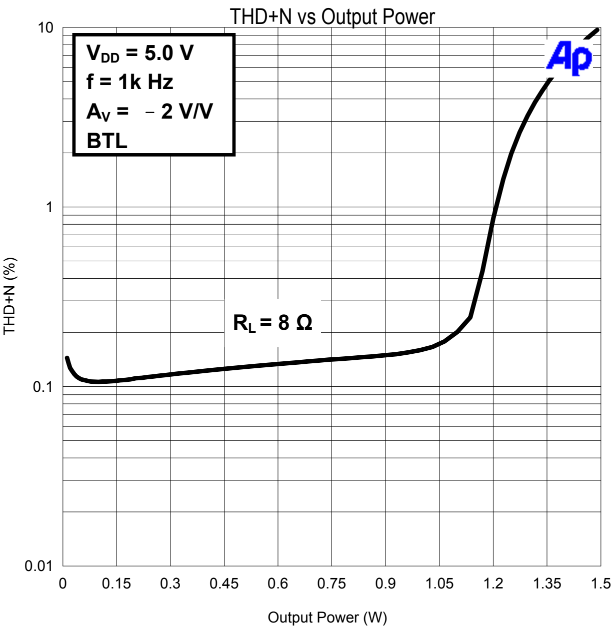

THD+N vs Frequency
VDD = 3.3 V
RL = 8 Ω
AV = －2 V/V
BTL
PO = 125mW
PO = 50mW
PO = 250mW
THD+N (N)
Frequecny (Hz)

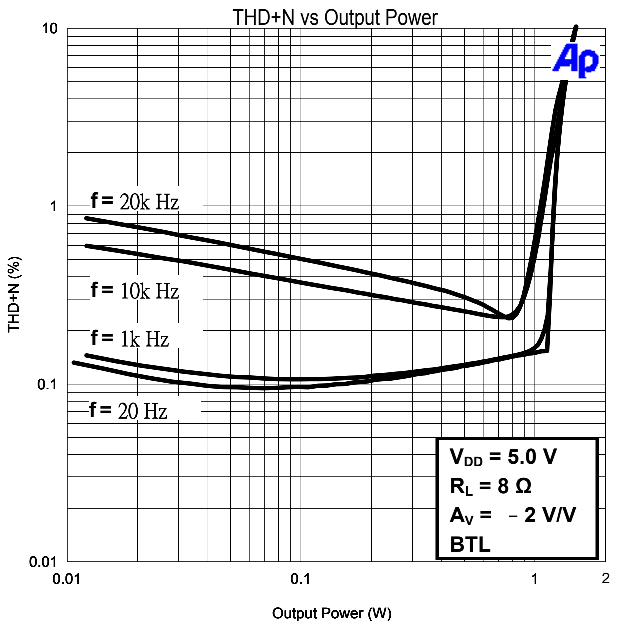

THD+N vs Output Power
VDD = 3.3 V
f = 1k Hz
AV = －2 V/V
BTL
RL = 8 Ω
THD+N (%)
Output Power (W)

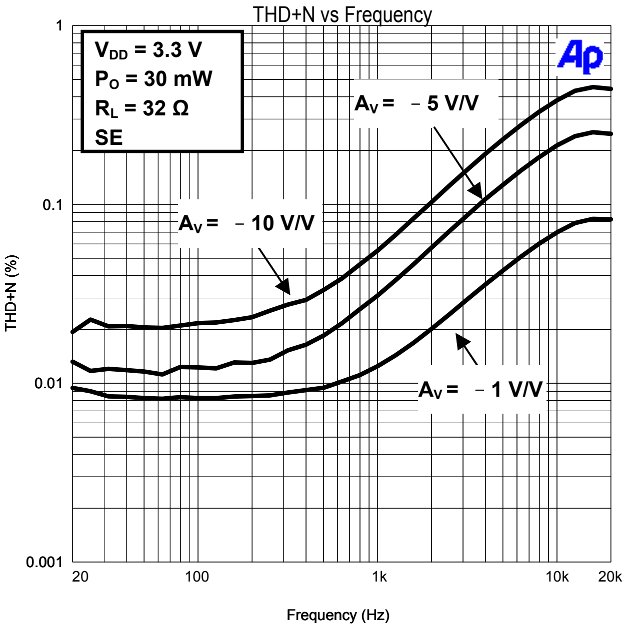

THD+N vs Output Power
f = 20k Hz
f = 10k Hz
f = 1k Hz
f = 20 Hz
VDD = 3.3 V
RL = 8 Ω
AV = －2 V/V
BTL
THD+N (%)
Output Power (W)

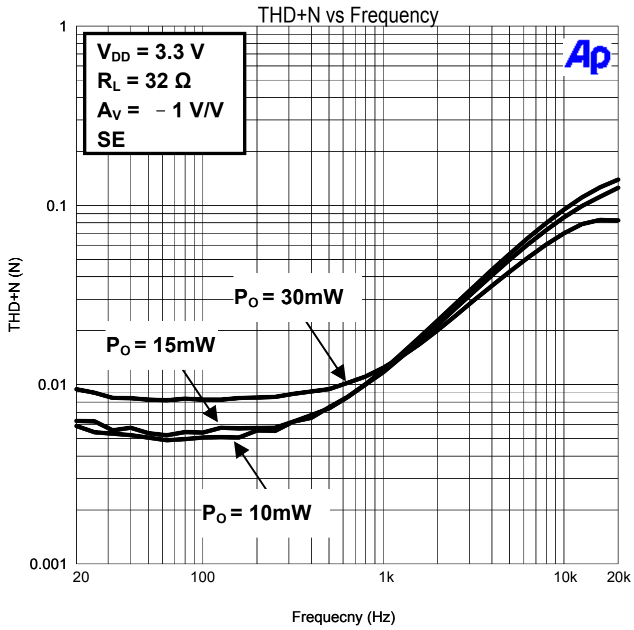

THD+N vs Frequency
$V_{DD}$ = 5.0 V
$P_O$ = 700 mW
$R_L$ = 8 Ω
BTL
$A_V$ = －10 V/V
$A_V$ = －20 V/V
$A_V$ = －2 V/V
THD+N (%)
Frequency (Hz)
10
1
0.1
0.01
20
100
1k
10k
20k

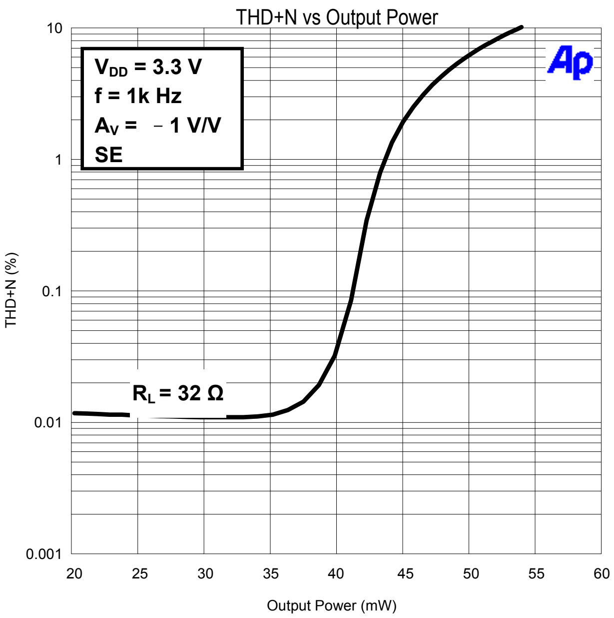

THD+N vs Frequency
$V_{DD}$ = 5.0 V
$R_L$ = 8 Ω
$A_V$ = －2 V/V
BTL
$P_O$ = 350mW
$P_O$ = 700mW
$P_O$ = 50mW
THD+N (N)
Frequecny (Hz)
10
1
0.1
0.01
20
100
1k
10k
20k

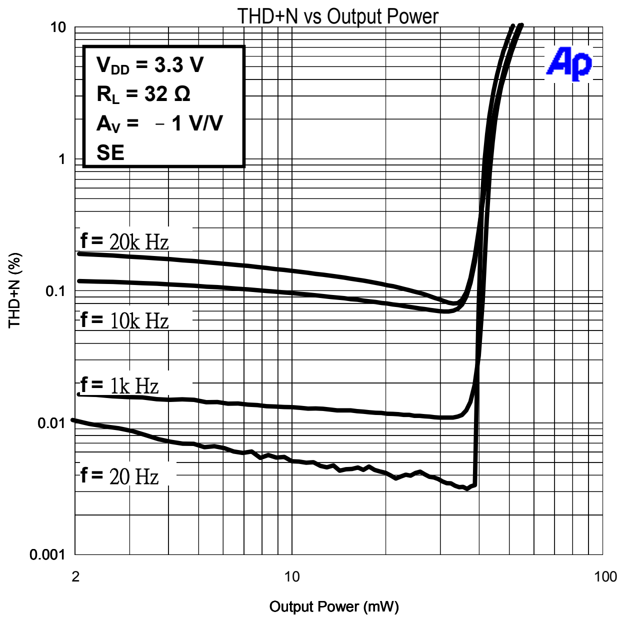

THD+N vs Output Power
$V_{DD}$ = 5.0 V
f = 1k Hz
$A_V$ = －2 V/V
BTL
$R_L$ = 8 Ω
THD+N (%)
Output Power (W)
10
1
0.1
0.01
0
0.15
0.3
0.45
0.6
0.75
0.9
1.05
1.2
1.35
1.5

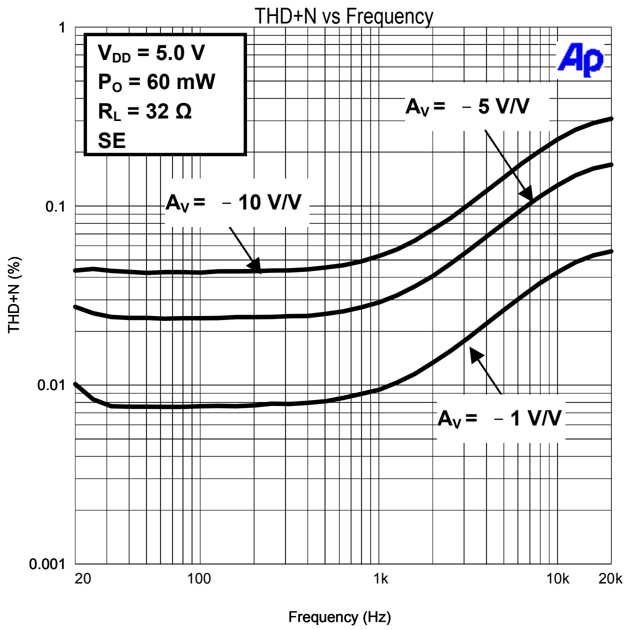

THD+N vs Output Power
f = 20k Hz
f = 10k Hz
f = 1k Hz
f = 20 Hz
$V_{DD}$ = 5.0 V
$R_L$ = 8 Ω
$A_V$ = －2 V/V
BTL
THD+N (%)
Output Power (W)
10
1
0.1
0.01
0.01
0.1
1
2

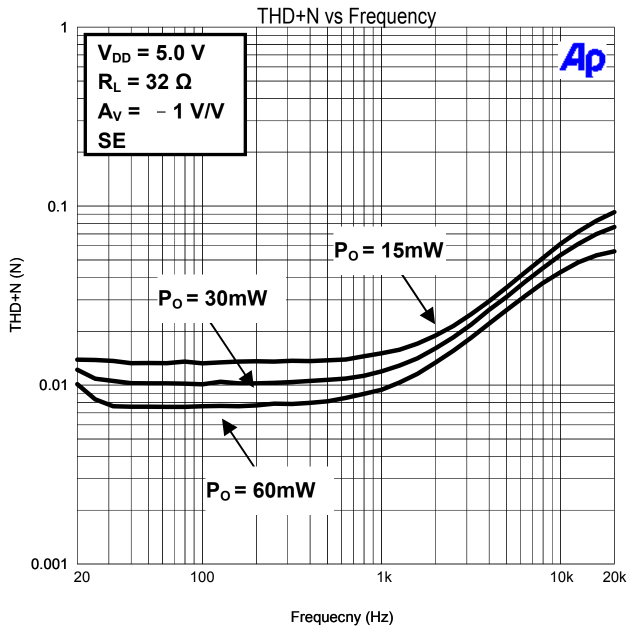

THD+N vs Frequency
VDD = 3.3 V
PO = 30 mW
RL = 32 Ω
SE
AV = －5 V/V
AV = －10 V/V
AV = －1 V/V
THD+N (%)
Frequency (Hz)
1
0.1
0.01
0.001
20
100
1k
10k
20k

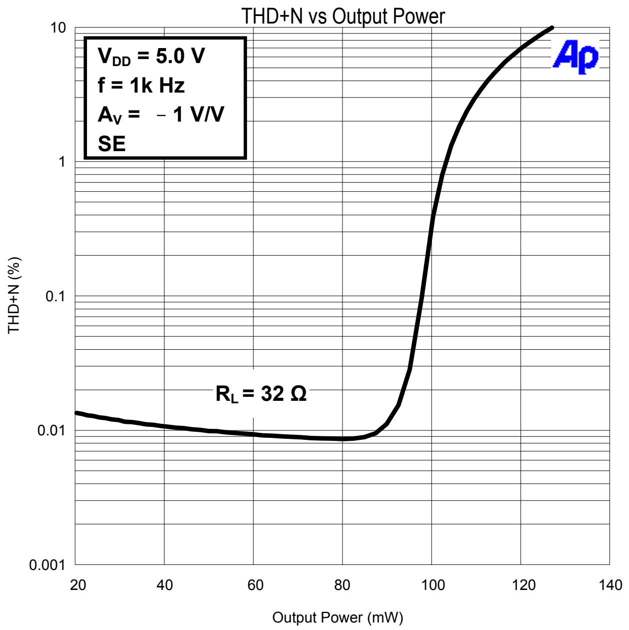

THD+N vs Frequency
VDD = 3.3 V
RL = 32 Ω
AV = －1 V/V
SE
PO = 30mW
PO = 15mW
PO = 10mW
THD+N (N)
Frequecny (Hz)
1
0.1
0.01
0.001
20
100
1k
10k
20k

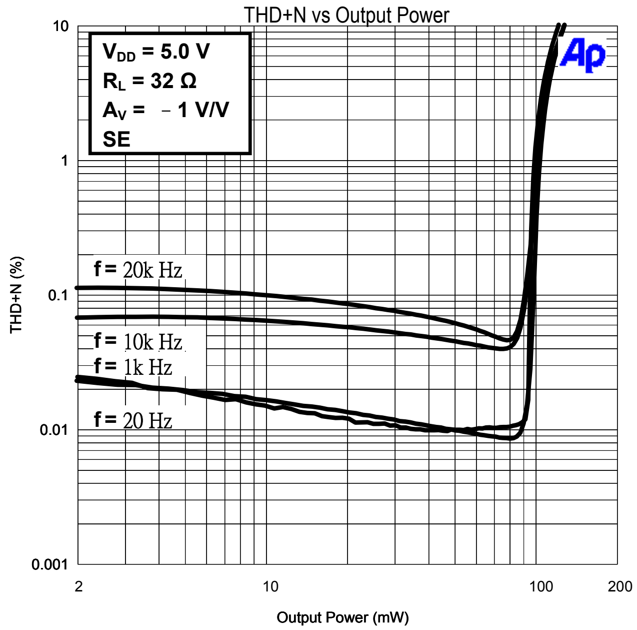

THD+N vs Output Power
VDD = 3.3 V
f = 1k Hz
AV = －1 V/V
SE
RL = 32 Ω
THD+N (%)
Output Power (mW)
10
1
0.1
0.01
0.001
20
25
30
35
40
45
50
55
60

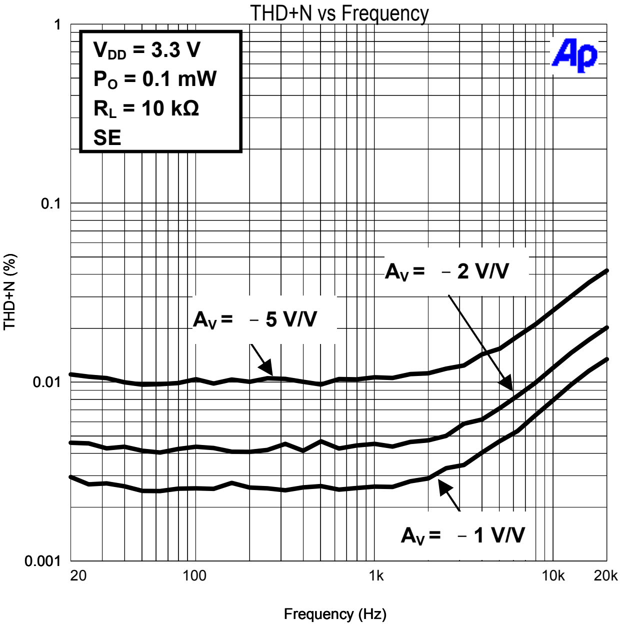

THD+N vs Output Power
VDD = 3.3 V
RL = 32 Ω
AV = －1 V/V
SE
f = 20k Hz
f = 10k Hz
f = 1k Hz
f = 20 Hz
THD+N (%)
Output Power (mW)
10
1
0.1
0.01
0.001
2
10
100

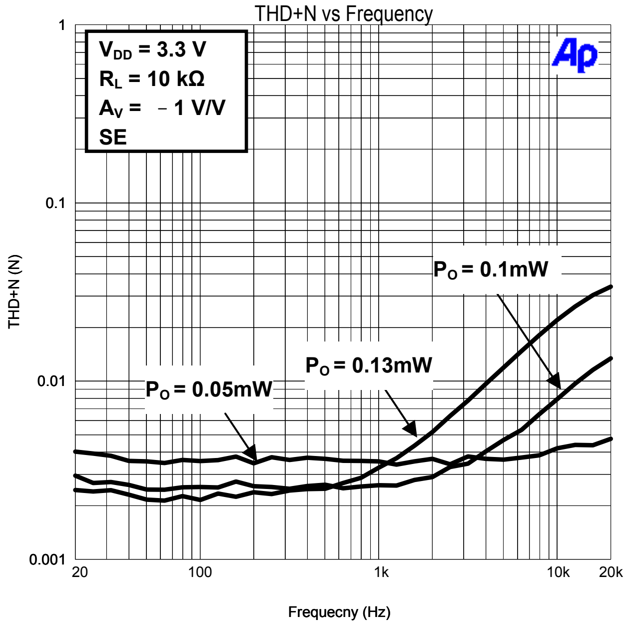

THD+N vs Frequency
$V_{DD}$ = 5.0 V
$P_O$ = 60 mW
$R_L$ = 32 Ω
SE
$A_V$ = －5 V/V
$A_V$ = －10 V/V
$A_V$ = －1 V/V
THD+N (%)
Frequency (Hz)

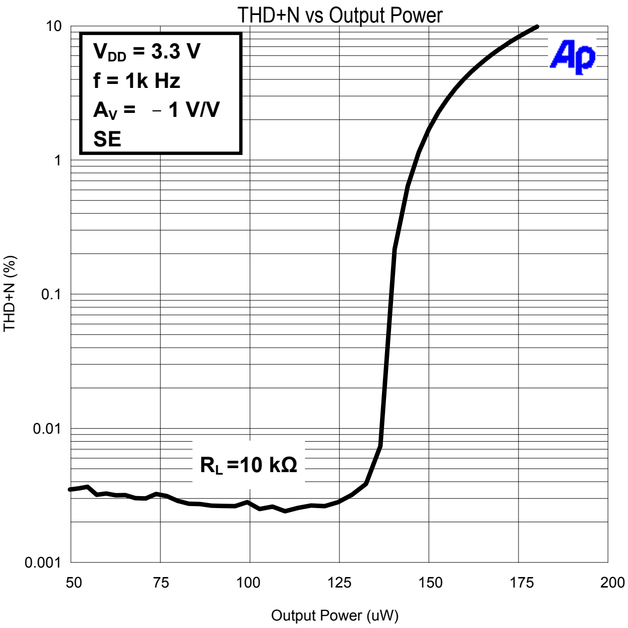

THD+N vs Frequency
$V_{DD}$ = 5.0 V
$R_L$ = 32 Ω
$A_V$ = －1 V/V
SE
$P_O$ = 15mW
$P_O$ = 30mW
$P_O$ = 60mW
THD+N (N)
Frequecny (Hz)

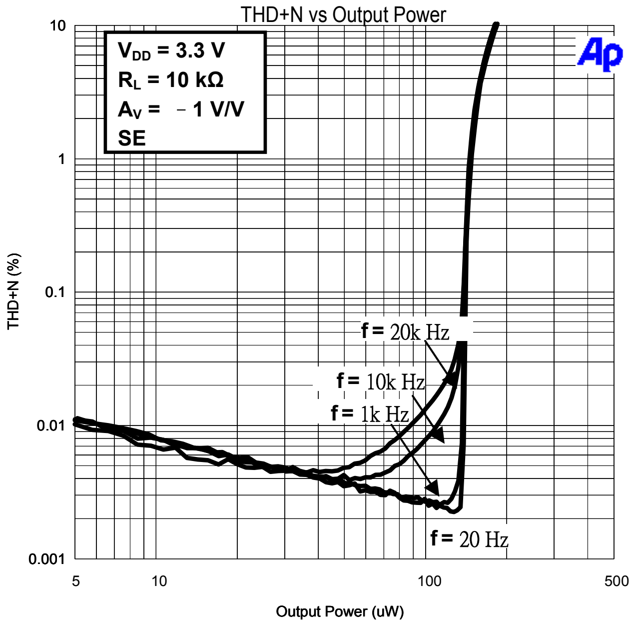

THD+N vs Output Power
$V_{DD}$ = 5.0 V
f = 1k Hz
$A_V$ = －1 V/V
SE
$R_L$ = 32 Ω
THD+N (%)
Output Power (mW)

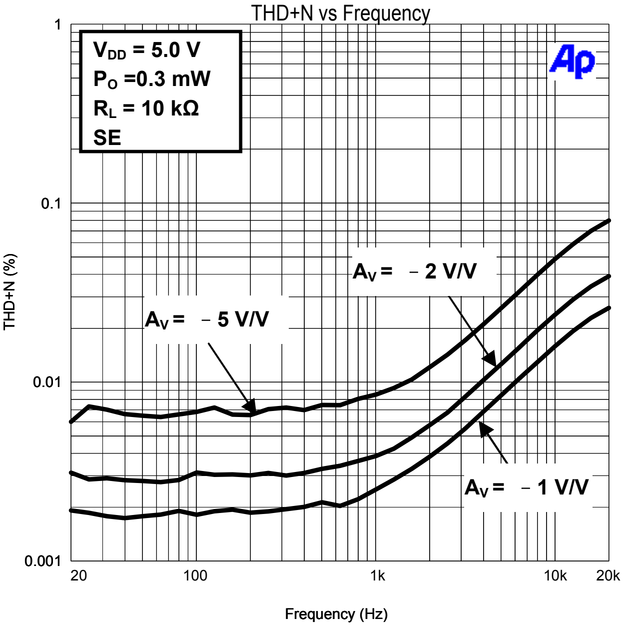

THD+N vs Output Power
$V_{DD}$ = 5.0 V
$R_L$ = 32 Ω
$A_V$ = －1 V/V
SE
f = 20k Hz
f = 10k Hz
f = 1k Hz
f = 20 Hz
THD+N (%)
Output Power (mW)

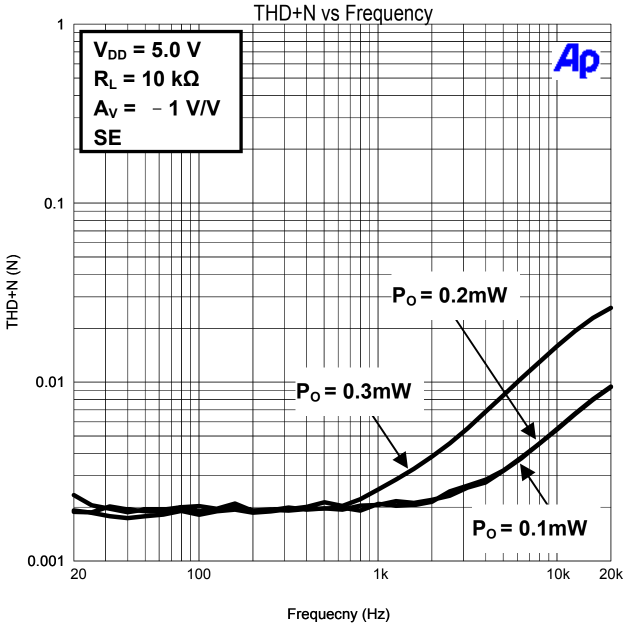

THD+N vs Frequency
VDD = 3.3 V
PO = 0.1 mW
RL = 10 kΩ
SE
AV = －2 V/V
AV = －5 V/V
AV = －1 V/V
THD+N (%)
Frequency (Hz)
1
0.1
0.01
0.001
20
100
1k
10k
20k

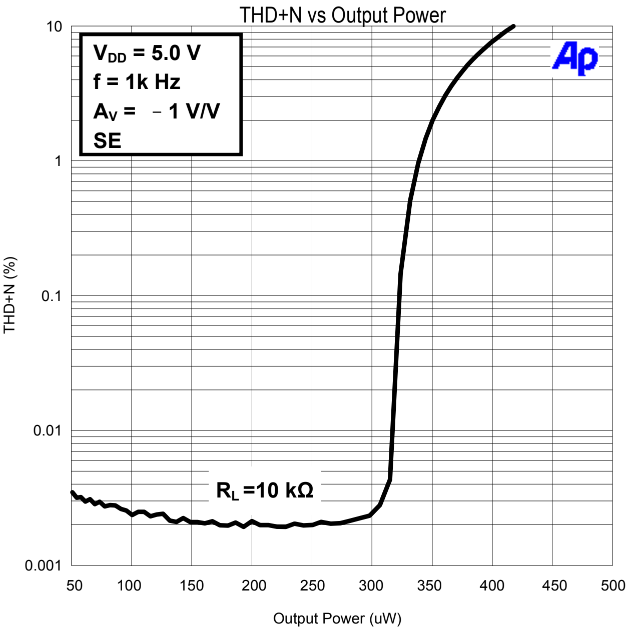

THD+N vs Frequency
VDD = 3.3 V
RL = 10 kΩ
AV = －1 V/V
SE
PO = 0.1mW
PO = 0.13mW
PO = 0.05mW
THD+N (N)
Frequecny (Hz)
1
0.1
0.01
0.001
20
100
1k
10k
20k

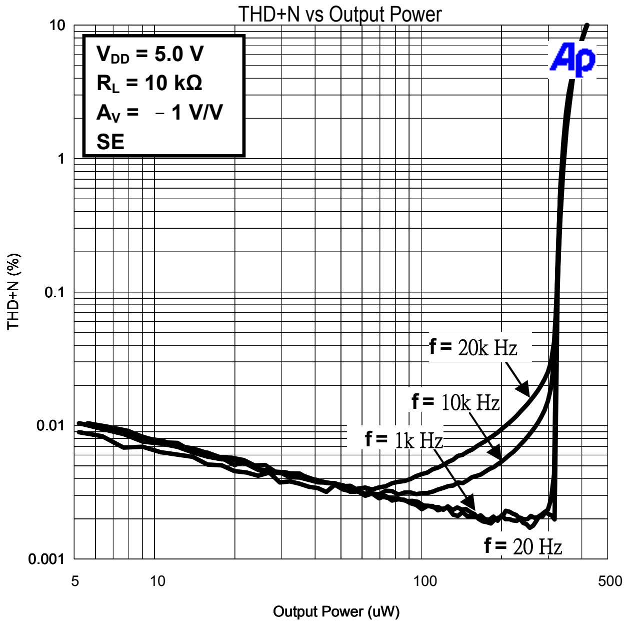

THD+N vs Output Power
VDD = 3.3 V
f = 1k Hz
AV = －1 V/V
SE
RL =10 kΩ
THD+N (%)
Output Power (uW)
10
1
0.1
0.01
0.001
50
75
100
125
150
175
200


THD+N vs Output Power
VDD = 3.3 V
RL = 10 kΩ
AV = －1 V/V
SE
f = 20k Hz
f = 10k Hz
f = 1k Hz
f = 20 Hz
THD+N (%)
Output Power (uW)
10
1
0.1
0.01
0.001
5
10
100
500

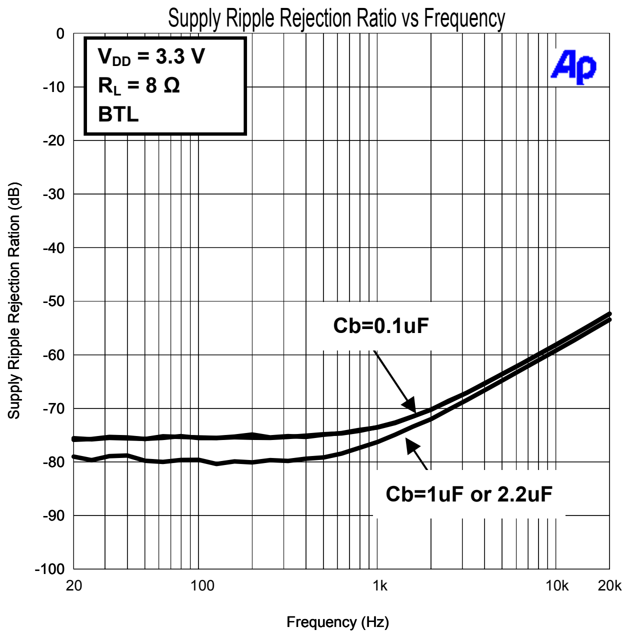

THD+N vs Frequency
$V_{DD}$ = 5.0 V
$P_O$ =0.3 mW
$R_L$ = 10 kΩ
SE
$A_V$ = －2 V/V
$A_V$ = －5 V/V
$A_V$ = －1 V/V
THD+N (%)
1
0.1
0.01
0.001
20
100
1k
10k
20k
Frequency (Hz)

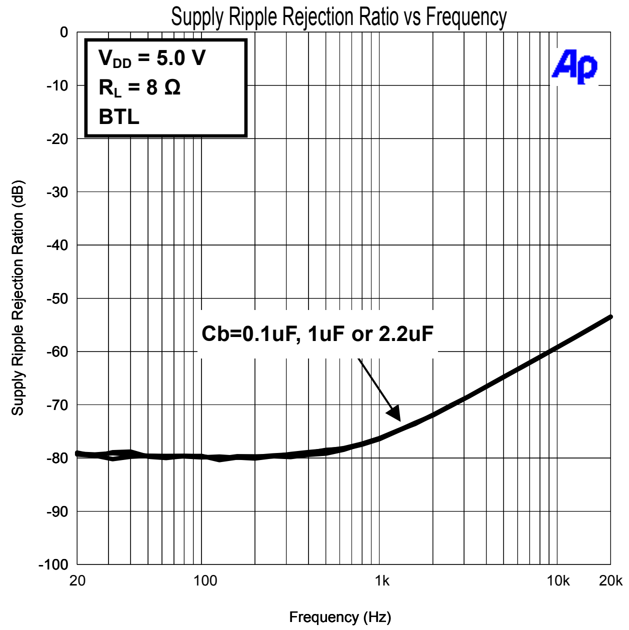

THD+N vs Frequency
$V_{DD}$ = 5.0 V
$R_L$ = 10 kΩ
$A_V$ = －1 V/V
SE
$P_O$ = 0.2mW
$P_O$ = 0.3mW
$P_O$ = 0.1mW
THD+N (N)
1
0.1
0.01
0.001
20
100
1k
10k
20k
Frequecny (Hz)

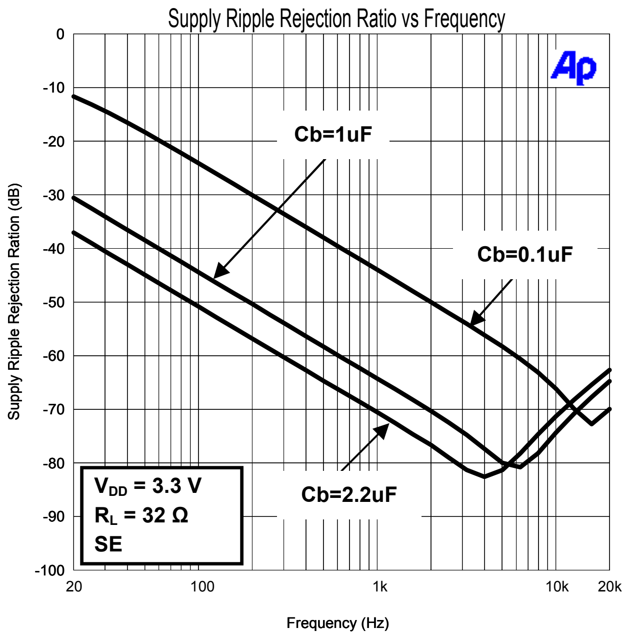

THD+N vs Output Power
$V_{DD}$ = 5.0 V
f = 1k Hz
$A_V$ = －1 V/V
SE
$R_L$ =10 kΩ
THD+N (%)
10
1
0.1
0.01
0.001
50
100
150
200
250
300
350
400
450
500
Output Power (uW)

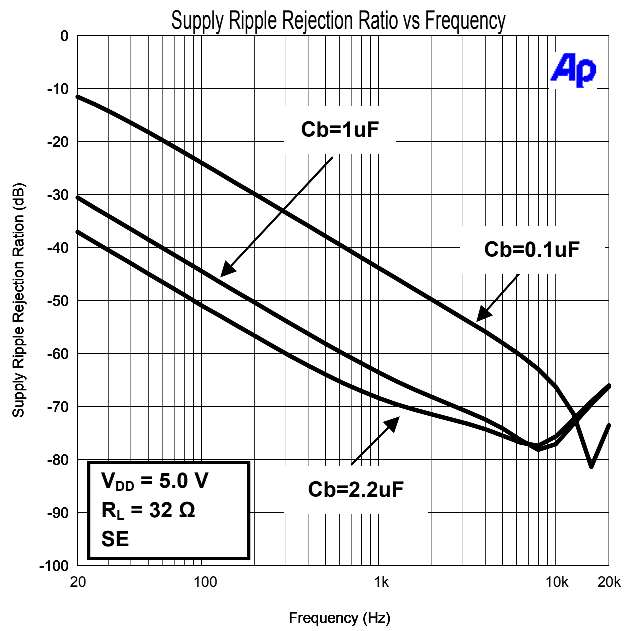

THD+N vs Output Power
$V_{DD}$ = 5.0 V
$R_L$ = 10 kΩ
$A_V$ = －1 V/V
SE
f = 20k Hz
f = 10k Hz
f = 1k Hz
f = 20 Hz
THD+N (%)
10
1
0.1
0.01
0.001
5
10
100
500
Output Power (uW)

### 5.4.3. Supply ripple rejection ratio vs. frequency

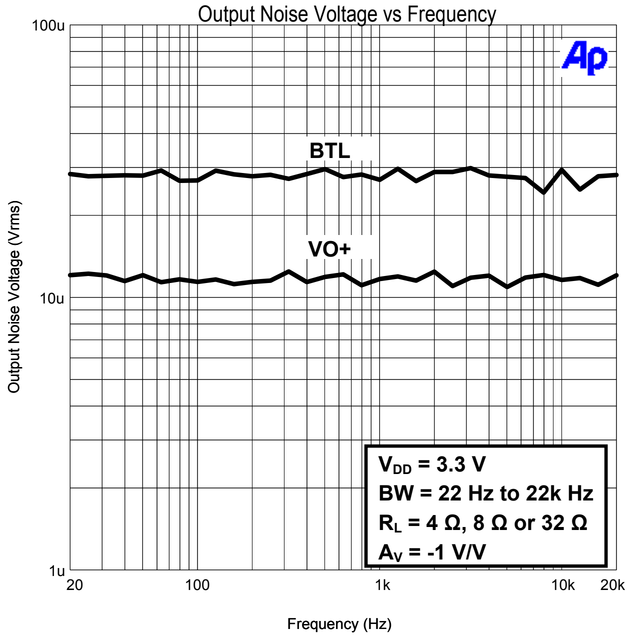


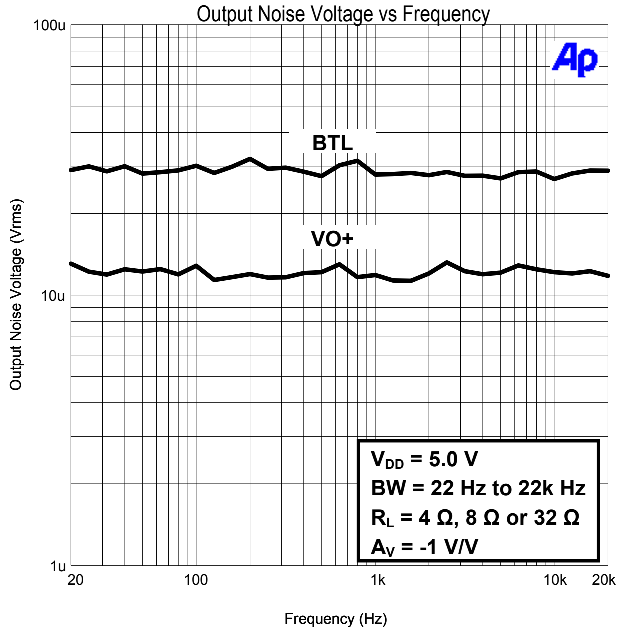



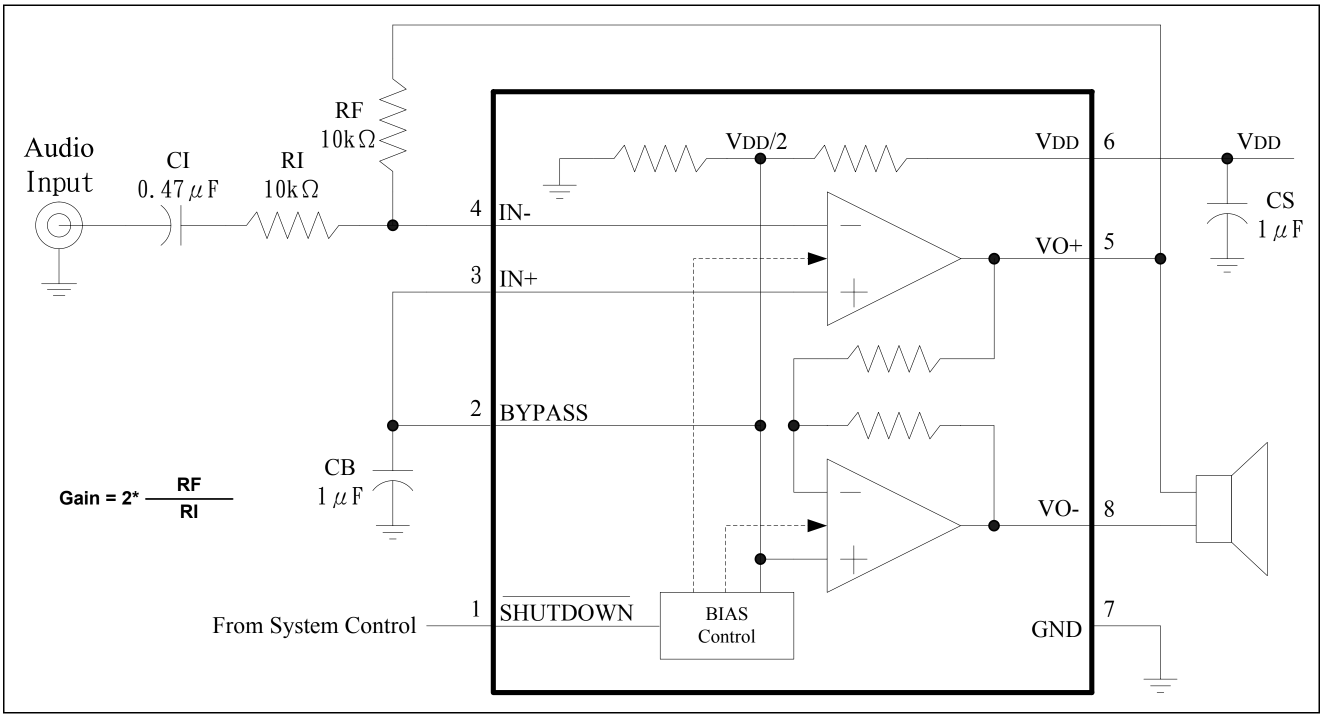
### 5.4.4. Noise


Output Noise Voltage vs Frequency
100u
10u
1u
Output Noise Voltage (Vrms)
BTL
VO+
20
100
1k
10k
20k
Frequency (Hz)
$V_{DD}$ = 3.3 V
BW = 22 Hz to 22k Hz
$R_L$ = 4 Ω, 8 Ω or 32 Ω
$A_V$ = -1 V/V

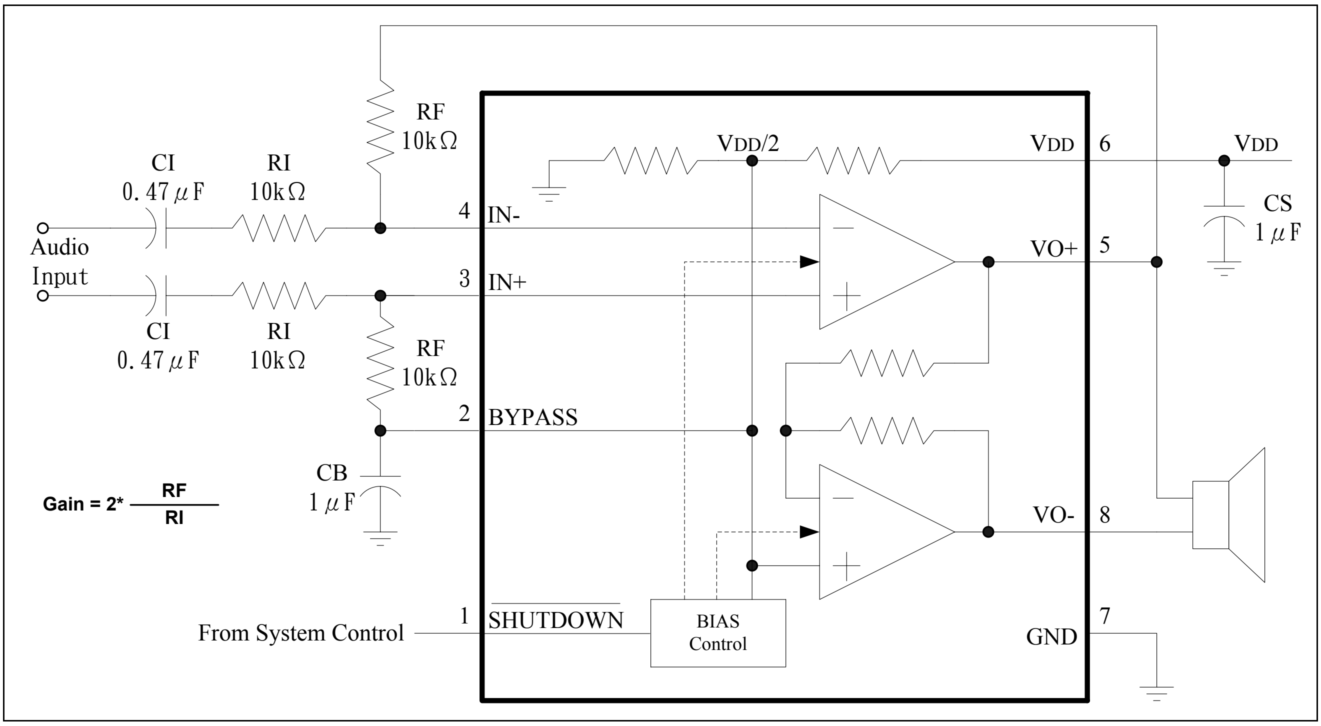

Output Noise Voltage vs Frequency
100u
10u
1u
Output Noise Voltage (Vrms)
BTL
VO+
20
100
1k
10k
20k
Frequency (Hz)
$V_{DD}$ = 5.0 V
BW = 22 Hz to 22k Hz
$R_L$ = 4 Ω, 8 Ω or 32 Ω
$A_V$ = -1 V/V

## 6. APPLICATION INFORMATION

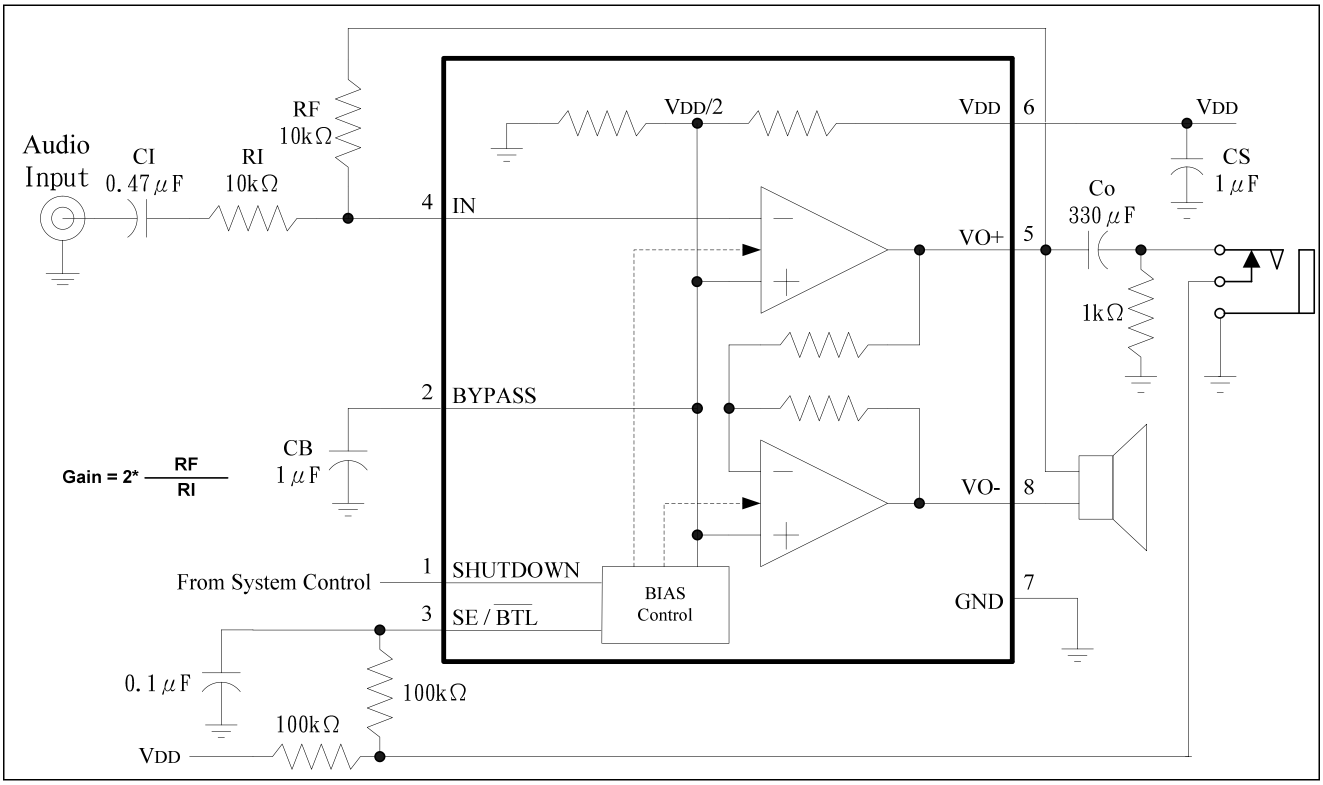
### 6.1. GPY0031A Typical Application Circuit




### 6.2. GPY0031A Differential Input Application Circuit



### 6.3. GPY0032A Typical Application Circuit




### 6.4. BTL Amplifier Efficiency

The following equations are basis for calculating amplifier efficiency.

$$\text{Efficiency} = \frac{\text{Output Power}}{\text{Input Power}} = \frac{P_{OUT}}{P_{SUP}} \quad (1)$$

Where

$$P_{OUT} = \frac{V_{O.RMS}^2}{R_L} = \frac{V_P^2}{2R_L} \quad (2)$$

$$V_{O.RMS} = \frac{V_P^2}{\sqrt{2}} \quad (3)$$

$$P_{SUP} = V_{DD} \times I_{DD.AVG} = V_{DD} \times \frac{2V_P}{\pi R_L} \quad (4)$$

Efficiency of a BTL configuration:

$$\frac{P_{OUT}}{P_{SUP}} = \frac{\pi V_P}{4V_{DD}} \quad (5)$$

$$P_D = P_{SUP} - P_{OUT} \quad (6)$$

**Table-1 Efficiency vs. Output Power in 3.3V 8Ω BTL System**

| $P_{OUT}$ (W) | Efficiency (%) | $V_P$ (V) | $P_D$ (W) |
|---|---|---|---|
| 0.125 | 33.6 | 1.41 | 0.26 |
| 0.250 | 47.6 | 2.00 | 0.29 |
| 0.375 | 58.3 | 2.45* | 0.28 |

* High-peak voltage values cause the THD to increase.

### 6.5. Power Dissipation

Power Dissipation is major concern when designing a successful amplifier, whether the amplifier is bridged or single-ended. Equation 7 states the maximum power dissipation point for a single-ended mode operating at a given supply voltage and driving a specified output load.

$$P_{D.MAX} = (V_{DD})^2/(2\pi^2 R_L) \qquad \text{Single-Ended (7)}$$

However, a direct consequence of the increased power delivered to the load by bridge amplifier is an increment in internal power dissipation point for a bridge amplifier operating at the same conditions.

$$P_{D.MAX} = 4(V_{DD})^2/(2\pi^2 R_L) \qquad \text{Bridge-Mode (8)}$$

Since the GPY0031A/32A has two operational amplifiers in one package, the maximum internal power dissipation is four times that of a single-end amplifier. The maximum power dissipation from equation 8 must not be greater than the power dissipation that results from the equation 9.

$$P_{D.MAX} = (T_{J.MAX} - T_J) / \theta_{JA} \qquad (9)$$

For SOP-8 package with and without thermal pad, the thermal resistance ($\theta_{JA}$) is equal to 60°C/W and 160°C/W, respectively.

Since the maximum junction temperature ($T_{J.MAX}$) of GPY0031A/32A is 150°C and ambient temperature ($T_A$) is defined by the power system design, the maximum power dissipation which the IC package is able to handle from equation 9. Once the power dissipation is greater than the maximum limit ($P_{D.MAX}$), either the supply voltage ($V_{DD}$) must be decreased, the load impedance ($R_L$) must be increased, or the $\theta_{JA}$ must be reduced with heat-sink.

Example: $V_{DD}$=6.0V, Load=8Ω, $T_A$=30°C, GPY0031A SOP-8 without thermal pad ($\theta_{JA}$=160°C/W).

From equation 9:
$P_{D.MAX} = (150-30)/160 = 0.75W < 4(V_{DD})^2/(2\pi^2 R_L) = 0.913W$

Decrease Power Voltage $V_{DD}$ to 5V.
$P_{D.MAX} = (150-30)/160 = 0.75W > 4(V_{DD})^2/(2\pi^2 R_L) = 0.634W$

### 6.6. Thermal Pad Considerations

The thermal pad must be connected to ground. The package with thermal pad of the GPY0031A/32A requires special attention on thermal design. If the thermal design issues are not properly addressed, the GPY0031A/32A will go into thermal shutdown when driving an 8Ω load.

Thermal pad on the bottom of the GPY0031A/32A should be soldered down to a copper pad on the circuit board. Heat can be conducted away from the thermal pad through the copper plane to ambient. The copper plane used to conduct heat away from the thermal pad should be as large as practical.

If the ambient temperature is higher than 25°C, a larger copper plane or forced-air cooling will be required to keep the GPY0031A/32A junction temperature below thermal shutdown temperature (150°C).

In higher ambient temperature, higher airflow rate and/or larger copper area will be required to keep the IC out of thermal shutdown.

Table-2 Output Power vs. Junction Temperature in BTL System ($T_A$=25°C)

| Output Power $P_{OUT}$ (W) | Efficiency (%) | Internal Dissipation $P_D$ (W) | Power From Supply $P_{SUP}$ (W) | $V_{OUT}$ Peak-to-Peak $V_P$ (V) | Junction Temperature $T_J$ – SOP-8 (°C) | Junction Temperature $T_J$ – MSOP-8 (°C) | Junction Temperature $T_J$ – SOP-8-P / MSOP-8-P (°C) |
|---|---|---|---|---|---|---|---|
| $V_{DD}$ = 3.3V, Load=4Ω System | | | | | | | |
| 0.5 | 47.6 | 0.55 | 1.05 | 2.00 | 113.0 | 135.0 | 58.0 |
| 0.8 | 60.2 | 0.53 | 1.33 | 2.53 | 109.8 | 131.0 | 56.8 |
| 1.1 | 70.7 | 0.46 | 1.56 | 2.97 | 98.6 | 117.0 | 52.6 |
| $V_{DD}$ = 5V, Load=4Ω System | | | | | | | |
| 0.5 | 31.4 | 1.09 | 1.59 | 2.00 | **199.4*** | **243.0*** | 90.4 |
| 1 | 44.0 | 1.25 | 2.25 | 2.83 | **225.0*** | **275.0*** | 100.0 |
| 2 | 62.8 | 1.18 | 3.18 | 4.00 | **213.8*** | **261.0*** | 95.8 |
| $V_{DD}$ = 6V, Load=4Ω System | | | | | | | |
| 0.5 | 26.2 | 1.41 | 1.91 | 2.00 | **250.6*** | **307.0*** | 109.6 |
| 1 | 37.0 | 1.70 | 2.70 | 2.83 | **297.0*** | **365.0*** | 127.0 |
| 2 | 52.3 | 1.82 | 3.82 | 4.00 | **316.2*** | **389.0*** | 134.2 |
| $V_{DD}$ = 3.3V, Load=8Ω System | | | | | | | |
| 0.25 | 47.6 | 0.28 | 0.53 | 2.00 | 69.8 | 81.0 | 41.8 |
| 0.4 | 60.2 | 0.26 | 0.66 | 2.53 | 66.6 | 77.0 | 40.6 |
| 0.55 | 70.7 | 0.22 | 0.77 | 2.97 | 60.2 | 69.0 | 38.2 |
| $V_{DD}$ = 5V, Load=8Ω System | | | | | | | |
| 0.5 | 44.4 | 0.63 | 1.13 | 2.83 | 125.8 | **151.0*** | 62.8 |
| 1 | 62.8 | 0.59 | 1.59 | 4.00 | 119.4 | 143.0 | 60.4 |
| 1.27 | 70.7 | 0.52 | 1.79 | 4.50 | 108.2 | 129.0 | 56.2 |
| $V_{DD}$ = 6V, Load=8Ω System | | | | | | | |
| 0.5 | 37.0 | 0.85 | 1.35 | 2.83 | **161.0*** | **195.0*** | 76.0 |
| 1 | 52.3 | 0.91 | 1.91 | 4.00 | **170.6*** | **207.0*** | 79.6 |
| 1.82 | 70.7 | 0.76 | 2.58 | 5.40 | 146.6 | **177.0*** | 70.6 |

*** $T_J$ must be less than $T_{J,MAX}$ (150°C).**

**** $T_J = \theta_{JA} \times P_D + T_A$ ; $\theta_{JA}$(SOP-8) = 160°C/W ; $\theta_{JA}$(MSOP-8) = 200°C/W; $\theta_{JA}$(SOP-8-P or MSOP-8-P) = 60°C/W**

## 7. PACKAGE/PAD LOCATIONS

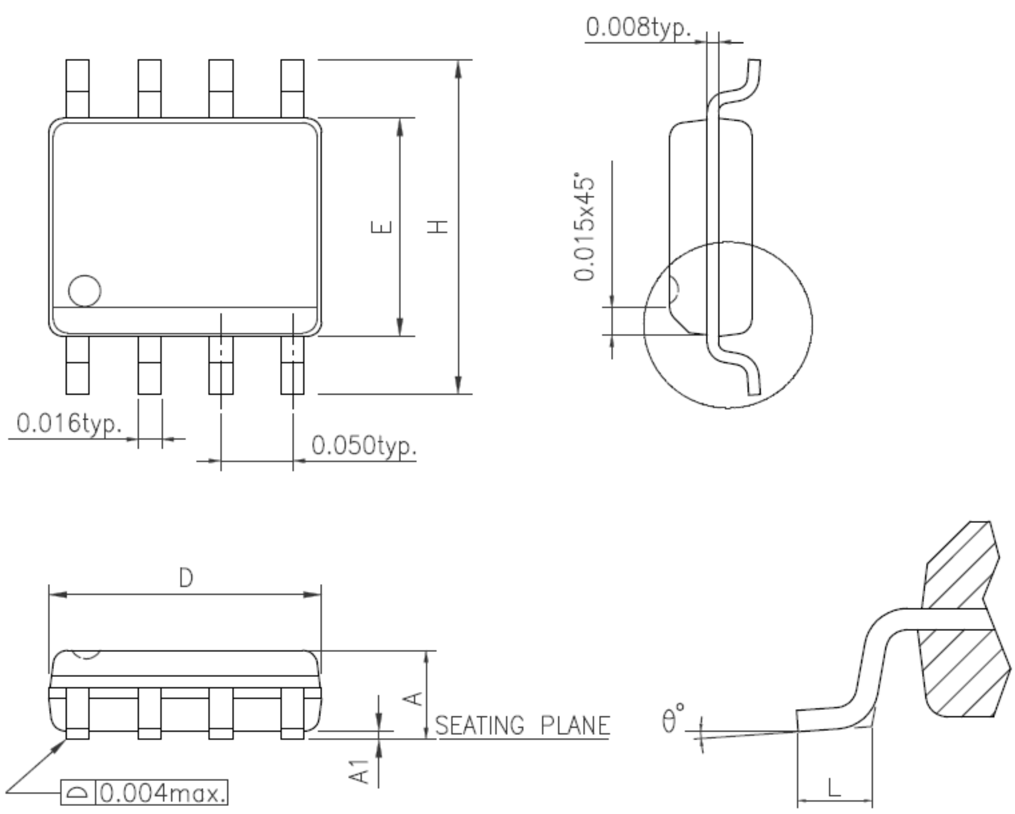
### 7.1. Ordering Information

| Product Number | Package Type |
|---|---|
| GPY0031A – HS011 | Green Package – SOP-8 (150mil) |
| GPY0031A – HS141 | Green Package – SOP-8-P With Thermal PAD (150mil) |
| GPY0032A – HS01x | Green Package – SOP-8 (150mil) |

**Note:** Package form number (x = 1 - 9, serial number).

### 7.2. Package Information

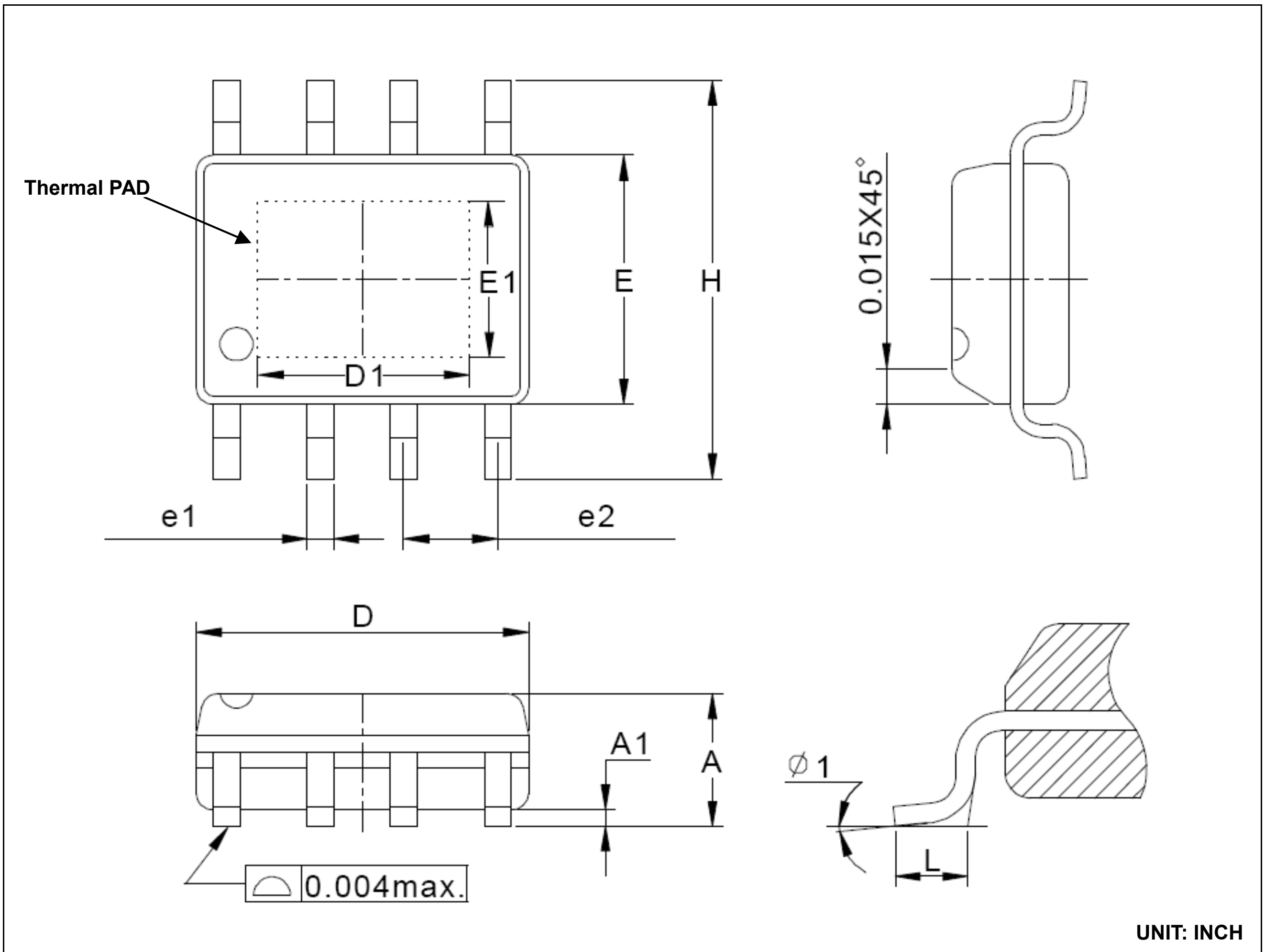
#### 7.2.1. SOP-8




**UNIT: INCH**

| Symbol | Dimension in inch | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| **A** | 0.053 | - | 0.069 |
| **A1** | 0.004 | - | 0.010 |
| **D** | 0.189 | - | 0.196 |
| **E** | 0.150 | - | 0.157 |
| **H** | 0.228 | - | 0.244 |
| **L** | 0.016 | - | 0.050 |
| **θº** | 0 | - | 8 |

### 7.2.2. SOP-8-P




| Symbol | Dimension in inch | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| **A** | 0.053 | - | 0.067 |
| **A1** | 0.000 | - | 0.006 |
| **D** | 0.189 | | 0.196 |
| **D1** | 0.077 | - | 0.090 |
| **E** | 0.150 | - | 0.157 |
| **E1** | 0.077 | - | 0.090 |
| **H** | 0.228 | - | 0.244 |
| **L** | 0.016 | - | 0.050 |
| **e1** | - | 0.016 | - |
| **e2** | - | 0.050 | - |
| **Φ1** | 8° | | |

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## 9. REVISION HISTORY

| Date | Revision # | Description | Page |
|---|---|---|---|
| MAR. 14, 2014 | 1.5 | 1. Modify Package Pin Assignment in section 4.1.<br>2. Modify Thermal Characteristics in section 5.2.<br>3. Modify Order Information in section 7.1.<br>4. Delete MSOP-8 and MSOP-8-P Package Information in section 7.2.3 and 7.2.4 | 6<br>7<br>24<br>26-27 |
| JAN. 18, 2010 | 1.4 | 1. Modify Order Information in section 7.1. | 25 |
| SEP. 08, 2009 | 1.3 | 1. Modify Package Pin Assignment in section 4.1.<br>2. Modify Thermal Characteristics in section 5.2.<br>3. Add Current Limitation in section 5.3.<br>4. Add BTL Amplifier Efficiency in section 6.4.<br>5. Add Power Dissipation in section 6.5.<br>6. Add Thermal Pad Considerations in section 6.6.<br>7. Add Table 2. Output Power vs. Junction Temperature in BTL System in section 6.<br>8. Modify Ordering Information in section 7.1.<br>9. Add MSOP-8 Package Information in section 7.2.3.<br>10. Add MSOP-8-P Package Information in section 7.2.4. | 6<br>7<br>7-8<br>21<br>21-22<br>22<br>23<br>24<br>26<br>27 |
| JUL. 14, 2009 | 1.2 | 1. Modify Signal Description in section 4.<br>2. Modify Thermal Characteristics in section 5.2 | 5<br>7 |
| MAY 06, 2009 | 1.1 | 1. Modify Feature in section 2.<br>2. Modify DC Characteristics in section 5.3. | 3<br>7, 8 |
| DEC. 19, 2008 | 1.0 | 1. Modify the title page for 2.0W Audio Power Amplifier.<br>2. Modify Package Pin Assignment in section 4.1.<br>3. Modify DC Characteristics in section 5.3.<br>4. Modify Typical Performance Characteristics in section 5.4.<br>5. Modify Ordering Information section 7.1.<br>6. Modify Package Information in section 7.2. | 1<br>6<br>7<br>9<br>22<br>22 |
| AUG. 20, 2008 | 0.1 | Original | 16 |