# APA4863

Stereo 2.2W Audio Power Amplifier

## Features

- Depop Circuitry Integrated
- Thermal Shutdown Circuitry Integrated
- Bridge-Tied Load (BTL) or Single-Ended (SE) Modes Operation
- Output Power at 1% THD+N, $V_{DD}$=5V
  - 2.2W/Ch (typ) into a 3 Ω Load
  - 1.8W/Ch (typ) into a 4 Ω Load
  - 1.2 W/Ch (typ) into a 8 Ω Load
- Shutdown Control Mode, $I_{SD}$= 0.5 µA
- Output Power (SE) at 0.5% THD+N, $V_{DD}$=5V
  - 90mW/Ch (typ.) into a 32Ω Load
- Various Power Packages Available SOP, TSSOP, TSSOP-P

## Applications

- Stereo Audio Power Amplifier for Notebook Computer
- Portable Televisions
- Portable and Desktop Computers

## General Description

The APA4863 is a stereo bridge-tied audio power amplifier in various power packages , including SOP , TSSOP and TSSOP-P . When connecting to a 5V voltage supply , the APA4863 is capable of delivering 2.2W/1.8W/1.2W of continuous RMS power per channel into 3Ω/4Ω/8Ω bridge-tied loads with less than 1% THD+N respectively . When APA4863 operates in the single-ended load , it is capable of delivering 90mW of continuous RMS power per channel into 32Ω load . The APA4863 simplifies design and frees up board space for other features .

The APA4863 also served well in low-voltage applications , which provides 750mW (1% THD+N) per channel into 4Ω loads with a 3.3V supply voltage . Both of the depop circuitry and the thermal shutdown protection circuitry are integrated in the APA4863 , that reduces pops and clicks noise during power up and when using the shutdown mode and protects the chip from being destroyed by over-temperature failure . To simplify the audio system design in notebook computer applications , the APA4863 combines a stereo bridge-tied loads mode for speaker drive and a stereo single-end mode for headphone drive into a single chip , where both modes are easily switched by the HP-IN input control pin signal . For power sensitive applications , the APA4863 also features a shutdown function which keeps the supply current only 0.5 µA (typ.) .

## Ordering Information

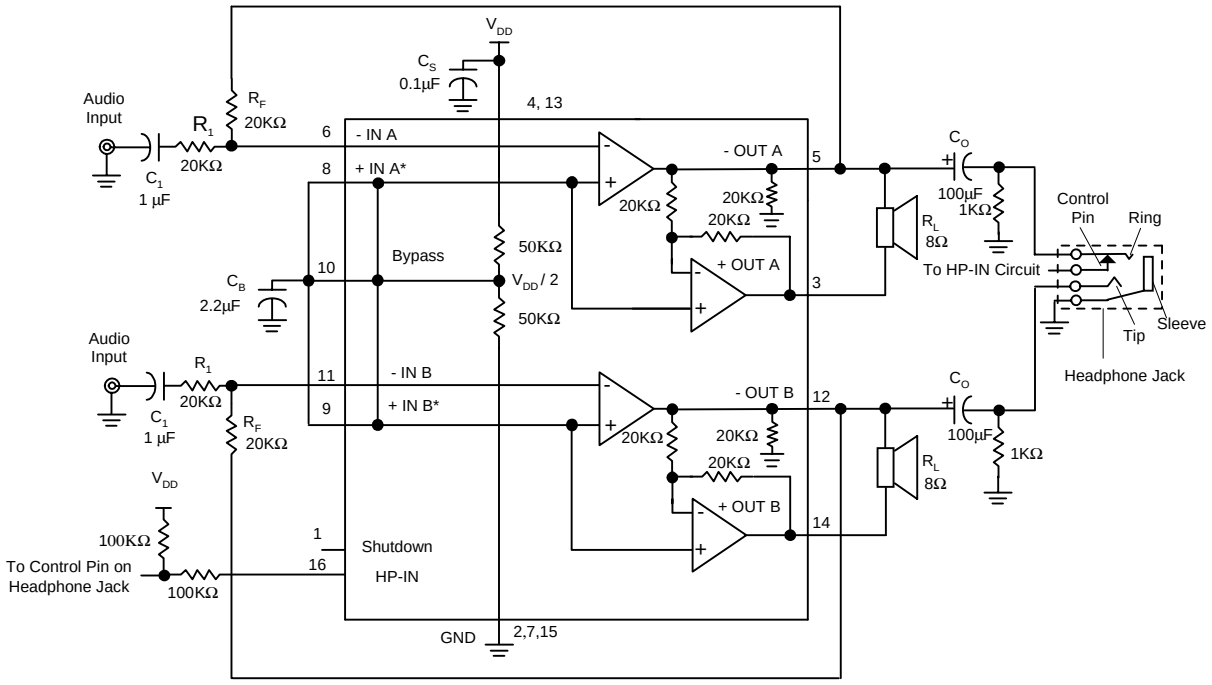
APA4863 □□-□□

- Handling Code
- Temp. Range
- Package Code

Package Code
K: SOP
O: TSSOP R: TSSOP-P*
Temp. Range
I : -40 to 85 °C
Handling Code
TU : Tube
TR : Tape & Reel TY: Tray

* TSSOP-P is a standard TSSOP package with a thermal pad exposed on the bottom of the package.

## Block Diagram




* +INA and +INB pins are connected to Bypass pin inside the IC.

## Absolute Maximum Ratings

(Over operating free-air temperature range unless otherwise noted.)

| Symbol | Parameter | Rating | Unit |
|---|---|---|---|
| $V_{DD}$ | Supply Voltage | 6 | V |
| $T_A$ | Operating Ambient Temperature Range | -40 to 85 | °C |
| $T_J$ | Maximum Junction Temperature | 150 | °C |
| $T_{STG}$ | Storage Temperature Range | -65 to +150 | °C |
| $T_S$ | Soldering Temperature,10 seconds | 260 | °C |
| $V_{ESD}$ | Electrostatic Discharge | -2000 to 2000 *1 | V |

Note: *1. Human body model : C=100pF, R=1500Ω, 3 positive pulses plus 3 negative pulses

## Recommended Operating Conditions

| | | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage, $V_{DD}$ | | | 3 | 5 | 5.5 | V |
| Operating free-air temperature, $T_A$ | $V_{DD}$=5V, 250mW/Ch average power | 4-Ω stereo BTL drive, with proper PCB design | -20 | | 85 | °C |
| | $V_{DD}$=5V, 1.8 W/Ch average power | 4-Ω stereo BTL drive, with proper PCB design and 300 CFM forced-air cooling | -20 | | 85 | |
| Common mode input voltage, $V_{ICM}$ | $V_{DD}$=5 V | | 1.25 | | 4.5 | V |
| | $V_{DD}$=3.3V | | 1.25 | | 2.7 | |

## Dissipation Rating Table

| Package | Air Flow (CFM) | Thermal Resistance $\theta_{JA}$(°C/W) | $T_A$≤25°C | $T_A$=70°C |
|---|---|---|---|---|
| SO16 + | 0 | 50 | 2.5W | 1.6W |
| TSSOP ++ | 0 | 73.2 | 1.7W | 1.1W |
| | 200 | 66.6 | 1.8W | 1.2W |
| TSSOP-P ++ | 0 | 37.6 | 3.3W | 2.1W |
| | 200 | 32.3 | 3.8W | 2.4W |

+ : The parameter is measured with the recommended copper heat sink pattern on an 2-layer PCB, 11.7 $in^2$ 3.0×2.4 $in^2$ in PCB, 1oz. copper, 3.0×1.5 $in^2$ in coverage at Top-layer and Bottom-layer at 100% coverage (7.2$in^2$).
++:The parameter is measured with the JEDEC standard test boards (multi-layer PCB).

## Electical Characteristics

### Electrical Characteristics for Entire IC

The following specifications apply for $V_{DD}$= 5V unless otherwise noted. Limits apply for $T_A$= 25°C

| Symbol | Parameter | Test Conditions | APA4863 | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $V_{DD}$ | Supply Voltage | | 3 | | 5.5 | V |
| $I_{DD}$ | Quiescent Power Supply Current | $V_{IN}$=0V, $I_O$=0A, HP-IN=0V | | 9 | 13.5 | mA |
| | | $V_{IN}$=0V, $I_O$=0A, HP-IN=4V | | 5 | 7.5 | |
| $I_{SD}$ | Shutdown Current | $V_{PIN1}$= $V_{DD}$ | 5 | 0.5 | | µA |
| $V_{IH}$ | Headphone High Input Voltage | | 4 | | | V |
| $V_{IL}$ | Headphone Low Input Voltage | | | | 0.8 | V |

## Electical Characteristics Cont.

### Electrical Characteristics for BTL Mode Operation

The following specifications apply for $V_{DD}$= 5V unless otherwise noted. Limits apply for $T_A$= 25°C

| Symbol | Parameter | Test Conditions | APA4863 Typ. | Unit |
|---|---|---|---|---|
| $V_{OS}$ | Output Offset Voltage | $V_{IN}$=0V | 5 | mV |
| $P_O$ | Output Power | THD=1%, f=1kHz | | W |
| | | $R_L$=3Ω | 2.2 | |
| | | $R_L$=4Ω | 1.8 | |
| | | $R_L$=8Ω | 1.2 | |
| | | THD=10%, f=1kHz | | |
| | | $R_L$=3Ω | 2.7 | |
| | | $R_L$=4Ω | 2.3 | |
| | | $R_L$=8Ω | 1.5 | |
| THD+N | Total Harmonic Distortion + Noise | $A_{VD}$=2, f=1kHz | | % |
| | | $R_L$=4Ω , $P_O$=1.8W | 0.3 | |
| | | $R_L$=8Ω , $P_O$ =1W | 0.15 | |
| RSRR | Power Supply Rejection Ratio | $V_{DD}$=5V, $V_{RIPPLE}$=200$Mv_{Rms}$ , $R_L$=8Ω $C_B$=2.2µF | 64 | dB |
| $X_{TALK}$ | Channel Separation | f=1kHz , $C_B$=2.2µF, $P_O$=1W, $R_L$=8Ω | 90 | dB |
| SNR | Signal-to-Noise Ratio | $V_{DD}$=5V, $P_O$ =1.1W, $R_L$=8Ω | 95 | dB |

### Electrical Characteristics for SE Mode Operation

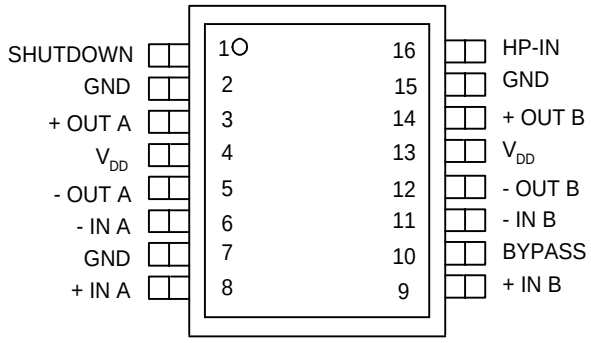
The following specifications apply for $V_{DD}$= 5V unless otherwise noted. Limits apply for $T_A$= 25°C

| Symbol | Parameter | Test Conditions | APA4863 Typ. | Unit |
|---|---|---|---|---|
| $V_{OS}$ | Output Offset Voltage | $V_{IN}$=0V | 5 | mV |
| $P_O$ | Output Power | THD=0.5%, f=1kHz, $R_L$=32Ω | 90 | mW |
| | | THD=1%, f=1kHz, $R_L$=8Ω | 320 | |
| | | THD=10%, f=1kHz, $R_L$=8Ω | 400 | |
| THD+N | Total Harmonic Distortion plus Noise | $A_V$= -1 , $P_O$=75mW, f=1kHz, $R_L$=32Ω | 0.02 | % |
| RSRR | Power Supply Rejection Ratio | $V_{RIPPLE}$=200mV $_{RMS}$ , f=1kHz, $C_B$=2.2µF, $R_L$=8Ω | 49 | dB |
| $X_{TALK}$ | Channel Separation | f=1kHz , $C_B$=2.2µF, $P_O$=32mW, $R_L$=32Ω | 85 | dB |
| SNR | Signal-to-Noise Ratio | $V_{DD}$=5V , $P_O$ =340mW, $R_L$=8Ω | 95 | dB |

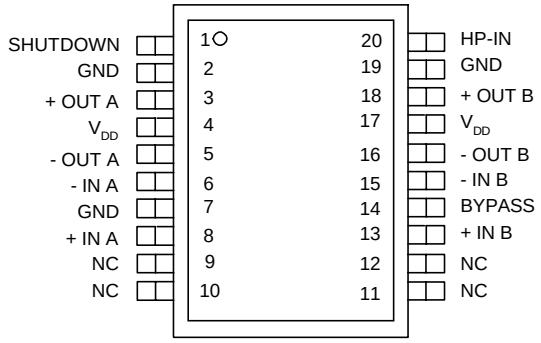
### Truth Table for Logic Inputs

| Shutdown | HP-IN | APA4863 Mode |
|---|---|---|
| Low | Low | Bridge -Tied |
| Low | High | Single-Ended |
| High | Low | APA4863 Shutdown |
| High | High | APA4863 Shutdown |

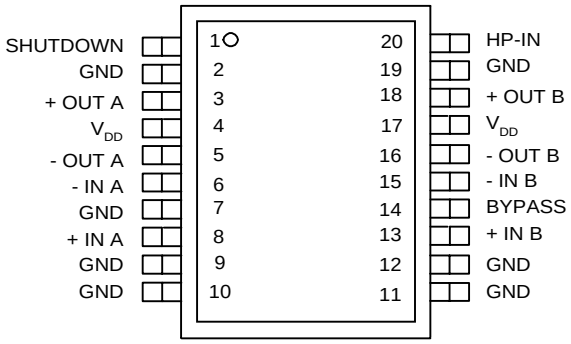
## Pin Description



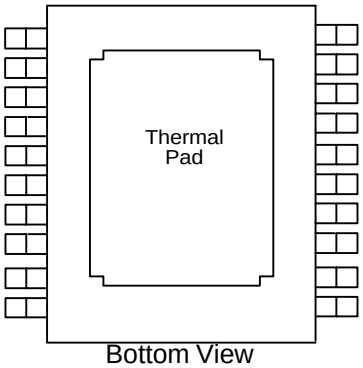

Top View
for SOP




Top View
for TSSOP




Top View
for TSSOP-P




Bottom View
for TSSOP -P

## Pin Description

| Name | I/O | Description |
|---|---|---|
| GND | | Ground connection of circuitry |
| $V_{DD}$ | I | Supply voltage input |
| + INA | I | Non-inverting input of channel A, connected to bypass pin inside the IC |
| - INA | I | Input pin of channel A |
| + OUT A | O | A channel + output in BTL mode, high impedance in SE mode |
| - OUT A | O | A channel - output in BTL mode, + output in SE mode |
| + IN B | I | Non-inverting input of channel B, connected to bypass pin inside the IC |
| - IN B | I | Input pin of channel B |
| + OUT B | O | B channel + output in BTL mode, high impedance in SE mode |
| - OUT B | O | B channel - output in BTL mode, + output in SE mode |
| BYPASS | | Connect to voltage divider for internal mid-supply bias |
| HP-IN | I | Headphone control pin input, hold high for single-ended mode operation |
| SHUTDOWN | I | Shutdown mode control pin input, places entire IC in shutdown mode when held high, $I_{DD}$= 0.5µA |

## Typical Characteristics

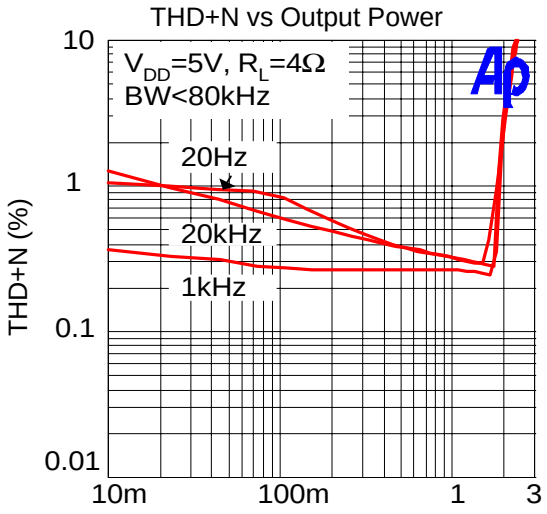



Figure 1 : Output Power (W)

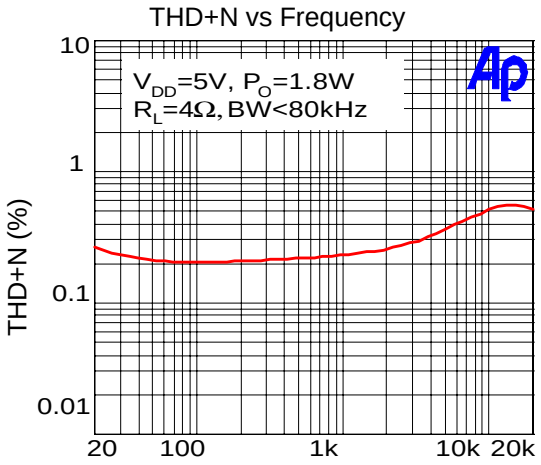



Figure 2 : Frequency (Hz)

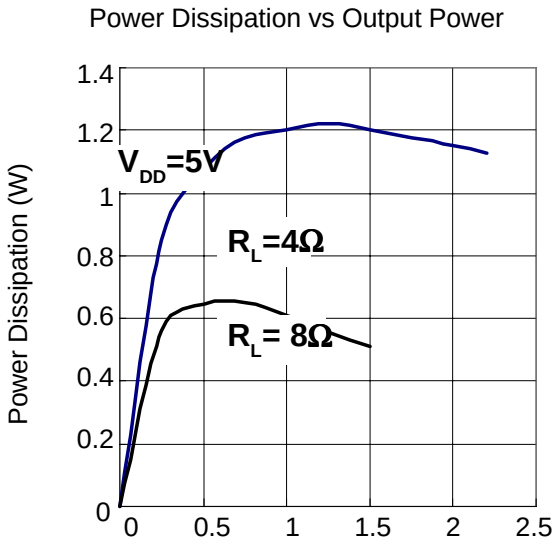



Figure 3 : Output Power (W)

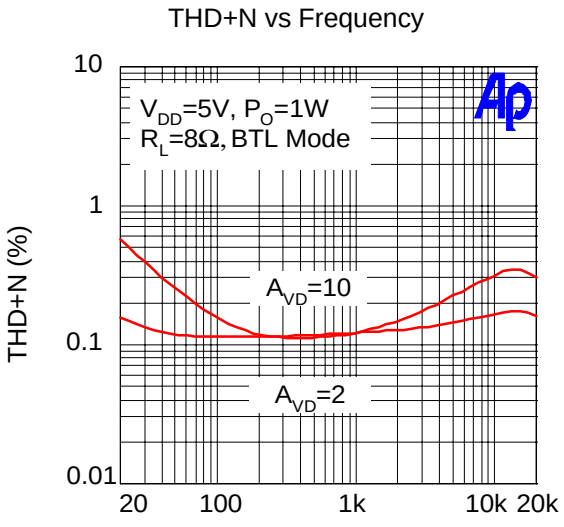



Figure 4 : Frequency (Hz)

## Typical Characteristics Cont.

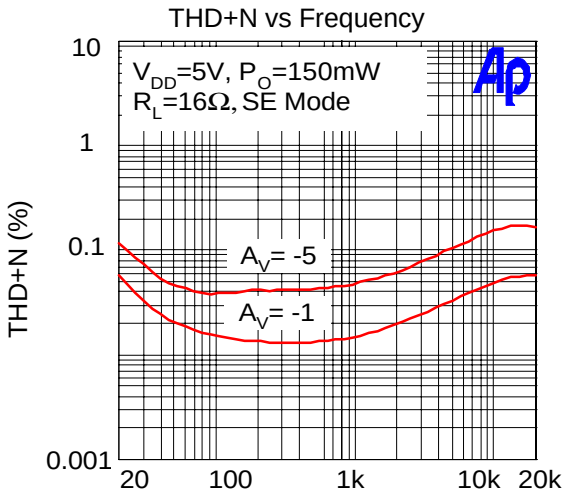



Figure 5 : Frequency (Hz)

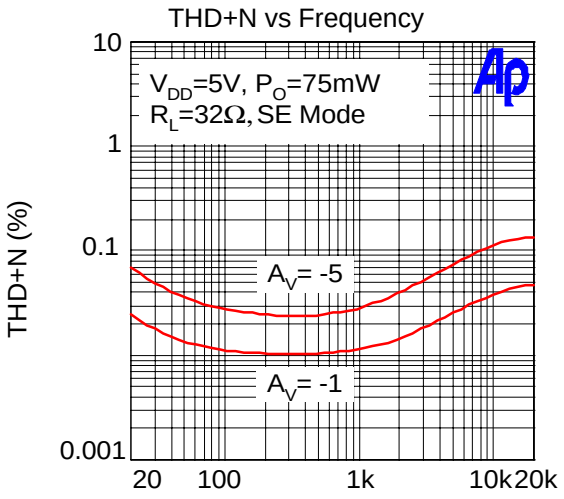



Figure 6 : Frequency (Hz)

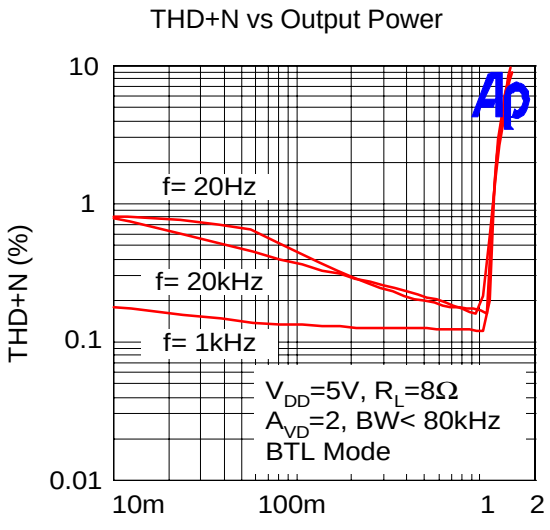



Figure 7 : Output Power (W)

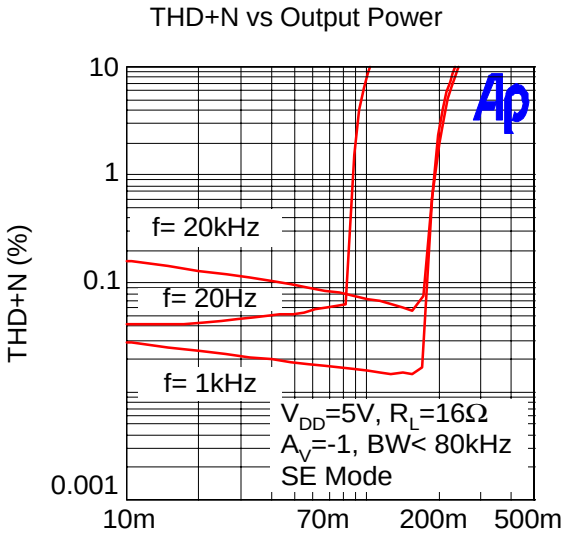



Figure 8 : Output Power (W)

## Typical Characteristics Cont.

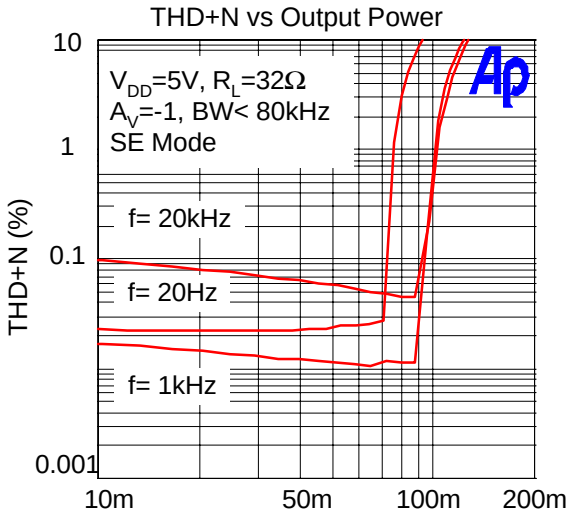



Figure 9 : Output Power (W)

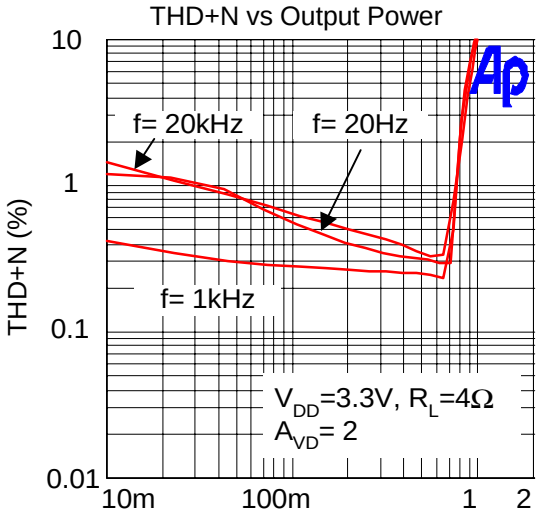



Figure 10 : Output Power (W)

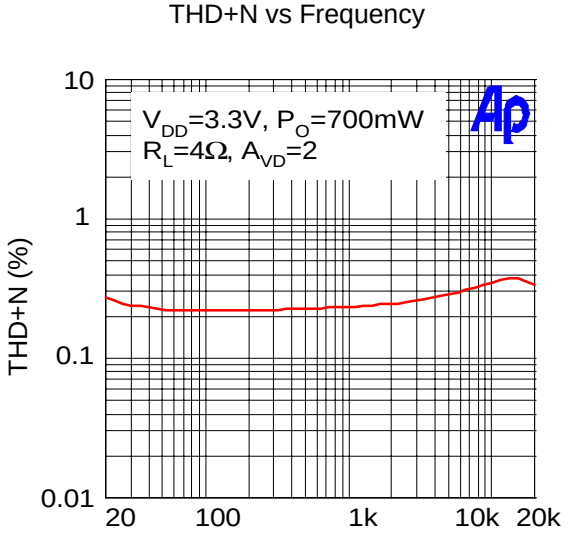



Figure 11 : Frequency (Hz)

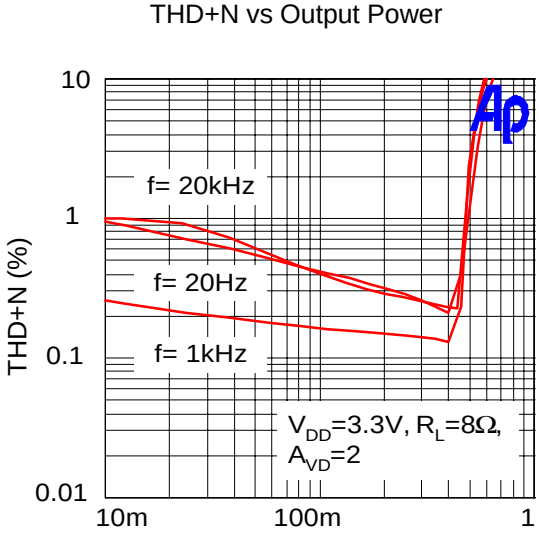



Figure 12 : Output Power (W)

## Typical Characteristics Cont.

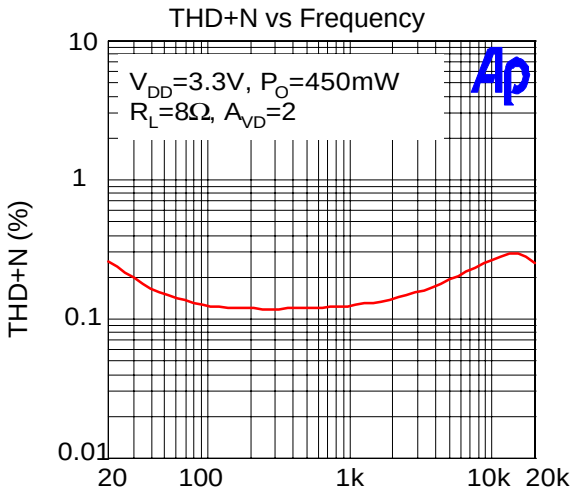



Figure 13 : Frequency (Hz)

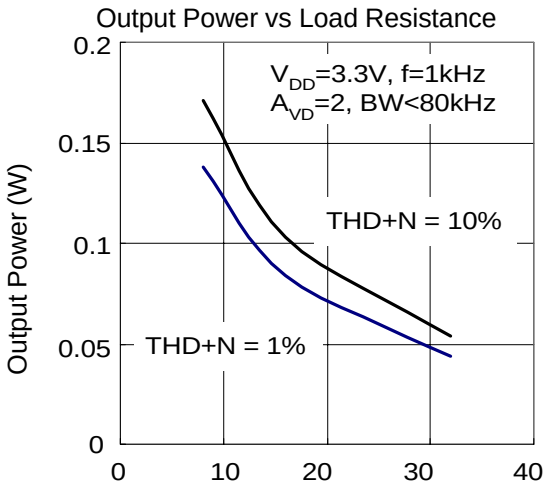



Figure 14 : Load Resistance (Ω)

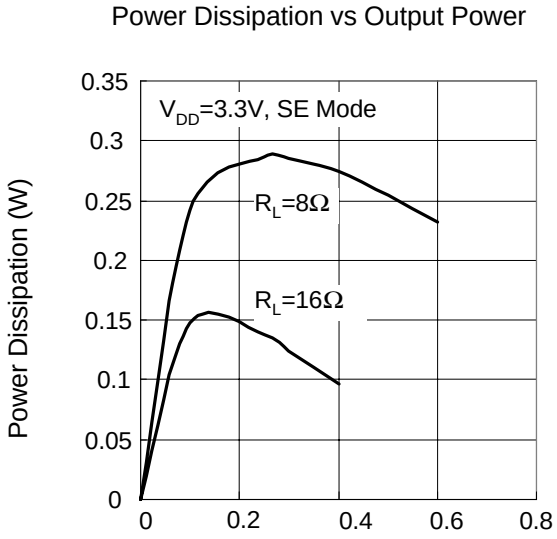



Figure 15 : Output Power (W)

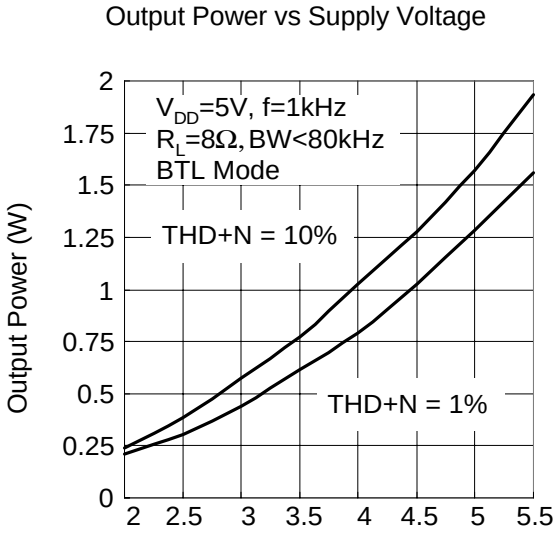



Figure 16 : Supply Voltage (V)

## Typical Characteristics Cont.

Output Power vs Supply Voltage

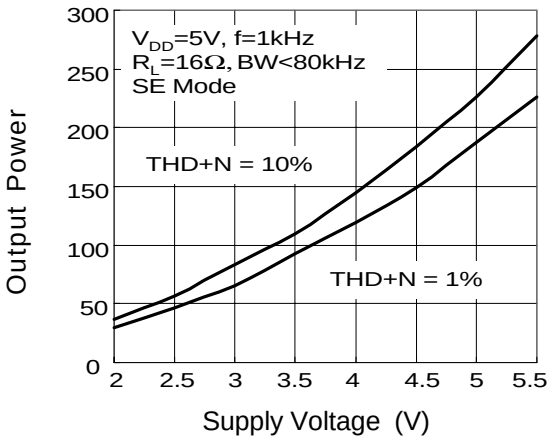



Figure 17

Output Power vs Supply Voltage

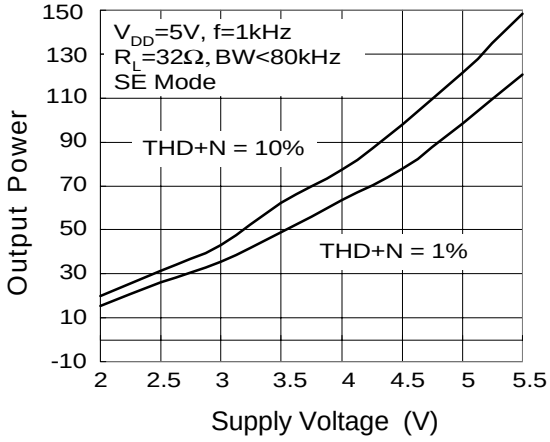



Figure 18

Output Power vs Load Resistance

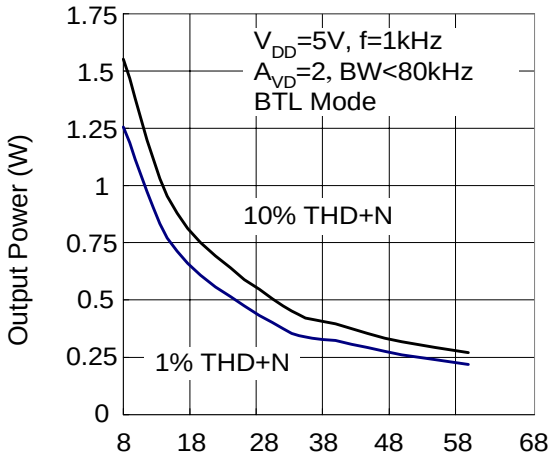



Figure 19 : Load Resistance (Ω)

Output Power vs Load Resistance

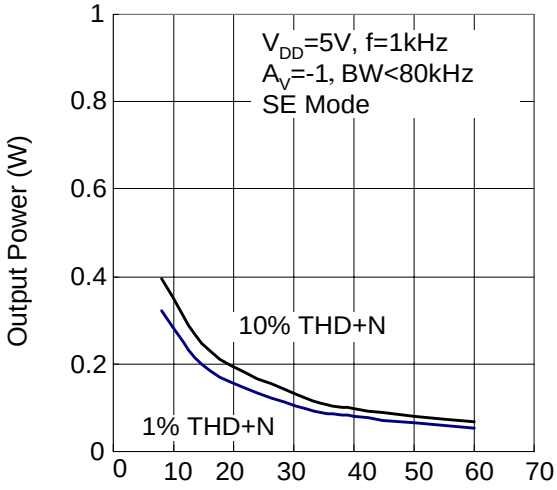



Figure 20 : Load Resistance (Ω)

## Typical Characteristics Cont.

Power Dissipation vs Output Power

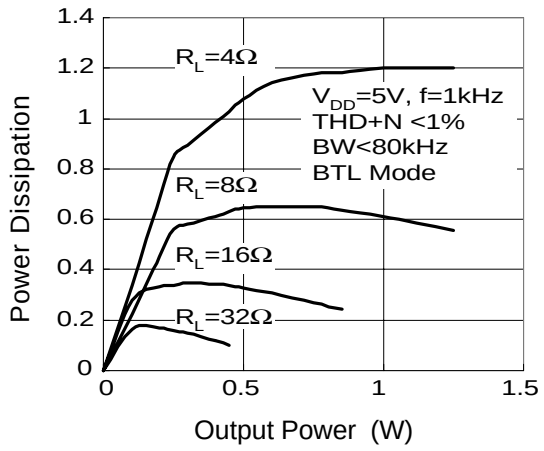



Figure 21

Power Dissipation vs Output Power

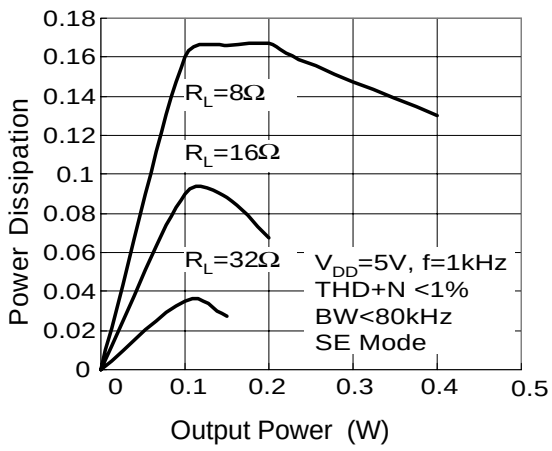



Figure 22

Noise Floor

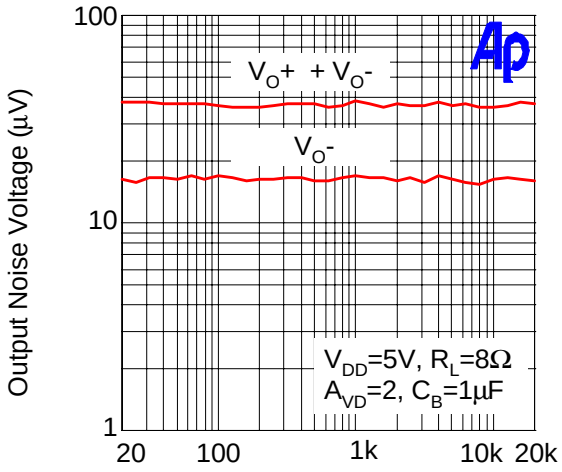



Figure 23 : Frequency (Hz)

Channel Separation

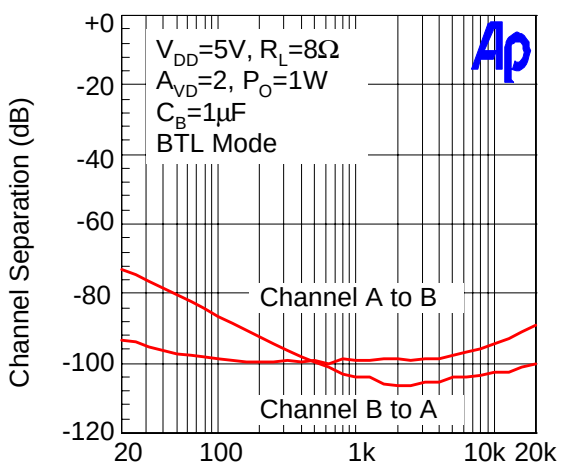



Figure 24 : Frequency (Hz)

## Typical Characteristics Cont.

Channel Separation

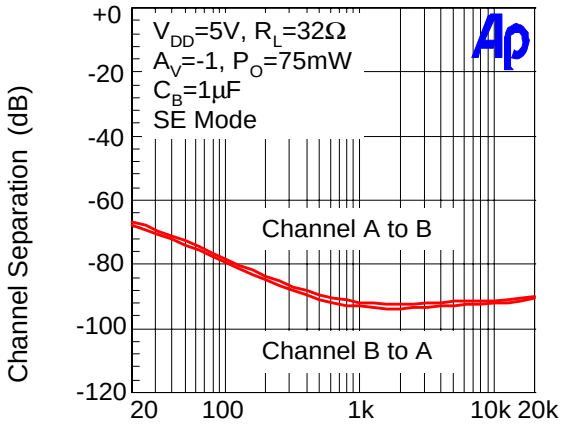



Figure 25 : Frequency (Hz)

Open Loop Frequency Response

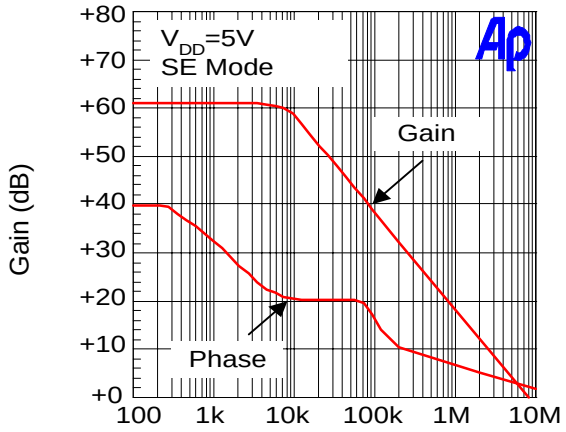



Figure 26 : Frequency (Hz)

Supply Current vs Supply Voltage

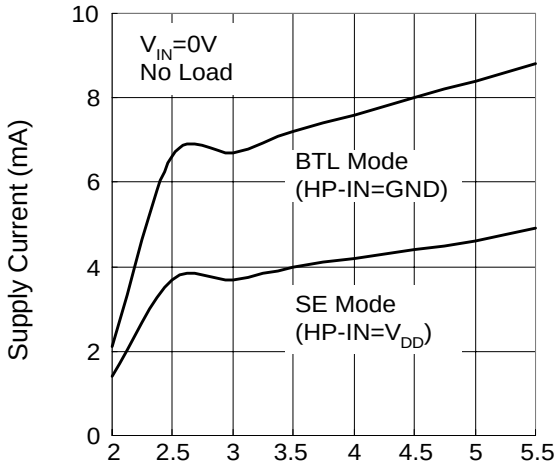
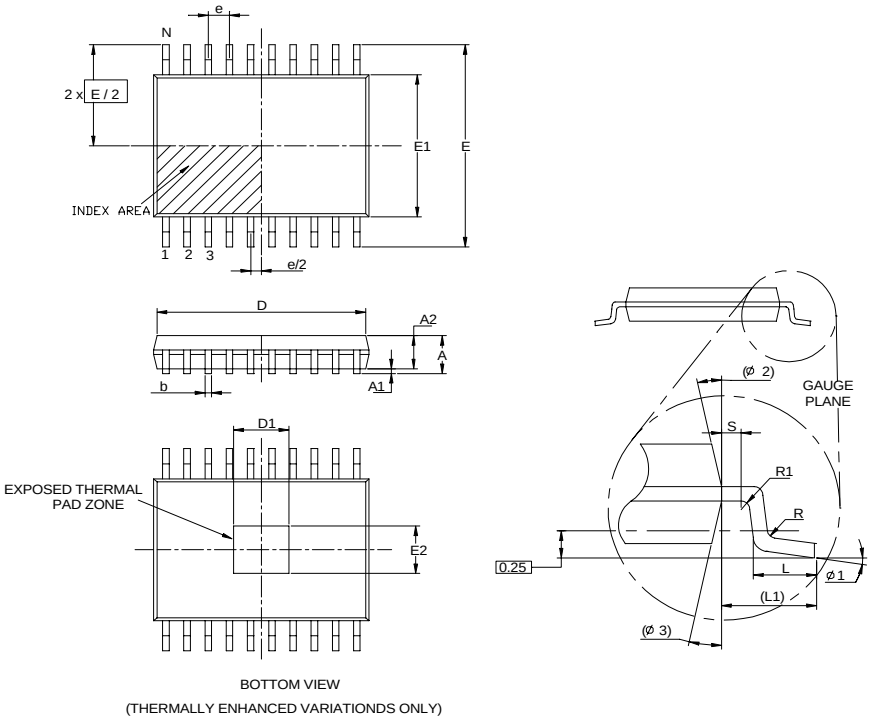



Figure 27 : Supply Voltage(V)

## Packaging Information

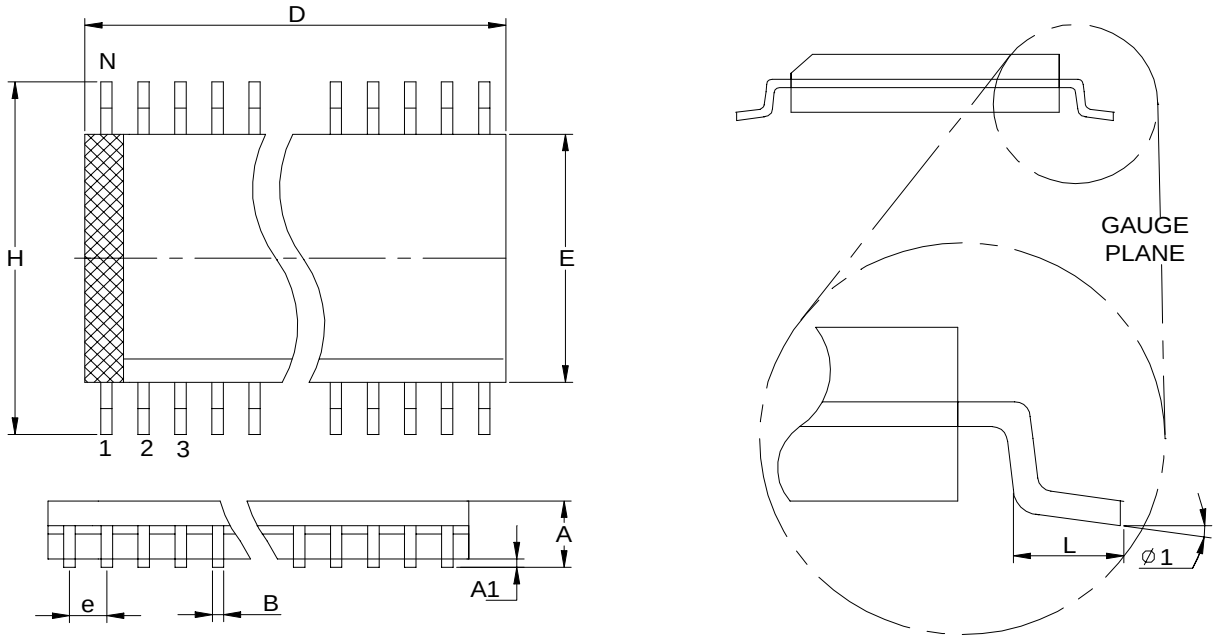
TSSOP/ TSSOP-P ( Reference JEDEC Registration MO-153)




| Dim | Millimeters | | Inches | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | | 1.2 | | 0.047 |
| A1 | 0.00 | 0.15 | 0.000 | 0.006 |
| A2 | 0.80 | 1.05 | 0.031 | 0.041 |
| D | 6.4 (N=20PIN)<br>7.7 (N=24PIN) | 6.6 (N=20PIN)<br>7.9 (N=24PIN) | 0.252 (N=20PIN)<br>0.303 (N=24PIN) | 0.260 (N=20PIN)<br>0.311 (N=24PIN) |
| D1 | 2.20 (N=20PIN)<br>2.70 (N=24PIN) Thermally Enhanced | | 0.087 (N=20PIN)<br>0.106 (N=24PIN) Thermally Enhanced | |
| e | 0.65 BSC | | 0.026 BSC | |
| E | 6.40 BSC | | 0.252 BSC | |
| E1 | 4.30 | 4.50 | 0.169 | 0.177 |
| E2 | 1.50 | | 0.059 | |
| L | 0.45 | 0.75 | 0.018 | 0.030 |
| L1 | 1.0 REF | | 0.039REF | |
| R | 0.09 | | 0.004 | |
| R1 | 0.09 | | 0.004 | |
| S | 0.2 | | 0.008 | |
| ϕ1 | 0° | 8° | 0° | 8° |
| ϕ2 | 12° REF | | 12° REF | |
| ϕ3 | 12° REF | | 12° REF | |

## Packaging Information

SO – 300mil ( Reference JEDEC Registration MS-013)



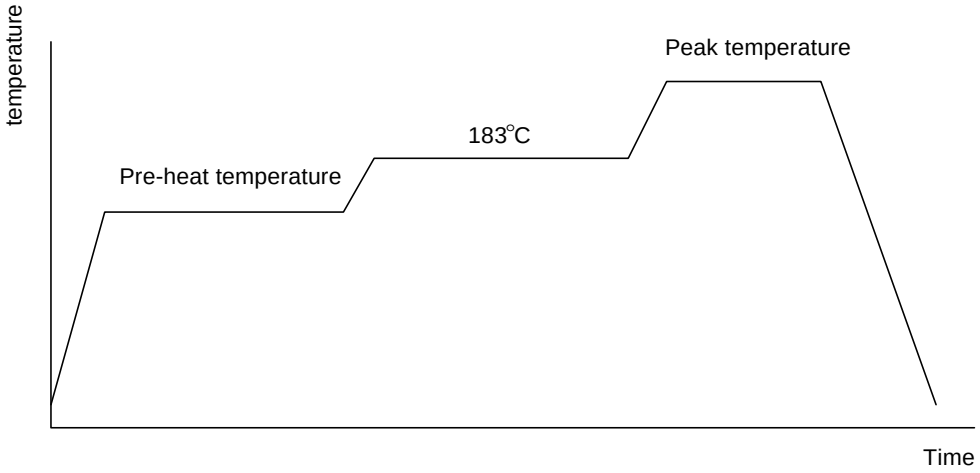

| Dim | Millimeters | | Variations- D | | | Dim | Inches | | Variations- D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min. | Max. | Variations | Min. | Max. | | Min. | Max. | Variations | Min. | Max. |
| A | 2.35 | 2.65 | SO-16 | 10.10 | 10.50 | A | 0.093 | 0.1043 | SO-16 | 0.398 | 0.413 |
| A1 | 0.10 | 0.30 | SO-18 | 11.35 | 11.76 | A1 | 0.004 | 0.0120 | SO-18 | 0.447 | 0.463 |
| B | 0.33 | 0.51 | SO-20 | 12.60 | 13 | B | 0.013 | 0.020 | SO-20 | 0.496 | 0.512 |
| D | See variations | | SO-24 | 15.20 | 15.60 | D | See variations | | SO-24 | 0.599 | 0.614 |
| E | 7.40 | 7.60 | SO-28 | 17.70 | 18.11 | E | 0.2914 | 0.2992 | SO-28 | 0.697 | 0.713 |
| e | 1.27BSC | | SO-14 | 8.80 | 9.20 | e | 0.050BSC | | SO-14 | 0.347 | 0.362 |
| H | 10 | 10.65 | | | | H | 0.394 | 0.419 | | | |
| L | 0.40 | 1.27 | | | | L | 0.016 | 0.050 | | | |
| N | See variations | | | | | N | See variations | | | | |
| ϕ 1 | 0° | 8° | | | | ϕ 1 | 0° | 8° | | | |

## Physical Specifications

| | |
|---|---|
| Terminal Material | Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb) |
| Lead Solderability | Meets EIA Specification RSI86-91, ANSI/J-STD-002 Category 3. |
| Packaging | 2000 devices per reel |

## Reflow Condition (IR/Convection or VPR Reflow)

Reference JEDEC Standard J-STD-020A APRIL 1999




## Classification Reflow Profiles

| | Convection or IR/ Convection | VPR |
|---|---|---|
| Average ramp-up rate(183°C to Peak) | 3°C/second max. | 10 °C /second max. |
| Preheat temperature 125 ± 25°C) | 120 seconds max | |
| Temperature maintained above 183°C | 60 – 150 seconds | |
| Time within 5°C of actual peak temperature | 10 –20 seconds | 60 seconds |
| Peak temperature range | 220 +5/-0°C or 235 +5/-0°C | 215-219°C or 235 +5/-0°C |
| Ramp-down rate | 6 °C /second max. | 10 °C /second max. |
| Time 25°C to peak temperature | 6 minutes max. | |

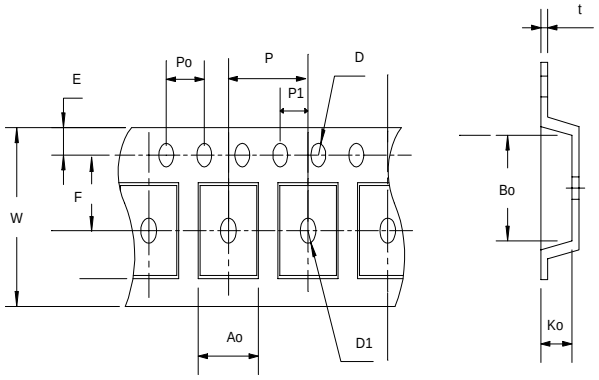
## Package Reflow Conditions

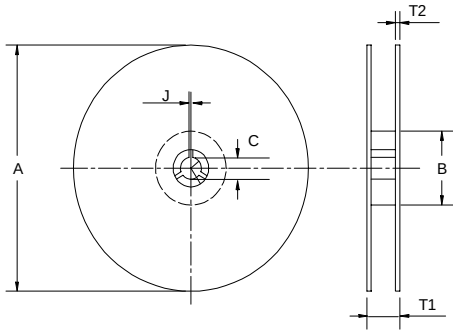
| **pkg. thickness ≥ 2.5mm and all bgas** | **pkg. thickness < 2.5mm and pkg. volume ≥ 350 mm³** | **pkg. thickness < 2.5mm and pkg. volume < 350mm³** |
|---|---|---|
| Convection 220 +5/-0 °C | | Convection 235 +5/-0 °C |
| VPR 215-219 °C | | VPR 235 +5/-0 °C |
| IR/Convection 220 +5/-0 °C | | IR/Convection 235 +5/-0 °C |

## Reliability test program

| Test item | Method | Description |
|---|---|---|
| SOLDERABILITY | MIL-STD-883D-2003 | 245°C , 5 SEC |
| HOLT | MIL-STD-883D-1005.7 | 1000 Hrs Bias @ 125 °C |
| PCT | JESD-22-B, A102 | 168 Hrs, 100 % RH , 121°C |
| TST | MIL-STD-883D-1011.9 | -65°C ~ 150°C, 200 Cycles |
| ESD | MIL-STD-883D-3015.7 | VHBM > 2KV, VMM > 200V |
| Latch-Up | JESD 78 | 10ms , $I_{tr}$ > 100mA |

## Carrier Tape & Reel Dimensions




| Application | A | B | C | J | T1 | T2 | W | P | E |
|---|---|---|---|---|---|---|---|---|---|
| SOP-16W | 330±3 | 100 ± 2 | 13 + 0.5 | 2 ± 0.5 | 16.4 +0.3 -0.2 | 2.5± 0.5 | 16 ± 0.2 | 12± 0.1 | 1.75± 0.1 |
| **Application** | F | D | D1 | Po | P1 | Ao | Bo | Ko | t |
| SOP-16W | 7.5 ± 0.1 | 1.5 +0.1 | 1.5 +0.25 | 4.0 ± 0.1 | 2.0 ± 0.1 | 10.9 ± 0.1 | 10.8± 0.1 | 3.0± 0.1 | 0.3±0.013 |

(mm)

## Cover Tape Dimensions

| | |
|---|---|
| **Carrier Width** | 16 |
| **Cover Tape Width** | 13.3 |

(mm)

## Customer Service

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