Stereo 2-W Audio Power Amplifier

Features

- Low Supply Current , I_{DD}= 8mA at Stereo BTL
- Low Shutdown Current , I_{DD}= 0.5μA
- Depop Circuitry Integrated
- Low Supply Voltage
- Thermal Shutdown Circuitry Integrated
- Output Power at 1% THD+N , V_{DD}=5V
  - 1.8 W/Ch (typ) into a 4 Ω Load
  - 1.2 W/Ch (typ) into a 8 Ω Load
- Bridge-Tied Load (BTL) or Single-Ended (SE) Modes Operation
- Various 24-Pin Power Packages Available SOP , TSSOP-P
- High Supply Voltage Ripple Rejection

Applications

- Stereo Audio Power Amplifier for Notebook Computer

General Description

The APA2020A is a stereo bridge-tied audio power amplifier in various 24-pin power packages , including SOP , TSSOP-P. When connecting to a 5V voltage supply , the APA2020A is capable of delivering 1.8W/1.2W of continuous RMS power per channel into 4Ω/8Ω loads with less than 1% THD+N , respectively. The APA2020A simplifies design and frees up board space for other features .

The APA2020A also served well in low-voltage applications , which provides 800-mW 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 APA2020A , that reduces pops and clicks noise during power up and when using the shutdown or mute modes and protects the chip from being destroyed by over-temperature failure.

To simplify the audio system design in notebook computer applications , the APA2020A combines a stereo bridge-tied loads ($\overline{\text{BTL}}$) mode for speaker drive and a stereo single-end (SE) mode for headphone drive into a single chip , where both modes are easily switched by the SE/$\overline{\text{BTL}}$ input control pin signal . For power sensitive applications , the APA2020A also features a shutdown function which keeps the supply current only 0.5 μA (typ) .

Ordering Information

APA2020A □□-□□

- Handling Code
- Temp. Range
- Package Code

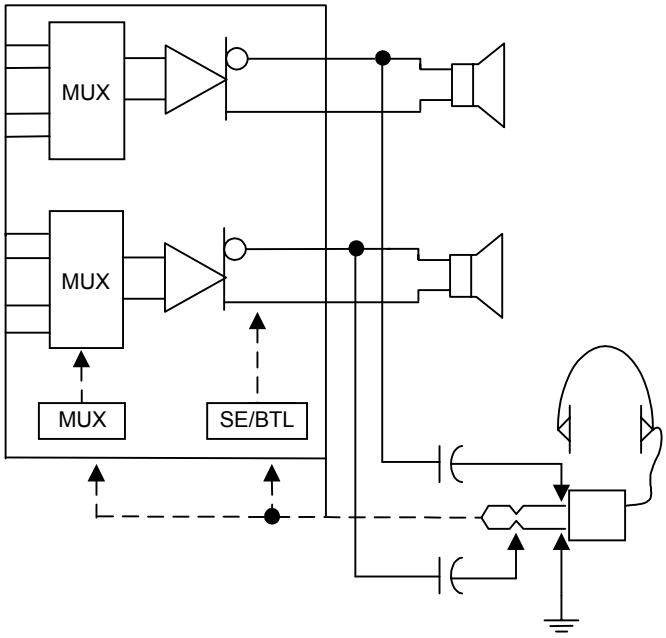
Package Code
K : SOP R : TSSOP-P *

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 exposure on the bottom of the package.

Block Diagram



Absolute Maximum Ratings

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

Symbol	Parameter	Rating	Unit
V_{CC}	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	300	°C
V_{ESD}	Electrostatic Discharge	-3000 to 3000 *1 -200 to 200 *2	V

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

2. Machine model : C=200pF , L=0.5mH , R=0Ω , 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, 2 W/Ch average power,	3-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	

Electrical Characteristics (Cont.)

AC Operating Characteristics , V_{DD}= 5V , T_A= 25°C , R_L= 4Ω (unless otherwise noted)

Symbol	Parameter	Test Condition	APA2020A			Unit
			Min.	Typ.	Max.	
P(out)	Output power (each channel) see Note 1	THD = 10% , BTL , R_L=4Ω		2.3		W
		R_L=8Ω		1.5		
		THD = 1% , BTL , R_L=4Ω		1.8		
		R_L=8Ω		1.2		
		THD = 10% , SE , R_L=4Ω		650		mW
		R_L=8Ω		400		
		THD = 1% , SE , R_L=4Ω		500		
		R_L=8Ω		320		
		THD = 0.5% , SE , R_L=32 Ω		90		
THD + N	Total harmonic distortion plus noise	P_O = 1.6W , BTL , R_L=4Ω		300		m%
		P_O = 1W , BTL , R_L=8Ω		150		
		P_O = 78mW , SE ,R_L=32Ω		20		
		V_1 = 1V , R_L=4Ω , G = 1		10		
B_{OM}	Maximum output power bandwidth	G = 10 , THD < 1%		>20		KHz
	Phase margin	R_L = 4Ω , BTL		72		°
		R_L = 4Ω , Open Load		71		
		R_L = 4Ω , SE		52		

Electrical Characteristics (Cont.)

AC Operating Characteristics , V_{DD}= 5V , T_A= 25°C , R_L= 4Ω (unless otherwise noted)

Symbol	Parameter	Test Condition	APA2020A			Unit
			Min.	Typ.	Max.	
PSRR	Power supply ripple rejection	f =100 Hz		80		dB
	Mute attenuation			85		dB
	Channel-to-channel output separation			85		dB
	Line/$\overline{HP}$ input separation			75		dB
	BTL attenuation in SE mode			80		dB
ZI	Input impedance			2		MΩ
	Signal-to-noise ratio	Po = 500 mW , BTL		90		dB
Vn	Output noise voltage			80		μV(rms)

Notes 1 : Output power is meaured at the output teminals of the IC at 1 KHz.

AC Operating Characteristics , V_{DD}= 3.3V , T_A= 25°C , R_L= 4Ω (unless otherwise noted)

Symbol	Parameter	Test Condition	APA2020A			Unit
			Min.	Typ.	Max.	
P(out)	Output power (each channel) see Note 2	THD = 10% , BTL , R_L=4Ω		1		W
		R_L=8Ω		0.6		
		THD = 1% , BTL , R_L=4Ω		0.8		
		R_L=8Ω		0.5		
		THD = 10% , SE , R_L=4Ω		290		mW
		R_L=8Ω		180		
		THD = 1% , SE , R_L=4Ω		230		
		R_L=8Ω		140		
		THD = 0.5% , SE , R_L=32 Ω		43		
THD + N	Total harmonic distortion plus noise	P_O = 1.6W , BTL , R_L=4Ω		270		m%
		P_O = 1W , BTL , R_L=8Ω		150		
		P_O = 78mW , SE ,R_L=32Ω		20		
		V_1 = 1V , R_L=4Ω , G = 1		10		
B_{OM}	Maximum output power bandwidth	G = 10 , THD < 1%		>20		KHz
	Phase margin	R_L = 4Ω , BTL		92		°
		R_L = 4Ω , Open Load		70		
		R_L = 4Ω , SE		57		

Electrical Characteristics (Cont.)

AC Operating Characteristics , V_{DD}= 3.3V , T_A= 25°C , R_L= 4Ω (unless otherwise noted)

Symbol	Parameter	Test Condition	APA2020A			Unit
			Min.	Typ.	Max.	
PSRR	Power supply ripple rejection	f =100 Hz		70		dB
	Mute attenuation			85		dB
	Channel-to-channel output separation	f =1 KHz		85		dB
	Line/$\overline{HP}$ input separation			75		dB
	BTL attenuation in SE mode			80		dB
ZI	Input impedance			2		MΩ
	Signal-to-noise ratio	Po = 500 mW , BTL		90		dB
Vn	Output noise voltage			50		μV(rms)

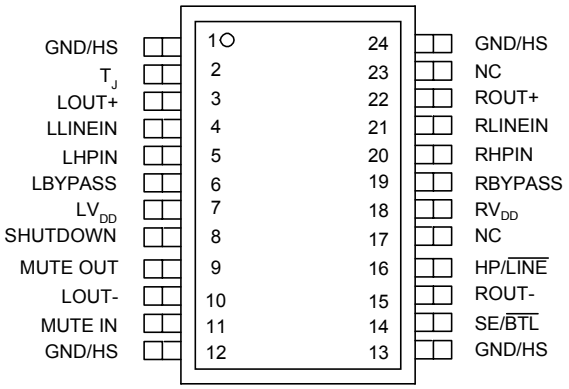
Notes 2 : Output power is meaured at the output teminals of the IC at 1 KHz.

DC Electrical Characteristic , T_A=25 °C

Symbol	Parameter	Test Conditions		APA2020A		Unit
				Typ.	Max.	
I_{DD}	Supply Current	V_{DD} = 5V	Stereo BTL	8	11	mA
			Stereo SE	4	6.5	mA
		V_{DD} = 3.3 V	Stereo BTL	7	9	mA
			Stereo SE	3.5	5.6	mA
$V_{O\ (DIFF)}$	DC Differential Output Voltage	V_{DD} =5V, Gain = 2, see Note3		5	25	mV
$I_{DD(MUTE)}$	Supply Current in Mute Mode	V_{DD} = 5V		8	11	mA
I_{SD}	I_{DD} in Shutdown	V_{DD} = 5V		0.5	5	μA

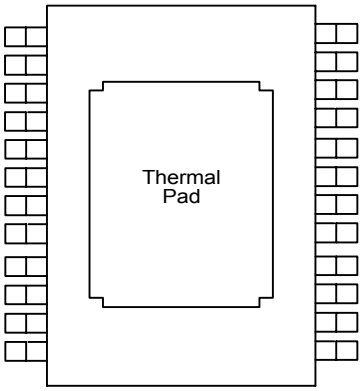
Note 3 : at 3V<V_{DD}<5V , the DC output voltage is approximately V_{DD} / 2.

Pin Description



Top View

For SOP and TSSOP-P



Bottom View

For TSSOP-P Only

Pin		I/O	Description
Name	No		
GND/HS	1,12, 13,24		Ground connection for circuitry, directly connected to thermal pad (only in TSSOP-P package).
TJ	2	O	Shutdown mode control signal input, sources a current proportional to the junction temperature. This pin should be left unconnected during normal operation. For more information, see the junction temperature measurement section of this document.
LOUT +	3	O	Left channel + output in BTL mode, + output in SE mode.
L LINE IN	4	I	Left channel line input, selected when HP/$\overline{\text{LINE}}$ pin (16) is held low.
LHP IN	5	I	Left channel headphone input, selected when HP/$\overline{\text{LINE}}$ pin (16) is held high.
LBYPASS	6		Connect to voltage divider for left channel internal mid-supply bias.
LV_{DD}	7	I	Supply voltage input for left channel and for primary bias circuits.
SHUTDOWN	8	I	Shutdown mode control signal input, places entire IC in shutdown mode when held high, I_{DD}= 0.5µA.
MUTE OUT	9	O	Follows MUTE in pin (11), provides buffered output.
LOUT -	10	O	Left channel - output in BTL mode, high-impedance state in SE mode.
MUTE IN	11	I	Mute control signal input, hold low for normal operation, hold high to mute.
SE/$\overline{\text{BTL}}$	14	I	Mode control signal input, hold low for BTL mode, hold high for SE mode.
ROUT-	15	O	Right channel - output in BTL mode, high impedance state in SE mode.
HP/$\overline{\text{LINE}}$	16	I	MUX control input, hold high to select headphone inputs (5,20), hold low to select line inputs (4,21).

Pin Description (Cont.)

Pin		I/O	Description
Name	No		
NC	17,23		No internal connection.
RV_{DD}	18	I	Supply voltage input for right channel.
RBYPASS	19		Connect to voltage divider for right channel internal mild-supply bias.
RHP IN	20	I	Right channel headphone input, selected when HP/$\overline{\text{LINE}}$ pin (16) is held high.
RLINE IN	21	I	Right channel line input, selected when HP/$\overline{\text{LINE}}$ pin (16) is held low.
ROUT+	22	O	Right channel + output in BTL mode, + output in SE mode.

Test Information

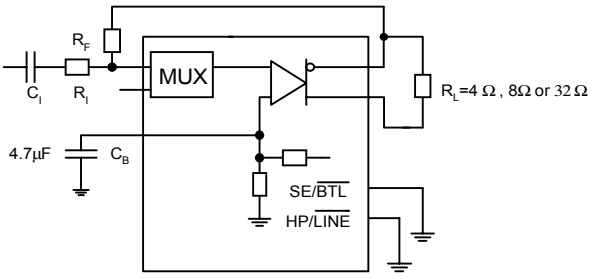


Figure 2. BTL Test Circuit

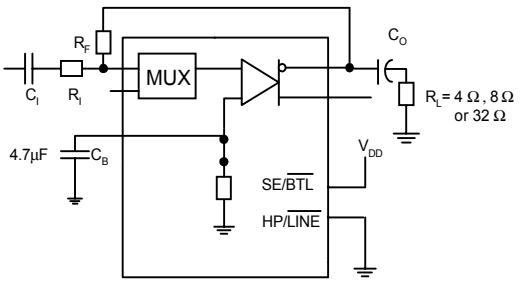
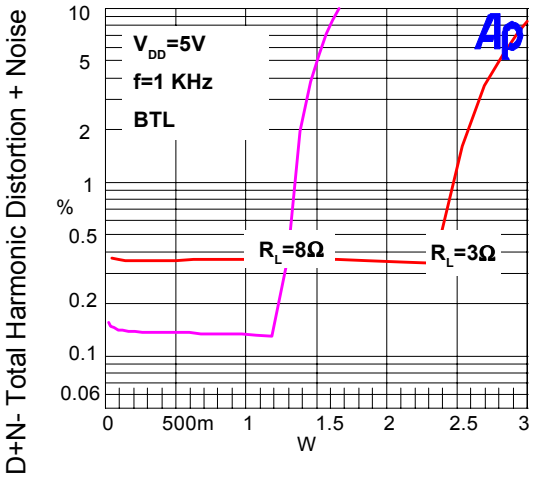
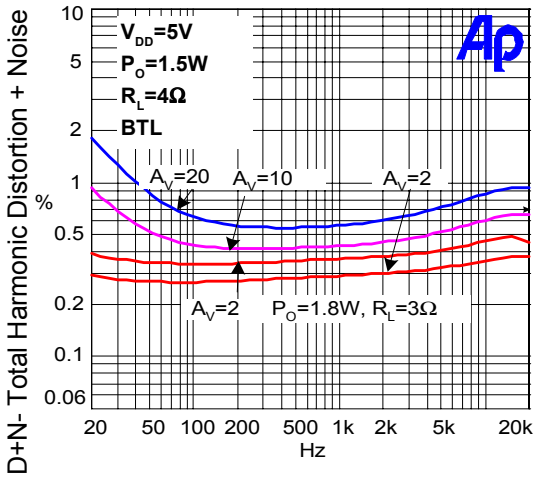


Figure 3. SE Test Circuit

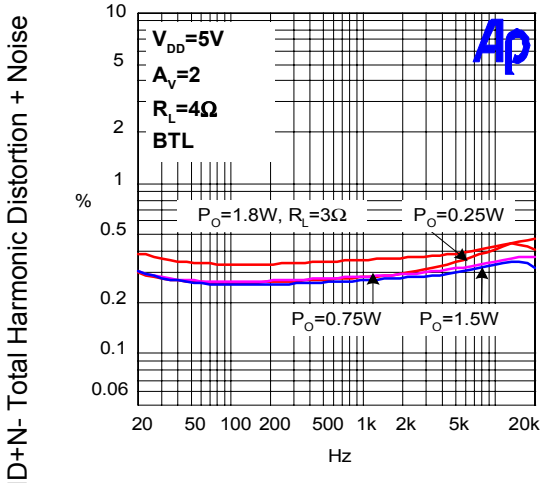
Typical Characteristics



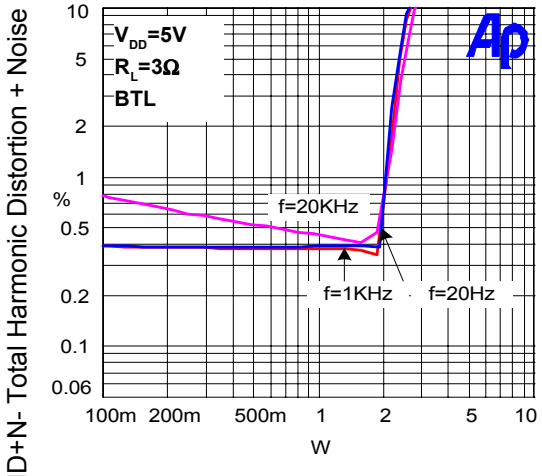
Po - Output Power
Figure 4



f - Frequency
Figure 5

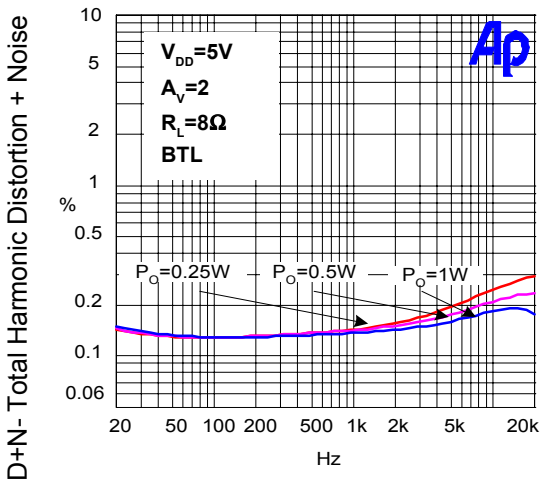


f - Frequency
Figure 6

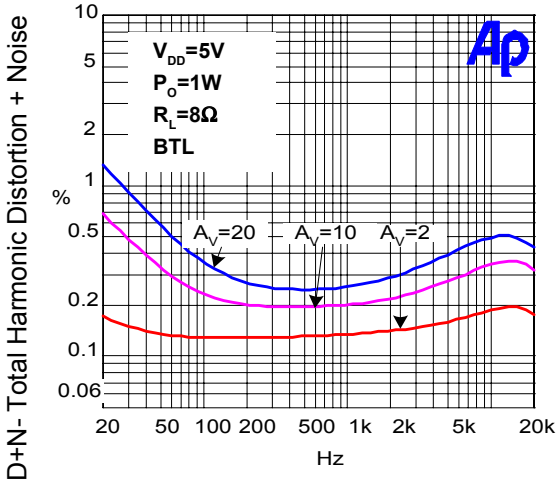


Po - Output Power
Figure 7

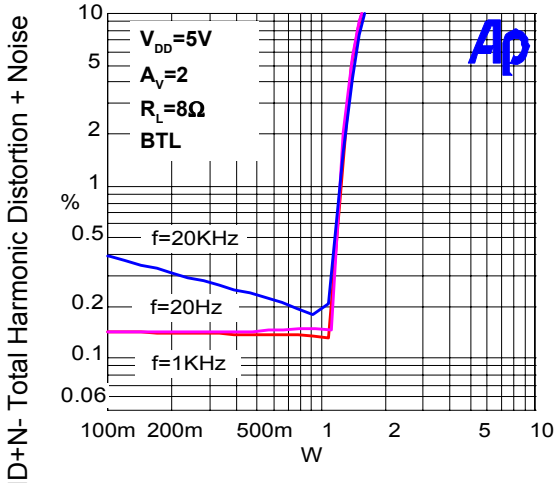
Typical Characteristics (Cont.)



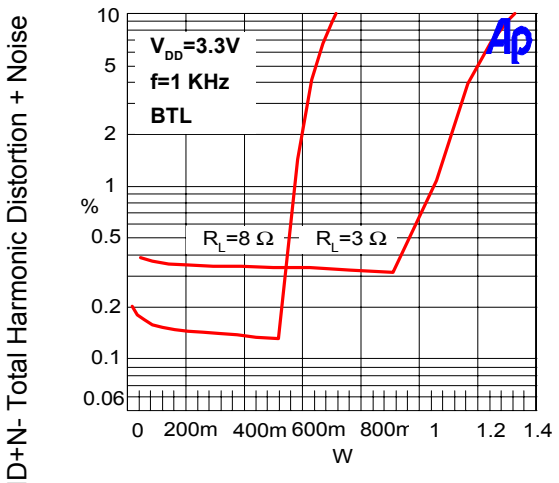
f - Frequency- Hz
Figure 8



f - Frequency- Hz
Figure 9

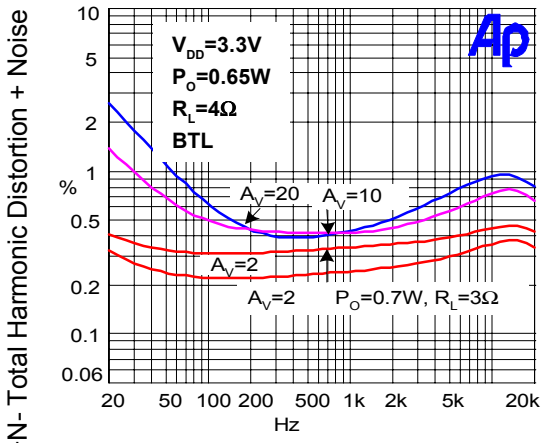


Po - Output Power
Figure 10

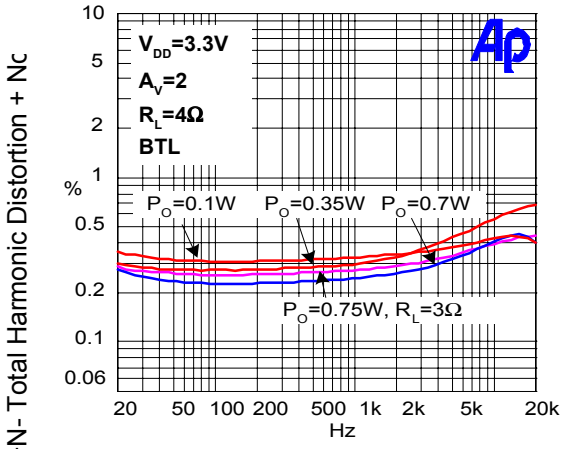


Po - Output Power
Figure 11

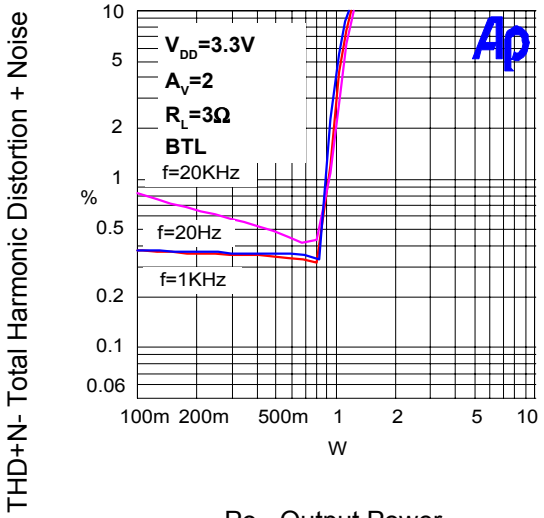
Typical Characteristics (Cont.)



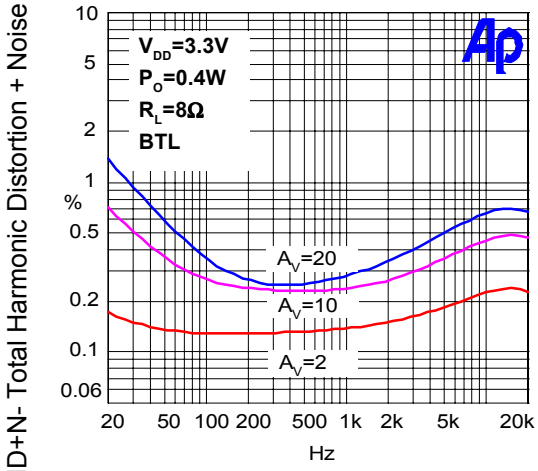
f - Frequency
Figure 12



f - Frequency
Figure 13

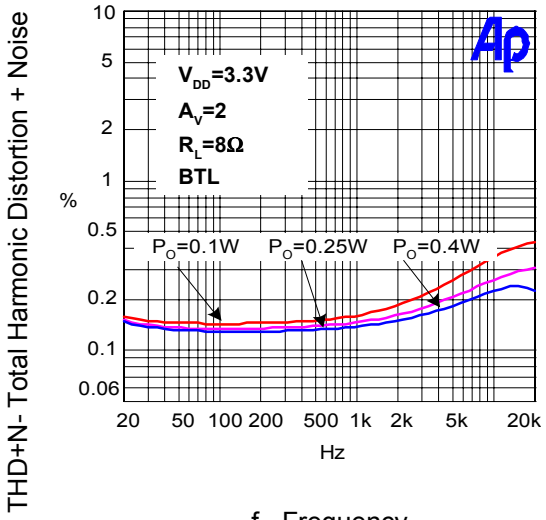


Po - Output Power
Figure 14

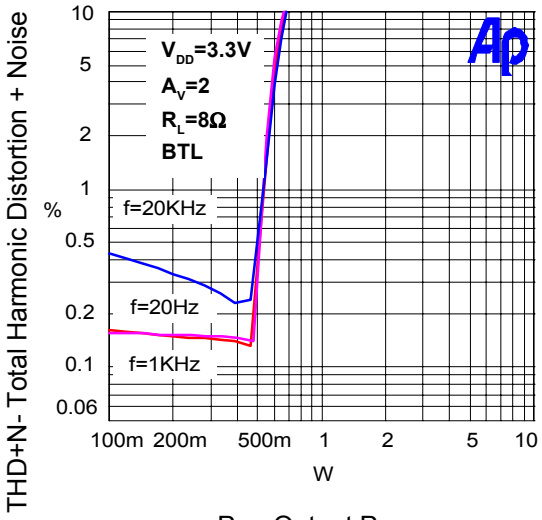


f - Frequency
Figure 15

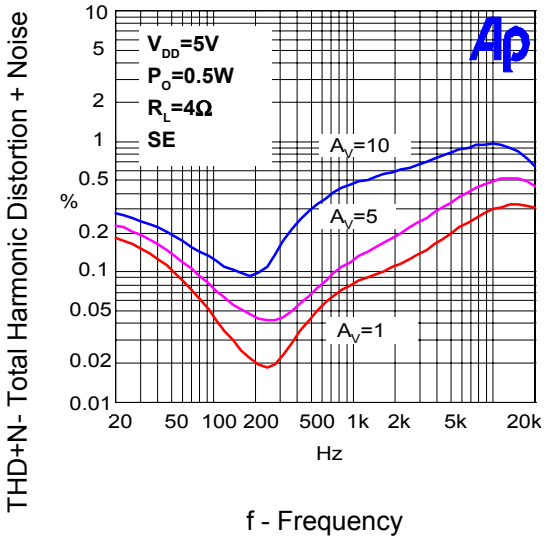
Typical Characteristics (Cont.)



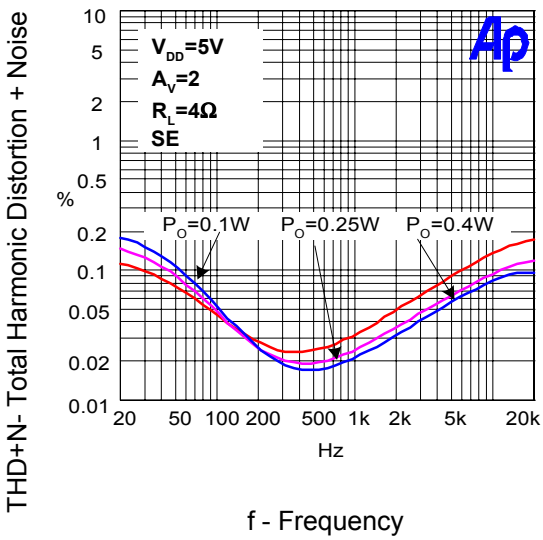
f - Frequency
Figure 16



Po - Output Power
Figure 17

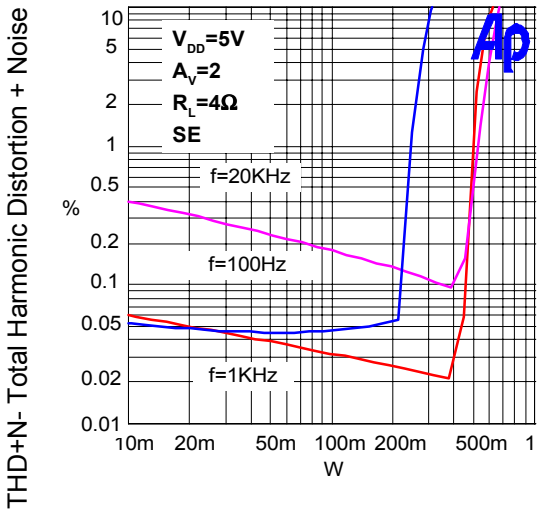


f - Frequency
Figure 18

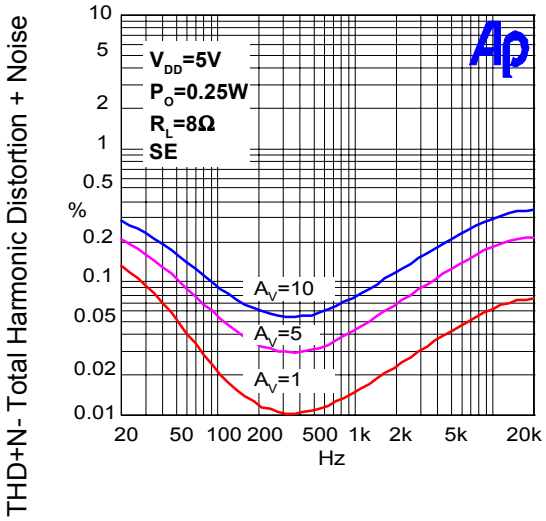


f - Frequency
Figure 19

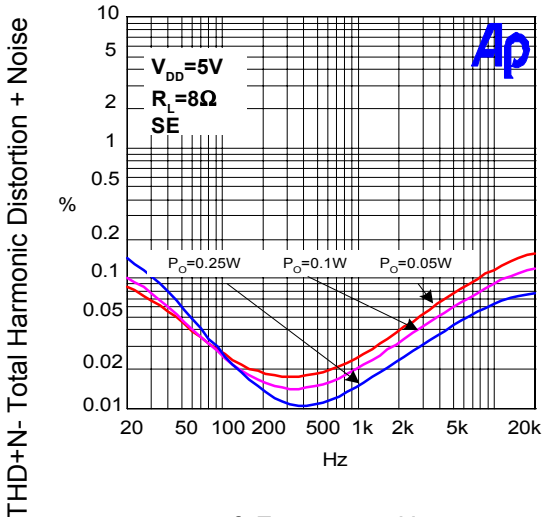
Typical Characteristics (Cont.)



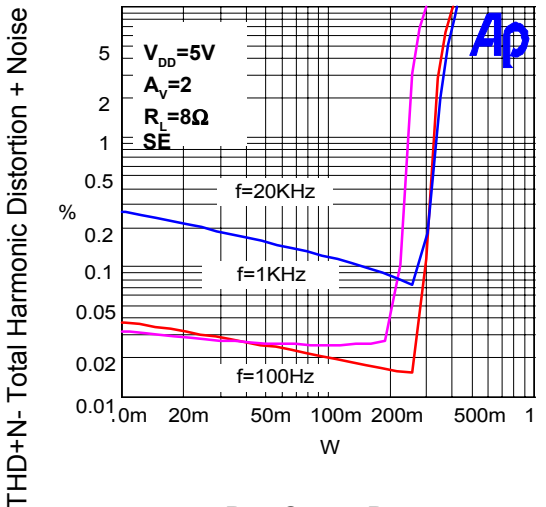
Po - Output Power
Figure 20



f - Frequency- Hz
Figure 21

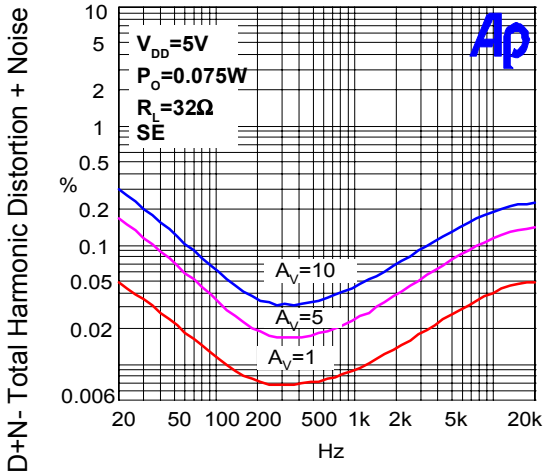


f- Frequency- Hz
Figure 22

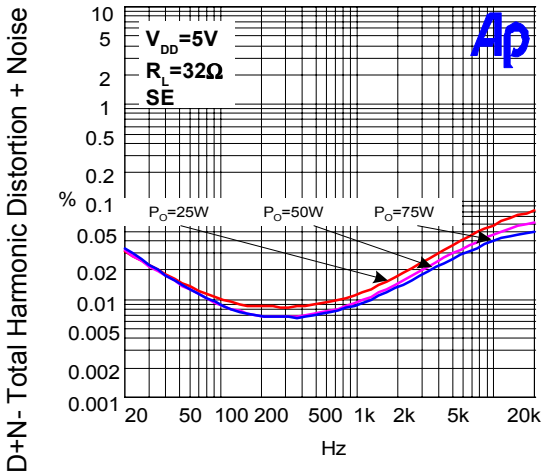


Po - Output Power
Figure 23

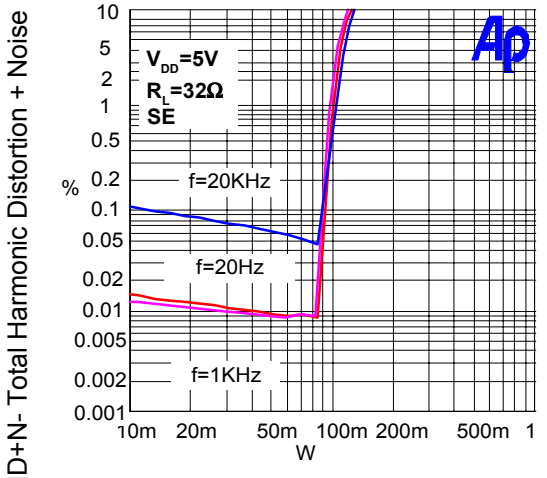
Typical Characteristics (Cont.)



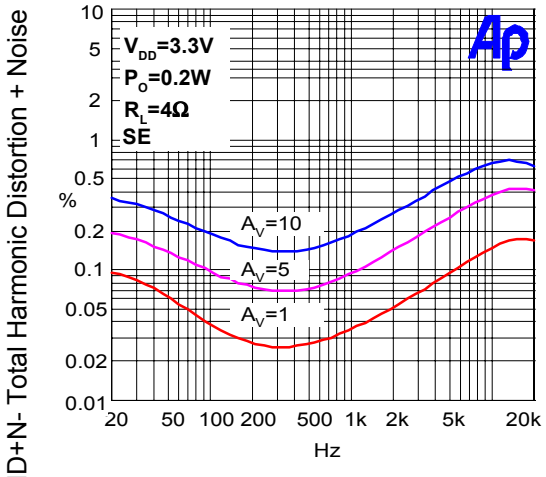
f - Frequency- Hz
Figure 24



f - Frequency- Hz
Figure 25

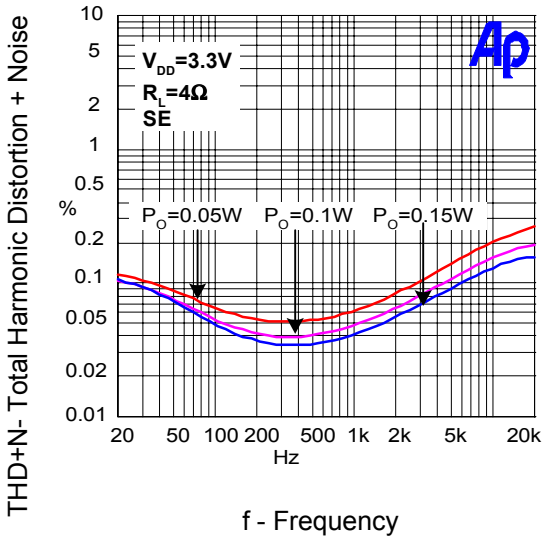


Po - Output Power
Figure 26

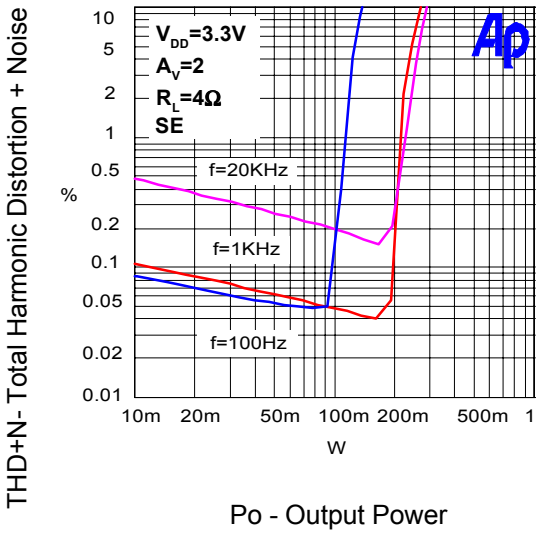


f - Frequency- Hz
Figure 27

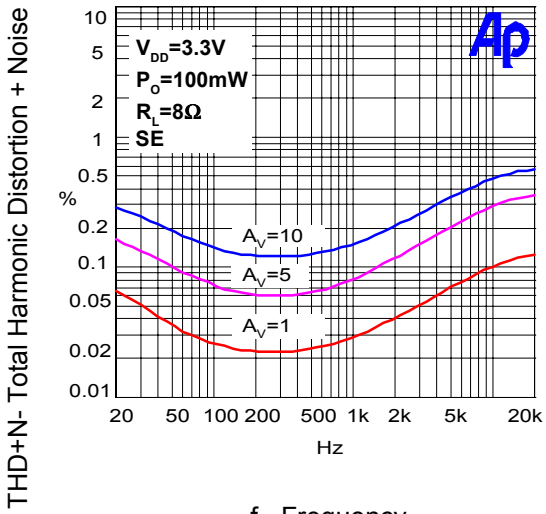
Typical Characteristics (Cont.)



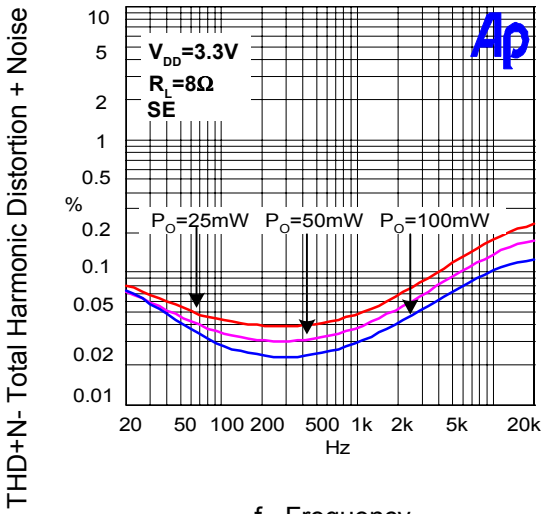
f - Frequency
Figure 28



Po - Output Power
Figure 29

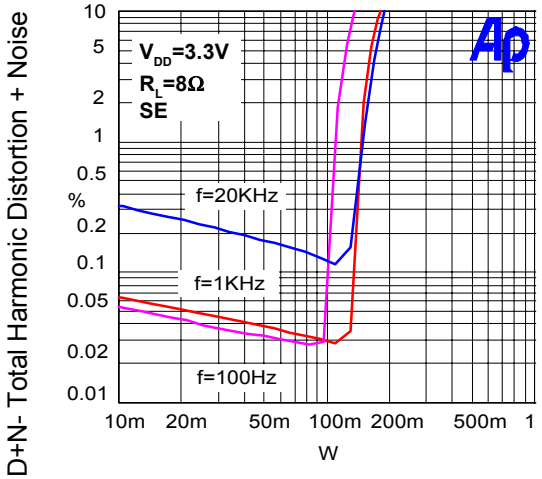


f - Frequency
Figure 30

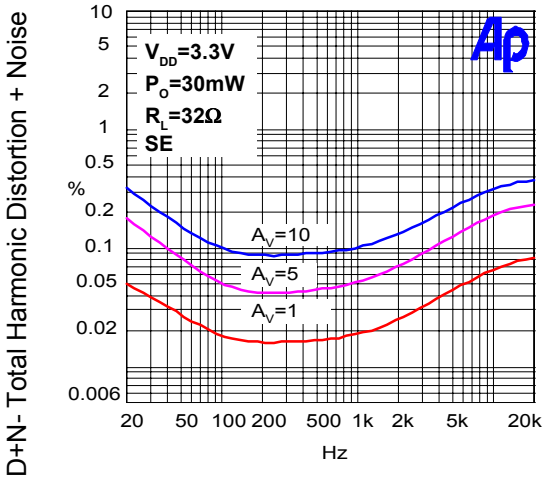


f - Frequency
Figure 31

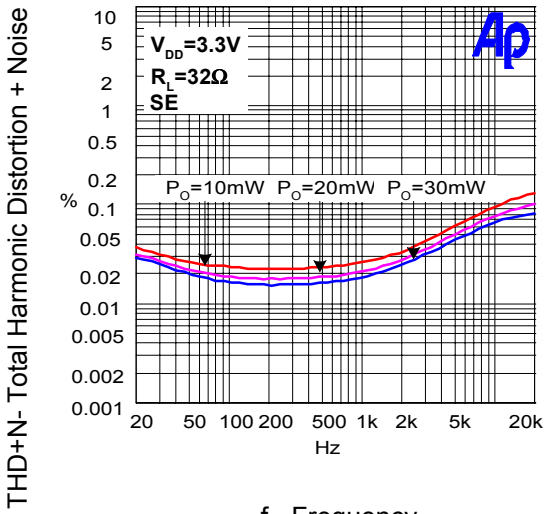
Typical Characteristics (Cont.)



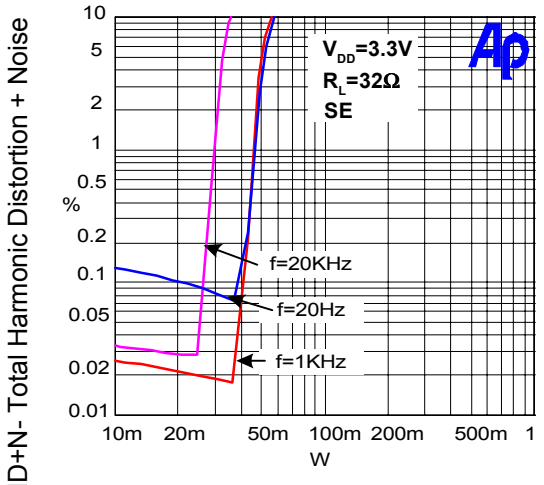
Po - Output Power
Figure 32



f - Frequency
Figure 33

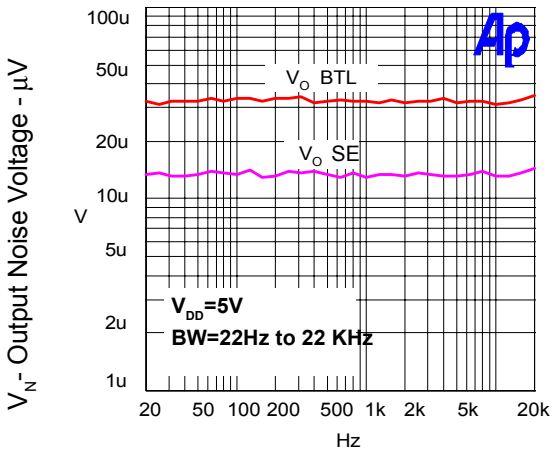


f - Frequency
Figure 34

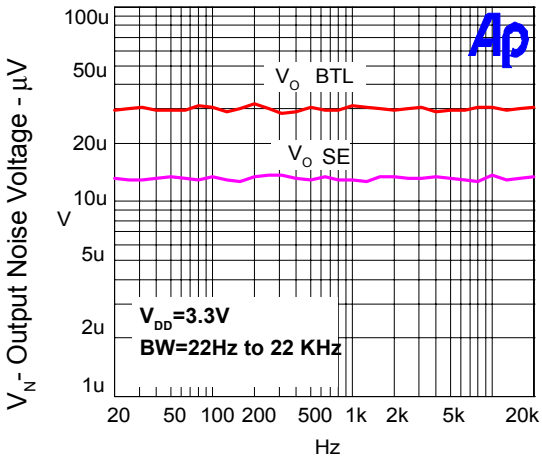


Po - Output Power
Figure 35

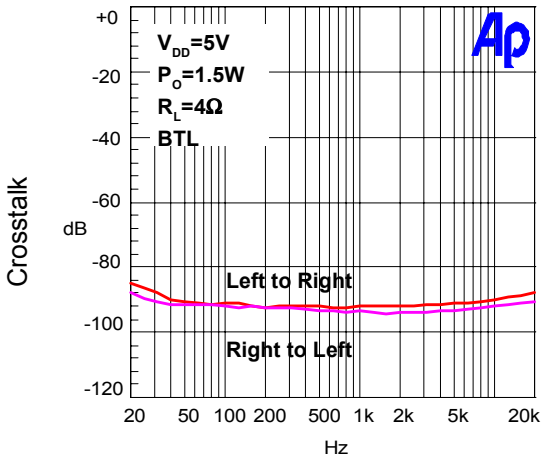
Typical Characteristics (Cont.)



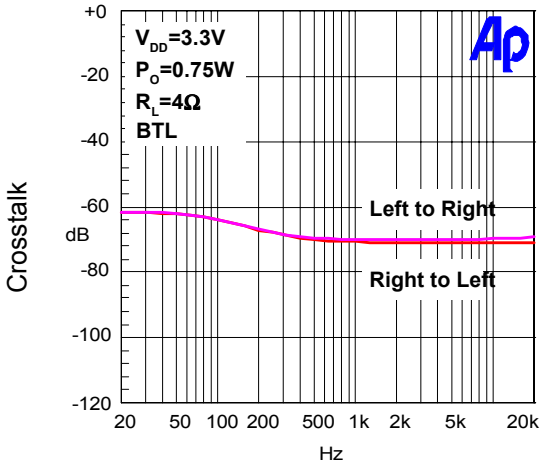
f - Frequency
Figure 36



f - Frequency
Figure 37

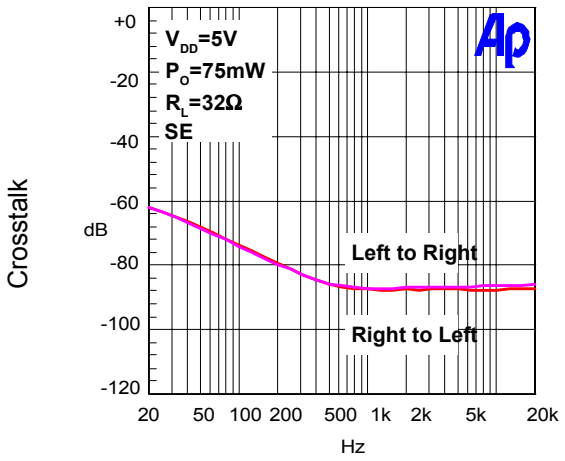


f - Frequency
Figure 38

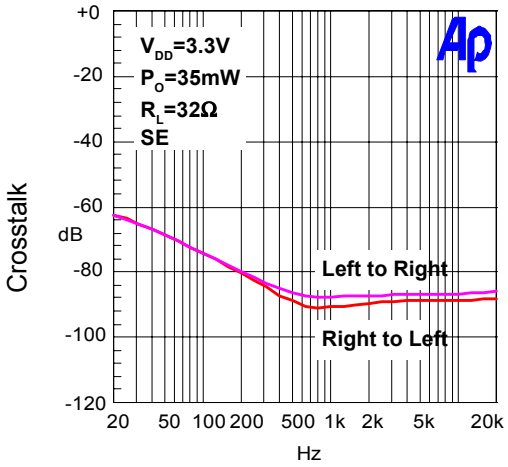


f - Frequency
Figure 39

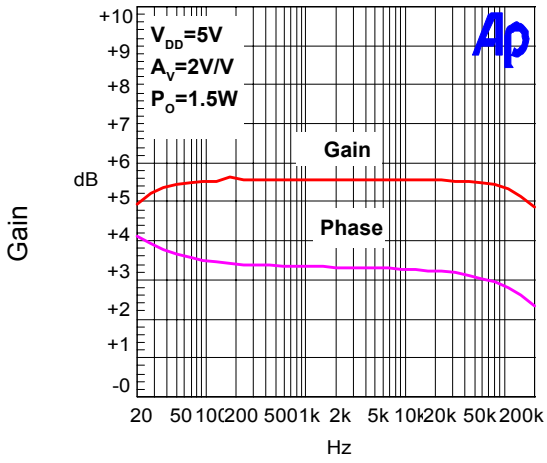
Typical Characteristics (Cont.)



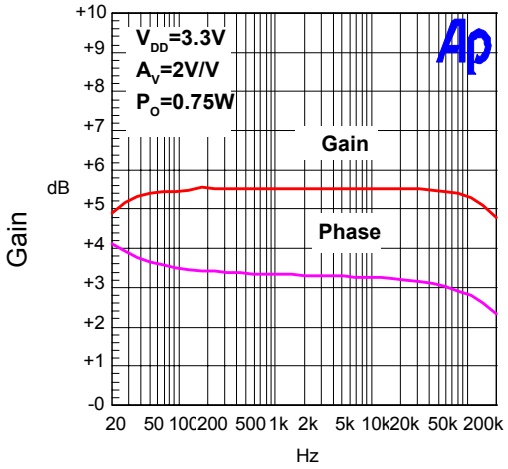
f - Frequency
Figure 40



f - Frequency
Figure 41

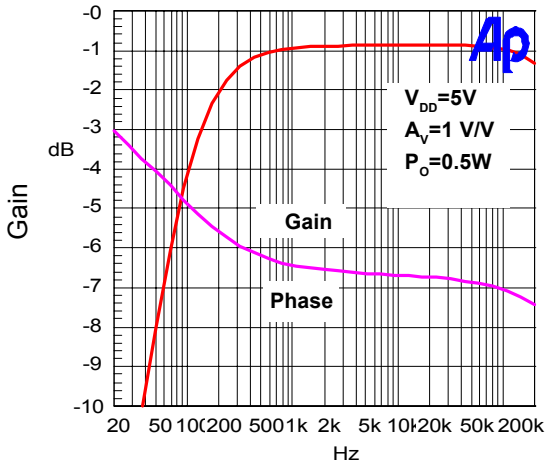


f- Frequency
Figure 42

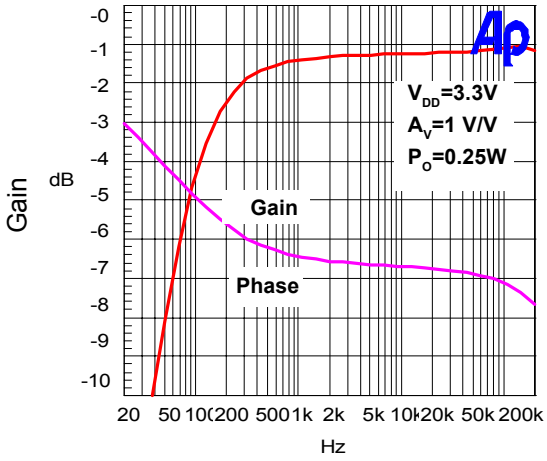


f- Frequency
Figure 43

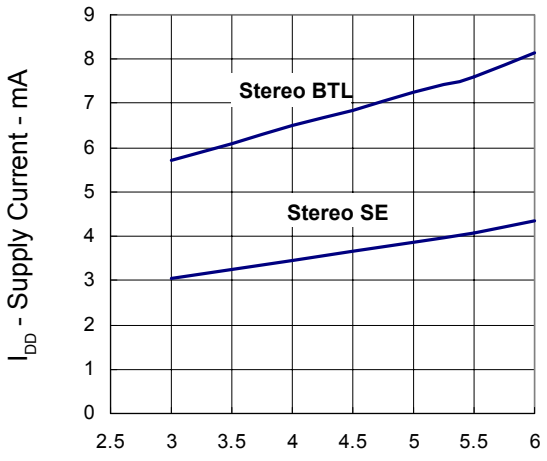
Typical Characteristics (Cont.)



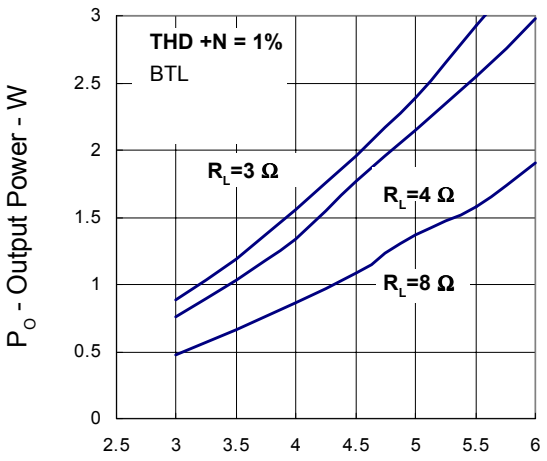
f- Frequency
Figure 44



f- Frequency
Figure 45

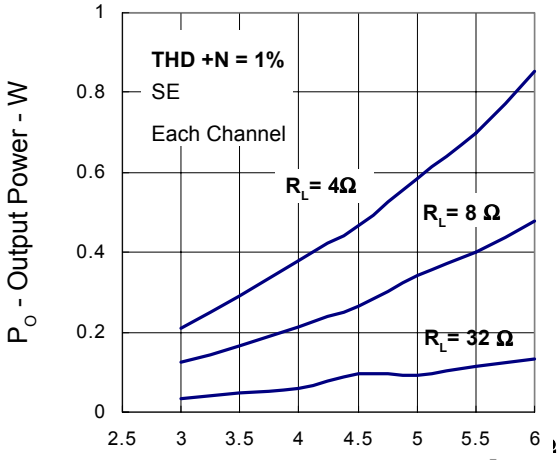


V_{DD} - Supply Voltage - V
Figure 46

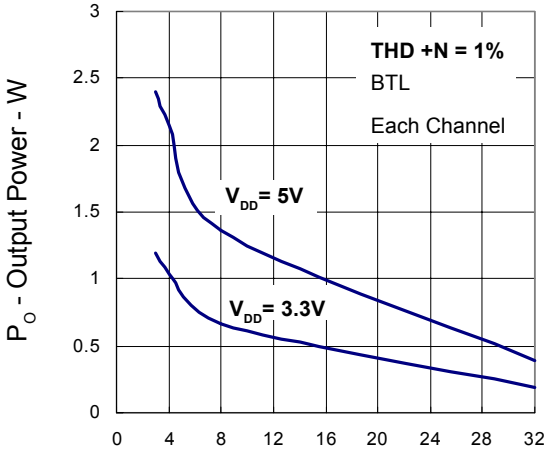


V_{DD} - Supply Voltage - V
Figure 47

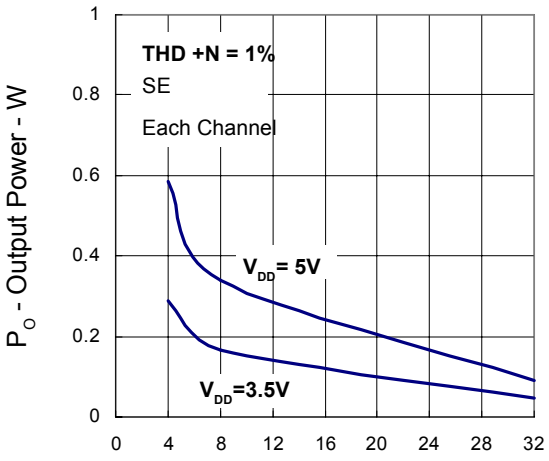
Typical Characteristics (Cont.)



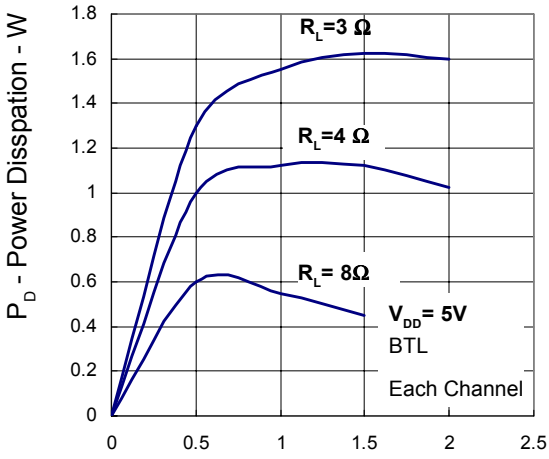
V_{DD} - Supply Voltage - V
Figure 48



R_L - Load Resistance- Ω
Figure 49

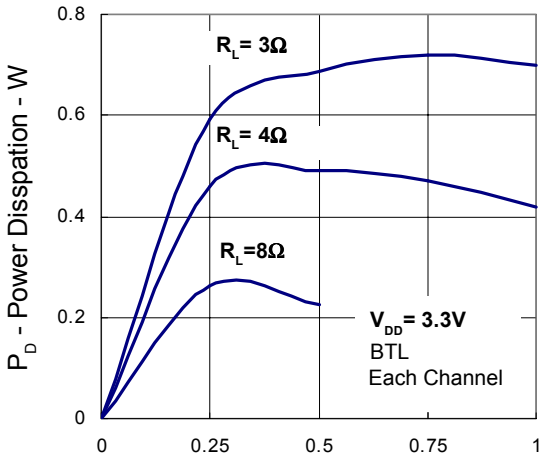


R_L - Load Resistance- Ω
Figure 50

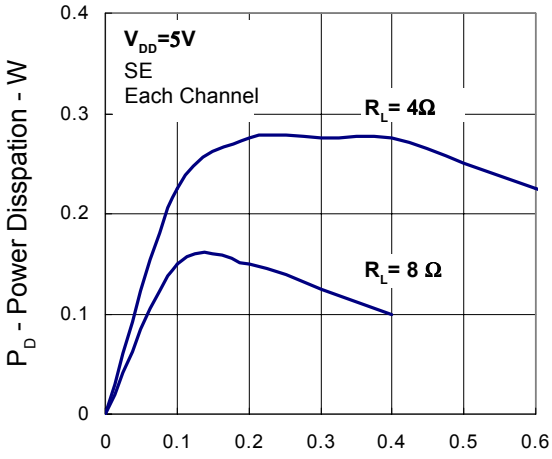


P_O - Output Power - W
Figure 51

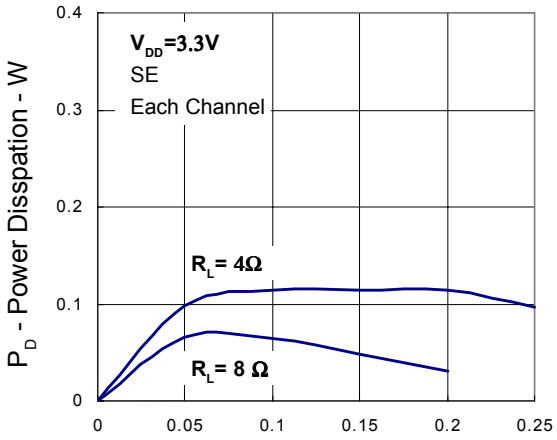
Typical Characteristics (Cont.)



P_O - Output Power - W
Figure 52



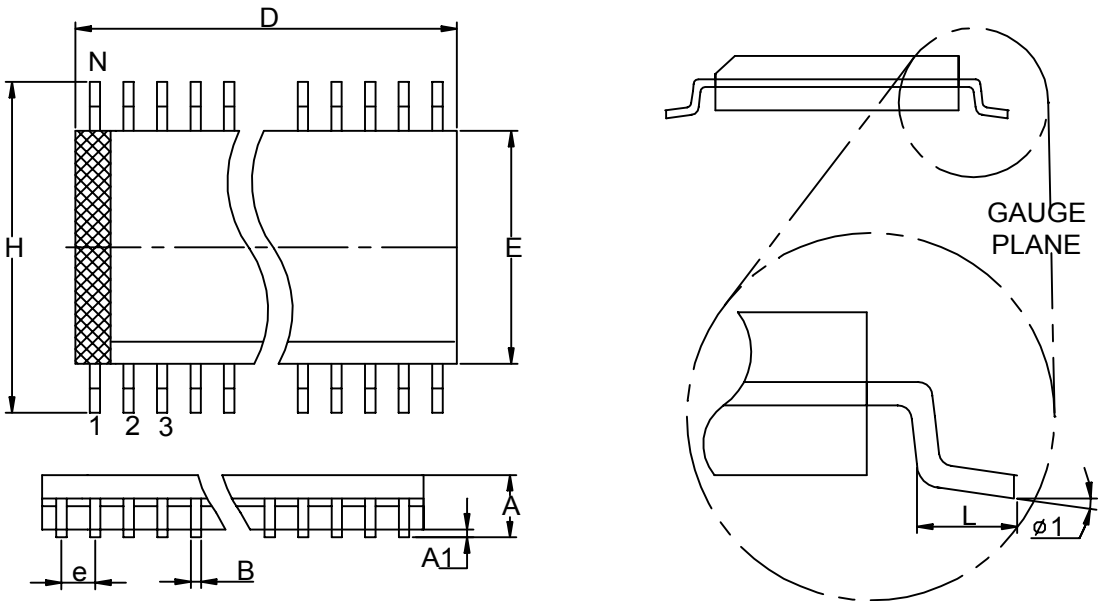
P_O - Output Power - W
Figure 53



P_O - Output Power - W
Figure 54

Packaging Information

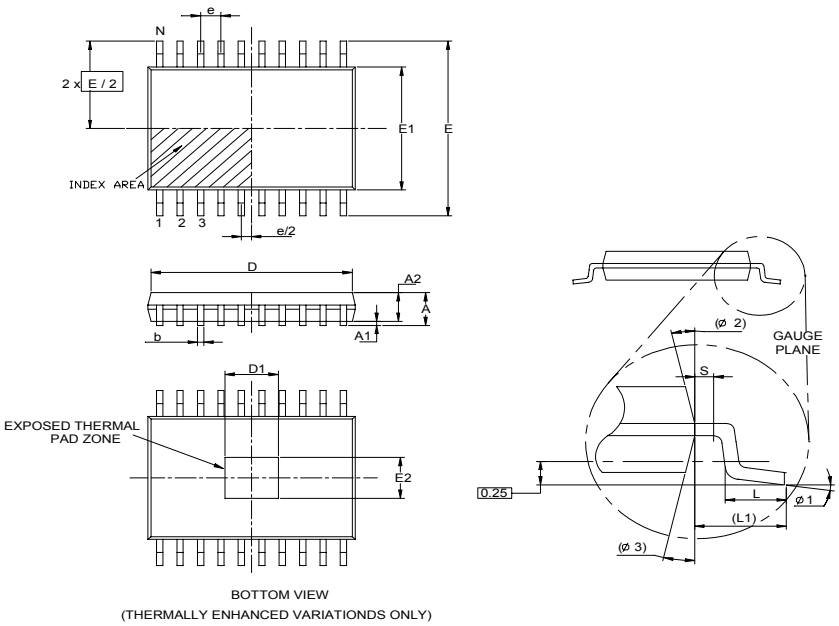
SO – 300mil (Reference JEDEC Registration MS-013)



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°			

Packaging Information

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



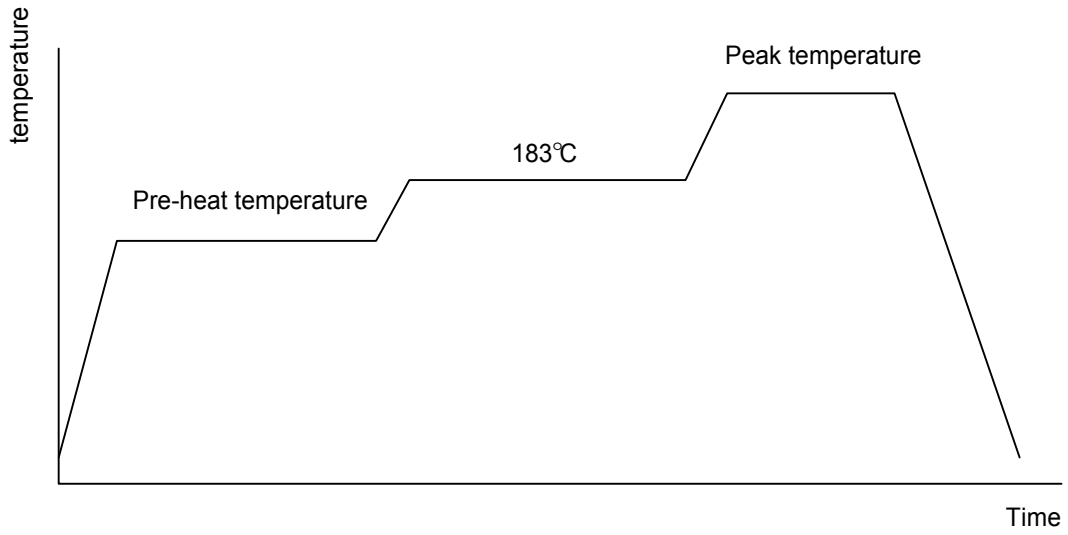
Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A		1.2		0.047
A1	0.00	0.15	0.000	0.006
A2	0.80	1.05	0.031	0.041
D	6.4 (N=20PIN) 7.7 (N=24PIN) 9.6 (N=28PIN)	6.6 (N=20PIN) 7.9 (N=24PIN) 9.8 (N=28PIN)	0.252 (N=20PIN) 0.303 (N=24PIN) 0.378 (N=28PIN)	0.260 (N=20PIN) 0.311 (N=24PIN) 0.386 (N=28PIN)
D1	4.2 BSC (N=20PIN) 4.7 BSC (N=24PIN) 3.8 BSC (N=28PIN)		0.165 BSC (N=20PIN) 0.188 BSC (N=24PIN) 0.150 BSC (N=28PIN)	
e	0.65 BSC		0.026 BSC	
E	6.40 BSC		0.252 BSC	
E1	4.30	4.50	0.169	0.177
E2	3.0 BSC (N=20PIN) 3.2 BSC (N=24PIN) 2.8 BSC (N=28PIN)		0.118 BSC (N=20PIN) 0.127 BSC (N=24PIN) 0.110 BSC (N=28PIN)	
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	

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.

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.	

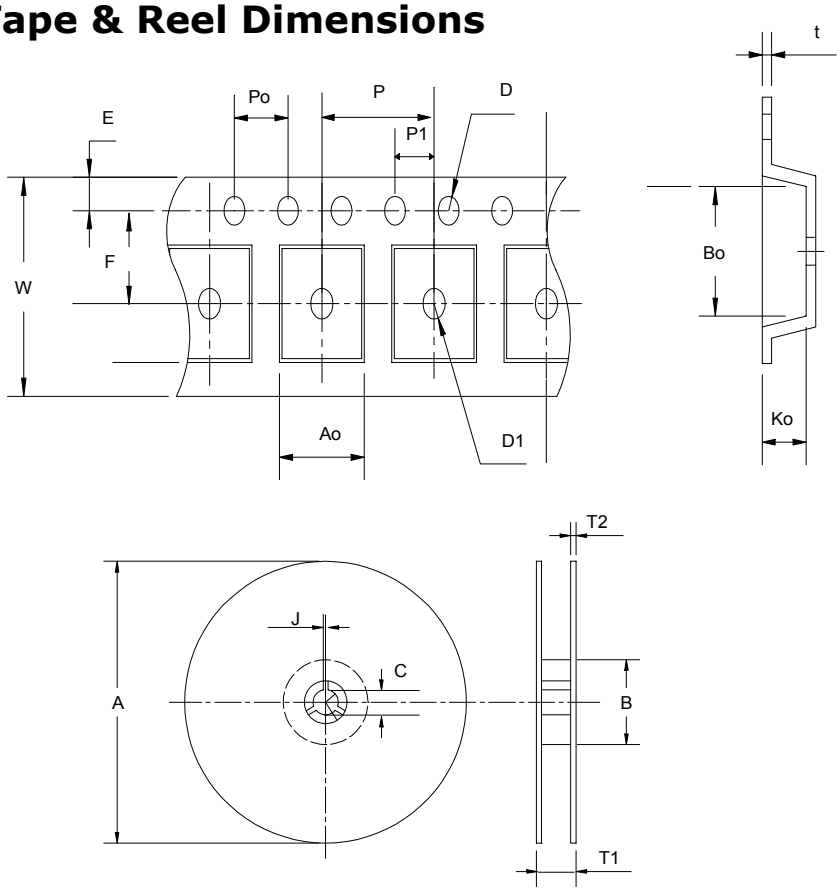
Package Reflow Conditions

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- 24	330±1	62 ±1.5	12.75 ± 0.15	2 ± 0.6	24.4 ± 0.2	2± 0.2	24 ± 0.3	12 ± 0.1	1.75± 0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	11.5 ± 0.1	1.55 +0.1	1.5+ 0.25	4.0 ± 0.1	2.0 ± 0.1	10.9 ± 0.1	15.9± 0.1	3.1± 0.1	0.35±0.05

(mm)

Cover Tape Dimensions

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOP- 16 / 20 / 24 / 28	24	21.3	1000

Customer Service

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