

Stereo 2.8W Audio Power Amplifier with DC Volume Control and Selectable Gain

Features

- Operating Voltage : 3.3V to 5V
- Stereo switchable bridged/single-ended power amplifiers
- DC Volume Control Interface , 0dB to -105dB
- Low Supply Current , $I_{DD} = 13\text{mA}$ at Stereo BTL
- Low Shutdown Current , $I_{DD} = 0.7\mu\text{A}$
- Bridge-Tied Load (BTL) or Single-Ended-(SE) Modes Operation
- Output Power at 1% THD+N , $V_{DD}=5\text{V}$
 - 2.2W/Ch (typ) into a 3 Ω Load
 - 2.0W/Ch (typ) into a 4 Ω Load
 - 1.2W/Ch (typ) into a 8 Ω Load
- Output Power at 10% THD+N , $V_{DD}=5\text{V}$
 - 2.8W/Ch (typ) into a 3 Ω Load
 - 2.3W/Ch (typ) into a 4 Ω Load
 - 1.5W/Ch (typ) into a 8 Ω Load
- Single-ended mode at 1.0% THD+N
 - 95mW/Ch (typ) into 32 Ω Load
- Depop Circuitry Integrated
- System Beep Detect
- Thermal shutdown protection circuitry
- High supply voltage ripple rejection
- Low Crossover Distortion
- PC99 Compliant
- 28-pin TSSOP-P (with enhanced thermal pad) power package available

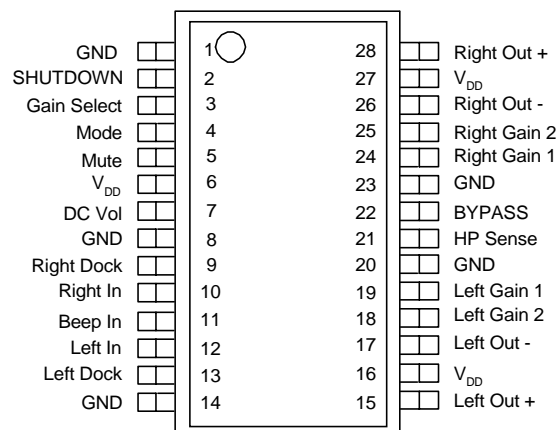
Applications

- Notebook and Desktop Computers
- Multimedia Monitors
- Portable Applications

General Description


The APA4835 is a monolithic integrated circuit , which provides DC volume control , and a stereo bridged audio power amplifiers capable of producing 2.8W (2.2W) into 3 Ω with less than 10% (1.0%) THD+N. APA4835 includes a DC volume control , stereo bridge-tied and single-ended audio power amplifiers , stereo docking outputs , and a selectable gain control , that makes it optimally fittable for notebook PC , multimedia monitors , and other portable applications. The attenuator range of the volume control in APA4835 is from 0dB ($DC_Vol=0.7V_{DD}$) to -105dB ($DC_Vol=0\text{V}$) with 32 steps. Both of the depop circuitry and the thermal shutdown protection circuitry are integrated in APA4835 , that reduces pops and clicks noise during power up or shutdown mode operation , and protects the chip from being destroyed by over temperature failure. To simplify the audio system design , APA4835 combines a stereo bridge-tied loads (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/BTL input control pin signal. Besides the low supply current design to increase the efficiency of the amplifiers , APA4835 also features a shutdown function which keeps the supply current only 0.7 μA (typ).

Pin Description

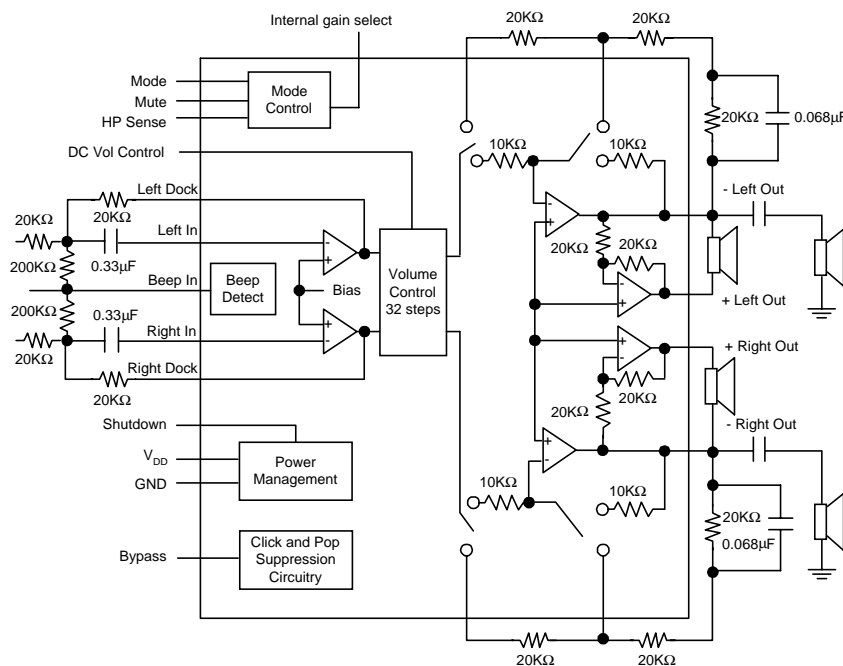


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Ordering Information

<p>APA4835 □□-□□</p> <p style="margin-left: 40px;">└─ Handling Code</p> <p style="margin-left: 40px;">└─ Temp. Range</p> <p style="margin-left: 40px;">└─ Package Code</p>	<p>Package Code R : TSSOP-P</p> <p>Temp. Range I : -40 to 85 °C</p> <p>Handling Code TU : Tube TR : Tape & Reel</p>
<p>APA4835 R : </p>	<p>XXXXX - Date Code</p>

Block Diagram



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	Internally limited*1	°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*2	V

Note :*1. APA4835 integrates internal thermal shutdown protection when junction temperature ramp up to 150°C.

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

Thermal Characteristics

Symbol	Parameter	Rating	Unit
R _{THJA}	Thermal Resistance from Junction to Ambient in Free Air		
	TSSOP-P*	60	°C/W
	TSSOP-P**	35	

*5in² printed circuit board with 2oz trace and copper pad through 12 25mil diameter vias. The thermal pad on the TSSOP_P package without solder on the printed circuit board.

**5in² printed circuit board with 2oz trace and copper pad through 12 25mil diameter vias. The thermal pad on the TSSOP_P package with solder on the printed circuit board.

Electrical 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	APA4835			Unit
			Min.	Typ.	Max.	
V _{DD}	Supply Voltage		3.3		5.5	V
I _{DD}	Quiescent Power Supply Current	V _{IN} =0V, I _O =0A		13	25	mA
I _{SD}	Shutdown Current	V _{PIN2} = V _{DD}		0.7	2.0	μA
V _{IH}	SE/BTL High Input Voltage		4			V
V _{IL}	SE/BTL Low Input Voltage				0.8	V

Electrical Characteristics for Volume Attenuators

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

Symbol	Parameter	Test Conditions	APA4835			Unit
			Min.	Typ.	Max.	
C _{RANGE}	Attenuator Range	Gain with V _{PIN7} =5V			±0.5	dB
		Attenuation with V _{PIN7} =0V	-90	-105		
A _M	Mute Attenuation	V _{PIN5} =5V, Bridged Mode	-88			dB
		V _{PIN5} =5V, Single-Ended Mode	-88			

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	APA4835	Unit
			Typ.	
V _{OS}	Output Offset Voltage	V _{IN} =0V	5	mV
P _O	Output Power	THD=1%, f=1kHz R _L =3Ω R _L =4Ω R _L =8Ω THD=10%, f=1kHz R _L =8Ω	2.2 2.0 1.2 1.5	W

Electrical Characteristics (Cont.)

Electrical Characteristics for BTL Mode Operation (Cont.)

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

Symbol	Parameter	Test Conditions	APA4835	Unit
			Typ.	
THD+N	Total Harmonic Distortion + Noise	$A_{VD}=2, 20Hz < f < 20kHz$		
		$R_L=4\Omega, P_O=1W$	0.2	%
		$R_L=8\Omega, P_O=1W$	0.15	
		$R_L=32\Omega, P_O=340mW$	0.1	
PSRR	Power Supply Rejection Ratio	$V_{RIPPLE}=200mV_{RMS}, R_L=8\Omega$ $C_B=2.2\mu F, f=120Hz$	74	dB
X_{TALK}	Channel Separation	$f=1kHz, C_B=2.2\mu F$	95	dB
SNR	Signal-to-Noise Ratio	$V_{DD}=5V, P_O=1.1W, R_L=8\Omega, A\text{-Wtd Filter}$	95	dB
V_N	Output Noise Voltage	$R_L=8\Omega, A\text{-Wtd Filter}$	30	μV

Electrical Characteristics for SE Mode Operation

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

Symbol	Parameter	Test Conditions	APA4835	Unit
			Typ.	
V_{OS}	Output Offset Voltage	$V_{IN}=0V$	5	mV
P_O	Output Power	THD=1%, $f=1kHz, R_L=32\Omega$	95	mW
		THD=10%, $f=1kHz, R_L=32\Omega$	100	
THD+N	Total Harmonic Distortion plus Noise	$A_V=1, V_{OUT}=1V_{RMS}, f=1kHz, R_L=1k\Omega$	0.01	%
		$P_O=75mW, R_L=32\Omega, A_V=1, f=1kHz$	0.005	%
PSRR	Power Supply Rejection Ratio	$V_{RIPPLE}=200mV_{RMS}, f=120Hz, C_B=2.2\mu F$	58	dB
X_{TALK}	Channel Separation	$f=1kHz, C_B=2.2\mu F$	95	dB
SNR	Signal-to-Noise Ratio	$P_O=75mW, R_L=32\Omega, A\text{-Wtd Filter}$	102	dB
V_N	Output Noise Voltage	$R_L=1k\Omega, A\text{-Wtd Filter}$	40	μV

Pin Description

Pin		I/O	Description
Name	No		
GND	1, 8, 14, 20, 23		Ground connection for circuitry.
Shutdown	2	I	Shutdown mode control signal input, place entire IC in shutdown mode when held high, $I_{DD}=0.7\mu A$
Gain Select	3	I	Gain select input pin
Mode	4	I	Mode select input pin
Mute	5	I	Mute control input pin

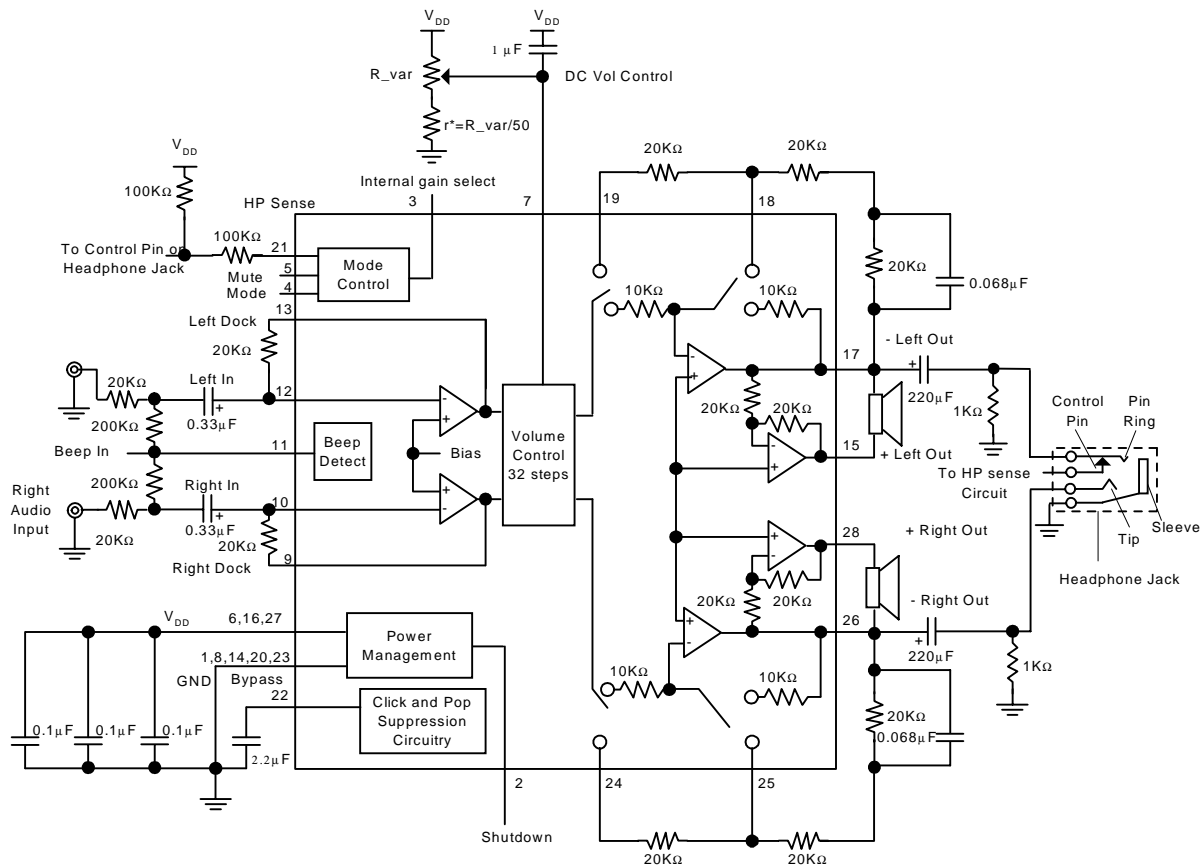
Pin Description

Pin		I/O	Description
Name	No		
VDD	6, 16, 27		Supply voltage input pin
DC_Vol	7	I	Volume control function input pin.
Right Dock	9	O	Right docking output pin
Right In	10	I	Right channel audio input pin
Beep In	11	I	Beep signal input pin
Left In	12	I	Left channel audio input pin
Left Dock	13	O	Right docking output pin
Left Out +	15	O	Left channel positive output pin
Left Out -	17	O	Left channel negative output pin
Left Gain 2	18		Connect pin 2 of the external gain setting resistor for left channel
Left Gain 1	19		Connect pin 1 of the external gain setting resistor for left channel
HP Sense	21	I	Headphone sense control pin
Bypass	22		Bypass pin
Right Gain 1	24		Connect pin 1 of the external gain setting resistor for right channel
Right Gain 2	25		Connect pin 2 of the external gain setting resistor for right channel
Right Out -	26	O	Right channel negative output pin
Right Out +	28	O	Right channel positive output pin

Truth Table for Logic Inputs

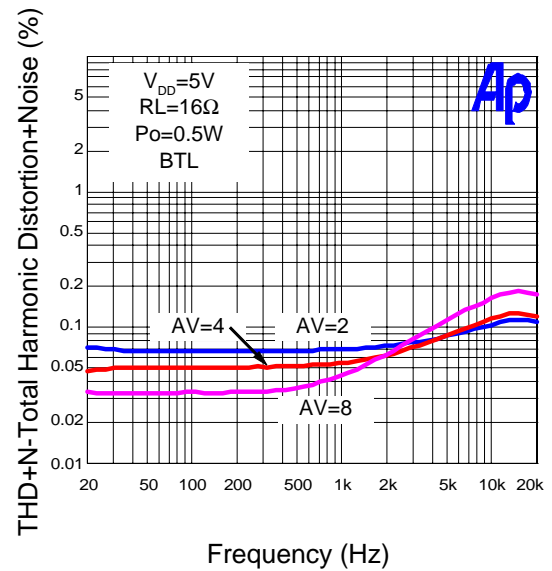
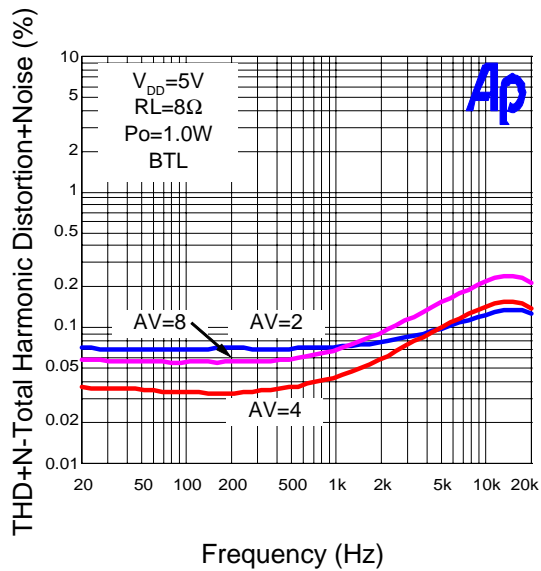
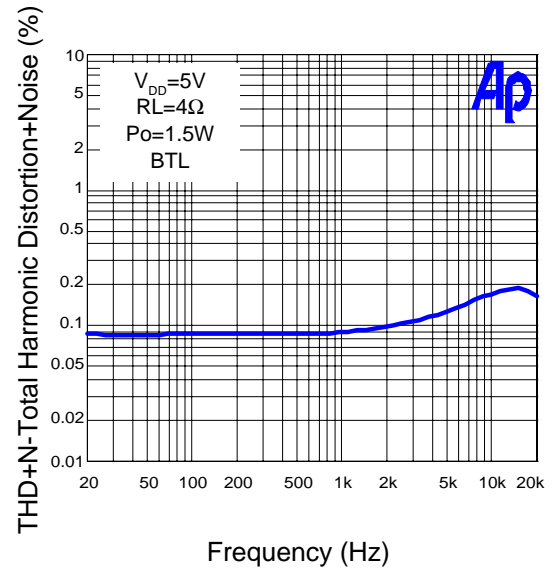
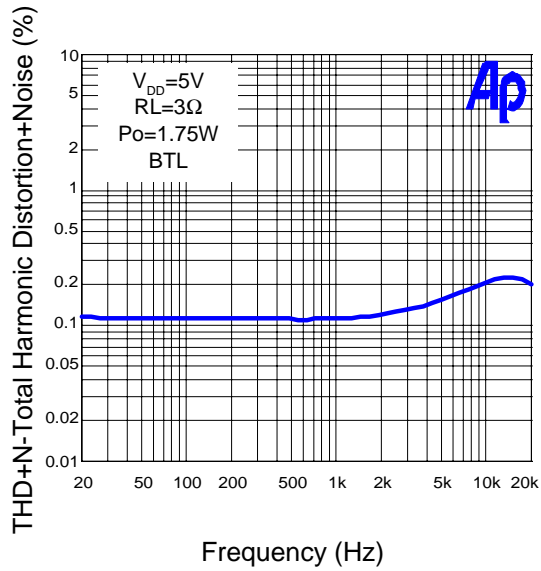
Mute	Mode	HP Sense	DC Vol. Control	Bridged Output	Single-Ended
0	0	0	Fixed Level	Vol. Fixed	-
0	0	1	Fixed Level	Muted	Vol. Fixed
0	1	0	Adjusted	Vol. Changes	-
0	1	1	Adjusted	Muted	Vol. Changed
1	x	x	-	Muted	Muted

Typical Application Circuit

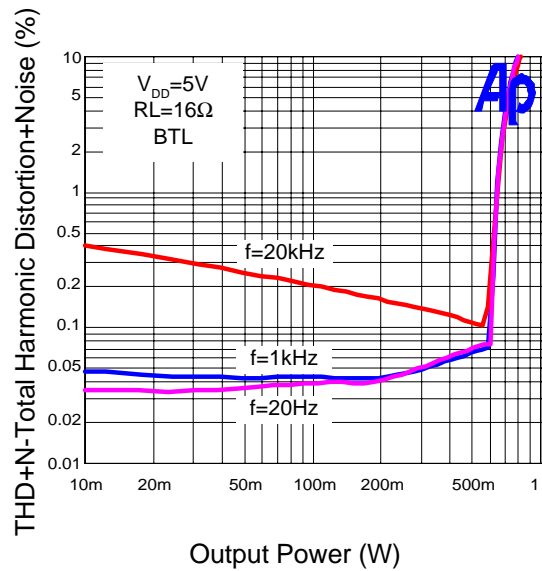
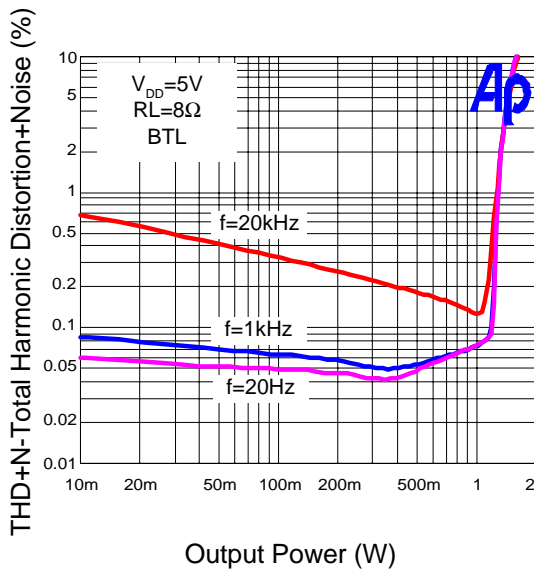
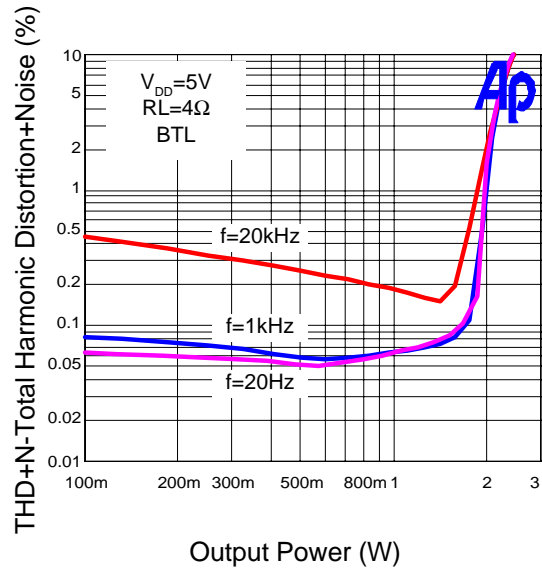
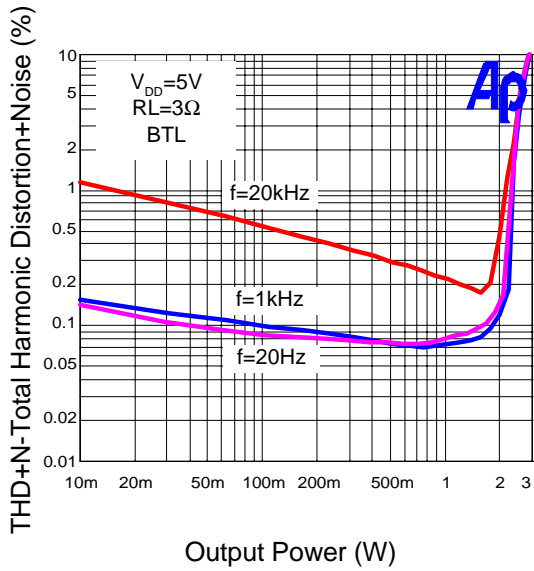


* Add a resistor to avoid volume control gain error at power on status. For the R_var with 10KΩ variable resistor, the recommended value of r is in range of 100~200Ω.

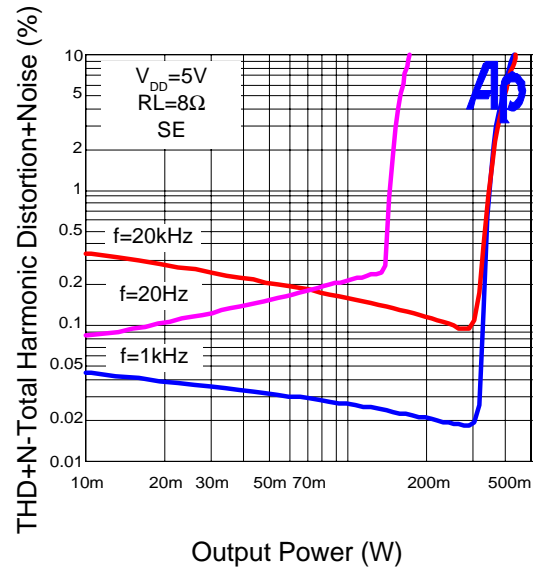
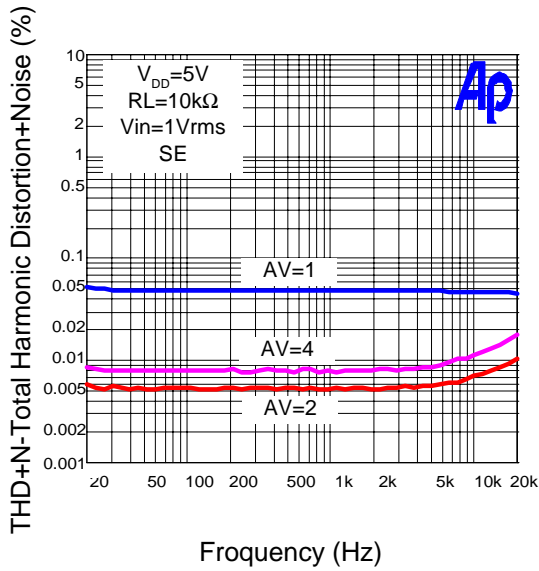
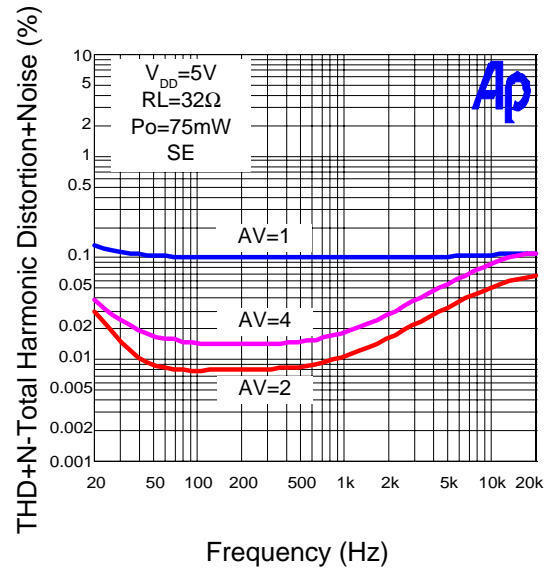
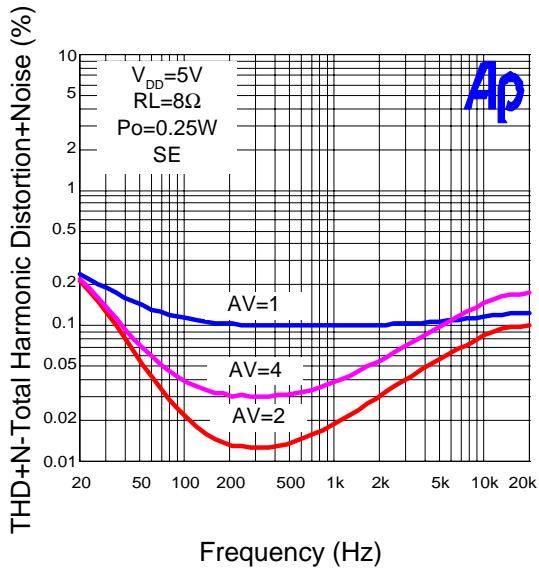
Typical Characteristics



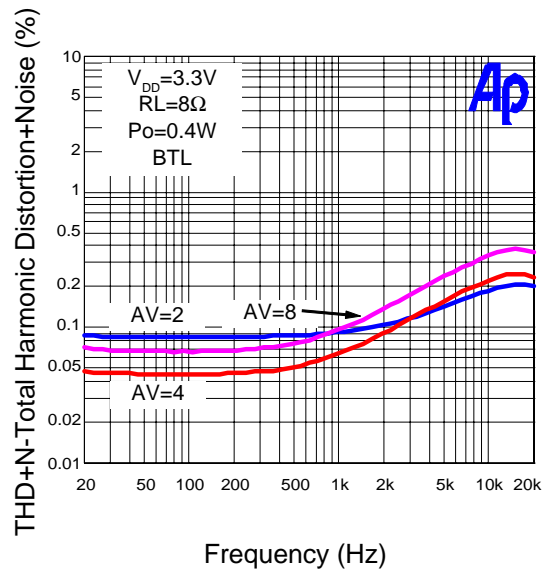
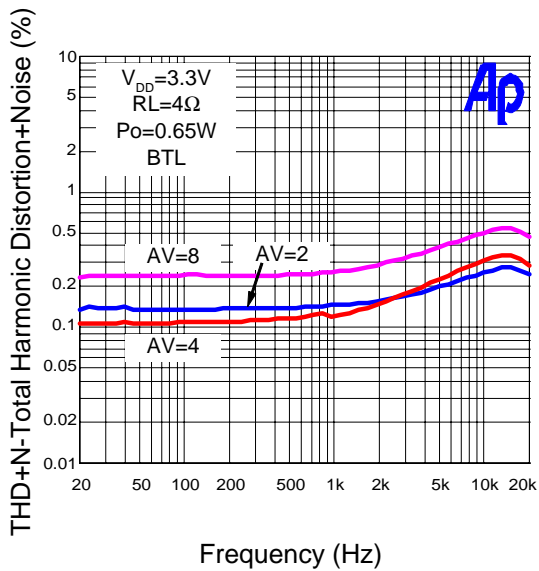
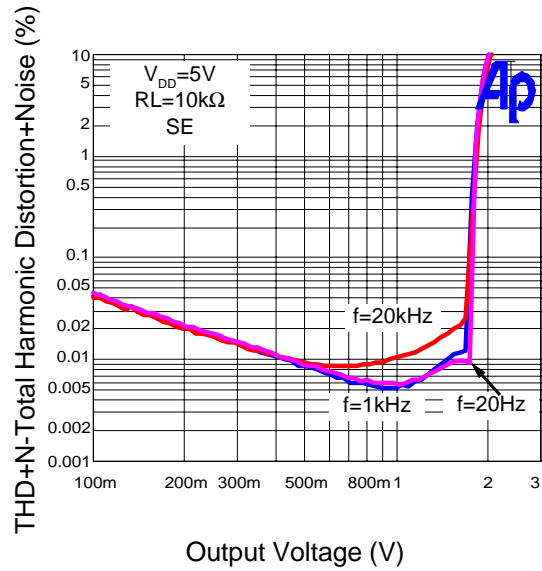
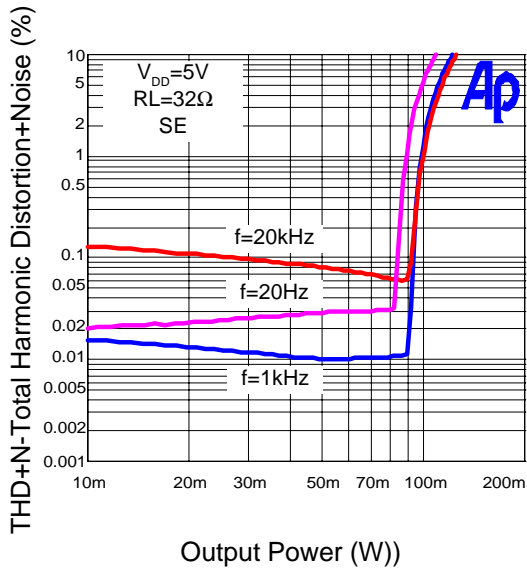
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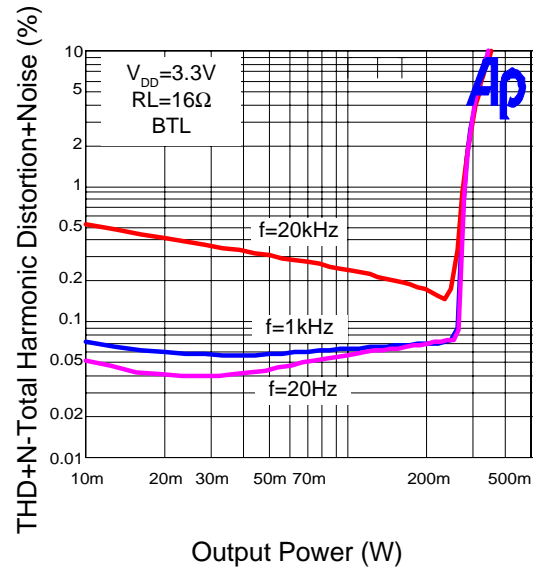
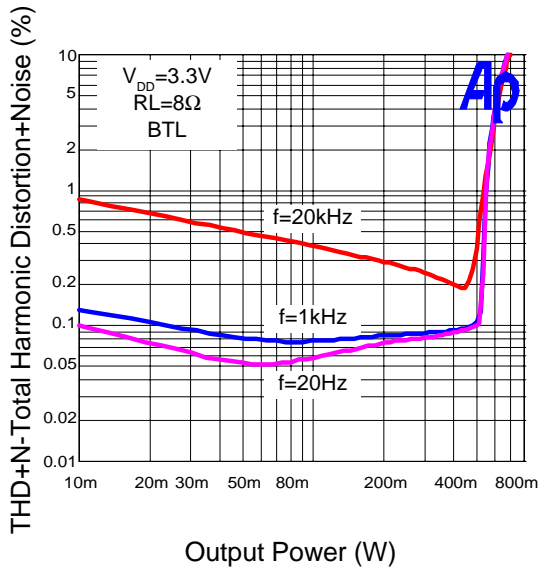
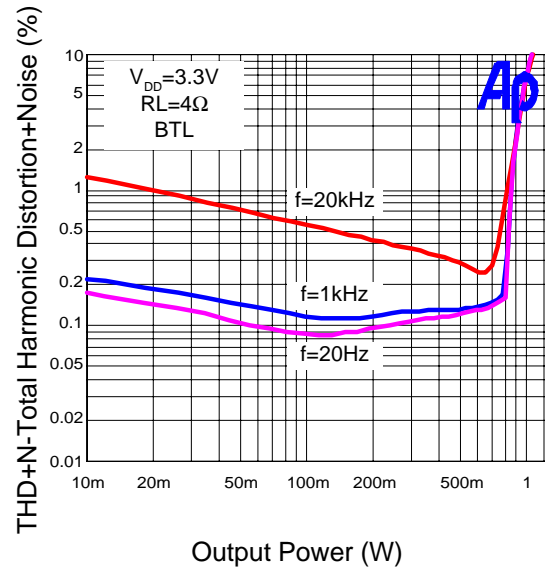
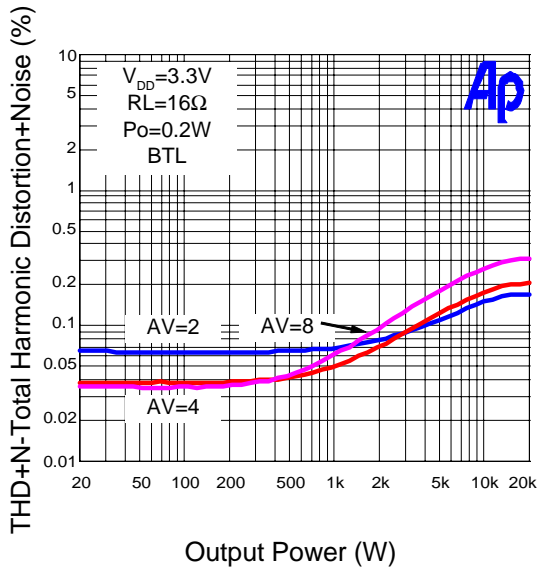
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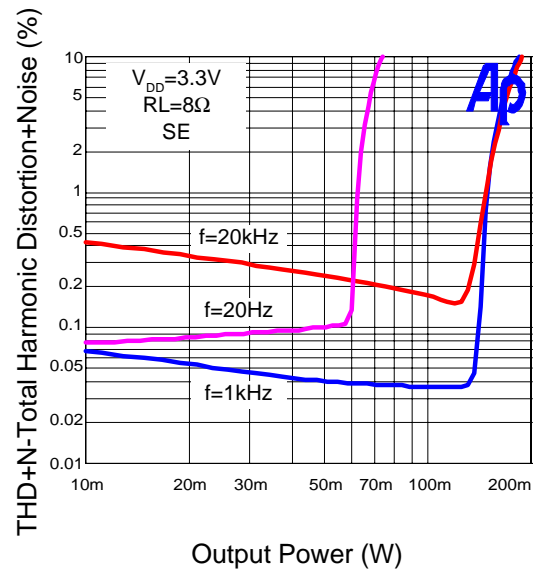
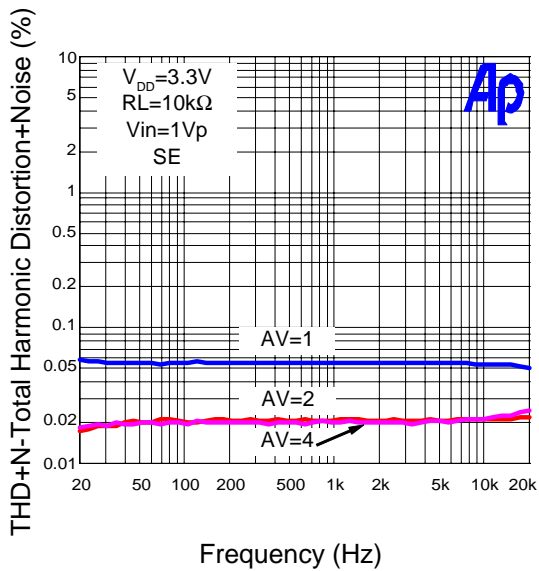
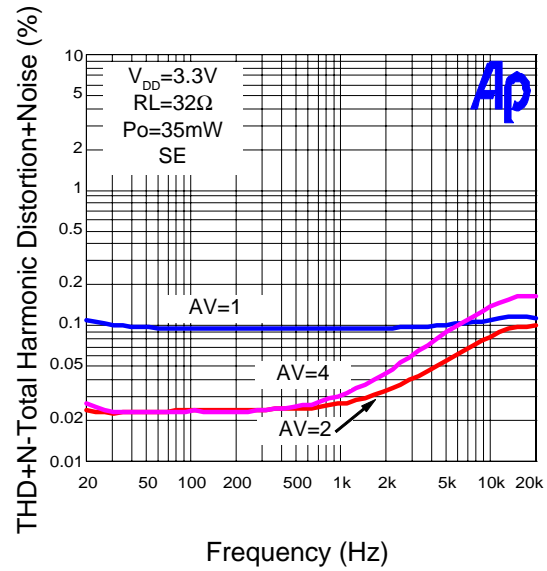
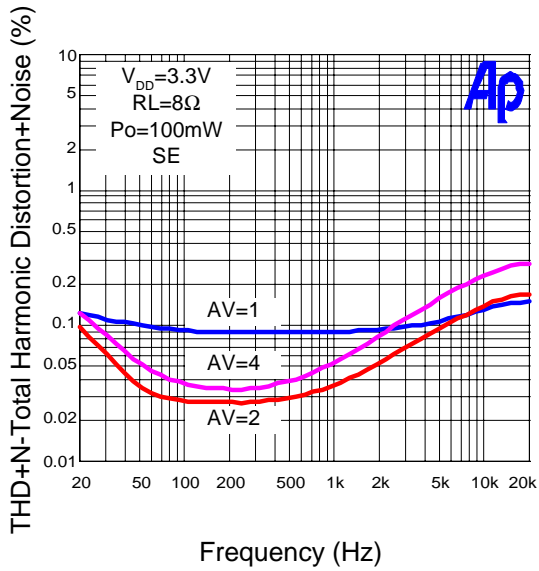
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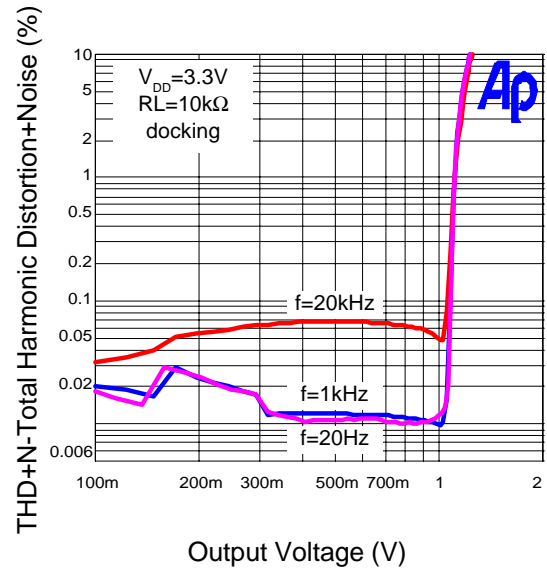
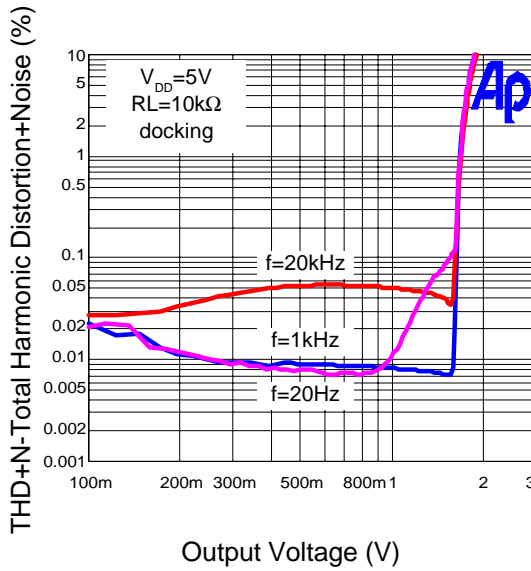
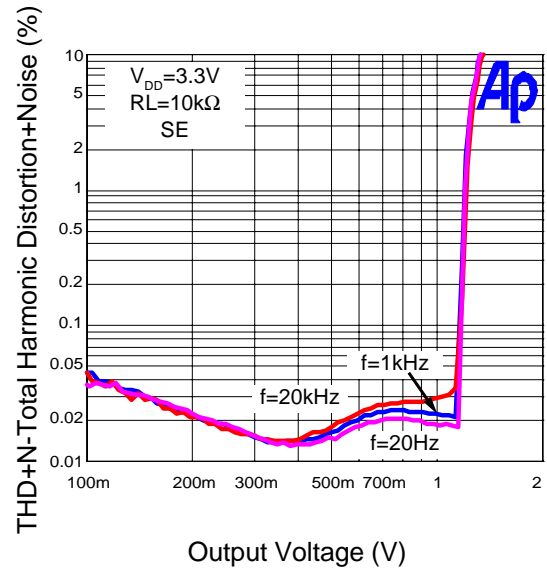
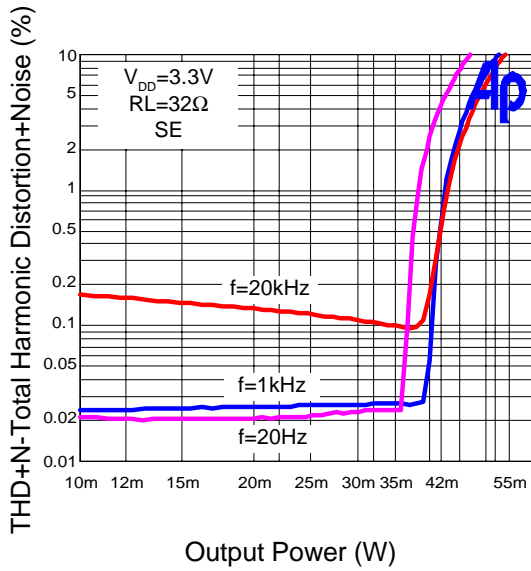
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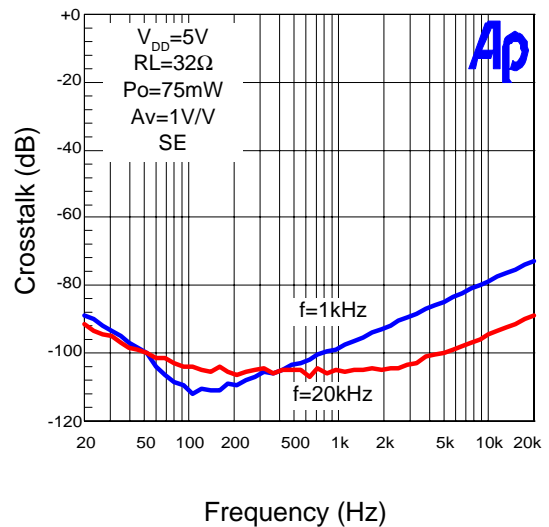
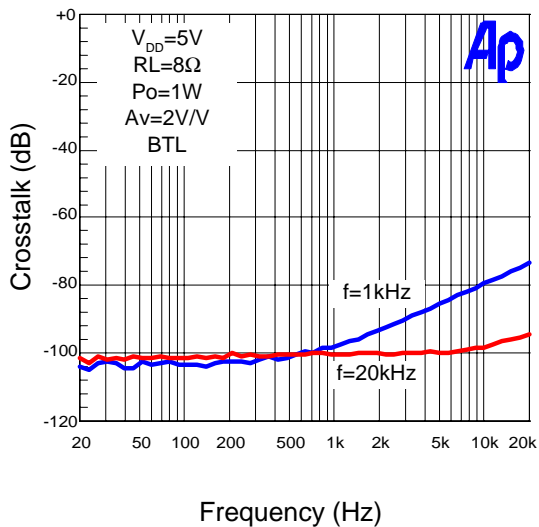
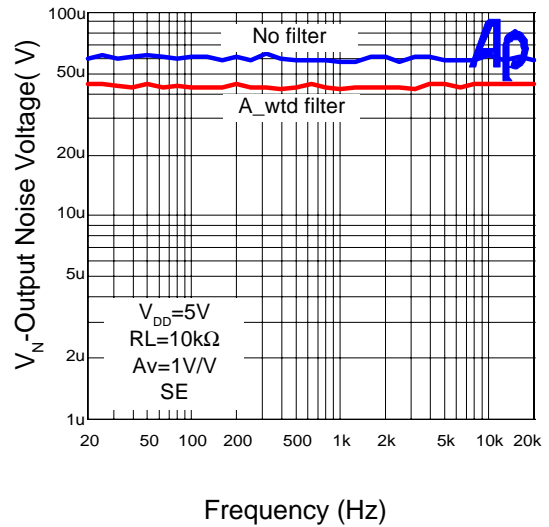
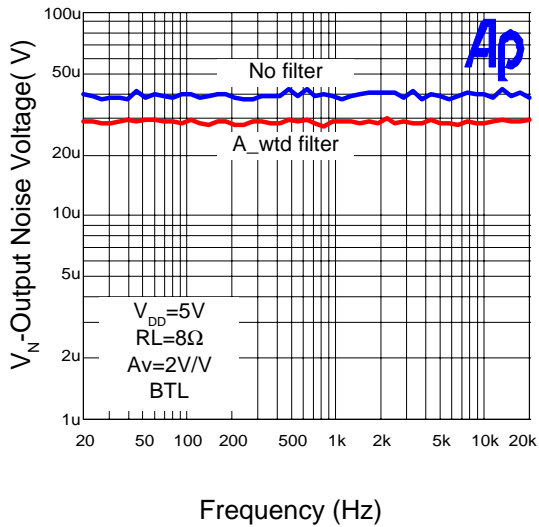
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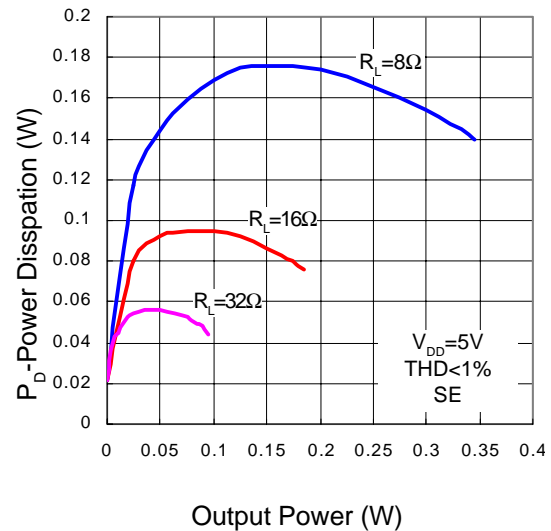
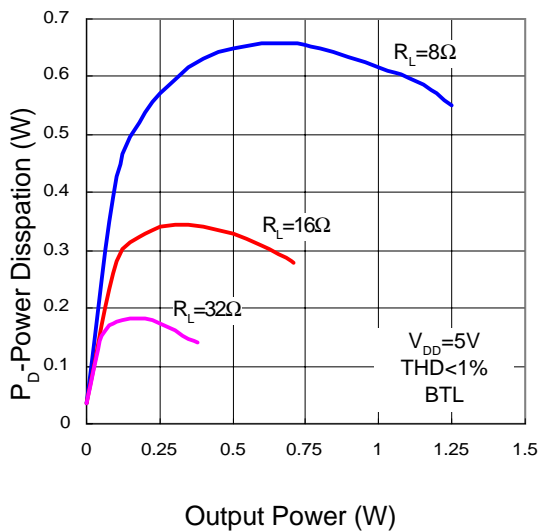
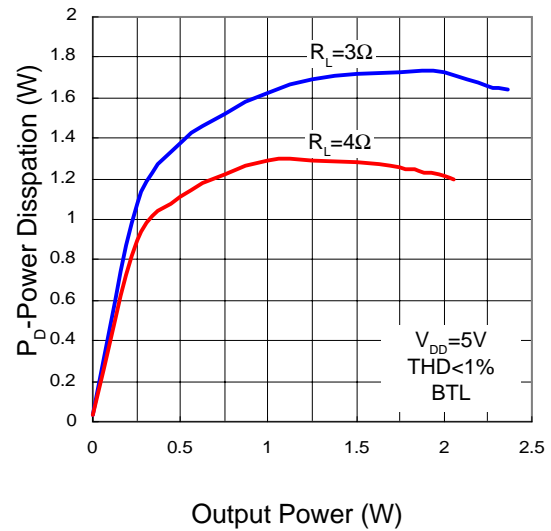
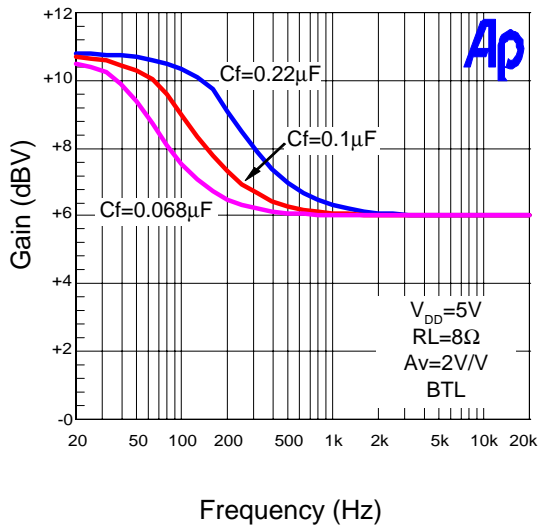
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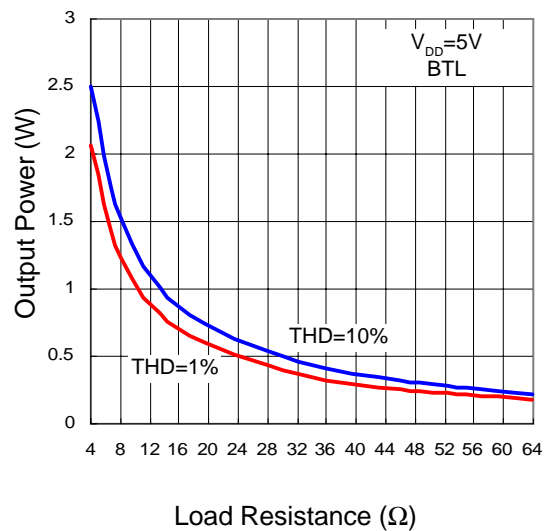
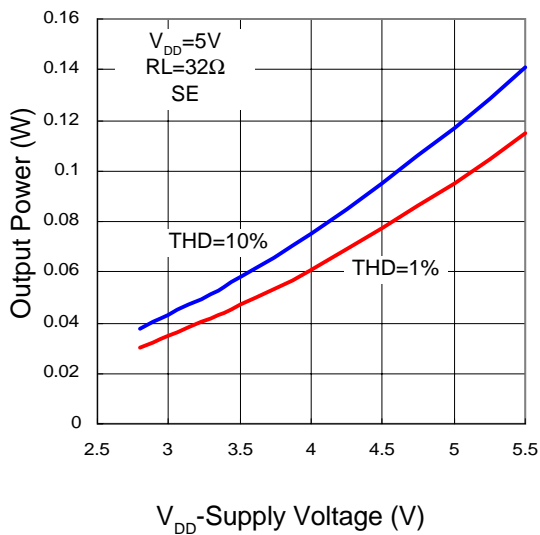
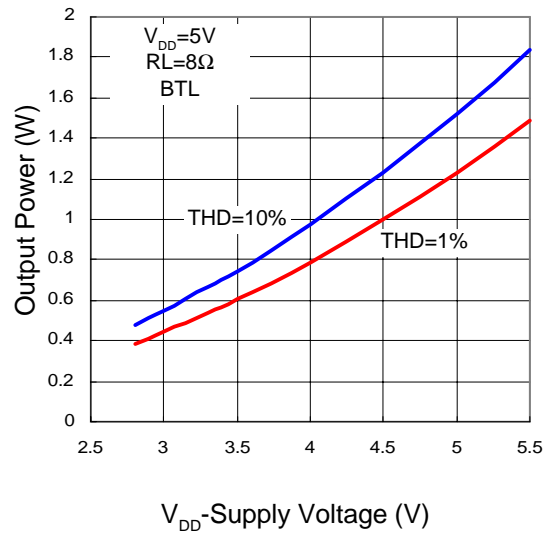
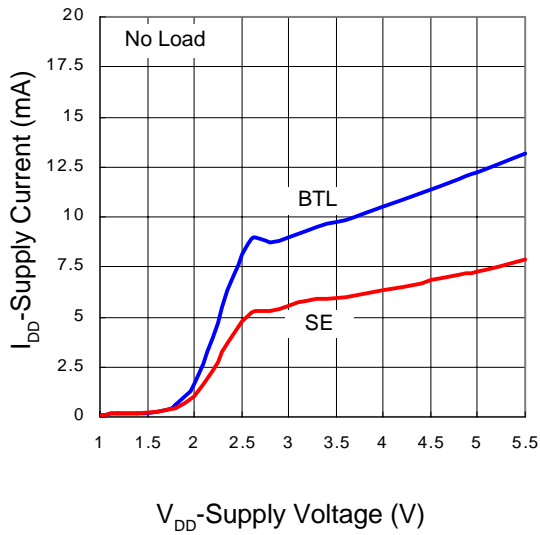
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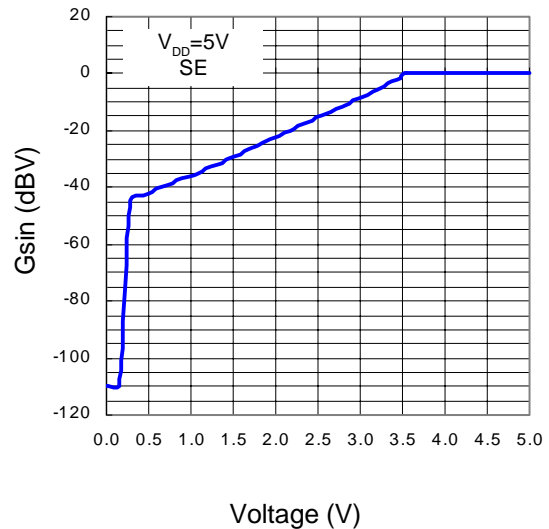
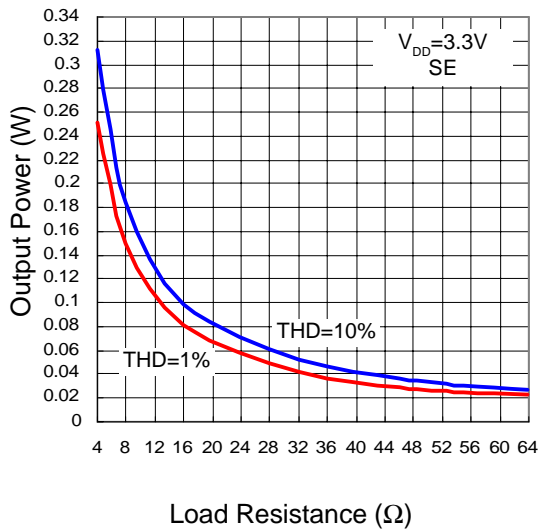
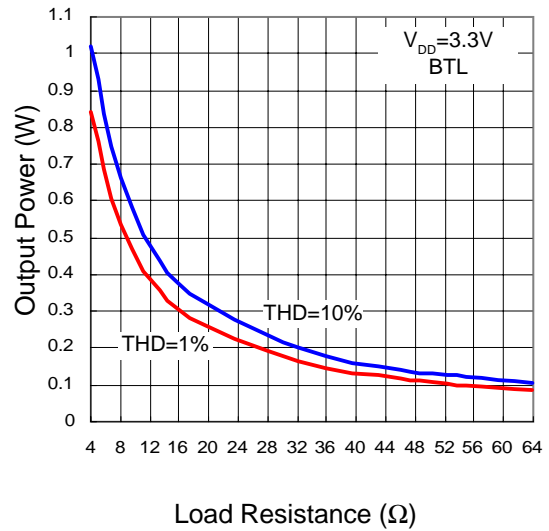
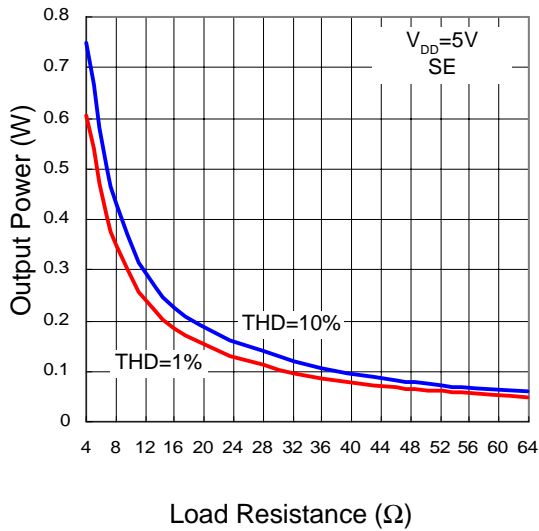
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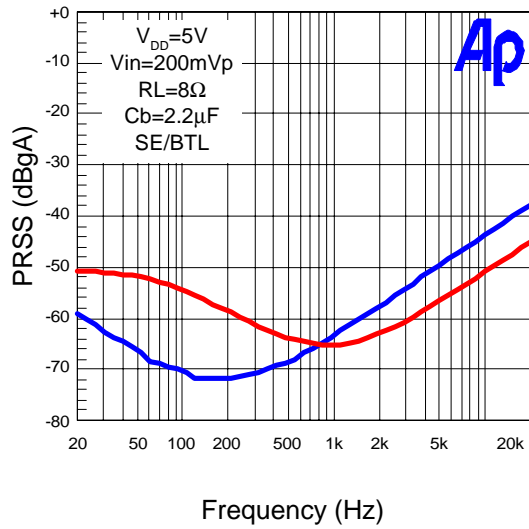
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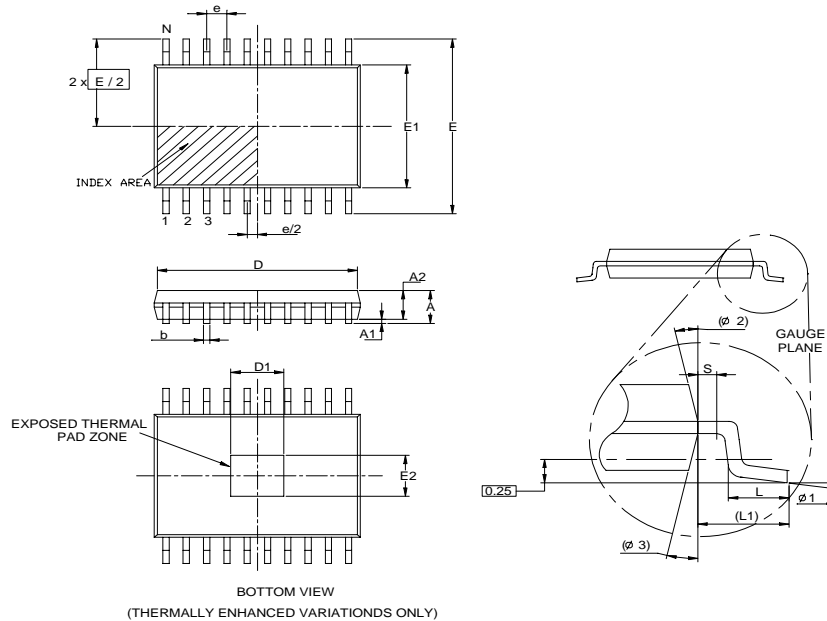


Typical Characteristics Cont.



Packaging Information

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



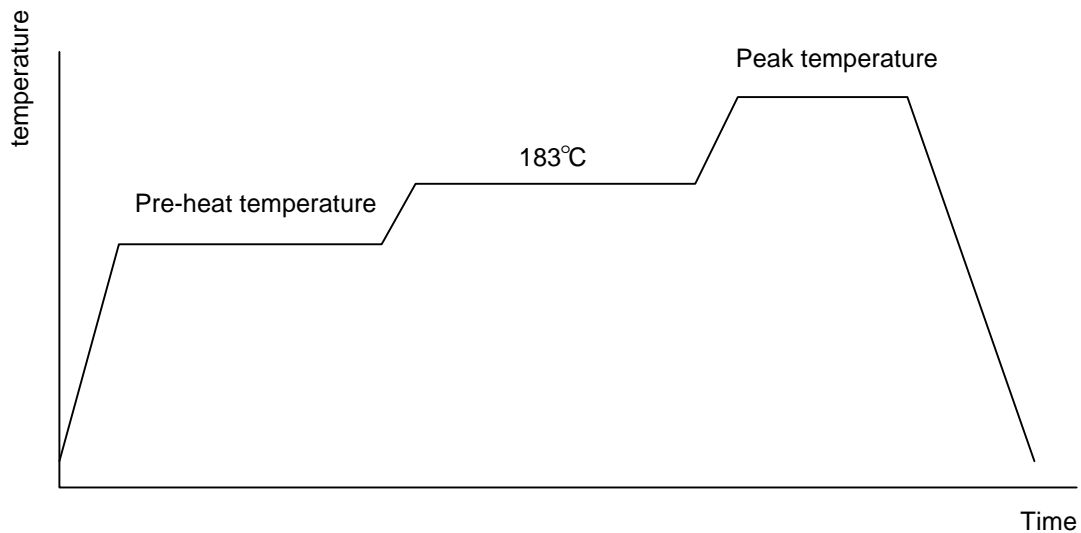
Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A		1.2		0.047
A1	0.00	0.15	0.000	0.006
A2	0.80	1.05	0.031	0.041
b	0.19	0.3	0.007	0.012
D	6.4 (N=20PIN)	6.6 (N=20PIN)	0.252 (N=20PIN)	0.260 (N=20PIN)
	7.7 (N=24PIN)	7.9 (N=24PIN)	0.303 (N=24PIN)	0.311 (N=24PIN)
	9.6 (N=28PIN)	9.8 (N=28PIN)	0.378 (N=28PIN)	0.386 (N=28PIN)
D1	4.2 BSC (N=20PIN)		0.165 BSC (N=20PIN)	
	4.7 BSC (N=24PIN)		0.188 BSC (N=24PIN)	
	3.8 BSC (N=28PIN)		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)		0.118 BSC (N=20PIN)	
	3.2 BSC (N=24PIN)		0.127 BSC (N=24PIN)	
	2.8 BSC (N=28PIN)		0.110 BSC (N=28PIN)	
L	0.45	0.75	0.018	0.030
L1	1.0 REF		0.039 REF	
R	0.09		0.004	
R1	0.09		0.004	
S	0.2		0.008	
$\phi 1$	0°	8°	0°	8°
$\phi 2$	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.	

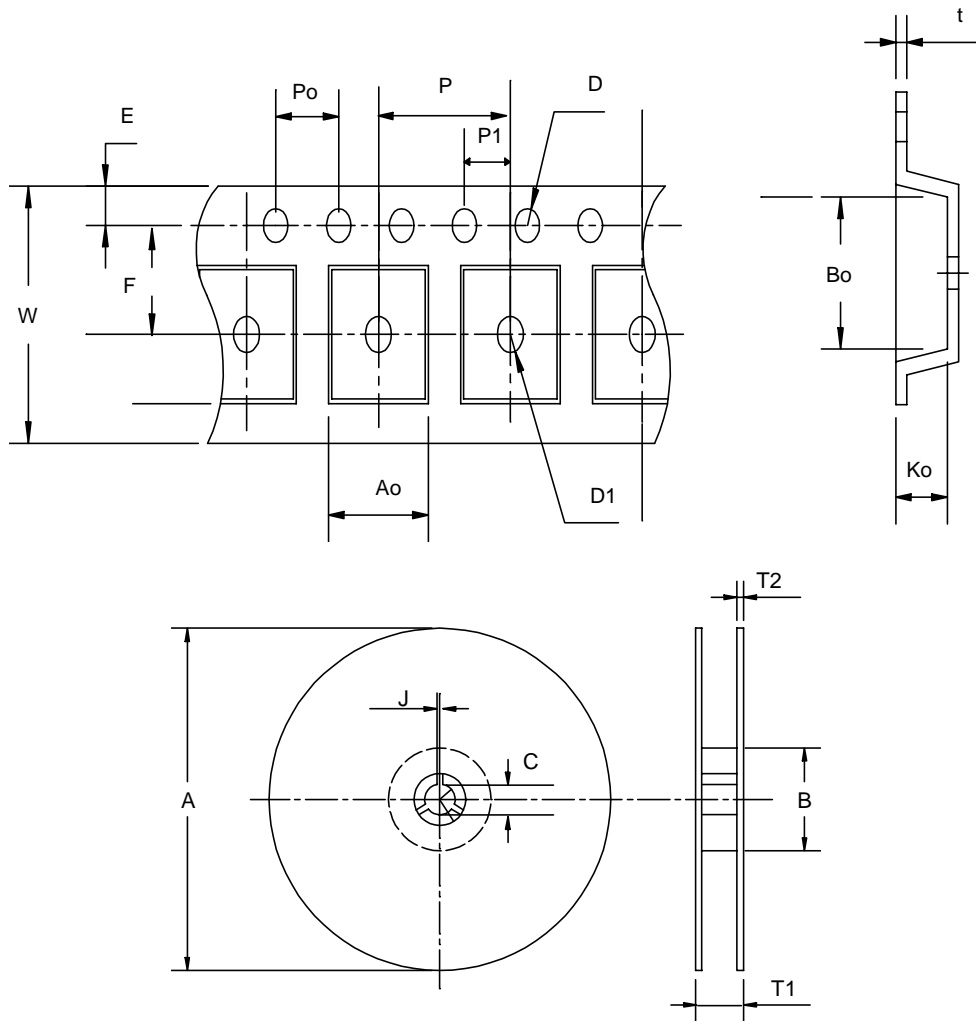
Package Reflow Conditions

pkg. thickness ≥ 2.5mm and all bgas	pkg. thickness < 2.5mm and pkg. volume ≥ 350 mm ³	pkg. thickness < 2.5mm and pkg. volume < 350mm ³
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
TSSOP- 20	330 ±1	100 ref	13 ±0.5	2 ±0.5	16.4 ±0.2	2 ±0.2	16 ±0.3	8.0 ±0.1	1.75±0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	7.5 ±0.1	1.5 +0.1	1.5 min	4.0 ±0.1	2.0 ±0.1	6.8 ±0.1	6.9 ±0.1	1.6 ±0.1	0.3±0.05
Application	A	B	C	J	T1	T2	W	P	E
TSSOP- 24	330 ±1	100 ref	13 ±0.5	2 ±0.5	16.4 ±0.2	2 ±0.2	16 ±0.3	12 ±0.1	1.75±0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	7.5 ±0.1	1.5 +0.1	1.5 min	4.0 ±0.1	2.0 ±0.1	6.9 ±0.1	8.3 ±0.1	1.5 ±0.1	0.3±0.05
Application	A	B	C	J	T1	T2	W	P	E
TSSOP- 28	330 ±1	100 ref	13 ±0.5	2 ±0.5	16.4 ±0.2	2 ±0.2	16 ±0.3	12 ±0.1	1.75±0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	7.5 ±0.1	1.5 +0.1	1.5 min	4.0 ±0.1	2.0 ±0.1	6.9 ±0.1	10.2 ±0.1	1.8 ±0.1	0.3±0.05

(m m)

Cover Tape Dimensions

Application	Carrier Width	Cover Tape Width	Devices Per Reel
TSSOP- 20 / 24 / 28	16	21.3	2000

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