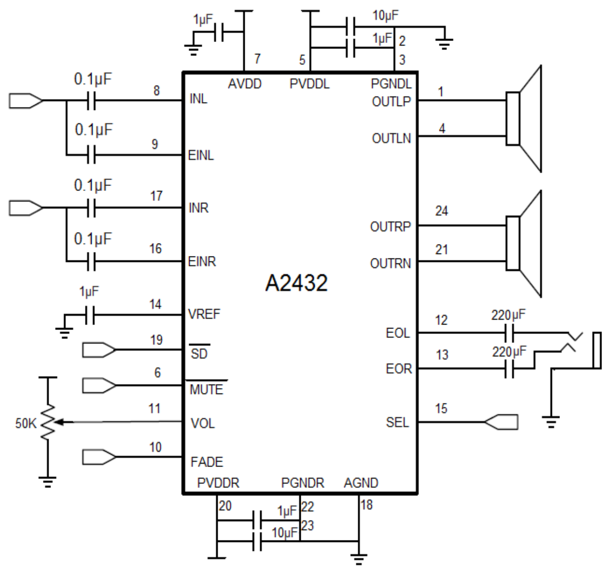
DESCRIPTION

The A2432 is a high efficiency, 3W/channel stereo class-D audio power amplifier with earphone amplifier. 64-step DC volume control minimizes external components and allows speaker volume control and earphone volume control. It offers low THD+N, to produce high-quality sound reproduction. A Low noise, filterless architecture eliminates the out filter, it required few external components for operation to save the board space and cost.

The A2432 features shutdown and mute controls functions. High PSRR and differential architecture provide increased immunity to noise and RF rectification.

The A2432 is available in SSOP24 package.

TYPICAL APPLICATION



FEATURES

- Low EMI Emission
- Output Power
  3W/ch into 4Ω at 5V
  1.7W/ch into 8Ω at 5V
- Supply Voltage:2.5V to 5.5V
- Low THD+N < 0.04% (V_{DD}=5.0V, P_O=1W,R_L=4Ω)
- High Efficiency up to 90%
- 64-step DC Volume Control
- Earphone Output function
- Short Circuit auto Recovery and Thermal Protection
- Few External Components to Save the Space and Cost
- Available in SSOP24 Package

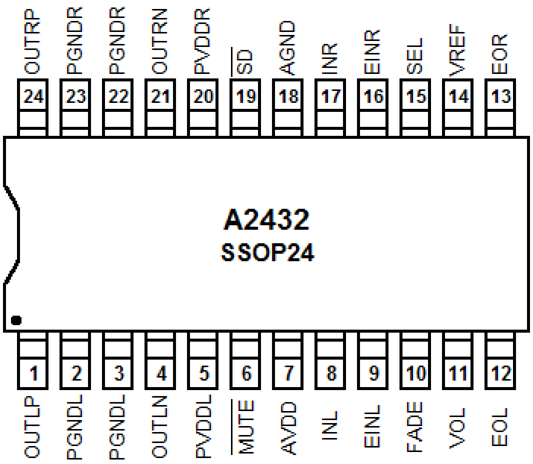
APPLICATION

- Portable DVD Players
- Notebook PC
- USB Speakers, Portable Speaker
- LCD TV/LCD Monitor

ORDERING INFORMATION

Package Type	Part Number	
SSOP24	MX24	A2432MX24R
		A2432MX24VR
Note	V: Halogen free Package R: Tape & Reel SPQ: 2,500pcs/Reel	
AiT provides all RoHS products		

PIN DESCRIPTION



Top View

Pin #	Symbol	Function
1	OUTLP	Left Channel Positive Audio Output
2,3	PGNDL	Left Channel Power Ground
4	OUTLN	Left Channel Negative Audio Output
5	PVDDL	Left Channel Power Supply
6	$\overline{\text{MUTE}}$	Mute Control Input Pin (active low)
7	AV_{DD}	Analog Supply Voltage Terminal
8	INL	Left Channel input
9	EINL	Left earphone input
10	FADE	Input for controlling volume ramp rate (active high default)
11	VOL	DC volume control to set the gain
12	EOL	Left Earphone output
13	EOR	Right Earphone output
14	V_{REF}	Internal analog reference
15	SEL	Speaker/Earphone select(Default Low: Speaker active)
16	EINR	Right earphone input
17	INR	Right Channel input
18	AGND	Analog Power Supply Ground
19	$\overline{\text{SD}}$	Shutdown Control Input Pin (active low)
20	PVDDR	Right Channel Power Supply
21	OUTRN	Right Channel Negative Audio Output
22,23	PGNDR	Right Channel Power Ground
24	OUTRP	Right Channel Positive Audio Output

ABSOLUTE MAXIMUM RATINGS

T_A=25°C Unless Otherwise Noted

V_{DD}, Supply Voltage	-0.3V~6V
V_I, Input Voltage	-0.3V ~ V_{DD}+0.3V
T_A, Operation free-air temperature range	-40℃~85℃
T_J, Operation free-air junction temperature	-40℃~125℃
T_{STG}, Storage Temperature Range	-65℃~150℃
T_{SOLD}, Soldering Temperature	300℃, 5sec

Stress beyond above listed “Absolute Maximum Ratings” may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Max	Units
Power supply voltage	V_{DD}	AV_{DD}, PV_{DD}	2.5	5.5	V
$\overline{MUTE}$ and $\overline{SD}$ Input High Voltage	V_{IH}	V_{DD}=5.0V	1.3	-	V
$\overline{MUTE}$ and $\overline{SD}$ Input Low Voltage	V_{IL}	V_{DD}=5.0V	-	0.35	V

THERMAL INFORMATION

Parameter	Symbol	Package	Max	Units
Thermal Resistance (Junction to Ambient)	θ_{JA}	SSOP24	96	℃/W
Thermal Resistance (Junction to Case)	θ_{JC}	SSOP24	32	℃/W

ELECTRICAL CHARACTERISTICS

V_{DD} =5V, Gain=23.6dB, R_L =8Ω, T =25°C, unless otherwise noted.

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Supply Power	V_{DD}			2.5		5.5	V
Output Power	P_O	f=1kHz, THD+N=10%, R_L=4Ω	V_{DD}=5.0V		3		W
			V_{DD}=3.6V		1.55		
		f=1kHz, THD+N=10%, R_L=8Ω	V_{DD}=5.0V		1.7		
			V_{DD}=3.6V		0.9		
		f=1kHz, THD+N=1%, R_L=4Ω	V_{DD}=5.0V		2.4		
			V_{DD}=3.6V		1.25		
		f=1kHz, THD+N=1%, R_L=8Ω	V_{DD}=5.0V		1.4		
			V_{DD}=3.6V		0.72		
Total Harmonic Distortion Plus Noise	THD+N	V_{DD}=5.0V, P_O=0.5W, R_L=8Ω	f=1kHz		0.02		%
		V_{DD}=3.6V, P_O=0.5W, R_L=8Ω	f=1kHz		0.03		
		V_{DD}=5.0V, P_O=1W, R_L=4Ω	f=1kHz		0.03		
		V_{DD}=3.6V, P_O=1W, R_L=4Ω	f=1kHz		0.03		
Power Supply Ripple Rejection	PSRR	V_{DD}=4.2V ±200mV_{P-P}, f=1kHz	f=100Hz		-60		dB
			f=1kHz		-65		
Crosstalk	C_S	V_{DD}=5.0V,P_O=0.5W, R_L=8Ω,G_V=23.6dB	f=1kHz		-95		dB
Signal/Noise Ratio	SNR	f=20Hz to 20kHz, THD=1%, R_L=8Ω			-76		dB
Class D Gain	G_V				23.6		dB
Switching Frequency	f_{SW}	V_{DD} = 2.5V to 5.5V		350	400	450	kHz
Output Noise	V_N	Inputs ac-grounding with C_{IN}=0.1μF	A-weighting		150		μV
			No A- weighting		200		
Dynamic Range	D_{YN}	V_{DD}=5.0V,THD=1%	f=1kHz		-84		dB
Shutdown Current	I_{SD}	V_{DD}=2.5V to 5.5V	V_{SD}=0.3V			20	μA
Muting Current	I_{MUTE}	V_{DD}=5.0V	V_{MUTE}=0.3V		4.6		mA
Quiescent Current	I_Q	V_{DD}=5.0V	No Load		7.6	12	mA
		V_{DD}=3.6V			6	10	
Efficiency	η	R_L=8Ω, P_O=1.6W			90		%
		R_L=8Ω, P_O=2.8W			83		
Output Offset Voltage	V_{OS}	V_{IN}=0V	No Load		10		mV
setup Time	t_{st}	Bypass capacitor =1uF			380		ms
Over Temperature Protection	T_{OTP}	No Load, Junction Temperature	V_{DD}=5.0V		160		℃
Over Temperature Hysteresis	T_{OTH}				30		

ELECTRICAL CHARACTERISTICS (EARPHONE)

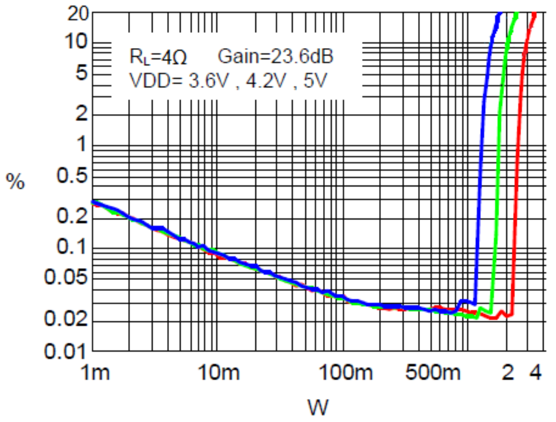
V_{DD} =5V, Gain=5.3dB, R_L =32Ω, T =25°C, unless otherwise noted

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Output Power	P_O	THD+N=1%,RL=32Ω	V_{DD}=5.0V		65		mW
Total Harmonic Distortion Plus Noise	THD+N	P_O=30mW,R_L=32Ω	f=1kHz		0.02		%
Earphone Gain	G_V	Earphone Gain			5.3		dB
Power Supply Ripple Rejection	PSRR	V_{DD}=4.2V ±200mV_{P-P}, f=1kHz			70		dB
Crosstalk	C_S	V_{DD}=5.0V,P_O=0.5W, R_L=8Ω,G_V=25dB	f=1kHz		-80		dB
Signal-to-Noise Ratio	SNR	V_{DD}=5.0V,V_{ORMS}=1V, G_V=25dB	f=1kHz		-92		dB
Output Noise	V_N	V_{DD}=5.0V,Input AC-GND	A-weighting		24		μV
Quiescent Current	I_Q	V_{DD}=5.0V	No Load		5.8		mA
		V_{DD}=3.6V			4.5		
Shutdown Current	I_{SD}	V_{DD}=2.5V to 5.5V	V_{SD}=0.3V			1	μA
Output DC Voltage	V_{OS}	No Load			V_{DD}/2		V
setup time	t_{st}	Bypass capacitor =1uF			380		ms
Over Temperature Protection	T_{OTP}	No Load, Junction Temperature	V_{DD}=5.0V		160		°C
Over Temperature Hysteresis	T_{OTH}				30		

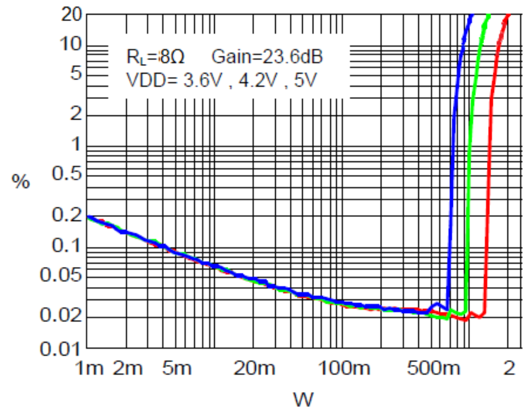
TYPICAL PERFORMANCE CHARACTERISTICS

V_{DD}=5V, Gain=23.5dB, T=25°C, unless Otherwise Noted

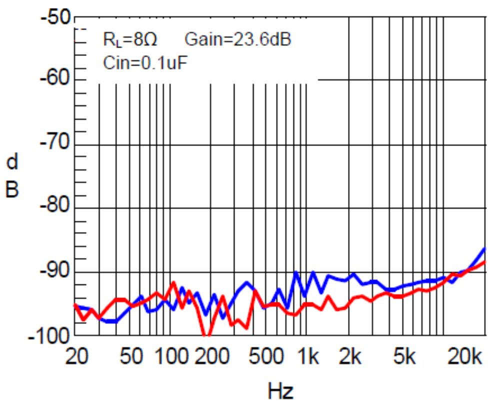
1. THD+N vs. Output Power



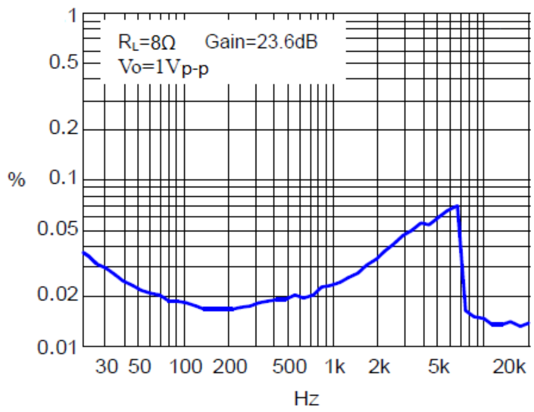
2. THD+N vs. Output Power



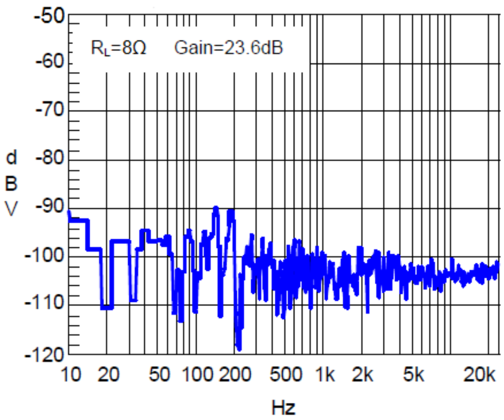
3. Cross Talk



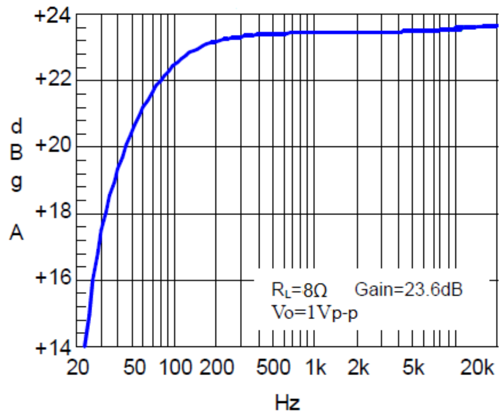
4. THD+N vs. Frequency



5. Noise Floor FET



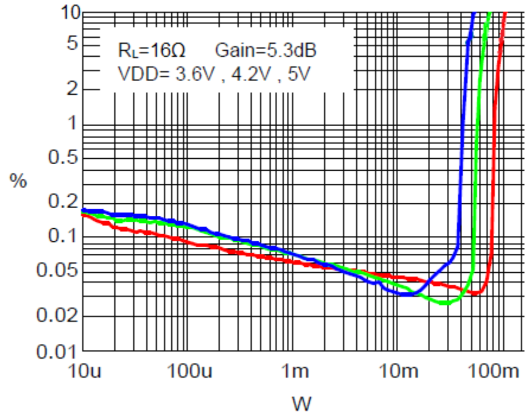
6. Frequency Response



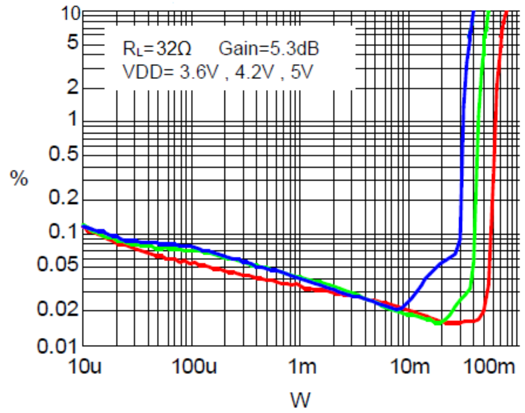
EARPHONE TYPICAL OPERATING CHARACTERISTICS

V_{DD}=5V, Gain=5.3dB, R_L=32Ω, T=25°C, unless Otherwise Noted

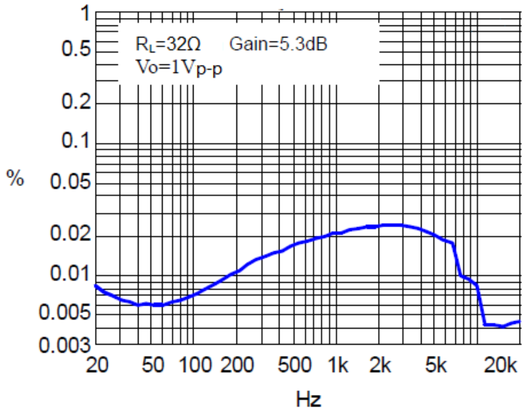
7. THD+N vs. Output Power



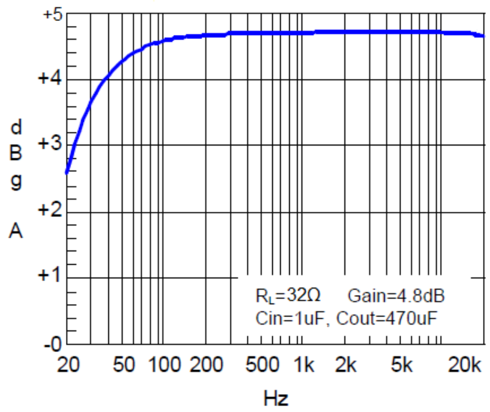
8. THD+N vs. Output Power



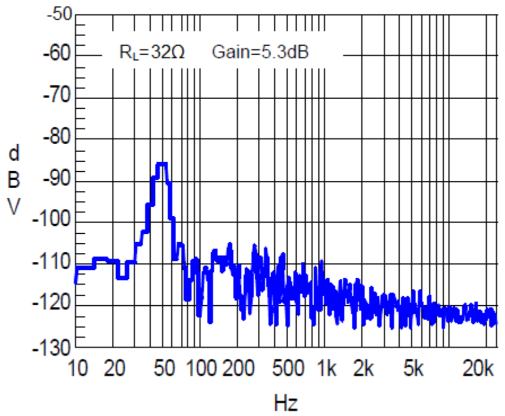
9. THD+N VS FREQUENCY



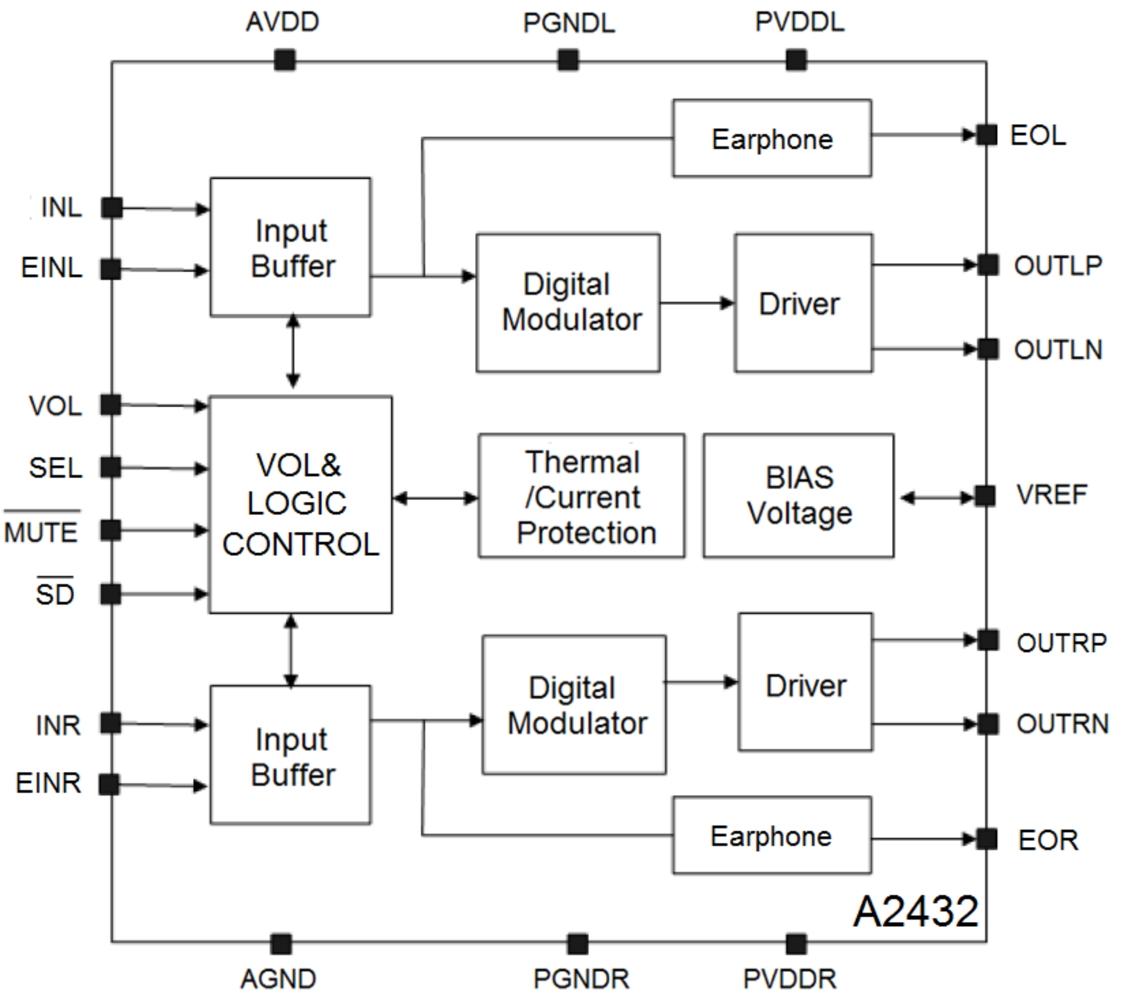
10. Frequency Response



11. NOISE FLOOR FET



BLOCK DIAGRAM



DC VOLUME CONTROL

STEP	GAIN(dB) Class D	GAIN(dB) Earphone	STEP	GAIN(dB) Class D	GAIN(dB) Earphone
1	-64.0	-80.0	33	13.1	-0.9
2	-40.6	-40.6	34	13.7	-0.5
3	-34.7	-34.5	35	14.3	-0.1
4	-28.5	-32.5	36	14.9	0.3
5	-22.3	-30.6	37	15.5	0.7
6	-16.2	-28.6	38	16.1	1.1
7	-14.2	-26.6	39	16.7	1.4
8	-12.2	-24.6	40	17.3	1.8
9	-10.1	-22.6	41	17.9	2.2
10	-8.1	-20.5	42	18.3	2.4
11	-6.1	-18.5	43	18.7	2.6
12	-5.1	-17.5	44	19.1	2.8
13	-4.1	-16.5	45	19.5	3.0
14	-3.1	-15.4	46	19.8	3.2
15	-2.1	-14.4	47	20.1	3.3
16	-1.1	-13.4	48	20.4	3.5
17	-0.1	-12.4	49	20.6	3.7
18	0.9	-11.4	50	20.9	3.9
19	1.9	-10.4	51	21.2	4.0
20	2.9	-9.4	52	21.5	4.1
21	3.9	-8.7	53	21.7	4.2
22	4.7	-8.0	54	21.9	4.3
23	5.5	-7.3	55	22.1	4.4
24	6.3	-6.6	56	22.2	4.5
25	7.1	-5.9	57	22.4	4.6
26	7.9	-5.2	58	22.6	4.7
27	8.7	-4.5	59	22.8	4.8
28	9.5	-3.8	60	23.0	4.9
29	10.3	-3.1	61	23.2	5.0
30	11.1	-2.4	62	23.3	5.1
31	11.9	-1.7	63	23.5	5.2
32	12.5	-1.3	64	23.6	5.3

DETAILED INFORMATION

Mute Operation

The $\overline{\text{MUTE}}$ pin is an input for controlling the output state of the A2432. A logic high on this pin enables the outputs, a logic low on this pin disables the outputs. The terminal may be used as a quick disable/enable of the outputs when changing channels between different audio sources. The $\overline{\text{MUTE}}$ pin can be left floating due to the internal pull-up.

Shutdown operation

The A2432 employs a shutdown mode of operation designed to reduce supply current to the absolute minimum level during periods of nonuse for power conservation. The $\overline{\text{SD}}$ input terminal should be held high during normal operation when the amplifier is in use. The $\overline{\text{SD}}$ pin can be left floating due to the internal pull-up.

Under Voltage Lock-out (UVLO)

The A2432 incorporates circuitry designed to detect low supply voltage. When the supply voltage drops to 1.8V or below, the A2432 outputs are disabled, and the device comes out of this state and starts to normal function when $V_{DD} \geqq 2.0V$.

Short -Circuit Protection

The A2432 has short circuit protection circuitry on the outputs to prevent damage to the device during output-to-output shorts, output-to-GND and output-to-GND short occurs. When a short circuit is detected on the outputs, the part immediately disables the drive. This is an unlatched fault. Normal operation is restored when the fault is removed.

Thermal Protection

Thermal protection on the A2432 prevents damage to the device when the internal die temperature exceeds 160℃. There is a ±20℃ tolerance on this trip point from device to device. Once the die temperature exceeds the thermal set point, the device enters into the shutdown state and the outputs are disabled. This is not a latched fault. The thermal fault is cleared once the temperature of the die is reduced by 25℃. The device begins normal operation at this point with no external system intervention.

Decoupling Capacitor (Cs)

The A2432 is a high-performance Class-D audio amplifier that requires adequate power supply decoupling to ensure the efficiency is high and total harmonic distortion (THD) is low. For higher frequency transients, spikes, or digital hash on the line a good low equivalent series resistance (ESR) ceramic capacitor, typically 1μF, placed as close as possible to the device PV_{DD} lead works best. Placing this decoupling capacitor close to the A2432 is important for the efficiency of the Class-D amplifier, because any resistance or inductance in the trace between the device and the capacitor can cause a loss in efficiency. For filtering lower-frequency noise signals, a 4.7μF or greater capacitor placed near the audio power amplifier would also help, but it is not required in most applications because of the high PSRR of this device.

Input Capacitors (C_I)

The A2432 does not require input coupling capacitors if the design uses a differential source that is biased from 0.5V to V_{DD}-0.8V. If the input signal is not biased within the recommended common-mode input range, if high pass filtering is needed, or if using a single-ended source, input coupling capacitors are required.

The input capacitors and input resistors from a high-pass filter with the corner frequency, f_C, determined in below equation

$$f_C = \frac{1}{2\pi R_I C_I}$$

The value of input capacitor is important to consider as it directly affects the bass (low frequency) performance of the circuit. Speaker in wireless phones cannot usually respond well to low frequencies, so the corner frequency can be set to block low frequencies in this application. Not using input capacitors can increase out offset. Below equation is used to solve for the input coupling capacitance.

$$C_I = \frac{1}{2\pi R_I f_C}$$

If the corner frequency is within the audio band, the capacitors should have tolerance of ±10% or better, because any mismatch in capacitance causes an impedance mismatch at the corner frequency and below.

Analog Reference Bypass Capacitor (C_{REF})

The Analog Reference Bypass Capacitor (C_{REF}) is the most critical capacitor and serves several important functions. During start-up or recovery from shutdown mode, C determines the rate at which the amplifier starts up. The second function is to reduce noise caused by the power supply coupling into the output drive signal. This noise is from the internal analog reference to the amplifier, which appears as degraded PSRR and THD+N. A ceramic bypass capacitor (C_{BYP}) with values of 0.47μF to 1.0μF is recommended for the best THD and noise performance. Increasing the bypass capacitor reduces clicking and popping noise from power on/off and entering and leaving shutdown.

Fade Operation

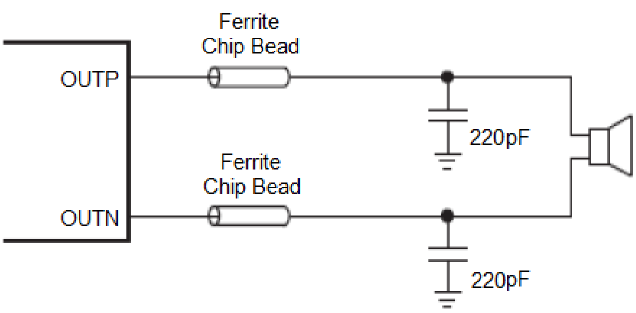
The FADE terminal is a logic input that controls the operation of the volume control circuitry during transitions to and from the shutdown state and during power-up.

A logic High on this terminal will set the amplifier in fade mode. During power-up or recovery from the shutdown state, the volume is smoothly ramped up from the mute state to the desired volume set by the voltage on the volume control terminal. A logic low on this pin disables the volume fade effect during transitions to and from the shutdown state and during power-up. During power-up or recovery from the shutdown state (a logic high is applied to the terminal), the transition from the mute state, -75dB, to the desired volume setting is less than 1ms.

Filter Free Operation and Ferrite Bead Filters

A ferrite bead filter can often be used if the design is failing radiated emissions without an LC filter and the frequency sensitive circuit is greater than 1MHz. This filter functions well for circuits that just have to pass FCC and CE because FCC and CE only test radiated emissions greater than 30MHz. When choosing a ferrite bead, choose one with high impedance at high frequencies, and very low impedance at low frequencies. In addition, select a ferrite bead with adequate current rating to prevent distortion of the output signal.

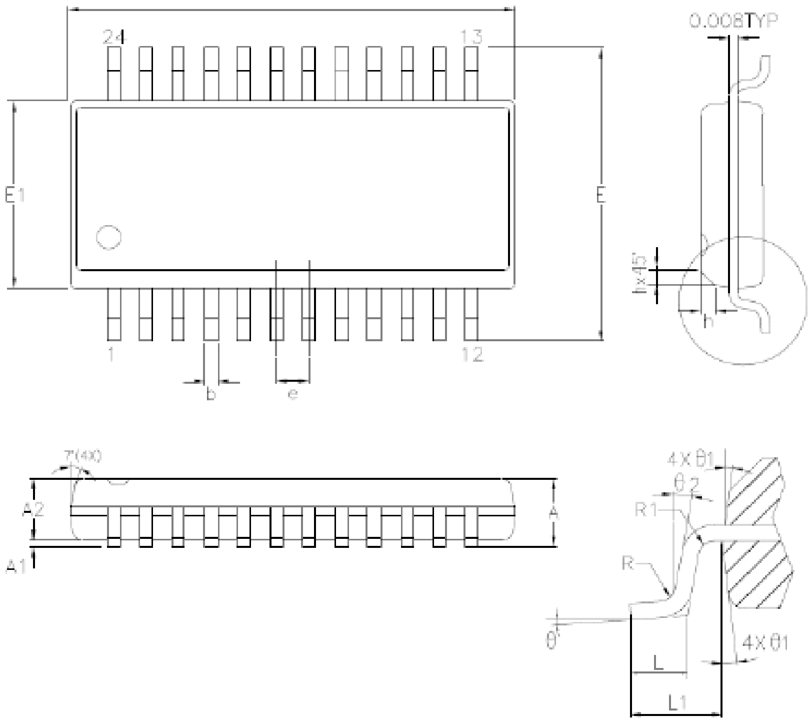
Use an LC output filter if there are low frequency (< 1 MHz) EMI sensitive circuits and/or there are long leads from amplifier to speaker.



Ferrite Bead Filter to reduce EMI

PACKAGE INFORMATION

Dimension in SSOP24 Package (Unit: mm)



Symbol	Min.	Max.
A	1.35	1.75
A1	0.10	0.25
A2	1.24	1.65
b	0.20	0.30
D	8.51	8.81
E	5.79	6.20
E1	3.81	4.01
e	0.64	
L	0.41	1.27
L1	1.04REF	
R	0.076	-
R1	0.076	-
h	0.25	0.51
θ	0°	8°
θ1	5°	15°
θ2	0°	-

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