HT82V7524
3W Mono Filter-free Class-D Audio Power Amplifier

Features

- 1.8V to 6V Single Supply
- Output Power:
  - 3W at 5V and 4Ω speaker
  - 5.1W at 6V and 3Ω speaker
- Up to 90% power efficiency
- Automatic output power control – APC
- 3.3mA quiescent current at 5V
- Less than 0.2μA shutdown current
- Pop noise elimination during power on/off
- Shutdown function
- Output pin short circuit protection with auto recovery
- Over-temperature and over-current protection with auto recovery
- Integrated hard limiter function
- Limiter time and gain control on the fly
- Differential 250kHz PWM allows Bridge-Tied-Load to increase output power and eliminate LC output filter
- Differential signal processing for improved CMRR

Applications

- Portable audio products
- Battery powered audio products
- MP3 players
- Bluetooth speakers
- Notebook/Tablet PCs
- Smartphones

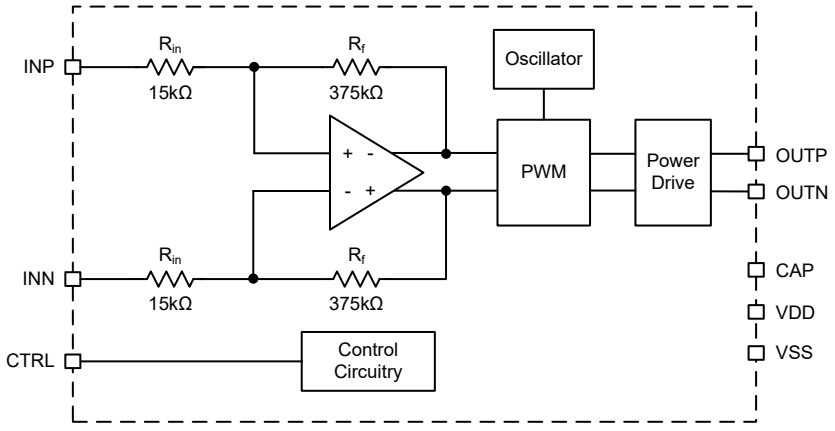
General Description

The HT82V7524 is a filter-less mono Class D audio power amplifier IC. The device can deliver 3 watts into a 4Ω load at a 5V operating voltage or 5.1 watts into a 3Ω load at a 6V operating voltage. The advantage of using class D amplifiers is that they offer superior efficiency over the traditional linear amplifiers. This advantage results in less heat generation thus eliminating the need for heat sinking making them ideal for use in small outline products.

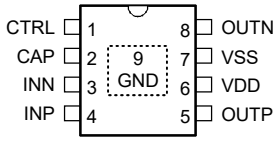
One special feature of the device is its ability to operate over a wide voltage range, from 1.8V to 6V. Additional features include automatic power level control, wherein the output power remains consistent for different voltages. A function to reduce the annoying "pop" sound which could be generated during power on/off operations is also included. The device contains a range of protection features, such as output short circuit protection, over current/thermal shut off and auto recovery functions which restores the device to normal operation once the source of the problem has been resolved.

The superior efficiency of this Holtek class D audio amplifier together with its wide operating voltage and ability to directly drive speakers make it excellent for use in compact portable battery operated equipment where battery life will be an important consideration.

Block Diagram



Pin Assignment



HT82V7524
8 SOP-A

Pin Description

Pin Number	Pin Name	Type	Description
1	CTRL	AI	Power down and LIM on/off control
2	CAP	AO	Capacitance for Limiter Operation
3	INN	AI	Negative input
4	INP	AI	Positive input
5	OUTP	AO	Positive output
6	VDD	PWR	Power supply
7	VSS	PWR	Ground
8	OUTN	AO	Negative output
9	GND	PWR	Exposed ground pad

Legend: AO: Analog Output; AI: Analog Input; PWR: Power Pin

Absolute Maximum Ratings

Supply Voltage .....V_{SS}-0.3V to 6.5V

Input Voltage.....V_{SS}-0.3V to V_{DD}+0.3V

Storage Temperature .....-50°C to 125°C

Operating Temperature...…….....-40°C to 85°C

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

D.C. Characteristics

V_{DD}=2.5V~5.5V, T_A=25°C, (unless otherwise noted)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Supply Voltage	—	—	1.8	—	6.0	V
I_Q	Quiescent Current	5V	No load	—	3.3	4	mA
		3.6V		—	2.3	2.8	mA
		2V		—	1.5	1.8	mA
I_{STB}	Standby Current	—	V_{CTRL}< 0.3V	—	0.2	0.5	μA
V_{OS}	Differential Output Offset Voltage	—	All inputs are AC grounded, A_V=24	—	±25	—	mV
R_{DSON}	Static Drain-source On-state Resistance	5V	R_L=8Ω	—	400	—	mΩ
R_{in}	INN/INP Input Resistance	—	INN/INP to Ground	—	15	—	kΩ
A_V	BTL Gain	—	R_L=8Ω	—	24	—	V/V
Ioc	Over-current Protection Threshold	5V	Vo+ shorted to VDD	—	3	—	A
			Vo- shorted to VDD	—	3	—	
			Vo+ shorted to GND	—	1.5	—	
			Vo- shorted to GND	—	1.5	—	
			Vo+ shorted to Vo-	—	1.8	—	
T_{AR}	Over-current Detection Time (Time from overcurrent detected to retrial)	5V	Vo+/Vo- shorted to VDD/GND, Vo+ shorted to Vo-	—	20	—	ms
Iq(oc)	Supply Current Under Over-current Protection			—	2	—	mA
T_A	Operating Temperature	—	—	-40	—	85	°C

A.C. Characteristics

V_{DD}=2.5V~5.5V, T_A=25°C, (unless otherwise noted)

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
LIM	THD (%) of Limiter Enable Point	3.6V~6.0V	—	—	1	—	%
f_{SW}	Switching Frequency	—	—	250	300	350	kHz
PSRR	Power Supply Rejection Ratio	—	—	—	-70	—	dB
SNR	Signal-to-noise Ratio	5V	P_O=1W, R_L=8Ω	—	100	—	dB
CMRR	Common Mode Rejection Ratio	5V	V_{IC}=1Vpp, R_L=8Ω	—	-70	—	dB

Note: When supply voltage is below 2.2V and 4Ω speaker is used, the protection will be triggered if total harmonic distortion of the output is greater than 1%, To prevent this protection from happening an 8Ω speaker should be used instead.

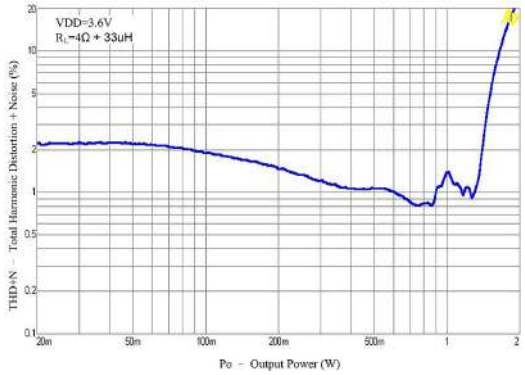
Operating Characteristics

V_{DD}=5V, Power Supply Capacitance=470μF, T_A=25°C, (unless otherwise noted)

Symbol	Parameter	Test Conditions			Min.	Typ.	Max.	Unit
		V_{DD}	Conditions					
P_O	Output Power	3.6V	THD=1%	3Ω	—	1.28	—	W
				4Ω	—	1.06	—	
				8Ω	—	0.61	—	
			THD=10%	3Ω	—	1.88	—	
				4Ω	—	1.54	—	
				8Ω	—	0.88		
		5.0V	THD=1%	3Ω	—	2.90	—	
				4Ω	—	2.41	—	
				8Ω	—	1.39	—	
			THD=10%	3Ω	—	3.60	—	
				4Ω	—	2.97	—	
				8Ω	—	1.72	—	
		5.5V	THD=1%	3Ω	—	3.53	—	
				4Ω	—	2.93	—	
				8Ω	—	1.69	—	
			THD=10%	3Ω	—	4.34	—	
				4Ω	—	3.60	—	
				8Ω	—	2.09	—	
		6.0V	THD=1%	3Ω	—	4.18	—	
				4Ω	—	3.46	—	
				8Ω	—	2.01	—	
			THD=10%	3Ω	—	5.12	—	
				4Ω	—	4.26	—	
				8Ω	—	2.48	—	

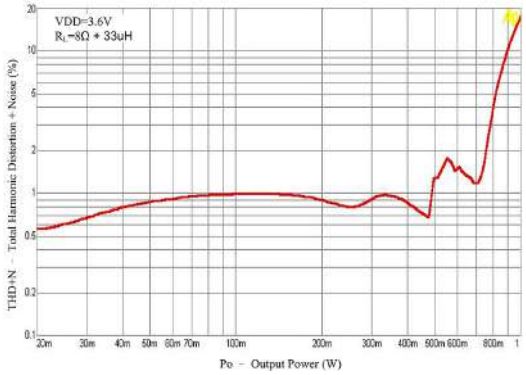
Typical Performance Characteristic

Total Harmonic Distortion + Noise vs. Output Power



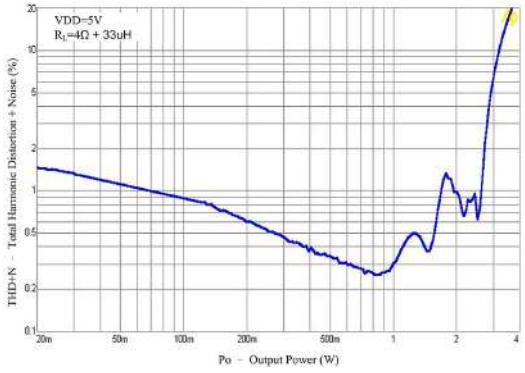
V_{DD}=3.6V @ 4Ω

Total Harmonic Distortion + Noise vs. Output Power



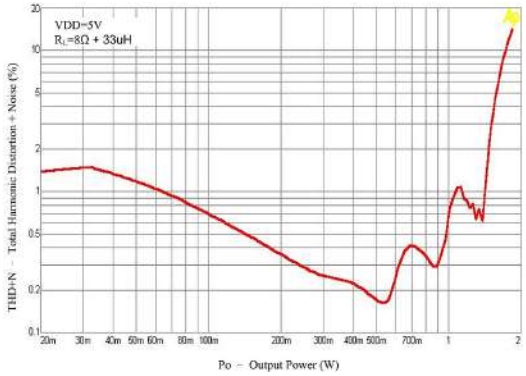
V_{DD}=3.6V @ 8Ω

Total Harmonic Distortion + Noise vs. Output Power



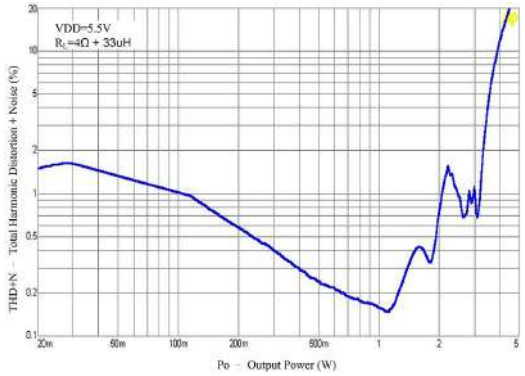
V_{DD}=5V @ 4Ω

Total Harmonic Distortion + Noise vs. Output Power



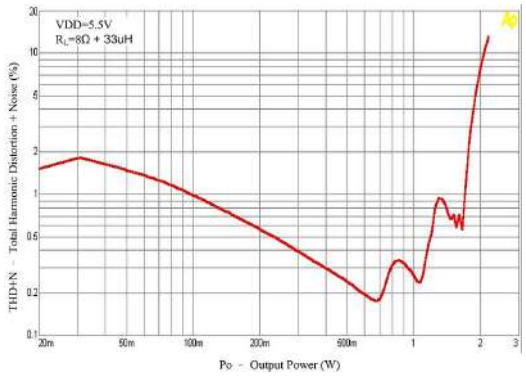
V_{DD}=5V @ 8Ω

Total Harmonic Distortion + Noise vs. Output Power

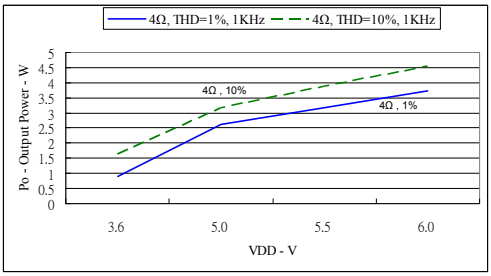


V_{DD}=5.5V @ 4Ω

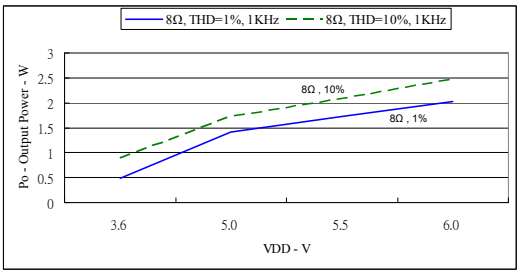
Total Harmonic Distortion + Noise vs. Output Power



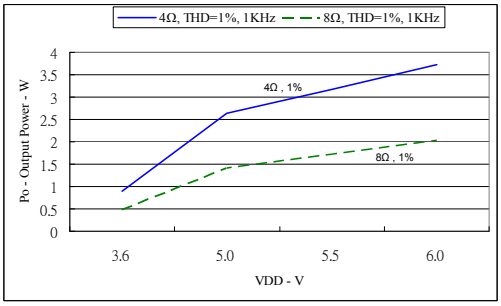
V_{DD}=5.5V @ 8Ω



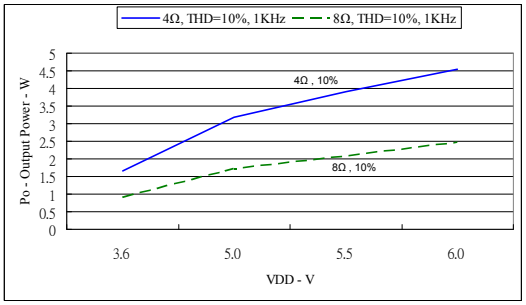
4Ω, THD=1% & 10%



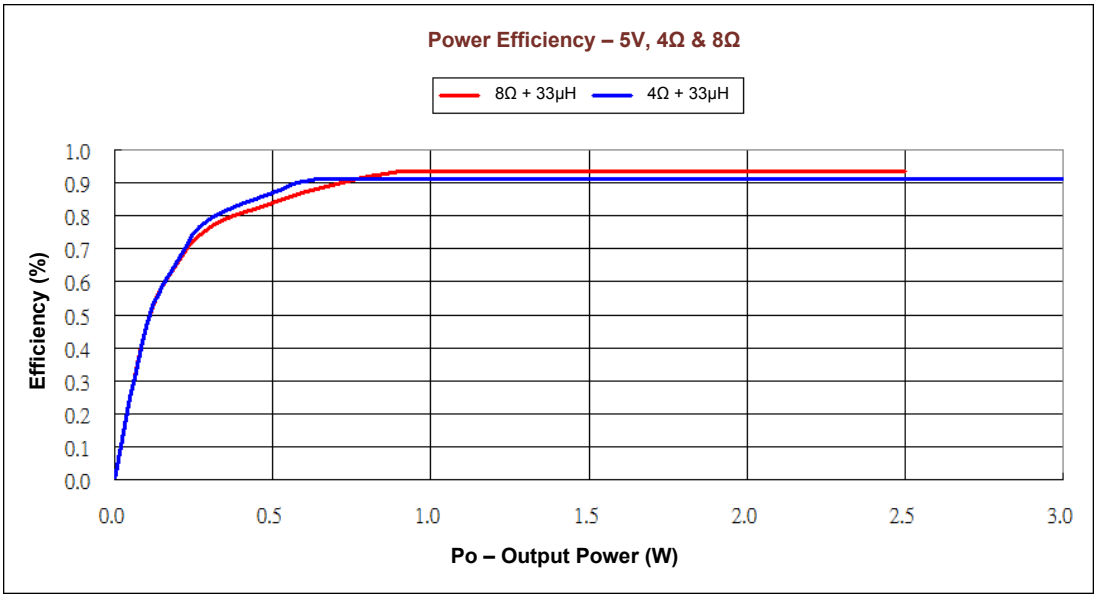
8Ω, THD=1% & 10%



4Ω vs 8Ω, THD=1%

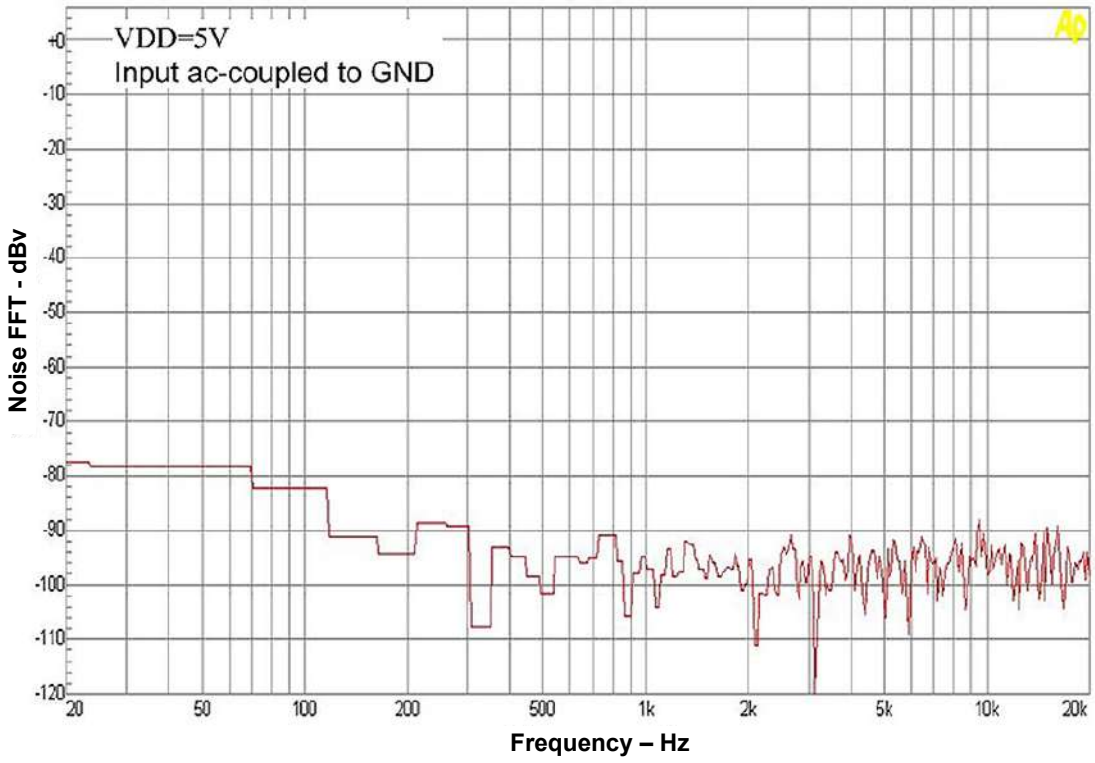


4Ω vs 8Ω, THD=10%



Power Efficiency, 4Ω & 8Ω @5V

Noise vs Frequency



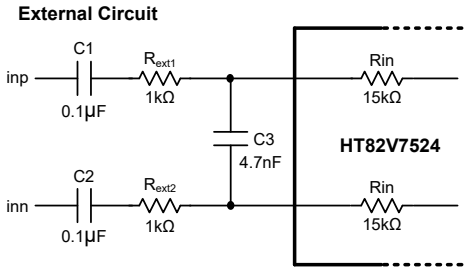
Noise vs Frequency @5V

Functional Description

The HT82V7524 is a Class D type Mono audio amplifier. Offering the advantages of fully digital operation this Class D audio amplifier has the advantages of low power losses resulting in higher efficiencies and reducing the need for heat sinking. Power down and Mute functions along with several protection features provide a highly functionally integrated audio amplifier solution.

Amplifier Input Stage

Looking into any of the audio pins will see a resistance of 15kΩ. The following diagram shows a typical input stage circuit.



Audio Input Stage

Here external resistors have been connected between the amplifier audio inputs and the external audio signal source to setup the gain value. As the external signal needs to be ac coupled to the amplifier using capacitors this will form a high pass filter with these resistors. The -3db frequency of this input high pass filter will be given by.

$$f_{-3db}=1/(2\pi RC)$$

Where C is the ac coupling capacitance, C1 or C2, and R is the total resistance in series with the capacitor. So here C=0.1μF and $R=R_{in}+R_{ext}$, in the example of the diagram which gives a value of 1kΩ+15kΩ. Putting these numbers into the above equation gives a -3db frequency of about 99.47Hz.

$$1/(2\times\pi\times(R_{ext}+R_{in})\times 0.1\mu F)$$

A bypass capacitor, C3, is also connected across the input pins to attenuate any high frequencies. This capacitor will form a low pass filter with the resistors. In this example, R_{ext}=1kΩ, R_{in}=15kΩ and C=4.7nF. Thus the -3db frequency on the high frequency side is about 18.06kHz.

$$1/(2\times\pi\times(R_{ext}//R_{in})\times 2\times 4.7nF)$$

It is important to ensure that any external input pin related components are well matched. Not ensuring good matching of these differential input components may create an annoying pop noise during operation.

$$Gain=375k\Omega/(15k\Omega+R_{ext})$$

Low Voltage Detection

A power supply voltage monitoring circuit is integrated into the device. Should the supply voltage fall below a value of about 1.7V then the outputs will be disabled. When the supply voltage is maintained above 1.8V then the device will operate normally.

Pop-Free

The device includes a pop-free function. However to fully eliminate any annoying "pop" sounds being generated when the device is powered on or off, switching in the mute mode, switching in the shutdown mode, recovery from temperature protection or recovery from over-current protection it is important to ensure that the differential inputs are fully balanced.

Automatic Output Power Control – APC

The voltage gain of the amplifier will automatically adjust itself over supply voltage. This means that, regardless of changes to the supply voltage, the output power will remain at approximately the same level for a given input level. This feature could be important in battery powered applications where the supply voltage will drop as the batteries lose their charge.

Shutdown Function

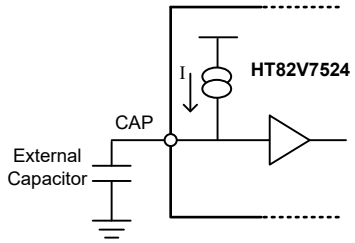
The device can be shut down to conserve power during times when the audio output function of the product is not required. The shutdown function is executed when the voltage of the CTRL pin is below 0.3V. When the voltage of the CTRL pin is above 0.3V, the device will operate normally.

Hard Limiter and Control – LIM

The device includes a hard limiter function. The hard limiter detects the THD of the output signals and if it is below approximately 1% takes no action. However should the THD of the output signal be above 1% the hard limiter will immediately reduce the magnitude of the output signal by 6dB. This prevents the output signals from being clipped, avoiding the generation of high order harmonic signals which create unpleasant distorted sound effects. The hard limiter function is enabled when the CTRL pin voltage is within a range of 0.5 V_{DD}~0.4V_{DD}. When the CTRL pin voltage is above 0.9V_{DD} the limiter will be disabled. When the limiter is disabled the amplifier will have a fixed gain as described elsewhere. Note that the limiter function will be in an unstable condition if the CTRL pin is within a range of 0.9 V_{DD}~0.5V_{DD}.

CTRL pin Setting	Operating Mode	LIM status
Above $0.9V_{DD}$	Normal	Off
$0.9V_{DD}$ ~ $0.5V_{DD}$	Normal	Unstable
$0.5V_{DD}$ ~ $0.4V_{DD}$	Normal	On
Below 0.3V	Sleep	—

This audio signal magnitude reduction will be maintained for a certain period of time which is determined by the size of an external capacitor connected to the CAP pin. After this time period has elapsed the output audio signal will return to its normal magnitude. For a capacitor value of 0.22μF, the magnitude reduction time period is 8.5 seconds. This time period changes with the capacitor value in a linear manner. Therefore for a capacitor value of 0.1μF the time period will be 3.8 seconds. An internal current source is connected to the CAP pin which charges the external capacitor in a linear manner.



CAP Pin Configuration

An external control signal connected to the CAP pin can be used as a gain control signal as it can overwrite the limiter operation and behave like a gain control. If an external control signal is connected to the CAP pin, then when this signal is high, the amplifier will maintain its normal gain setting. However driving this pin low will force the amplifier to have a reduced gain down to 6dB from the original value. The voltage gain can be changed on the fly and there is no delay when the control signal switches in between the low and high values.

EMI Output Filter Design

To reduce EMI interference ferrite bead filters can be used. A ferrite filter will reduce EMI frequencies of around 1MHz and higher. Note that FCC and CE only test radiated emissions greater than 30MHz. When selecting a ferrite bead, choose one with a high impedance at high frequencies but with a low impedance at low frequencies.

Over Temperature Protection

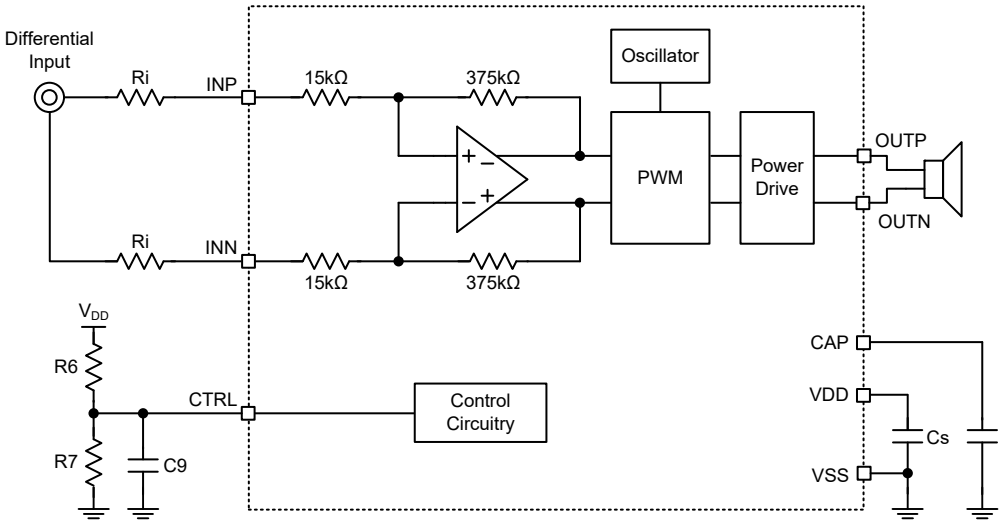
The device includes an integrated temperature sensor. When this detects an internal temperature about 120°C or above, the output signals will be disabled to protect the device from any damage. An automatic recovery circuit enables the device to return to normal operation when the internal temperature of the device returns to below around 100°C.

Over Current Protection

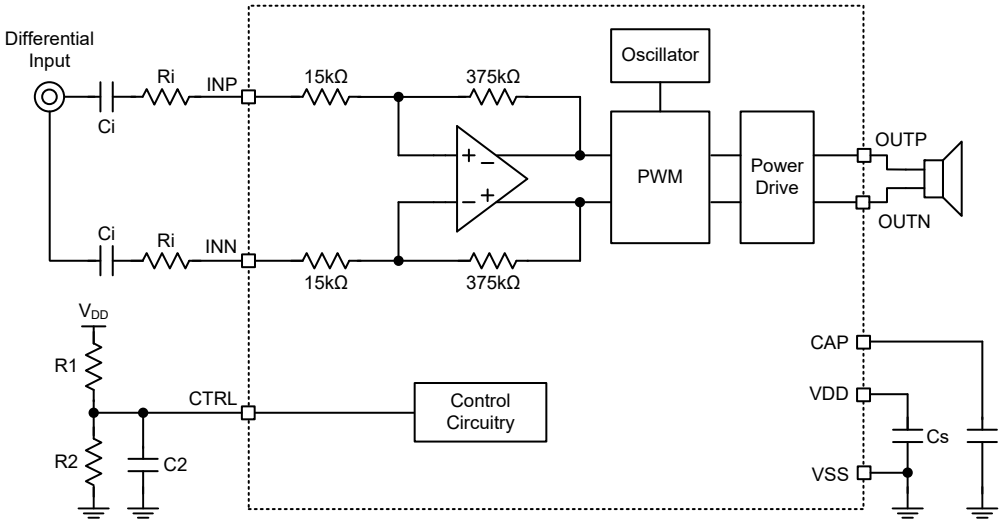
A current detection circuit is integrated into the device to detect the switching current of the output stages of the device. It disables the device when the current is beyond the current limits specified in the operating characteristics. This protects the device when there is an accidental short circuit between the outputs or between the output pins and power/ground pins. An automatic recovery circuit returns the device to normal operation when the problem source is removed. The delay time between protection and recovery is about 20ms. If the short circuit condition is not removed the after auto-recovery time the protection circuit will disable the output transistors again. The protection circuit will switch the output transistors on and off until the source of the short circuit condition is removed.

Application Circuits

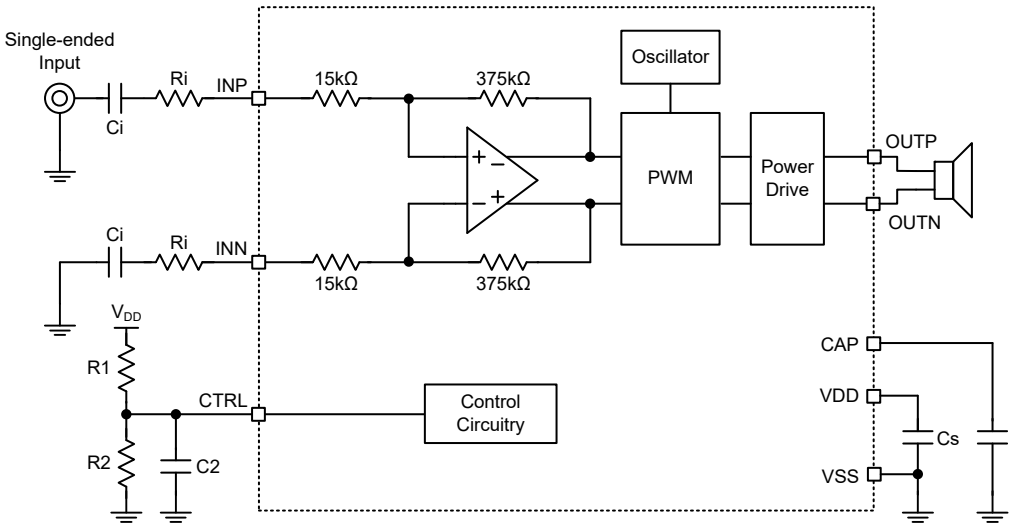
Differential Input Configuration Application Circuit



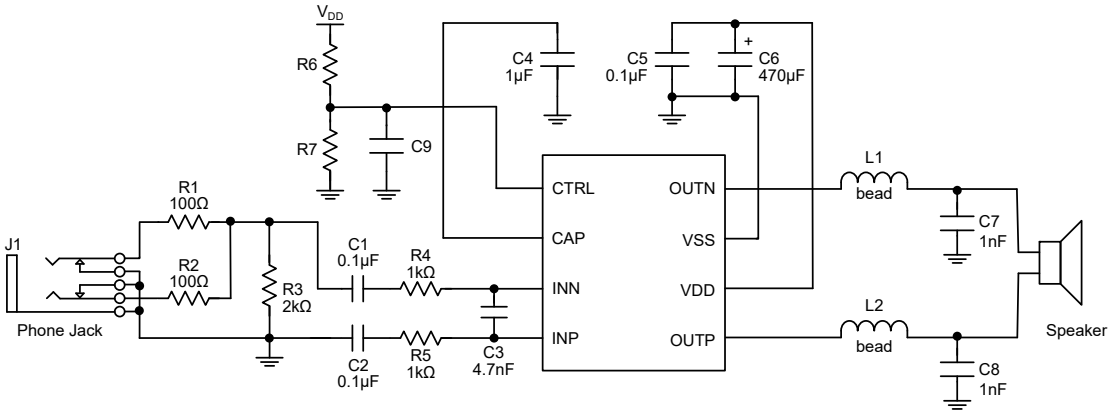
Differential Input Configuration with Input Capacitor Application Circuit



Single-ended Input Configuration



Development Circuit Board



With Band-pass Filter and Bead/Cap=1nF for EMI Suppression

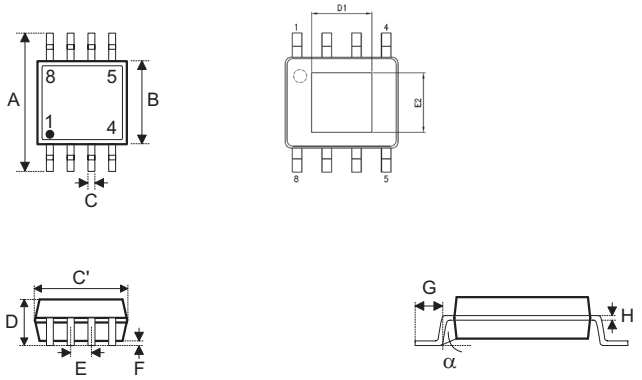
Package Information

Note that the package information provided here is for consultation purposes only. As this information may be updated at regular intervals users are reminded to consult the Holtek website for the latest version of the package information.

Additional supplementary information with regard to packaging is listed below. Click on the relevant section to be transferred to the relevant website page.

- Further Package Information (include Outline Dimensions, Product Tape and Reel Specifications)
- Packing Meterials Information
- Carton information

8-pin SOP-EP (150mil) Outline Dimensions



Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	—	0.236 BSC	—
B	—	0.154 BSC	—
C	0.012	—	0.020
C′	—	0.193 BSC	—
D	—	—	0.069
D1	0.059	—	—
E	—	0.050 BSC	—
E2	0.039	—	—
F	0.000	—	0.006
G	0.016	—	0.050
H	0.004	—	0.010
α	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	—	6.00 BSC	—
B	—	3.90 BSC	—
C	0.31	—	0.51
C′	—	4.90 BSC	—
D	—	—	1.75
D1	1.50	—	—
E	—	1.27 BSC	—
E2	1.00	—	—
F	0.00	—	0.15
G	0.40	—	1.27
H	0.10	—	0.25
α	0°	—	8°