

# 3W Stereo Filter-less Class-D Audio Amplifier

## Features

- Supply voltage range: 2.5 V to 5.5 V
- Support single-ended or differential analog input
- Low Quiescent Current
- Low Output Noise
- Low shut-down current
- Short power-on transient time
- Internal pull-low resistor on shut-down pins
- Short-circuit protection
- Over-temperature protection
- Loudspeaker power within 10% THD+N
  - 1.78W/ch into 8Ω loudspeaker
  - >3W/ch into 4Ω loudspeaker
- Loudspeaker efficiency
  - 93% @ 8Ω, THD+N=10%
  - 85% @ 4Ω, THD+N=10%
- E-TSSOP-14L package
- Integrated Feedback Resistor of 300kΩ

## Applications

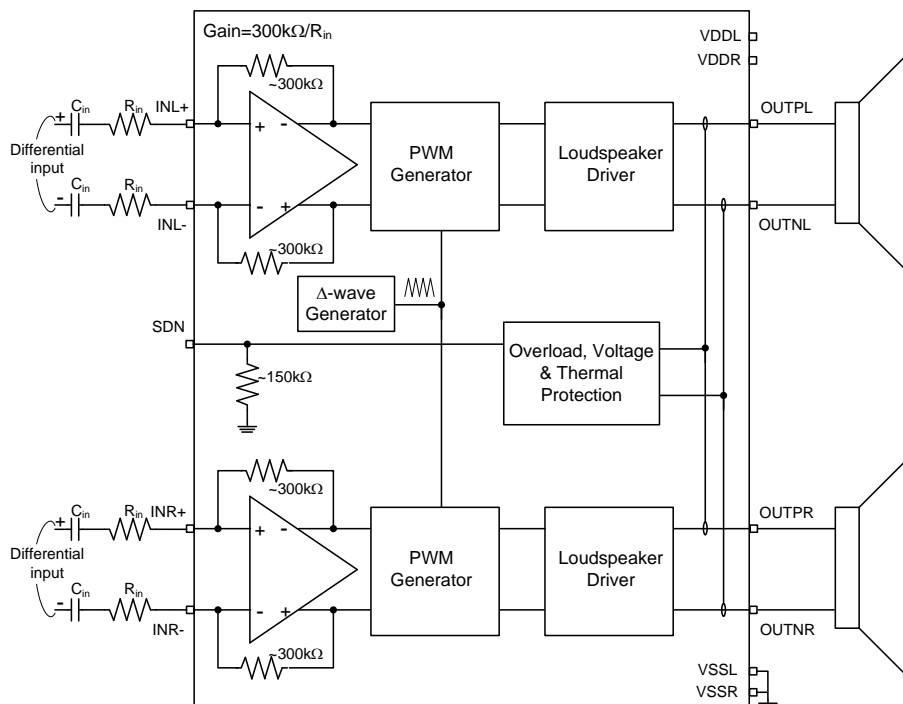
- Monitor audio
- PDA
- Portable multimedia devices
- Notebook computer
- Mobile phone

## Description

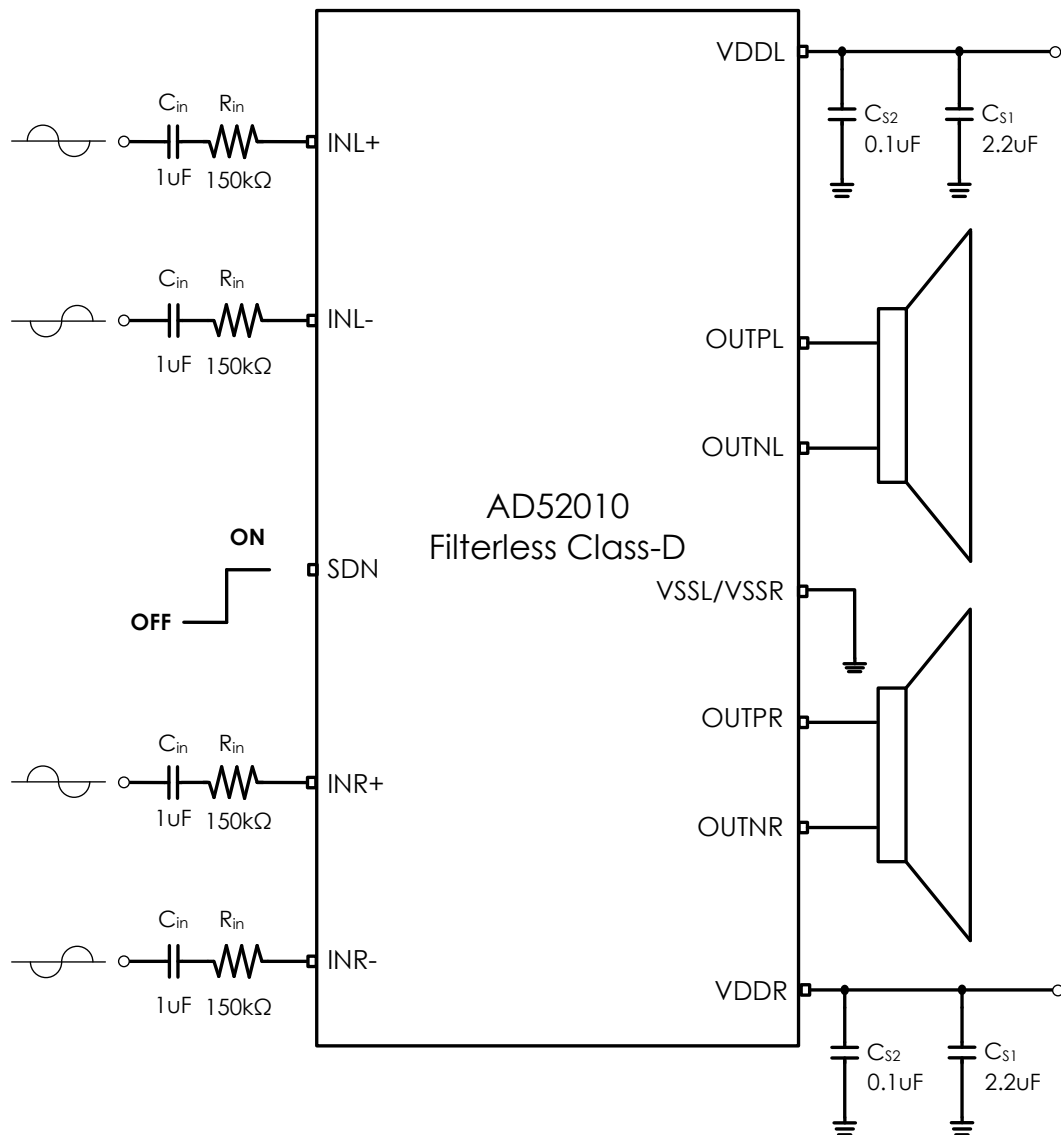
The AD52010 is a 3.0W stereo, filter-less class-D audio amplifier. Operating with 5.0V loudspeaker driver supply, it can deliver 3.0W output power into 4 Ω loudspeaker within 10% THD+N or 2.4W at 1% THD+N.

The AD52010 is a stereo audio amplifier with high efficiency and suitable for the notebook computer, and portable multimedia device.

## Functional Block Diagram

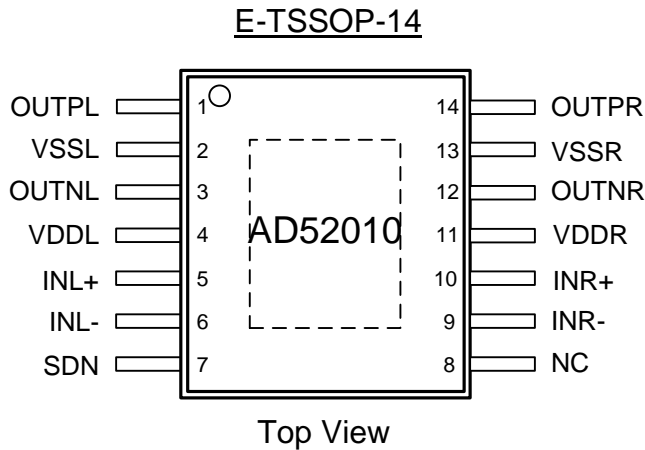


## Typical Application Circuit



Note. Gain=2 V/V

## Pin Assignments



## Order information

Product ID	Package	Packing	Comments
AD52010-QG14NRR	E-TSSOP-14L	Tape/Reel 2.5K Units/Reel	Green
AD52010-QG14NRT	E-TSSOP-14L	96 Units / Tube 100 Tubes / Small Box	Green

## Pin Description

NAME	PIN	IO TYPE	DESCRIPTION
	E-TSSOP-14		
OUTPL	1	O	Positive output for left channel.
VSSL	2	G	Power ground for left channel.
OUTNL	3	O	Negative output for left channel.
VDDL	4	P	Power supply for left channel.
INL+	5	I	Positive differential input for left channel.
INL-	6	I	Negative differential input for left channel.
SDN	7	I	Shutdown AD52010 (Low active logic).
NC	8	NC	No internal connected.
INR-	9	I	Negative differential input for right channel.
INR+	10	I	Positive differential input for right channel.
VDDR	11	P	Power supply for right channel.
OUTNR	12	O	Negative output for right channel.
VSSR	13	G	Power ground for right channel.
OUTPR	14	O	Positive output for right channel.
Thermal pad	N/A	G	To connect the package exposed pad to PCB for thermal power dissipation.

**Available Package**

Package Type	Device no.	$\theta_{JA}$ (°C/W)	Exposed Thermal Pad
E-TSSOP-14L	AD52010	38	Yes

Note.  $\theta_{ja}$  is measured at room temperature ( $T_A=25^\circ\text{C}$ ), natural convection environment test board, which is constructed with a thermal efficient, 4-layers PCB. The measurement is tested using the JEDEC51-5 thermal measurement standard.

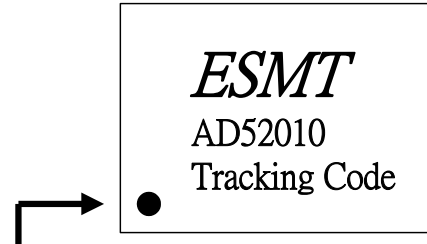
**Marking Information**

- E-TSSOP-14L Package Marking Information

Line 1 : LOGO

Line 2 : Product No

Line 3 : Tracking Code

**Absolute Maximum Ratings**

SYMBOL	PARAMETER	MIN	MAX	UNIT
VDD	Supply for analog cells & loudspeaker driver	-0.3	6.0	V
	Input pins voltage	-0.3	5.5	V
$T_A$	Operating free-air temperature range	-40	85	°C
$T_{stg}$	Storage temperature	-65	150	°C
$T_J$	Junction operating temperature	-40	150	°C

**Recommended Operating Conditions**

SYMBOL	PARAMETER	MIN	MAX	UNIT
VDD	Supply for analog cells & loudspeaker driver	2.5	5.5	V
$V_{IH}$	High-Level Input Voltage	1.3	-	V
$V_{IL}$	Low-Level Input Voltage	-	0.35	V
$T_J$	Junction operating temperature	-40	125	°C
$T_a$	Ambient Operating Temperature	-40	85	°C

## General Electrical Characteristics (T<sub>A</sub>=25°C)

SYMBOL	PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
I <sub>q</sub>	Operating current	VDD=SDN=5V, Output switching		6		mA
I <sub>PD</sub>	Supply current during power-down mode	VDD=5.5V; SDN=0V		<1		μA
V <sub>offset</sub>	Output offset voltage	Input ac grounded, VDD=2.5V ~ 5.5V		< 1	5	mV
T <sub>sd</sub>	Junction temperature for driver shutdown			165		°C
T <sub>hys</sub>	Temperature hysteresis for recovery from shutdown			20		°C
f <sub>sw</sub>	Switching rate of loudspeakers driver		250	300	350	kHz
A <sub>v</sub>	Gain		$\frac{270k\Omega}{R_n}$	$\frac{300k\Omega}{R_n}$	$\frac{330k\Omega}{R_n}$	V/V
T <sub>on</sub>	Turn-on time	VDD = 3.6 V		1.7	4	msec
R <sub>sc</sub>	Loudspeaker short-circuit detect resistance	VDD = 5.0 V		2.8	3.2	Ohm

## Electrical Characteristics and Specifications for Loudspeaker

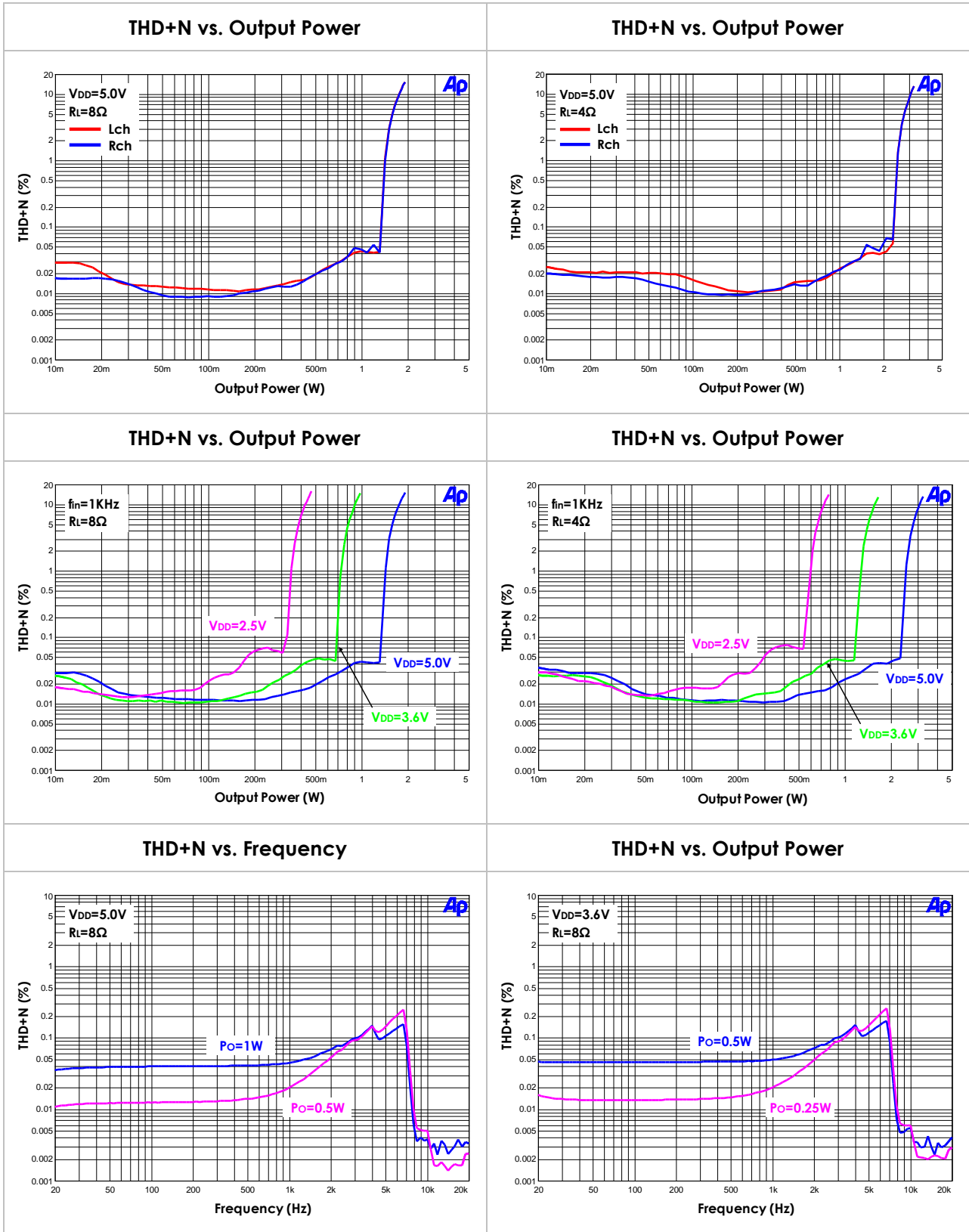
- Gain= 2 V/V, Load=8Ω,  $f_{in}$ =1 kHz,  $C_{S1}$ =2.2uF,  $C_{S2}$ =0.1uF,  $T_A$ =25°C (unless otherwise noted)

SYMBOL	PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
P <sub>O</sub>	RMS Output Power	VDD=5.0V	THD+N = 10 %		1.7	W
			THD+N = 1 %		1.4	W
		VDD=3.6V	THD+N = 10 %		0.90	W
			THD+N = 1 %		0.73	W
		VDD=2.5V	THD+N = 10 %		0.43	W
			THD+N = 1 %		0.35	W
THD+N	Total Harmonic Distortion plus Noise	VDD=5.0V, P <sub>O</sub> =1.0W			0.04	%
		VDD=3.6V, P <sub>O</sub> =0.5W			0.04	%
		VDD=2.5V, P <sub>O</sub> =0.2W			0.05	%
SNR	Signal to Noise Ratio	VDD=5.0V, P <sub>O</sub> =1.0W			98	dB
X-talk	Channel Separation	P <sub>O</sub> =1W, $f_{IN}$ =1kHz			>90	dB
PSRR	Power Supply Rejection Ratio	VDD=3.6V, V <sub>ripple</sub> =200mVpp Inputs ac grounded with C <sub>i</sub> =2μF f=217 Hz			74	dB
CMRR	Common-Mode Rejection	VDD=3.6V, V <sub>IC</sub> =1Vpp, f=217Hz			66	dB
V <sub>n</sub>	Output integrated noise (A-weighted)	VDD=3.6V $f_{in}$ =20Hz ~ 20kHz			23	μV
η	Efficiency	VDD=5V, THD+N=10%			90	%

- Gain= 2 V/V, Load=4Ω,  $f_{in}$ =1 kHz,  $C_{S1}$ =2.2uF,  $C_{S2}$ =0.1uF,  $T_A$ =25°C (unless otherwise noted)

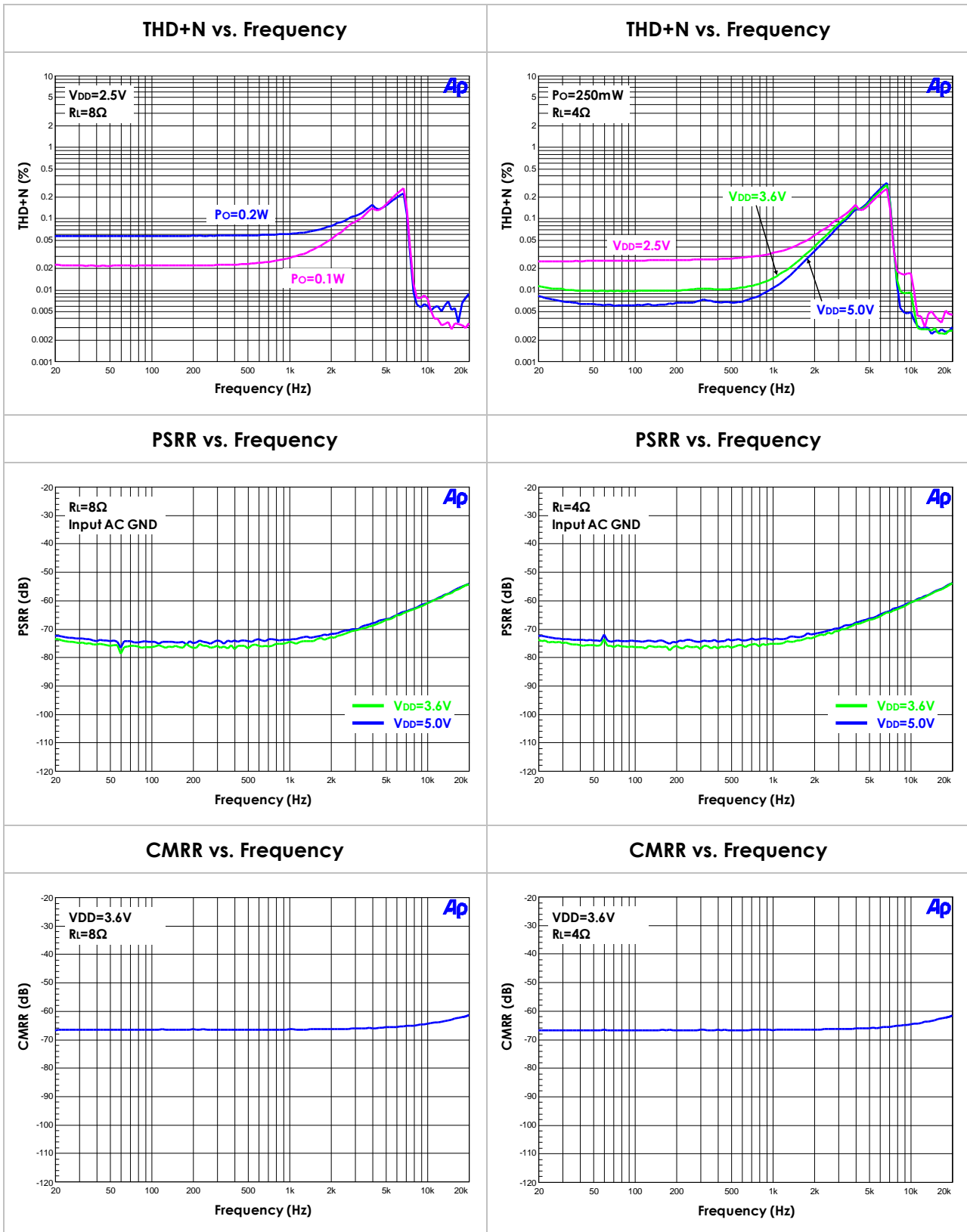
SYMBOL	PARAMETER	CONDITION	MIN	TYP	MAX	UNIT	
P <sub>O</sub>	RMS Output Power	VDD=5.0V	THD+N = 10 %		3.0		W
			THD+N = 1 %		2.4		W
		VDD=3.6V	THD+N = 10 %		1.5		W
			THD+N = 1 %		1.3		W
		VDD=2.5V	THD+N = 10 %		0.72		W
			THD+N = 1 %		0.58		W
THD+N	Total Harmonic Distortion plus Noise	VDD=5.0V, P <sub>O</sub> =2.0W			0.04		%
		VDD=3.6V, P <sub>O</sub> =1.0W			0.04		%
		VDD=2.5V, P <sub>O</sub> =0.5W			0.08		%
SNR	Signal to Noise Ratio	VDD=5.0V, P <sub>O</sub> =1.8W			98		dB
X-talk	Channel Separation	P <sub>O</sub> =1W, $f_{IN}$ =1kHz			>90		dB
PSRR	Power Supply Rejection Ratio	VDD=3.6V, V <sub>ripple</sub> =200mVpp Inputs ac grounded with C <sub>i</sub> =2μF f=217 Hz			77		dB
CMRR	Common-Mode Rejection	VDD=3.6V, V <sub>IC</sub> =1Vpp, f=217Hz			66		dB
V <sub>n</sub>	Output integrated noise (A-weighted)	VDD=3.6V $f_{in}$ =20Hz ~ 20kHz			22		μV
η	Efficiency	VDD=5.0V, THD+N=10%			82		%

## Typical Characteristics (Gain= 2 V/V, unless otherwise noted)

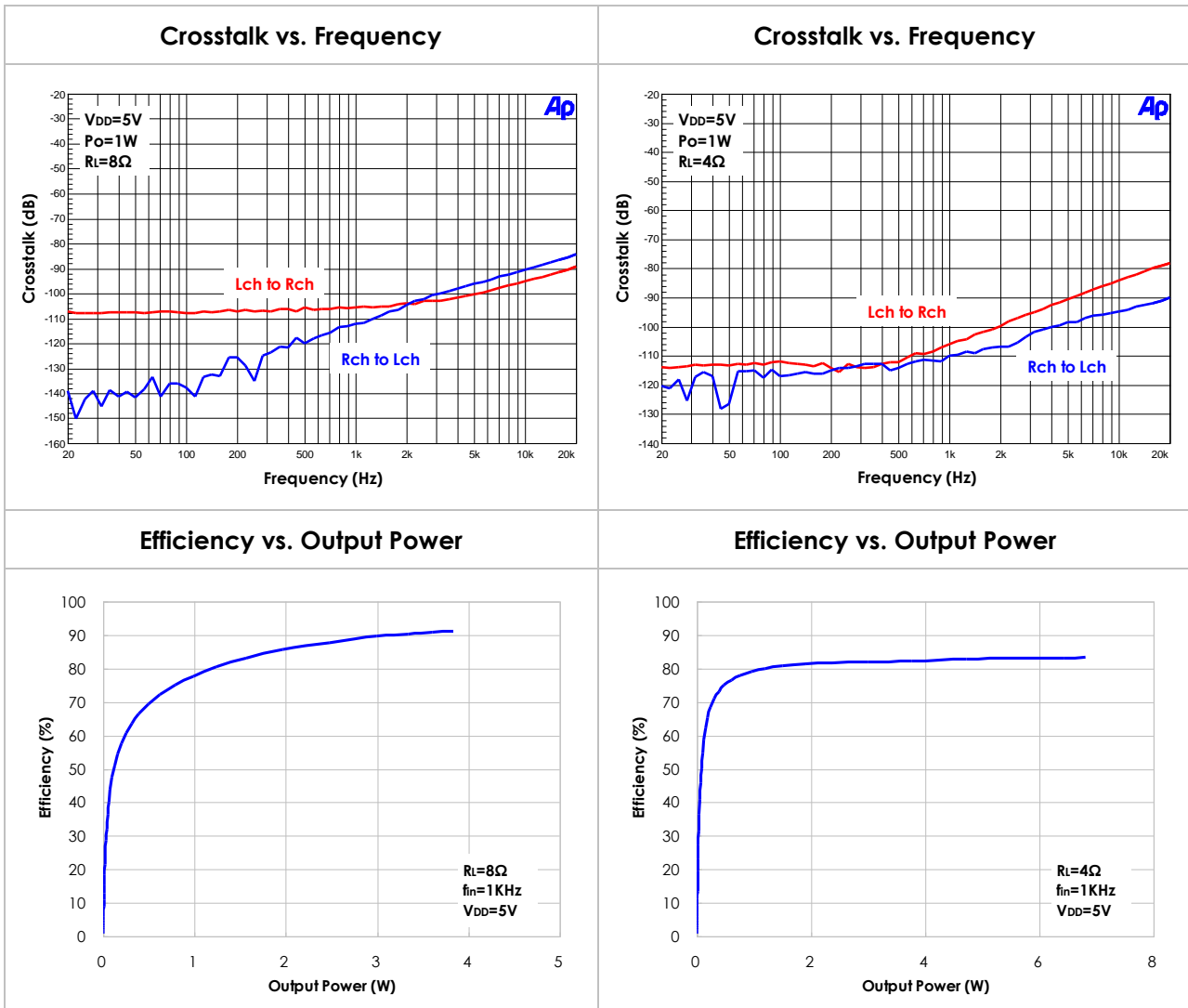




## Typical Characteristics (Gain= 2 V/V, unless otherwise noted)



## Typical Characteristics (Gain= 2 V/V, unless otherwise noted)



**Operation Descriptions**

- Self-protection circuits (Typical values are used below.)  
AD52010 has built-in over-temperature, overload and under-voltage detectors.
  - (i) If the internal junction temperature is higher than 165°C, the outputs of loudspeaker drivers will be disabled and connected to ground and the temperature hysteresis for AD52010 to return to normal operation is about 20°C. The variation of protected temperature is around 10%.
  - (ii) To protect loudspeaker drivers from current damage when the wires connected to loudspeakers are shorted to one another or shorted to GND, circuits for the detection of output loading are built in the AD52010. For normal operation, loudspeaker resistance is larger than 3.2Ω is required. Otherwise, overload detectors may activate. Once overload detector is active, loudspeaker drivers will be disabled and at low state. AD52010 will be recovery from overload fault by pulling SD# down to low and back to high after removing the short. Once the lines connected to loudspeakers are shorted to VDD, AD52010 will be burnt.
  - (iii) When the VDD voltage is lower than 2.3V, AD52010 will disable and loudspeaker drivers are at low state, cease AD52010 beside voltage detector circuit. When VDD becomes larger than 2.4V, AD52010 will return to normal operation.
- Anti-pop design  
AD52010 is with anti-pop design. Annoying pop sounds during initial power on and power down/up are suppressed. When one of the operations mentioned above is applied, AD52010 will internally generate appropriate control signals to suppress pop sounds.

**Application Circuit Information**

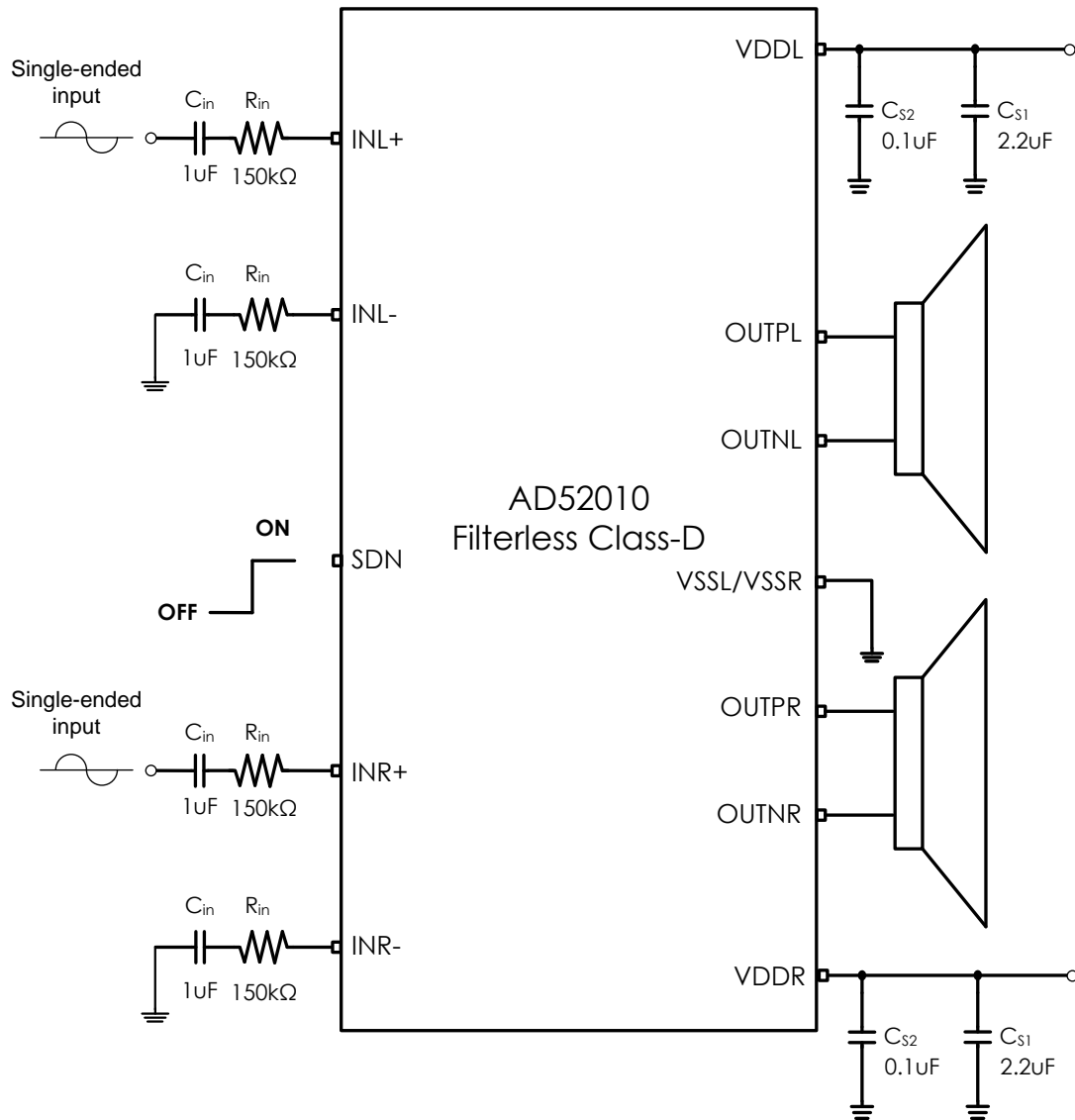
- Input resistors ( $R_{in}$ ) and input capacitors ( $C_{in}$ )  
The total gain of the audio amplifier (AD52010) is set by input resistor ( $R_{in}$ ) according to the following equation (a). The performance at low frequency (bass) is affected by the corner frequency ( $f_c$ ) of the high-pass filter composed of input resistors ( $R_{in}$ ) and input capacitors ( $C_{in}$ ), determined in equation (b).

$$Gain = \frac{300k\Omega}{R_{in}} \left( \frac{V}{V} \right) \dots\dots\dots (a)$$

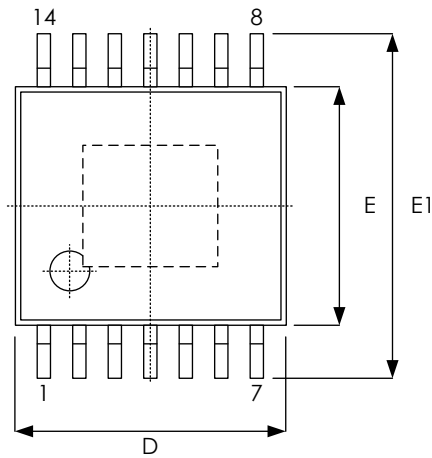
$$f_c = \frac{1}{2\pi R_{in} C_{in}} \text{ (Hz)} \dots\dots\dots (b)$$

For differential audio signal application, the input capacitors ( $C_{in}$ ), for DC decoupling, are not required. When single-ended audio source is used, the input capacitors ( $C_{in}$ ) are required.

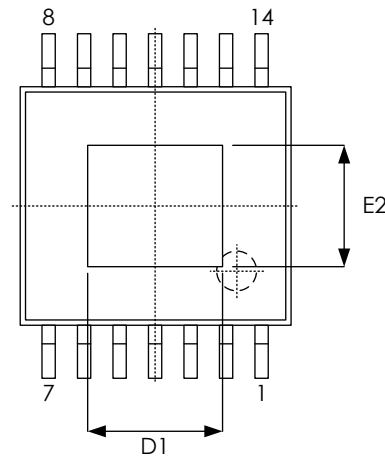
- Suggested application circuit for single-ended input



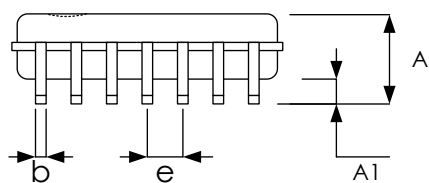
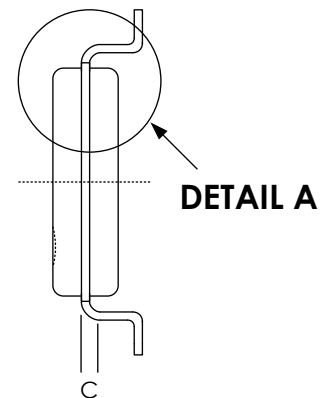
## Package Outline Dimensions TSSOP-14(E) (173 mil)



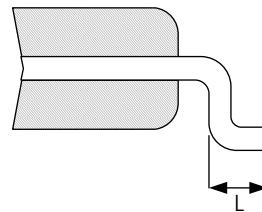
**TOP VIEW**



**BOTTOM VIEW**



**SIDE VIEW**



**DETAIL A**

Symbol	Dimension in mm	
	Min	Max
A	--	1.20
A1	0.05	0.15
b	0.19	0.30
D	4.90	5.10
E	4.30	4.50
E1	6.40 BSC	
e	0.65 BSC	
L	0.5	0.75

### Exposed pad

	Dimension in mm	
	Min	Max
D1	1.70	3.25
E2	1.50	3.15

**Revision History**

<b>Revision</b>	<b>Date</b>	<b>Description</b>
0.1	2014.07.22	Preliminary version.
1.0	2019.01.22	Remove "Preliminary" and reversion to 1.0 and add order information & add marking information & add Ta information & update POD
1.1	2019.06.03	Update description.
1.2	2021.11.16	Update functional block diagram.

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