Filterless 6W Class- F Mono Audio Amplifier

General Description

The LPA2171 is a 6W, class-F audio amplifier with a mode pin for switch the work mode. It offers low THD+N, allowing it to achieve high-quality Power Supply sound reproduction. The new filterless architecture allows the device to drive the speaker directly requiring no low-pass output filters, thus to save the system cost and PCB area. The LPA2171 is available in SOP-8.

Order Information

LPA2171 □ □ □

- F: Pb-Free
- Package Type
  SO: SOP-8

Applications

- ✧ Portable Bluetooth Speaker
- ✧ Cellular and Smart mobile phone
- ✧ Square Speaker

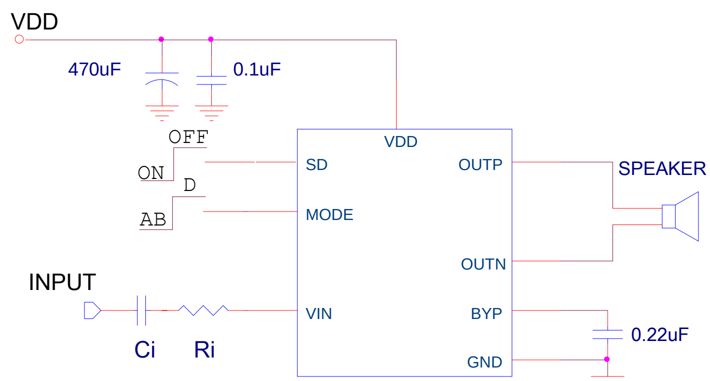
Features

- Shutdown current:<5uA
- 480KHz fixed frequency switching for amplifier
- 5.6W Output at 10% THD with a 2 Ω Load and 5V VDD for amplifier
- 4.4W Output at 1% THD with a 2 Ω Load and 5V VDD for amplifier
- 4.0W Output at 10% THD with a 4 Ω Load and 5.5V VDD for amplifier
- Filterless, Low Quiescent Current and Low EMI
- Amplifier Efficiency up to 85%
- Free LC filter digital modulation, direct-drive speakers
- Short Circuit Protection
- Thermal Shutdown
- Few External Components to Save the Space and cost
- Pb-Free Package

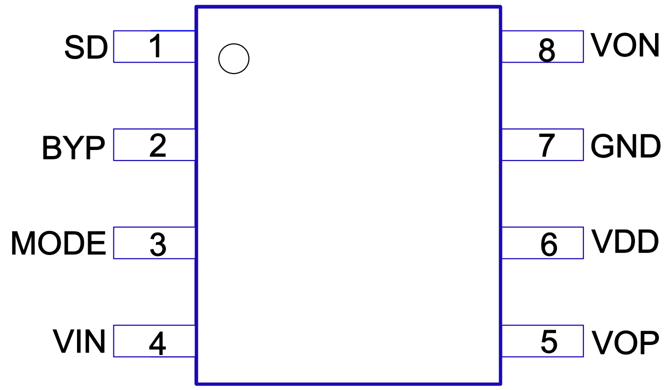
Marking Information

Device	Marking	Package	Shipping
LPA2171SOF	LPS LPA2171 YWX	SOP-8	3K/REEL
Y: Y is year code. W: W is week code. X: X is series number.			

Typical Application Circuit



Functional Pin Description

Package Type	Pin Configurations
SOP-8	

Functional Pin Description

Pin	PIN No.	DESCRIPTION
SD	1	Shutdown pin
BYP	2	Bypass pin. Connect a 0.22uF capacitor between this pin and GND.
MODE	3	Mode control pin. High voltage with Class_D mode and low voltage with Class_AB mode.
IN	4	Input of amplifier.
VOP	5	Positive output of signal.
VDD	6	Voltage supply pin.
GND	7	Power ground.
VON	8	Negative output of signal.

Absolute Maximum Ratings

Supply Input Voltage range-- 2.3V to 7.1V

Input voltage -- -0.3V to VDD+0.3V

Lead Temperature (Soldering, 10 sec.) -- 260°C

Storage Temperature Range -- −65°C to 150°C

Operation Junction Temperature Range --- −40°C to 125°C

Operation Ambient Temperature Range--- −40°C to 85°C

Maximum Junction Temperature Range--- 150°C

Maximum Power Dissipation (P_D,T_A<40°C) -- 2.6W

Thermal resistance (junction to ambient) --- 45°C/W

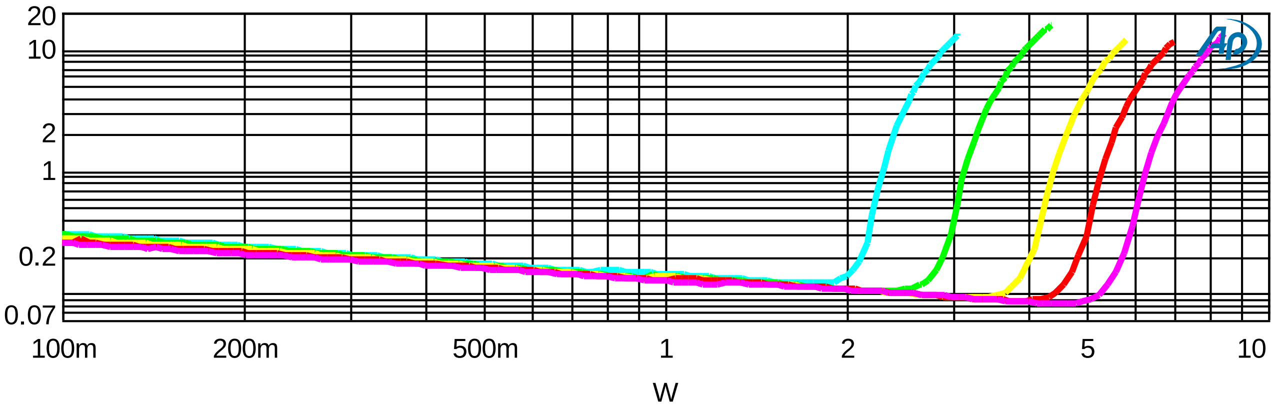
Electrical Characteristics For Amplifier

(VDD = 5V, GAIN = 20dB, RL=4Ω，TA = 25° C, Class_D Mode, unless otherwise specified)

Parameter	Symbol	Test Conditions		Min	Typ Class-D	Typ Class-AB	Max	Units
Supply power	VIN			2.5			6.0	V
Output power	Po	THD+N=10%, f=1KHz,RL=4Ω	VDD=6.0V		4.8	4.64		W
			VDD=5.5V		4.03	3.90		
			VDD=5.0V		3.31	3.25		
			VDD=4.2V		2.33	2.32		
			VDD=3.6V		1.70	1.70		
		THD+N=1%, f=1KHz,RL=4Ω	VDD=6.0V		3.91	3.60		
			VDD=5.5V		3.27	3.01		
			VDD=5.0V		2.7	2.51		
			VDD=4.2V		1.91	1.81		
			VDD=3.6V		1.37	1.32		
		THD+N=10%, f=1KHz,RL=2Ω	VDD=5.5V		6.8	6.75		
			VDD=5.0V		5.64	5.6		
			VDD=4.2V		3.3	3.9		
			VDD=3.6V		2.3	2.9		
Power supply ripple rejection	PSRR	INPUT ac-grounded with CIN=0.47uF, VDD=6.0V	f=100HZ		75			dB
			f=1KHz		50			
Signal-to-noise ratio	SNR	VDD=5V,Class_AB,f=1KHz			91			dB
		VDD=5V,Class_D,f=1KHz			90			
Output noise	V_N	INPUT ac-grounded with CIN=0.47uF, VDD=5.0V			100			μV
Efficiency	η	RL=4Ω, Po=3.2W，f=1KHz			84			%
Switching frequency	f_{SW}	VDD=2.5V to 5.5V			480			kHz
Output offset voltage	$\|V_{OS}\|$	VDD=5.0V, V_{SD} =0V			1.1	2.5		mV
Shutdown current	I_{LEAK}	V_{SD} =VDD=5.0V			2			uA
Quiescent current	I_Q	VDD=5.0V，No load			4	6.8		mA
Threshold voltage of class D	V_{MOD_D}	VDD=2.5-6.0V		70% VDD				V
Threshold voltage of class AB	V_{MOD_AB}	VDD=2.5-6.0V					25% VDD	
Threshold voltage of shutdown pin	V_{SD_H}	VDD=2.5-6.0V		1.4				
	V_{SD_L}	VDD=2.5-6.0V					0.4	

Typical Operating Characteristic

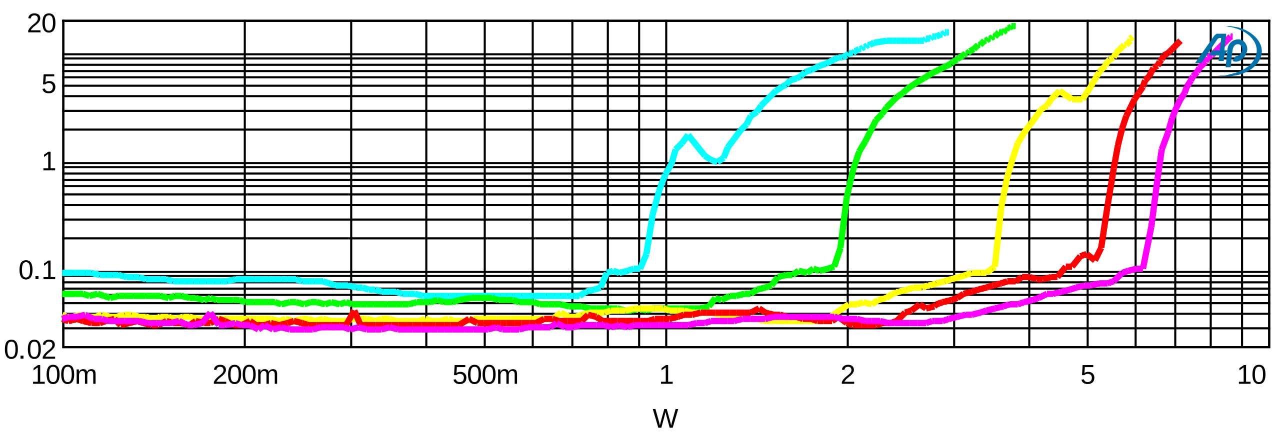
Audio Precision



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Cyan	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=3.6V Class AB
2	1	Green	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=4.2V Class AB
3	1	Yellow	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=5.0V Class AB
4	1	Red	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=5.5V Class AB
5	1	Magenta	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=6.0V Class AB

P0 VS THD(2ohm AB).ats2

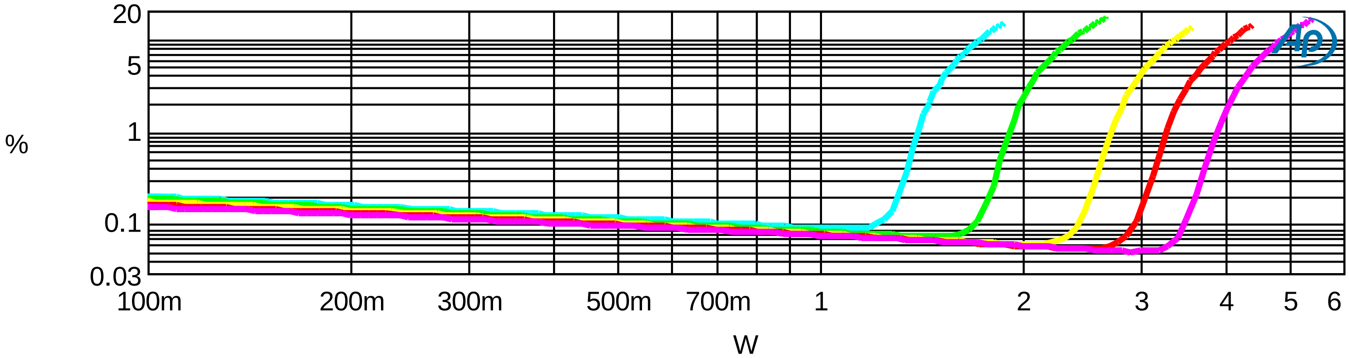
Audio Precision



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Cyan	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=3.6V Class D
2	1	Green	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=4.2V Class D
3	1	Yellow	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=5.0V Class D
4	1	Red	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=5.5V Class D
5	1	Magenta	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=6.0V Class D

P0 VS THD(2ohm D).ats2

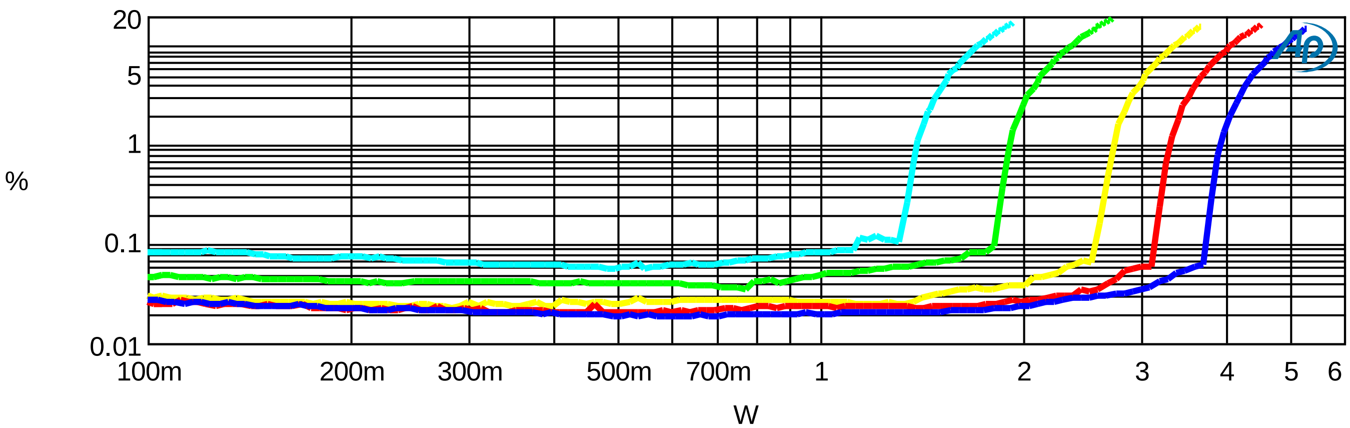
Audio Precision



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Cyan	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=3.6V Class AB
2	1	Green	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=4.2V Class AB
3	1	Yellow	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=5.0V Class AB
4	1	Red	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=5.5V Class AB
5	1	Magenta	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=6.0V Class AB

P0 VS THD(4ohm AB).ats2

Audio Precision



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Cyan	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=3.6V Class D
2	1	Green	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=4.2V Class D
3	1	Yellow	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=5.0V Class D
4	1	Red	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=5.5V Class D
5	1	Magenta	Solid	3	Analyzer.THD+N Ratio A	Left	
6	1	Blue	Solid	3	Analyzer.THD+N Ratio A	Left	VDD=6.0V Class D

P0 VS THD(4ohm D).ats2

Applications Information

Maximum Gain

The LPA2171 has two internal amplifier stages. The first stage's gain is externally configurable, while the second stage's is internally fixed. The closed-loop gain of the first stage is set by selecting the ratio of Rf to Ri while the second stage's gain is fixed at 2x.The output of amplifier 1 serves as the input to amplifier 2, thus the two amplifiers produce signals identical in magnitude, but different in phase by 180°. Consequently, the differential gain for the IC is

A VD=20*log [2*Rf/Ri]

T h e LPA2171 sets maximum:

Rf= 150 k Ω±10%	class-AB
Rf= 150 k Ω±10%	class-D

Shutdown operation

In order to reduce power consumption while not in use, the LPA2171 contains shutdown circuitry to turn off the amplifier's bias circuitry. This shutdown feature turns the amplifier off when logic high is applied to the SD pin. By switching the SD pin connected to VDD, the LPA2171 supply current draw will be minimized in idle mode.

Power supply decoupling

The LPA2171 is a high performance CMOS audio amplifier that requires adequate power supply decoupling to ensure the output THD and PSRR a low as possible. Power supply decoupling affects low frequency response. Optimum decoupling is achieved by using two capacitors of different types targeting to different types of noise on the power supply leads. For higher frequency transients, spikes, or digital hash on the line, a good low equivalent-series- resistance (ESR) ceramic capacitor, typically 1.0μF, works best, placing it as close as possible to the device VDD terminal. For filtering lower- frequency noise signals, a large capacitor of 20μF (ceramic) or greater is recommended, placing it near the audio power amplifier.

Input Capacitor (C i)

Ci for boost. Large input capacitors are both expensive and space hungry for portable designs. Clearly, a certain sized capacitor is needed to couple in low frequencies without severe attenuation. But in many cases the speakers used in portable systems, whether internal or external, have little ability to reproduce signals below 100Hz to 150Hz. In the typical application, an input capacitor Ci is required to allow the amplifier to bias the input signal to the proper dc level for optimum operation. Thus, using a large input capacitor may not increase actual system performance. In this case, input capacitor (Ci) and input resistance (Ri) of the amplifier form a high-pass filter with the corner frequency determined by equation below,

$$f_C = \frac{1}{2\pi R i C}$$

Analog Reference Bypass Capacitor (CBYP)

In addition to system cost and size, click and pop performance is affected by the size of the input coupling capacitor, Ci. A larger input coupling capacitor requires more charge to reach its quiescent DC voltage (nominally 1/2 VDD). This charge comes from the internal circuit via the feedback and is apt to create pops upon device enable. Thus, by minimizing the capacitor size based on necessary low frequency response, turn-on pops can be minimized.

The Analog Reference Bypass Capacitor (CBYP) is the most critical capacitor and serves several important functions. During start-up or recovery from shutdown mode, CBYP 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. The LPA2171 incorporates circuitry designed to detect low supply voltage. When the supply voltage drops to 2.7V or below, the LPA2171 outputs are disabled, and the device comes out of this state and starts to normal function when VDD≥2.7V.

Short Circuit Protection (SCP)

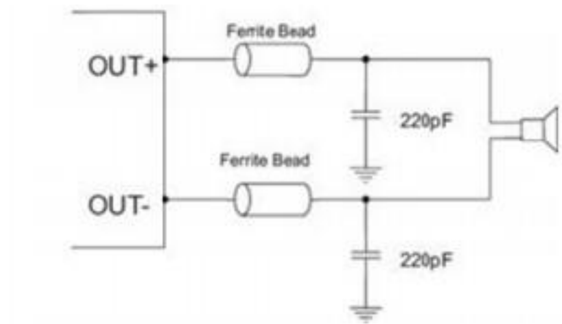
The LPA2171 has short circuit protection circuitry on the outputs to prevent damage to the device when output-to-output or output-to-GND short occurs. When a short circuit is detected on the outputs, the outputs are disabled immediately. If the short was removed, the device activates again.

Over Temperature Protection

Thermal protection on the LPA2171 prevents the device from damage when the internal die temperature exceeds 140℃. There is a 15 degree tolerance on this trip point from device to device. Once the die temperature exceeds the thermal set point, the device outputs are disabled. This is not a latched fault. The thermal fault is cleared once the temperature of the die is reduced by 30℃. This large hysteresis will prevent motor boating sound well and the device begins normal operation at this point without external system intervention.

How to reduce EMI

A simple solution is to put an additional capacitor 220pF at power supply terminal for power line. The traces from amplifier to speakers should design as short as we can.



PCB Layout notices

1, In the path of the input signal plus a 103-to-ground high-frequency filter capacitor.

2, The power and ground and filter capacitor and bypass capacitors as close to the chip's pins, remember not to put the capacitor on the back of the board, through tiny holes through the jumper even over.

3, Power, ground, and a large current signal line to go to try to rough, if you want to add vias, the number of through-holes must be at least 6.

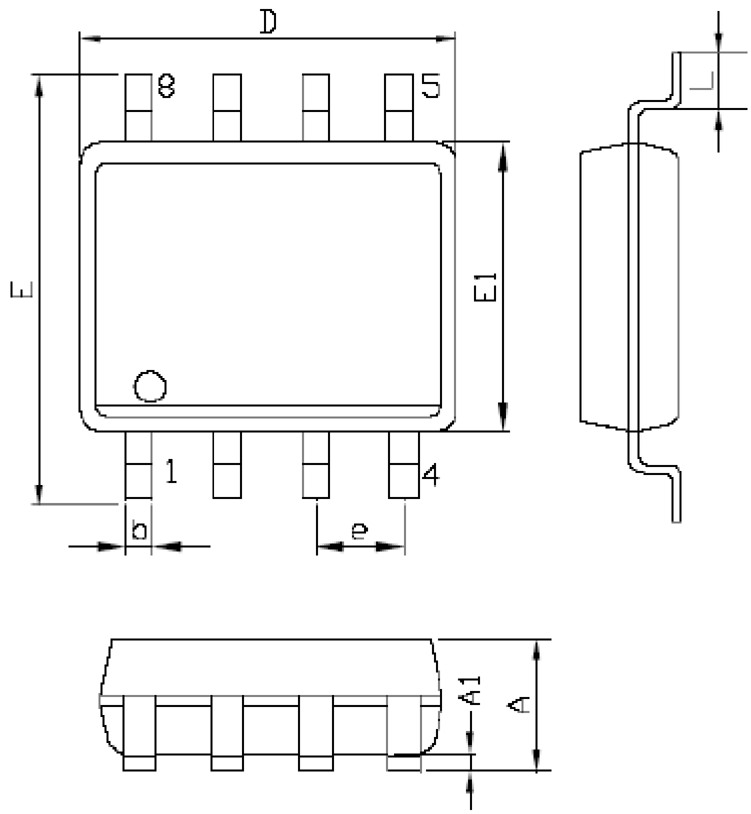
4, If you want to pursue as large as the effect of power, a large selection of speakers or sound chamber with low resistance (such as 3.6Ω) speakers, or added to improve the supply voltage boost circuit.

5, Sensitive attention to shielding the signal line, it is best to use a differential signal. Try not to interfere with the sensitive line through the signal line.

6, The position on the board under the amplifier chip must be added vents and large areas of exposed copper and tin to enhance heat dissipation.

Packaging Information

SOP8



SYMBOLS	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
D	4.90		0.193	
E	5.80	6.20	0.228	0.244
E1	3.90		0.153	
L	0.40	1.27	0.016	0.050
b	0.31	0.51	0.012	0.020
e	1.27		0.050	