



Filterless 2x8W Class- F Stereo Audio Amplifier

General Description

The LPA2154 is a 2x8W, 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 LPA2154 is available in ESOP-16.

Order Information



Applications

- ✧ Portable Bluetooth Speaker
- ✧ Square Speaker

Features

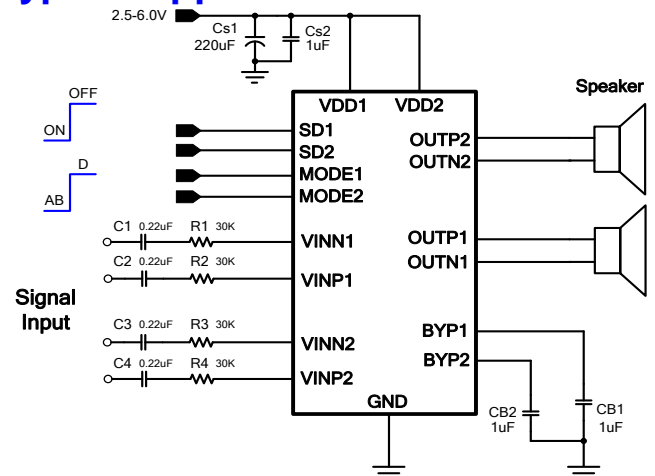
- ◆ 500KHz fixed frequency switching for amplifier
- ◆ 2x3.3W Output at 10% THD with a 4Ω Load and 5V PVDD for amplifier
- ◆ 2x4.8W Output at 10% THD with a 4Ω Load and 6.0V PVDD for amplifier
- ◆ 2x8W Output at 10% THD with a 2Ω Load and 6.0V PVDD for amplifier
- ◆ Filterless, Low Quiescent Current 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 |
|---------|-----------------------|---------|----------|
| LPA2154 | LPS LPA2154 YWX | ESOP-16 | 3K/REEL |

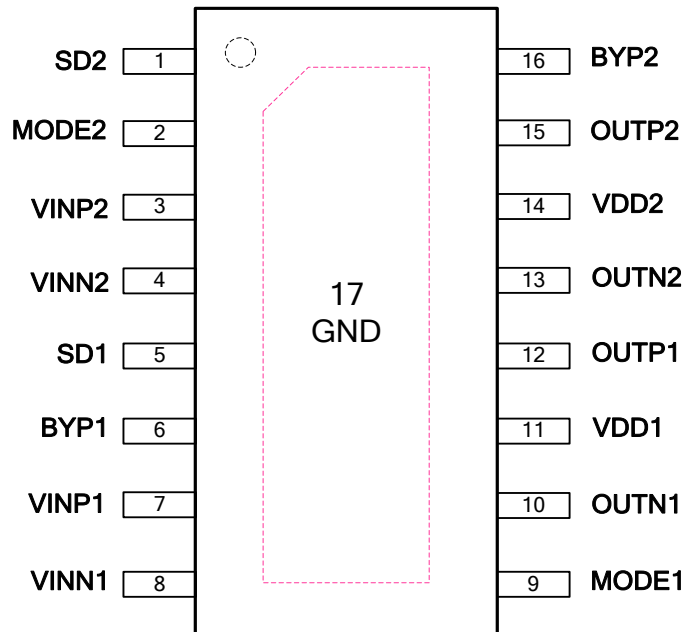
Y: Y is year code. W: W is week code. X: X is series number.

Typical Application Circuit





Pin Configuration



Functional Pin Description

| Pin | PIN No. | DESCRIPTION |
|-------|---------|---|
| SD2 | 1 | Channel 2 Shutdown pin (active high). |
| MODE2 | 2 | Channel 2 Mode control pin (High voltage with Class_D mode and low voltage with Class_AB mode). |
| VINP2 | 3 | Channel 2 Positive input Pin. |
| VINN2 | 4 | Channel 2 Negative input Pin. |
| SD1 | 5 | Channel 1 Shutdown pin (active high). |
| BYP1 | 6 | Channel 1 Bypass pin (Connect a 1uF capacitor between this pin and GND). |
| VINP1 | 7 | Channel 1 Positive input Pin. |
| VINN1 | 8 | Channel 1 Negative input Pin. |
| MODE1 | 9 | Channel 1 Mode control pin (High voltage with Class_D mode and low voltage with Class_AB mode). |
| OUTN1 | 10 | Channel 1 Negative output of signal. |
| VDD1 | 11 | Channel 1 Voltage supply pin. |
| OUTP1 | 12 | Channel 1 Positive output of signal. |
| OUTN2 | 13 | Channel 2 Negative output of signal. |
| VDD2 | 14 | Channel 2 Voltage supply pin. |
| OUTP2 | 15 | Channel 2 Positive output of signal. |
| BYP2 | 16 | Channel 2 Bypass pin (Connect a 1uF capacitor between this pin and GND). |
| GND | 17 | Ground pin. |



Absolute Maximum Ratings

| | |
|---|----------------|
| Input voltage ----- | -0.3V to 6.5V |
| 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 |

Recommended Operating Conditions

| | |
|--|----------------|
| Supply Input Voltage range ----- | 2.5V to 6.0V |
| Operation Ambient Temperature Range ----- | -40°C to 85°C |
| Operation Junction Temperature Range ----- | -40°C to 125°C |
| Thermal resistance (junction to ambient) ----- | 110°C/W |





Electrical Characteristics For Both Channel

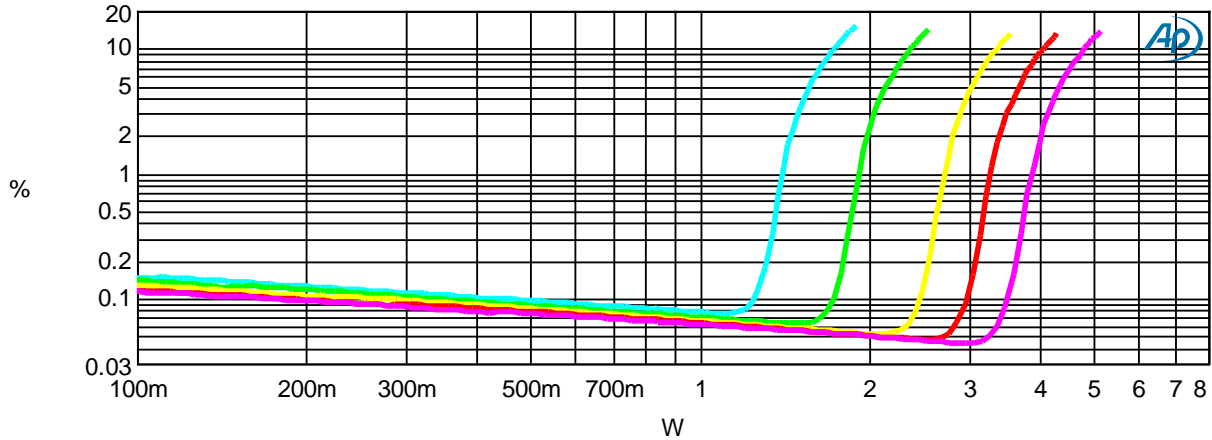
(VDD = 5V, RL=4Ω , TA = 25° C, unless otherwise specified)

| Parameter | Symbol | Test Conditions | Min | Typ | | Max | Units |
|-------------------------------|-------------------|---|----------|---------|----------|-----|-------|
| | | | | Class-D | Class-AB | | |
| Supply power | VIN | | 2.5 | | | 6.0 | V |
| Output power | Po | THD+N=10%, f=1KHz,RL=4Ω | VDD=6.0V | 4.8 | 4.7 | | W |
| | | | VDD=5.5V | 4.0 | 3.9 | | |
| | | | VDD=5.0V | 3.3 | 3.3 | | |
| | | | VDD=4.2V | 2.3 | 2.3 | | |
| | | | VDD=3.6V | 1.7 | 1.7 | | |
| | | THD+N=1%, f=1KHz,RL=4Ω | VDD=6.0V | 3.9 | 3.6 | | |
| | | | VDD=5.5V | 3.3 | 3.1 | | |
| | | | VDD=5.0V | 2.7 | 2.5 | | |
| | | | VDD=4.2V | 1.9 | 1.8 | | |
| | | | VDD=3.6V | 1.4 | 1.4 | | |
| | | THD+N=10%, f=1KHz,RL=2Ω | VDD=6.0V | 8 | 8 | | |
| | | | VDD=5.5V | 6.8 | 6.7 | | |
| | | | VDD=5.0V | 5.6 | 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=6.0V | | | 100 | | μV |
| Efficiency | η | RL=4Ω, Po=3.2W | f=1KHz | | 84 | | % |
| Switching frequency | f _{sw} | VDD=2.5V to 5.5V | | | 500 | | kHz |
| Output offset voltage | V _{OS} | V _{SD} =0V,VDD=5.0V | | | 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 |



Typical Operating Characteristic For Both Channel

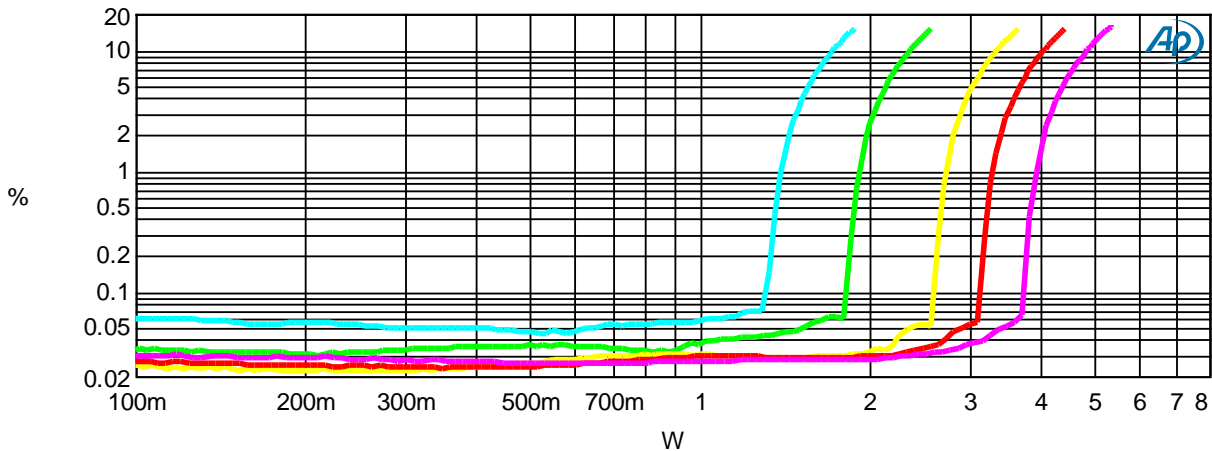
Audio Precision



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

PO VS THD(4ohm AB).ats2

Audio Precision

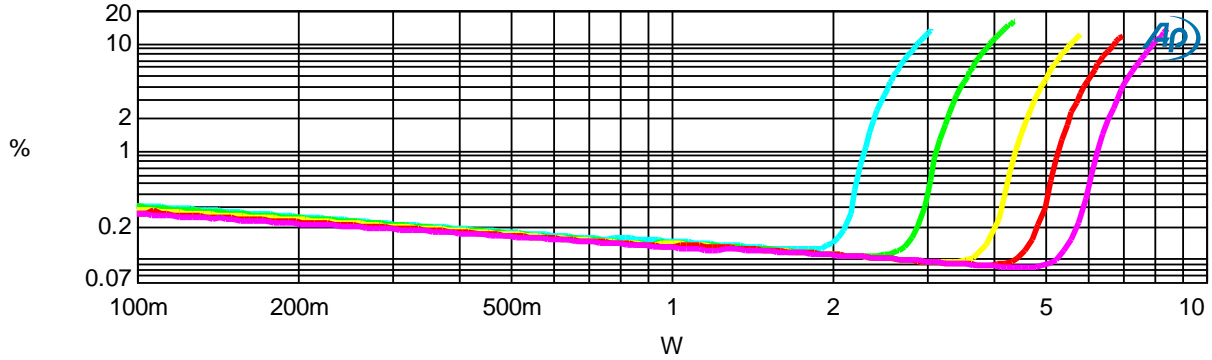


| Sweep | Trace | Color | Line Style | Thick | Data | Axis | Comment |
|-------|-------|---------|------------|-------|-------------------------------------|------|------------------|
| 1 | 1 | Cyan | Solid | 3 | Analyzer.TH _D +N Ratio A | Left | VDD=3.6V Class D |
| 2 | 1 | Green | Solid | 3 | Analyzer.TH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

PO VS THD(4ohm D).ats2



Audio Precision

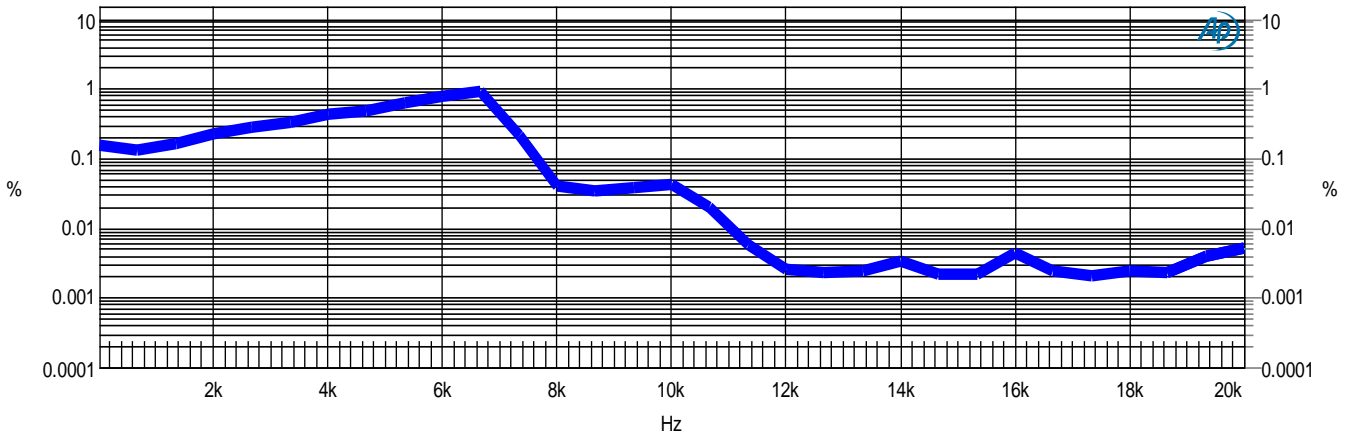


| Sweep | Trace | Color | Line Style | Thick | Data | Axis | Comment |
|-------|-------|---------|------------|-------|-------------------------|------|-------------------|
| 1 | 1 | Cyan | Solid | 3 | Analyzer.TH+D+N Ratio A | Left | VDD=3.6V Class AB |
| 2 | 1 | Green | Solid | 3 | Analyzer.TH+D+N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

P0 VS THD(2ohm AB).ats2

Audio Precision

A-A THD+N vs FREQUENCY



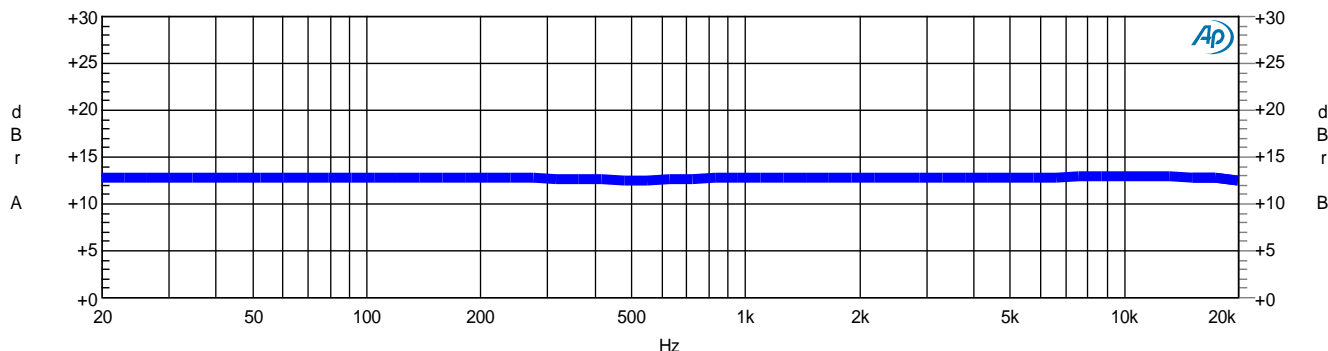
| Sweep | Trace | Color | Line Style | Thick | Data | Axis | Comment |
|-------|-------|-------|------------|-------|-------------------------|-------|---------|
| 1 | 1 | Cyan | Solid | 1 | Analyzer.TH+D+N Ratio B | Left | |
| 1 | 2 | Blue | Solid | 7 | Analyzer.TH+D+N Ratio B | Right | |

A single sweeps produces a stereo THD+N sweep of Ch A and Ch B when data 1 is set for THD+N and the Stereo box is checked. The upper Analyzer bandwidth is 20kHz. At a 6kHz fundamental only the 2nd and 3rd harmonics are included, above 10kHz only the noise is included in the measurement bandwidth. For band-limited systems IMD testing is better.

A-A THD+N VS FREQ @4ohm PO=3W CLASS D VDD=6V.ats2



Audio Precision



| Sweep | Trace | Color | Line Style | Thick | Data | Axis | Comment |
|-------|-------|-------|------------|-------|------------------|-------|---------|
| 1 | 1 | Cyan | Solid | 1 | Analyzer.Level A | Left | |
| 1 | 2 | Blue | Solid | 7 | Analyzer.Level B | Right | |

Rapid (<2 seconds) frequency response measurement.
 Can be even faster if the lowest frequencies are not included.
 Press F4 to set the 1kHz dBr A and dBr B reference.
 Optimize for a detailed view.

A-A-FREQ RESP FAST @ 4ohm PO=4.8W CLASS AB VDD=6V.ats2

Applications Information For Both Channel

Maximum Gain

The LPA2154 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 Rin while the second stage's gain is fixed at 1.5x. The output of amplifier 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:

$$A_v = 2 * 1.5 * R_f / R_{in} \text{ (for class_AB \& class_D)}$$

Shutdown operation

In order to reduce power consumption while not in use, the LPA2154 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 pull up to VDD, the LPA2154 supply current draw will be minimized in idle mode.

Power supply decoupling

The LPA2154 is a high performance CMOS audio amplifier that requires adequate power supply decoupling to ensure the output THD and PSRR a low as possible. 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.



Over Temperature Protection

Thermal protection on the LPA2154 prevents the device from damage when the internal die temperature exceeds 150°C. 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°C. This large hysteresis will prevent motor boating sound well and the device begins normal operation at this point without external system intervention.

Analog Reference Bypass Capacitor (C_{BYP})

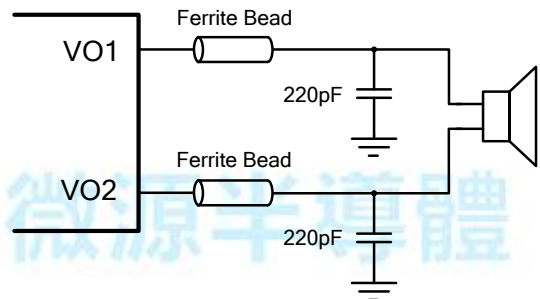
In addition to system cost and size, click and pop performance is affected by the size of the input coupling capacitor, C_{BYP} . A larger input coupling capacitor requires more charge to reach its quiescent DC voltage (nominally 1/2 VDD). This charge comes from the internal circuit via the feedback 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 (C_{BYP}) is

the most critical capacitor and serves several important functions. During start-up or recovery from shutdown mode, C_{BYP} 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.

How to reduce EMI

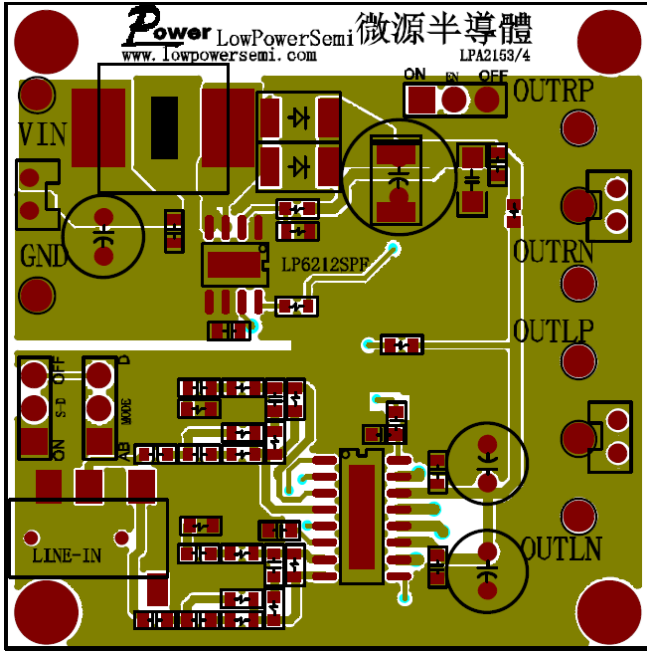
A simple solution is to put an additional capacitor 220pF at power supply terminal for power line. The traces from amplifier to speakers should design as short as we can.



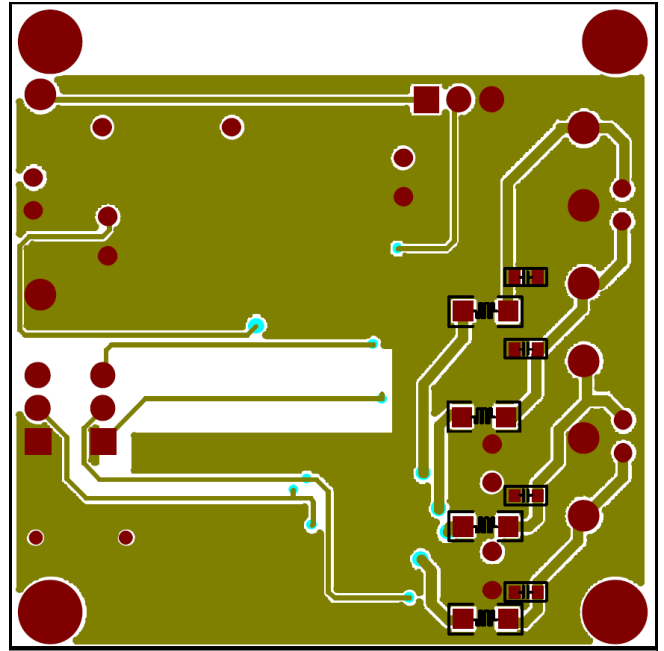


PCB LAYOUT

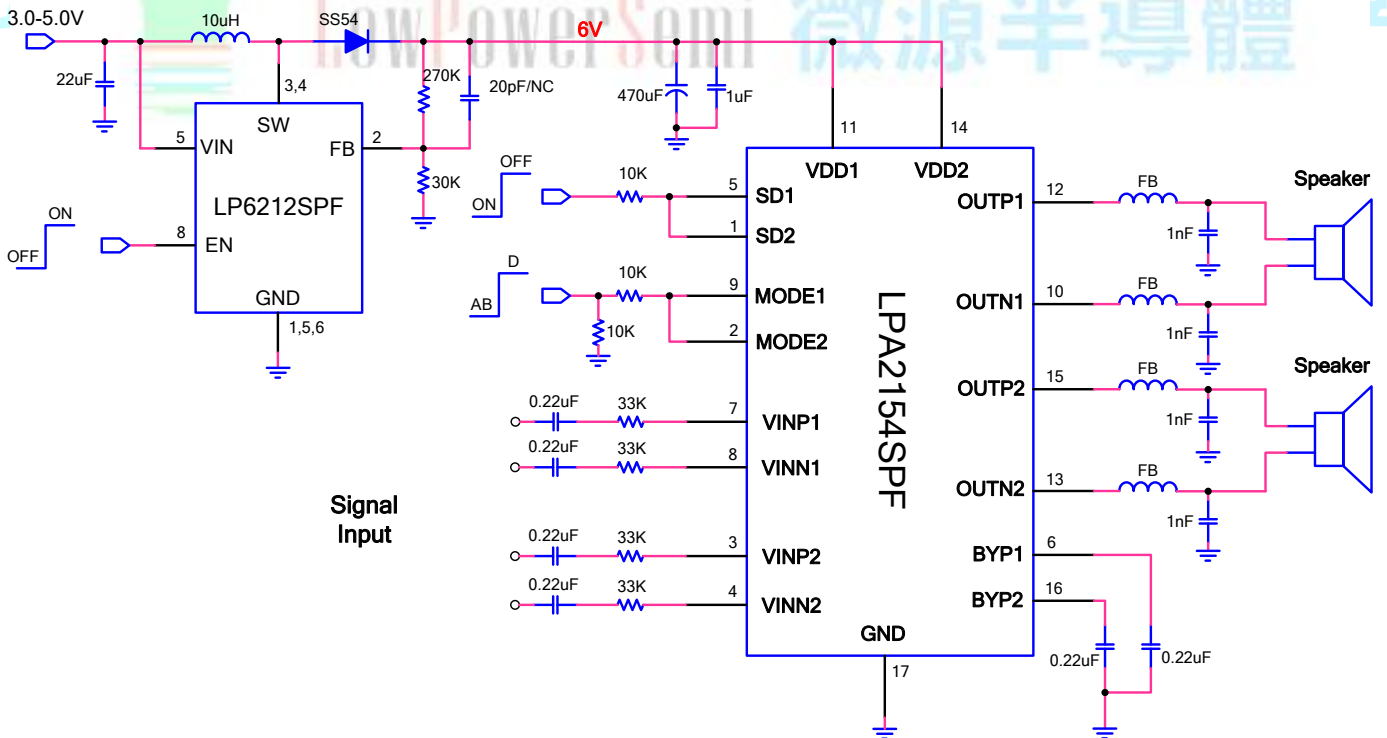
Top view



Bottom view



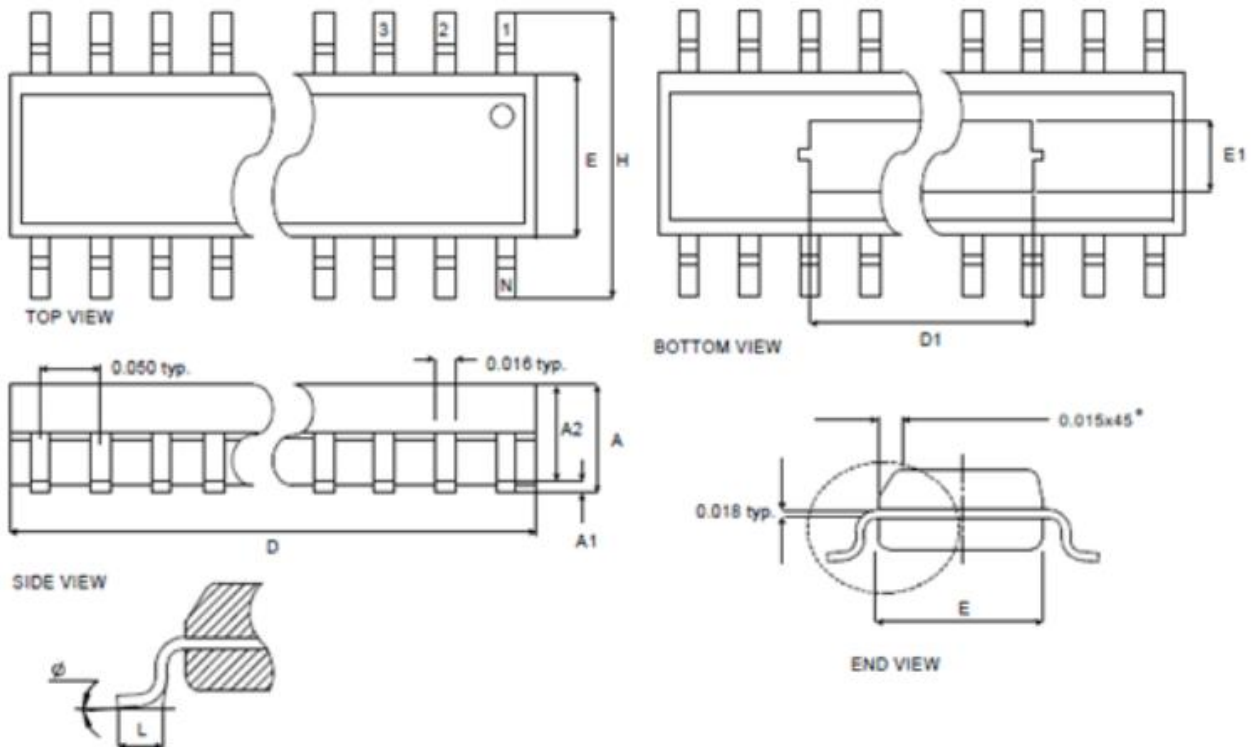
Recommend Application





Packaging Information

ESOP16



P1.1

| Dim | 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 | 9.80 | 10.0 | 0.386 | 0.394 |
| D1 | 4.115 REF | | 0.162 REF | |
| E | 3.81 | 3.99 | 0.150 | 0.157 |
| E1 | 2.184 REF | | 0.086 REF | |
| H | 5.79 | 6.20 | 0.228 | 0.244 |
| L | 0.41 | 1.27 | 0.016 | 0.050 |
| ϕ | 0° | 8° | 0° | 8° |