# IS31AP4915A

## 20$V_{P-P}$ CHARGE PUMP CERAMIC SPEAKER DRIVER

**July 2013**

### GENERAL DESCRIPTION

The IS31AP4915A features a mono power amplifier with an integrated charge-pump power supply specifically designed to drive the high capacitance of a ceramic loudspeaker.

The IS31AP4915A maximizes battery life by offering high performance efficiency.

The IS31AP4915A is ideally suited to deliver the high output-voltage swing required to drive ceramic/piezoelectric speakers.

The device utilizes comprehensive click-and-pop suppression and shutdown control. The IS31AP4915A is fully specified over the -40°C to +85°C extended temperature range and is available in small lead-free 16-pin QFN (4mm × 4mm) packages.

### FEATURES

- Integrated charge-pump power supply - no inductor required
- Thermal protection
- Pop reduction circuitry
- 20$V_{P-P}$ voltage swing into piezoelectric speaker
- QFN-16, 4mm × 4mm
- ESD (HBM): 2kV
  ESD (MM): 200V

### APPLICATIONS

- CD/MP3 players
- Smart phones
- Cellular phones
- PDAs
- Handheld gaming

### TYPICAL APPLICATION CIRCUIT

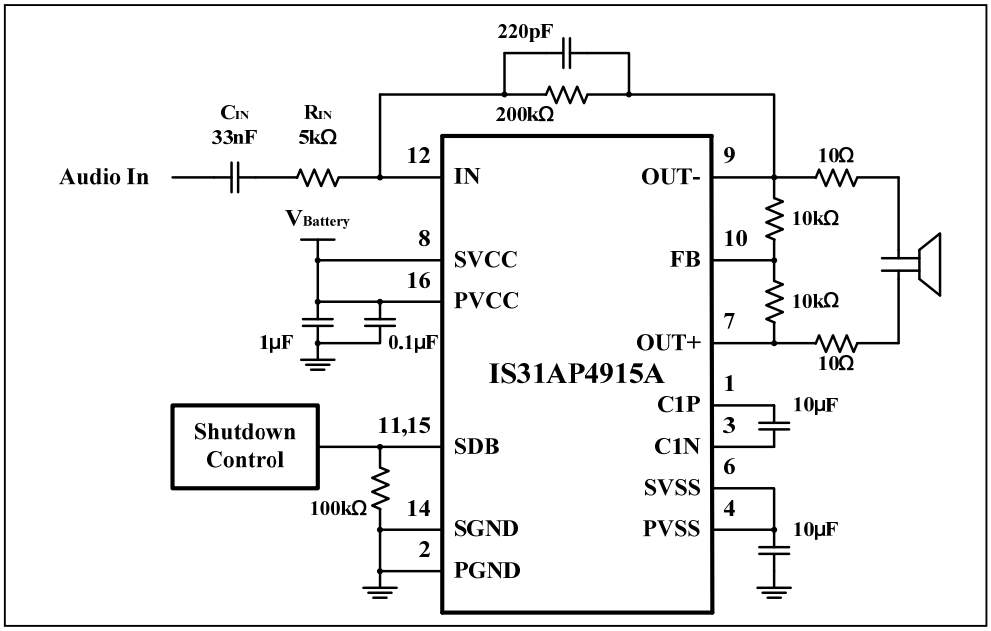
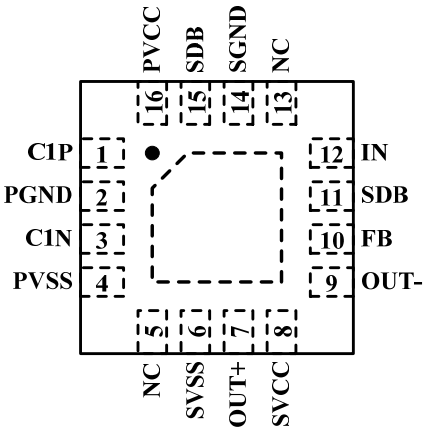



**Figure 1** Typical Application Circuit

## PIN CONFIGURATION

| Package | Pin Configuration (Top View) |
|---|---|
| QFN-16 |  |



## PIN DESCRIPTION

| No. | Pin | Description |
|---|---|---|
| 1 | C1P | Charge pump flying capacitor positive terminal. |
| 2 | PGND | Power ground, connect to ground. |
| 3 | C1N | Charge pump flying capacitor negative terminal. |
| 4 | PVSS | Output from charge pump. |
| 5, 13 | NC | No connection. |
| 6 | SVSS | Amplifier negative supply, connect to PVSS. |
| 7 | OUT+ | Positive output signal. |
| 8 | SVCC | Amplifier positive supply, connect to PVCC. |
| 9 | OUT- | Negative output signal. |
| 10 | FB | Feed back. |
| 11, 15 | SDB | Shutdown, active low logic. |
| 12 | IN | Audio input signal. |
| 14 | SGND | Signal ground, connect to ground. |
| 16 | PVCC | Charge pump supply voltage, connect to positive supply. |
| | Thermal Pad | Connect to GND. |

## ORDERING INFORMATION

**Industrial Range: -40°C to +85°C**

| Order Part No. | Package | QTY/Reel |
|---|---|---|
| IS31AP4915A-QFLS2-TR | QFN-16, Lead-free | 3000 |

## ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Supply voltage, $V_{CC}$ | −0.3V ~ +7.0V |
| Voltage at any input pin | −0.3V ~ $V_{CC}$+0.3V |
| Maximum junction temperature, $T_{JMAX}$ | 150°C |
| Storage temperature range, $T_{STG}$ | −65°C ~ +150°C |
| Operating temperature range, $T_A$ | −40°C ~ +85°C |

**Note:**
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

$T_A$=25°C, $V_{CC}$ = 2.5V ~ 5.5V (unless otherwise noted). *(Note 1)*

| Symbol | Parameter | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $SV_{CC}$, $PV_{CC}$ | Supply voltage | | 2.5 | | 5.5 | V |
| $V_{IH}$ | High level input voltage | | 1.5 | | | V |
| $V_{IL}$ | Low level input voltage | | | | 0.5 | V |
| $\|V_{OS}\|$ | Output offset voltage | | | 6 | | mV |
| $I_{CC}$ | Supply current | $V_{CC}$ = 3V, $V_{SDB}$ = $V_{CC}$ | | 6.0 | 8.0 | mA |
| | | $V_{CC}$ = 5V, $V_{SDB}$ = $V_{CC}$ | | 8.5 | 10.5 | |
| $I_{SD}$ | Shutdown current | $V_{SDB}$ = 0V | | | 1 | μA |

## ELECTRICAL CHARACTERISTICS

$V_{CC}$ = 3.6V, $T_A$ = 25°C (unless otherwise noted). *(Note 2)*

| Symbol | Parameter | Condition | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{OUT}$ | Output voltage | f = 1kHz<br>THD+N = 10%<br>$R_L$= 1μF+10Ω | $V_{CC}$ = 5.0V | | 7.8 | | $V_{RMS}$ |
| | | | $V_{CC}$ = 3.6V | | 5.6 | | |
| | | | $V_{CC}$ = 2.7V | | 4.3 | | |
| THD+N | Total harmonic distortion plus noise | $R_L$= 1μF+10Ω,$V_{OUT}$ = 1kHz/2$V_{RMS}$ | | | 0.004 | | % |
| | | $R_L$= 1μF+10Ω,$V_{OUT}$ = 1kHz/4$V_{RMS}$ | | | 0.014 | | |
| $V_{NO}$ | Noise output voltage | | | | 10 | | μ$V_{RMS}$ |
| $f_{OSC}$ | Charge pump switching frequency | | | | 320 | | kHz |
| $t_{ON}$ | Start-up time from shutdown | | | | 450 | | μs |
| SNR | Signal-to-noise ratio | | | | 100 | | dB |
| $T_{OVP}$ | Thermal shutdown threshold | | | | 160 | | °C |
| $T_{HY}$ | Thermal shutdown hysteresis | | | | 15 | | °C |

**Note 1:** Production testing of the device is performed at 25°C. Functional operation of the device and parameters specified over other temperature range, are guaranteed by design, characterization and process control.

**Note 2:** Guaranteed by design.

## TYPICAL OPERATING CHARACTERISTICS

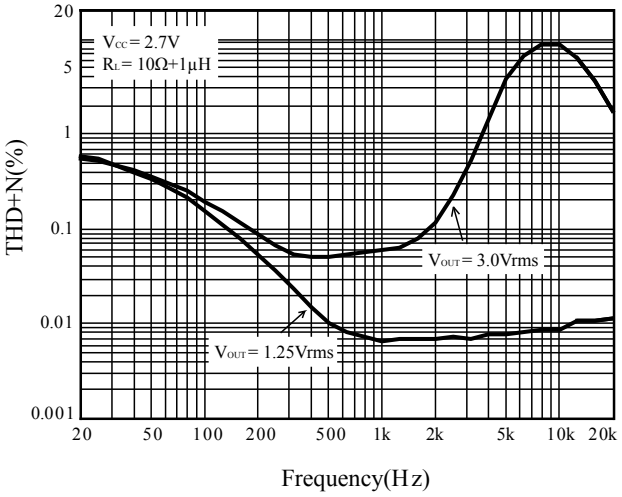



**Figure 2** THD+N vs. Frequency

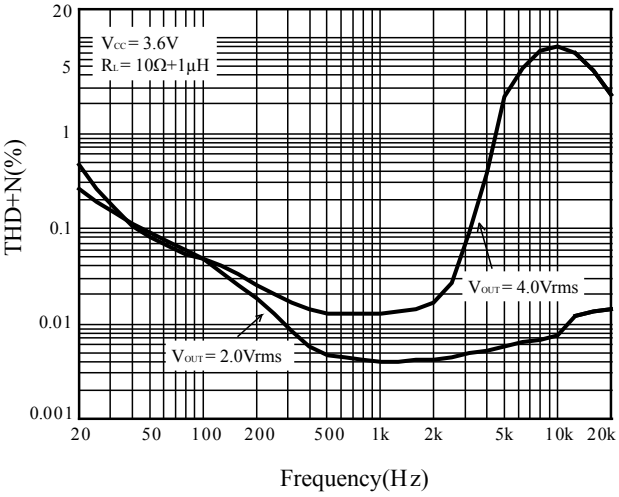



**Figure 3** THD+N vs. Frequency

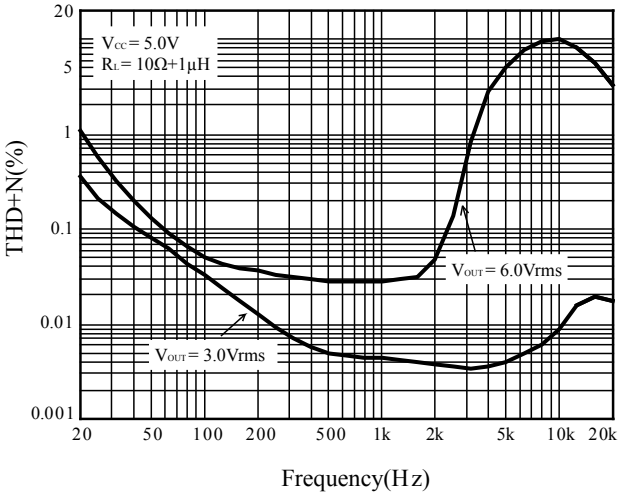



**Figure 4** THD+N vs. Frequency

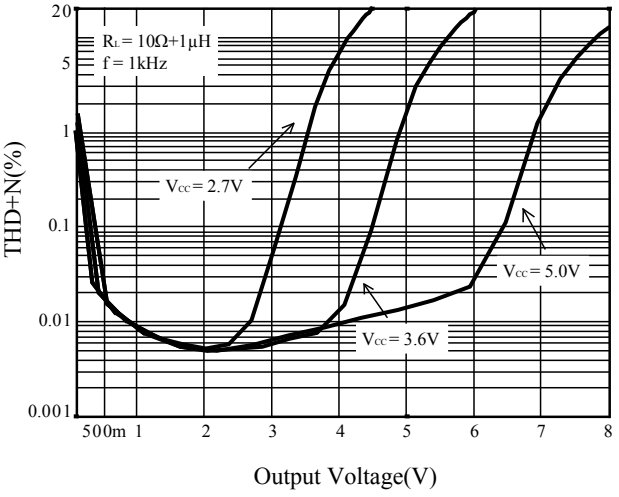



**Figure 5** THD+N vs. Output Voltage

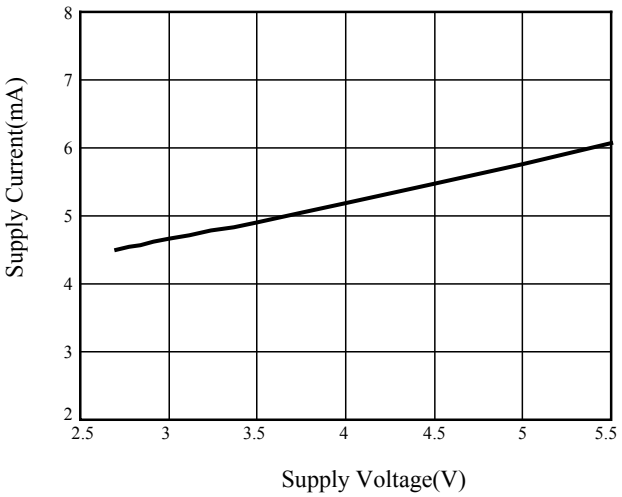



**Figure 6** Supply Current vs. Supply Voltage

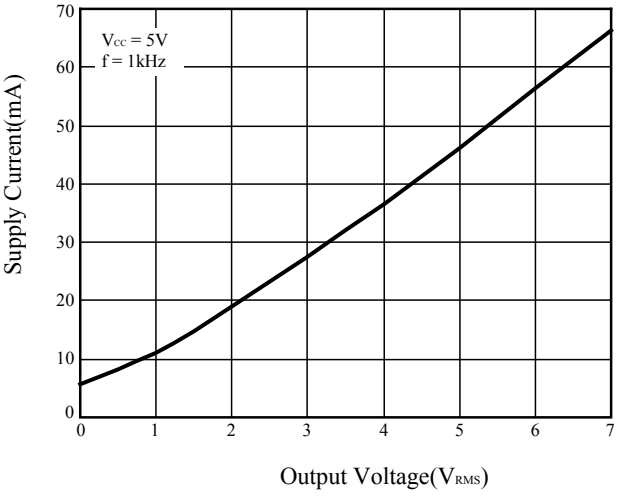
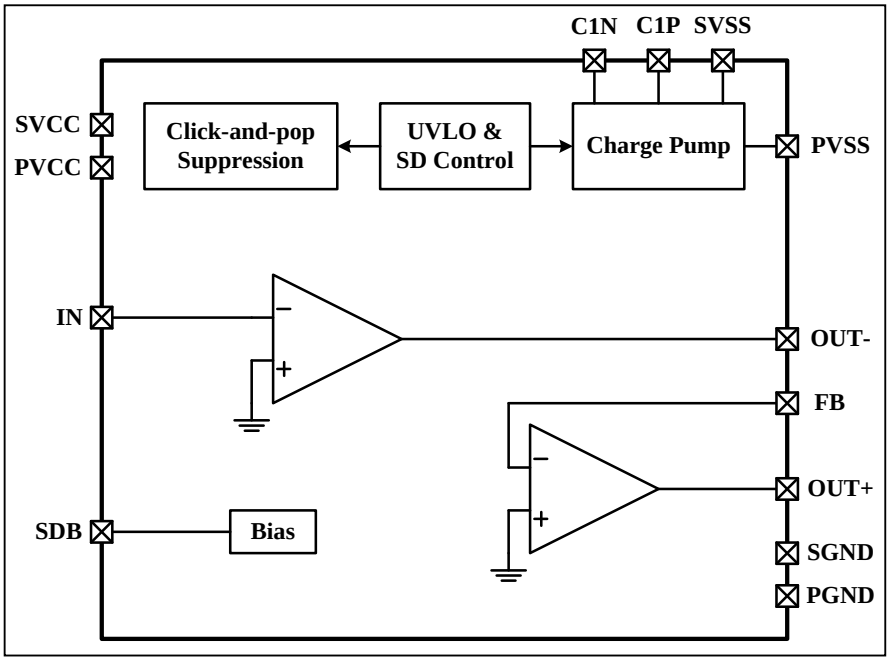



**Figure 7** Supply Current vs. Output Voltage

## FUNCTIONAL BLOCK DIAGRAM



## APPLICATION INFORMATION

### INPUT-BLOCKING CAPACITORS

DC input-blocking capacitors are required to be added in series with the audio signal into the input pin of the IS31AP4915A. This capacitor block the DC portion of the audio source and allow the IS31AP4915A inputs to be properly biased to provide maximum performance.

These capacitors form a high-pass filter with the input impedance of the IS31AP4915A. The cutoff frequency is calculated using Equation 1. For this calculation, the capacitance used is the input-blocking capacitor and the resistance is the input impedance of the IS31AP4915A. Because the gains of both the IS31AP4915A is fixed, the input impedance remains a constant value. Using the input impedance value from the operating characteristics table, the frequency and/or capacitance can be determined when one of the two values is given.

$$f_{CIN} = \frac{1}{2\pi R_{IN} C_{IN}} \quad (1)$$

or $C_{IN} = \frac{1}{2\pi f_{CIN} R_{IN}}$

### CHARGE PUMP FLYING CAPACITOR AND PVSS CAPACITOR

The charge pump flying capacitor serves to transfer charge during the generation of the negative supply voltage. The PVSS capacitor must be at least equal to the charge pump capacitor in order to allow maximum charge transfer. Low ESR capacitors are an ideal selection, and a value of 10μF is typical. Capacitor values that are smaller than 10μF can be used, but the maximum output power is reduced and the device may not operate to specifications

### DECOUPLING CAPACITORS

The IS31AP4915A require adequate power supply decoupling to ensure that the noise and total harmonic distortion (THD) are low. A good low equivalent-series-resistance (ESR) ceramic capacitor, typically 1μF, placed as close as possible to the device $V_{CC}$ lead works best. Placing this decoupling capacitor close to the IS31AP4915A is important for the performance of the amplifier. For filtering lower frequency noise signals, a 10μF 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.

### LAYOUT RECOMMENDATIONS

The SGND and PGND pins of the IS31AP4915A must be routed separately back to the decoupling capacitor in order to provide proper device operation. If the SGND and PGND pins are connected directly to each other, the part functions without risk of failure, but the noise and THD performance do not meet the specifications.

**CLASSIFICATION REFLOW PROFILES**

| Profile Feature | Pb-Free Assembly |
|---|---|
| **Preheat & Soak**<br>Temperature min (Tsmin)<br>Temperature max (Tsmax)<br>Time (Tsmin to Tsmax) (ts) | 150°C<br>200°C<br>60-120 seconds |
| Average ramp-up rate (Tsmax to Tp) | 3°C/second max. |
| Liquidous temperature (TL)<br>Time at liquidous (tL) | 217°C<br>60-150 seconds |
| Peak package body temperature (Tp)* | Max 260°C |
| Time (tp)** within 5°C of the specified classification temperature (Tc) | Max 30 seconds |
| Average ramp-down rate (Tp to Tsmax) | 6°C/second max. |
| Time 25°C to peak temperature | 8 minutes max. |

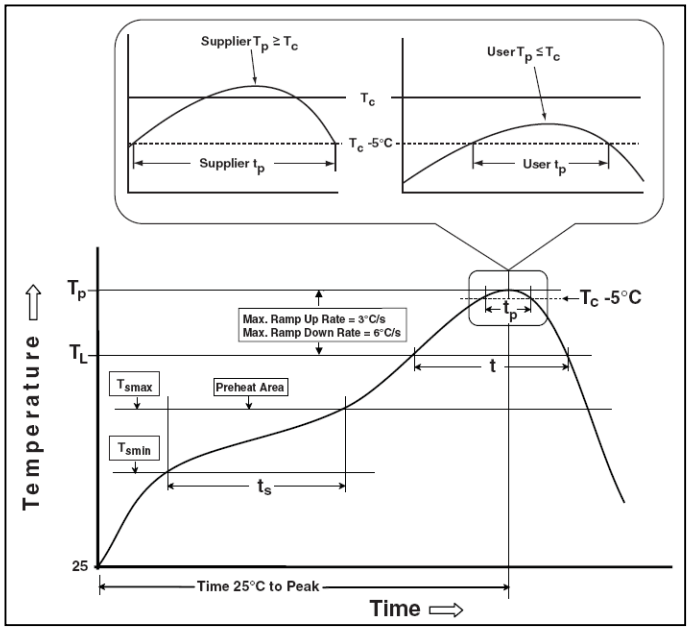
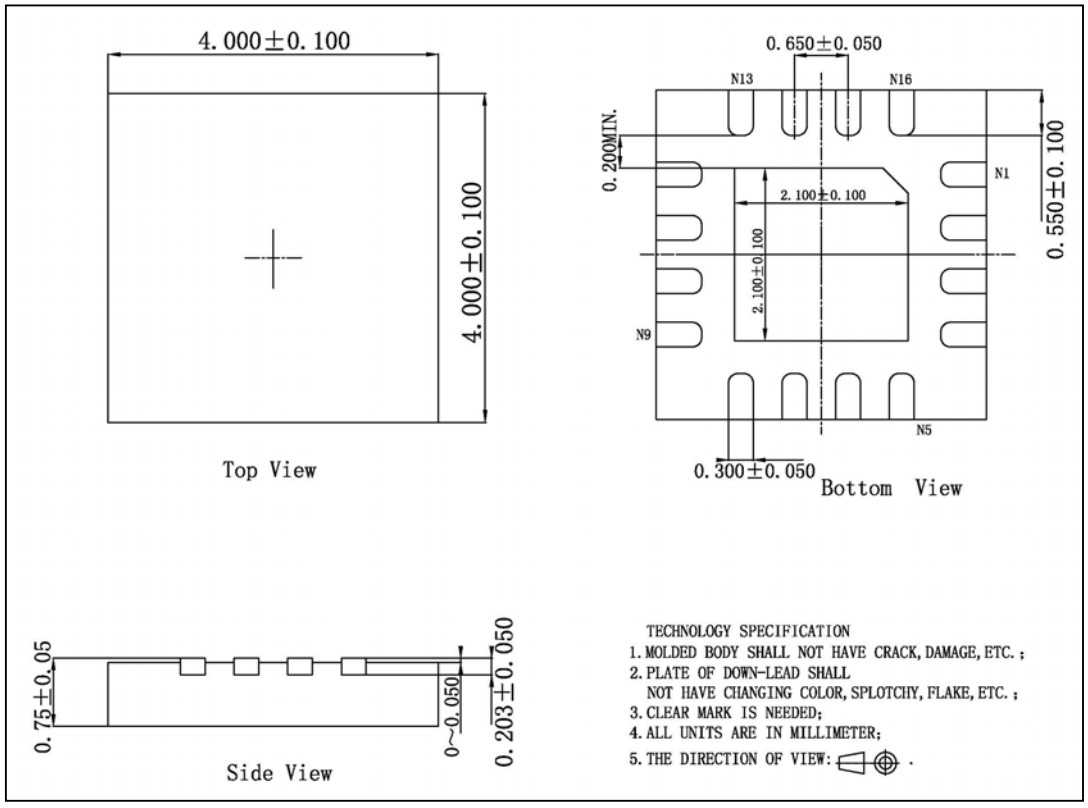



**Figure 8** Classification Profile

## PACKAGE INFORMATION

### QFN-16




**Note:** All dimensions in millimeters unless otherwise stated.