# 3W Anti-Clip Class-D Audio Power Amplifier

## Features

- Output Power
  - 3.0W ($V_{DD}$=5.0V, $R_L$ =4Ω, THD+N=10%)
  - 1.8W ($V_{DD}$=5.0V, $R_L$ =8Ω, THD+N=10%)
- Low THD+N and Low Noise
- High S/N Ratio to 95dB
- Low EMI
- Improved PSRR (−80dB) and Wide Supply Voltage (2.5 V to 5.0V) Eliminates Need for a Voltage Regulator
- Over-current and Thermal Protection function
- Pop noise reduction function
- Available in space-saving package: 9-Bump WLCSP

## Applications

- Mobile phone, PDA
- MP3/4, PMP, GPS
- Portable electronic devices

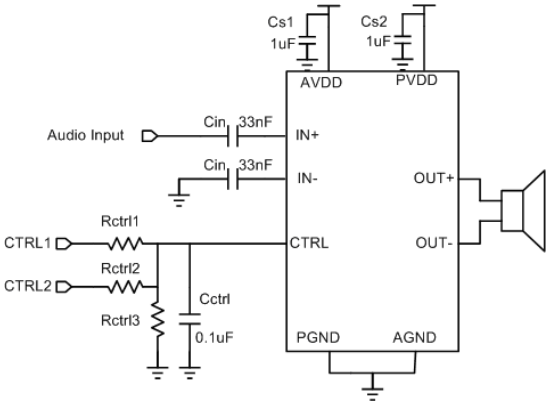
## General Description

BL6332 is a 3-W ($V_{DD}$=5.0V, $R_L$=4Ω) high efficiency filter-free class-D audio power amplifier in a wafer chip scale package (WLCSP).

BL6332 has a “Professional Anti-Clip output control circuit” which reducing distortion of output signal due to either the over level input signal or power supply voltage down with battery.

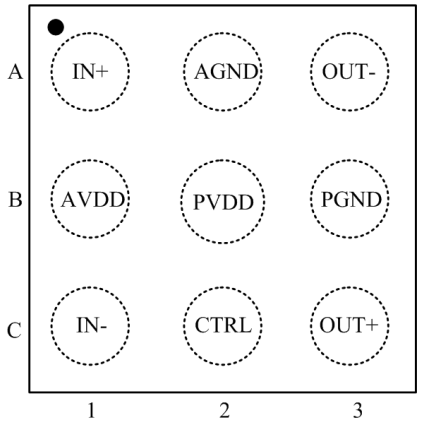
Features like high efficiency, −80dB PSRR, over-current protection and thermal protection function make the BL6332 ideal for cellular handsets.

## Typical Application Circuit




## Pin Description

## Pin Diagrams

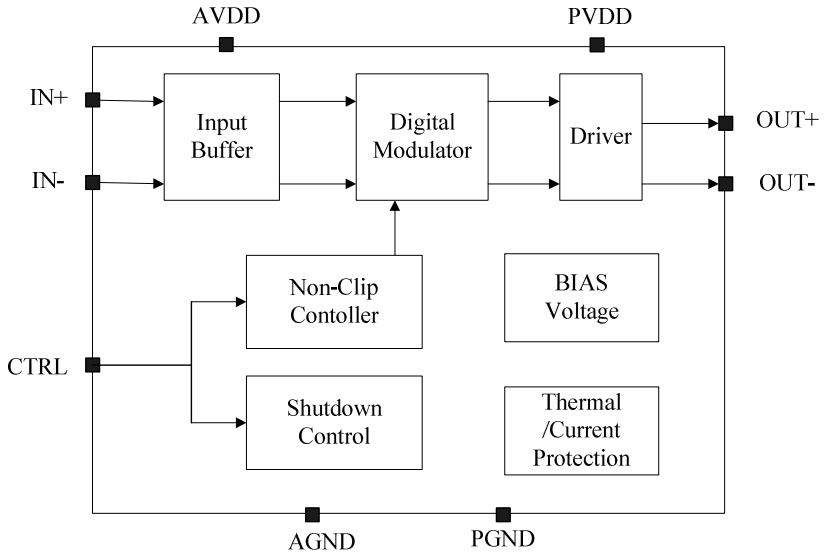



| PIN # | Name | Description |
|---|---|---|
| A1 | IN+ | Positive differential input |
| A2 | AGND | Analog GND |
| A3 | OUT- | Negative output terminal |
| B1 | AVDD | Analog Power Supply |
| B2 | PVDD | Power Supply |
| B3 | PGND | Power Ground |
| C1 | IN- | Negative input terminal |
| C2 | CTRL | Mode select |
| C3 | OUT+ | Positive output terminal |

## Order Information

| Part Number | Package | Shipping |
|---|---|---|
| BL6332 | 9-Bump WLCSP | 3000 pcs / Tape & Reel |

## Function Block Diagram




### Absolute Maximum Ratings (Over operating free-air temperature, unless otherwise noted)

| | | |
|---|---|---|
| $V_{DD}$ | Supply voltage | -0.3V to 5.5V |
| $V_I$ | Input voltage | -0.3V to $V_{DD}$+0.3V |
| $T_A$ | Operation free-air temperate range | -40℃ to 120℃ |
| $T_J$ | Operation free-air junction temperature | -40℃ to 1 50℃ |
| $T_{STG}$ | Storage temperature range | -65℃ to 150℃ |
| $T_{SLD}$ | Soldering temperature | 300℃, 5sec |

### Recommended Operating Conditions

| Symbol | Parameter | Conditions | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{DD}$ | Power Supply Voltage | | 2.5 | | 5.0 | V |
| $T_a$ | Operating Ambient Temperature | | -20 | | 85 | ℃ |
| $R_L$ | Speaker Impedance | | 4 | | | Ω |

### DC Characteristics ($V_{DD}$ =2.5V to 5 V, Ta =25℃, unless otherwise noted.)

| Symbol | Parameter | Test Conditions | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{UVLH}$ | Power Supply Start-up threshold voltage | | | 2.5 | | V |
| $V_{UVLL}$ | Power Supply shut-down threshold voltage | | | 1.8 | | V |
| $V_{MOD1}$ | Anti-Clip1 mode setting threshold voltage | | 1.3 | | $V_{DD}$ | V |
| $V_{MOD2}$ | Anti-Clip2 mode setting threshold voltage | | 0.85 | | 1.15 | V |
| $V_{MOD3}$ | Anti-Clip off mode setting threshold voltage | | 0.5 | | 0.72 | V |
| $V_{MOD4}$ | Power-down mode setting threshold voltage | | $V_{SS}$ | | 0.14 | V |
| $I_{DD}$ | Consumption current | VDD=3.6V, no load, no signal input | | 5 | | mA |
| $I_{PD}$ | Consumption current in power-down mode | CTRL<0.2V | | | 1 | μA |

## AC Characteristics ($V_{DD}$ =2.5V to 5V, Ta =25℃, unless otherwise noted.)

| Symbol | Parameter | Test Conditions | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{STUP}$ | Start-up time | VDD=5V | | 30 | | ms |
| $f_c$ | Input cut-off frequency | $C_{IN}$-33nF,Av=17.5dB | | 120 | | Hz |
| $t_{AT1}$ | Attack time 1 | $V_{DD}$=5V,g=10dB | | 45 | | ms |
| $T_{RL1}$ | Release time 1 | $V_{DD}$=5V,g=10dB | | 3.1 | | s |
| $t_{AT2}$ | Attack time 2 | $V_{DD}$=5V,g=10dB | | 10 | | ms |
| $T_{RL2}$ | Release time 2 | $V_{DD}$=5V,g=10dB | | 1.8 | | s |
| $t_{MOD}$ | Each mode setting time(Except power down) | | 0.1 | | | ms |

## Analog Characteristics

($V_{DD}$ =3.6V, Av=17.5dB,Ta =25℃, $C_{IN}$=100nF, Anti-Clip off, unless otherwise noted.)

| Symbol | Parameter | Test Conditions | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $P_o$ | Maximum output | $R_L$=4Ω,VDD=5V | f=1KHz, THD+N= 10% | | 3 | | W |
| | | $R_L$=8Ω,VDD=5V | | | 1.8 | | W |
| THD+N | Total Harmonic Distortion Rate | $R_L$=4Ω, $P_o$ =0.5W, f=1KHz | | | 0.09 | | % |
| | | $R_L$=8Ω, $P_o$ =0.5W, f=1KHz | | | 0.09 | | % |
| N | Residual Noise | Av=17.5dB A-Weighted | | | 60 | | $\mu V_{rms}$ |
| SNR | Signal/Noise Ratio | Av=17.5dB A-Weighted | | | 95 | | dB |
| PSRR | Power supply rejection ratio | 217Hz | | | -80 | | dB |
| η | Maximum Efficiency | $R_L$=8Ω, $P_o$ =0. 6W, | | | 85 | | % |
| | | $R_L$=8Ω, $P_o$ =0. 1W, | | | 80 | | % |
| Vo | Output offset voltage | | | | ±10 | | mV |
| $f_{RES}$ | Frequency characteristics | $C_{IN}$=0.1μF, f=100Hz to 20KHz | | -3 | | 1 | dB |
| Gv | Closed Loop Gain | VDD=5V Anti-Clip Off | | | 17.5 | | dB |

## Application Information

### Anti-Clip Control Function

This is the function to control the output in order to obtain a maximum output level without distortion when an excess input which causes clipping at the differential signal output is applied. That is, with the Anti-Clip function, BL6332 lowers the Gain of the amplifier to an appropriate value so as not to cause the clipping at the differential signal output. And, BL6332 follows also to the clip of the output wave form due to the decrease in the power-supply voltage.

The Attack time and the release time of Anti-Clip control are fixation two levels, and selects with the CTRL terminal.

The Attack time is a time interval until from gain falls to target attenuation gain -3dB with a big signal input enough. And the Release time is a time from target attenuation gain to not working of Anti-Clip.

Attack time and Release time

| Anti-Clip mode | Attack time | Release time |
|---|---|---|
| 1(Recommendation) | 45ms | 3.1s |
| 2 | 10ms | 1.8s |

### Over-current Protection function

This is the function to establish the over-current protection mode when detecting a short circuit between BL6332 differential output terminal and VSS, VDD, or another differential output. In the over current protection mode, the

differential output terminal becomes a high impedance state. Once the short is removed, the device will be reactivated..

**Thermal Protection function**

Thermal protection on the BL6332 prevents damage to the device when the internal die temperature exceeds 150℃. There is a ±20℃ tolerance on this trip point from device to device. Once the die temperature exceeds the thermal set point, the outputs are disabled. This is not a latched fault. The thermal fault is cleared once the temperature of the die is reduced by 20℃. The device begins normal operation at this point with no external system intervention.

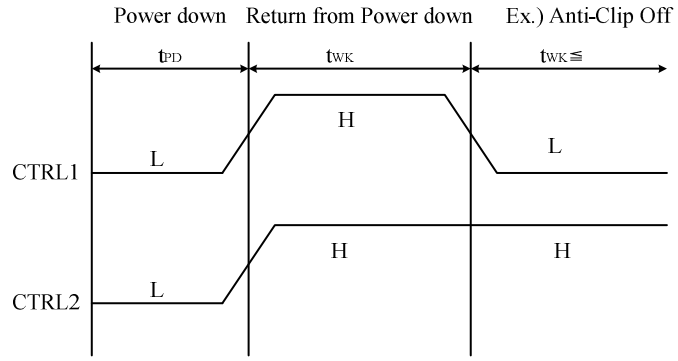
**Under Voltage Lock-out (UVLO)**

The BL6332 incorporates circuitry designed to detect low supply voltage. When the supply voltage drops to 1.8V or below, the BL6332 outputs are disabled, and the device comes out of this state and starts to normal function when $V_{DD}$ ≧2.5V.

**Power down and Initialization function**

When CTRL terminal is connected to the GND potential, the IC goes to the power-down mode. In the mode, all the circuit functions stop and its current consumption becomes the lowest.

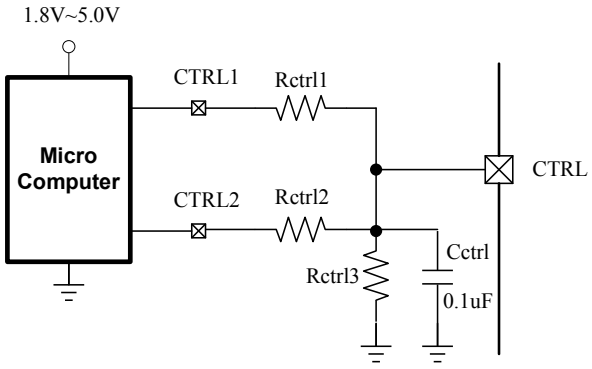
when CTRL terminal is set to H level, the power-down mode is canceled and the IC starts up after startup time ($t_{STUP}$). In order to return from the power-down mode a desired mode needs to be set after setting both CTRL1 and CTRL2 to H level during $t_{WK}$. In addition, at startup, cancel the power-down mode after supply voltages has been sufficiently stabilized.




**CTRL terminal function**

By connection external resistors (Rctrl1, Rctrl2, and Rctrl3: Accuracy of 1%) to CTRL terminal, and impression setting threshold voltage of each mode to CTRL terminal, the followings can be set: Anti-Clip1, Anti-Clip2, Anti-Clip OFF, and power-down mode. When turning on the supply voltage or cancelling the power-down mode, control the CTRL terminal according to the procedure for cancelling power-down.

Connect the terminal to the ground through a capacitor Cctrl (a ceramic capacitor of 0.1μF or more)




| CTRL1 | CTRL2 | Function |
|---|---|---|
| H | H | Anti-Clip 1 mode |
| H | GND | Anti-Clip 2 mode |
| GND | H | Anti-Clip off mode |
| GND | GND | Power-down mode |

"H" level indicates a microcomputer's I/O port H level output voltage that is input to CTRL1 and CTRL2 terminals and GND indicates GND of the microcomputer.

GND level of the microcomputer must be the same as that of BL6332.

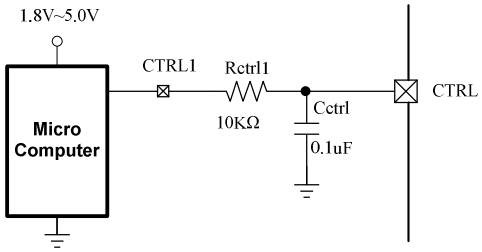
The control of CTRL terminal is based on I/O port H level output voltage of microcomputer that is connected.

Set resistance constants according the I/O port H level output voltage of each microcomputer as shown below.

| I/O port H level output voltage of Microcomputer | 1.8V | 2.6V | 3.0V | 3.3V | 5.0V |
|---|---|---|---|---|---|
| Rctrl1 | 27KΩ | 33KΩ | 33KΩ | 33KΩ | 56KΩ |
| Rctrl2 | 43KΩ | 51KΩ | 51KΩ | 51KΩ | 82KΩ |
| Rctrl3 | 82KΩ | 27KΩ | 22KΩ | 18KΩ | 15KΩ |

Functions of CTRL pin are designed with their control by two control pins (CTRL1 and CTRL2)

Only a Switching control between Anti-Clip1 mode and Power-down is available when a single control terminal used. A setting voltage should be set according to VMOD1 and VMOD4, and use a RC filter with time constant of 1msec or more in order to eliminate noise at transmission side such as Micon etc. (Example. Rctrl1=10KΩ and Cctrl=0.1μF).



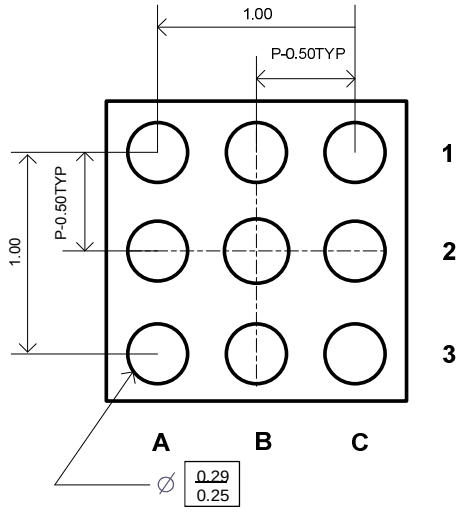

| CTRL1 | Function |
|---|---|
| H | Anti-Clip 1 mode |
| GND | Power-down mode |

**POP and Click Circuitry**

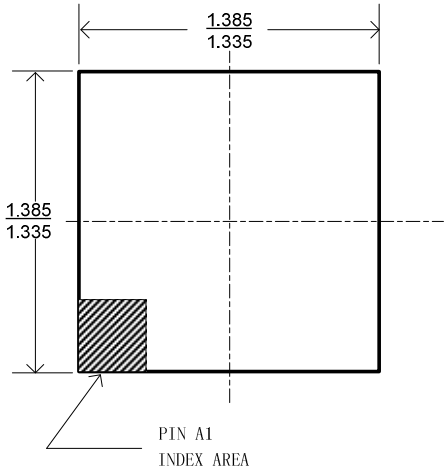
The BL6332 contains circuitry to minimize click and pops. For the best power-off pop performance, the amplifier should be set in shutdown mode prior to removing the power supply voltage.

## Package Information

Unit: Millimeter




Top View




Top View

