DESCRIPTION

A2331 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).

A2331 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 A2331 ideal for cellular handsets.

The A2331 is available in CSP9 package.

ORDERING INFORMATION

Package Type	Part Number	
CSP9	G9	A2331G9R
		A2331G9VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products Suffix “ V “ means Halogen free Package		

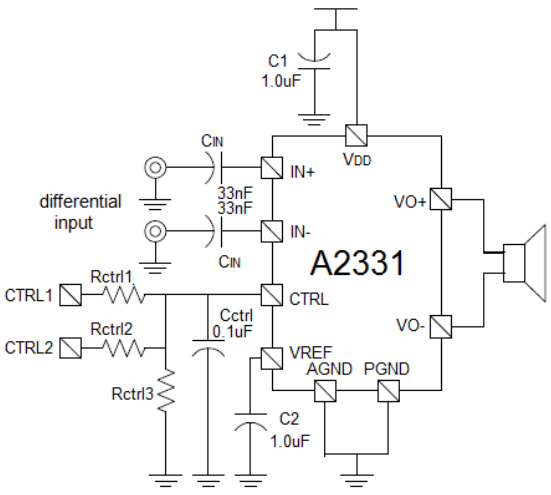
FEATURES

- 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%)
- Four mode can be selected with CTRL terminal: Anti-Clip 1, Anti-Clip 2, Anti-Clip off, Power-Down
- Low THD+N and Low Noise
- 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 CSP9 package

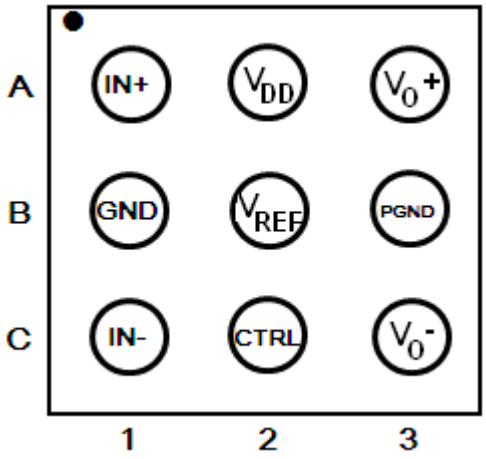
APPLICATION

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

TYPICAL APPLICATION



PIN DESCIPTION



TOP VIEW

Pin #	Symbol	Functions
A1	IN+	Positive differential input
A2	V_{DD}	Power Supply
A3	V_O+	Positive BTL output
B1	AGND	Analog Ground
B2	V_{REF}	Bypass capacitor connected
B3	PGND	Power Ground
C1	IN-	Negative differential input
C2	CTRL	Mode select
C3	V_O-	Negative BTL output

ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature, unless otherwise noted

V_{DD}, Supply Voltage	-0.3V~5.5V
V_I, Input Voltage	-0.3V~V_{DD}+0.3V
T_A, Operation Free-air Temperate Range	-40°C~120°C
T_J, Operation Free-air Junction Temperature	-40°C~150°C
T_{STG}, Storage Temperature Range	-65°C~150°C
T_{SLD}, Soldering Temperature	300°C, 5sec

Stresses above may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated in the Electrical Characteristics are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

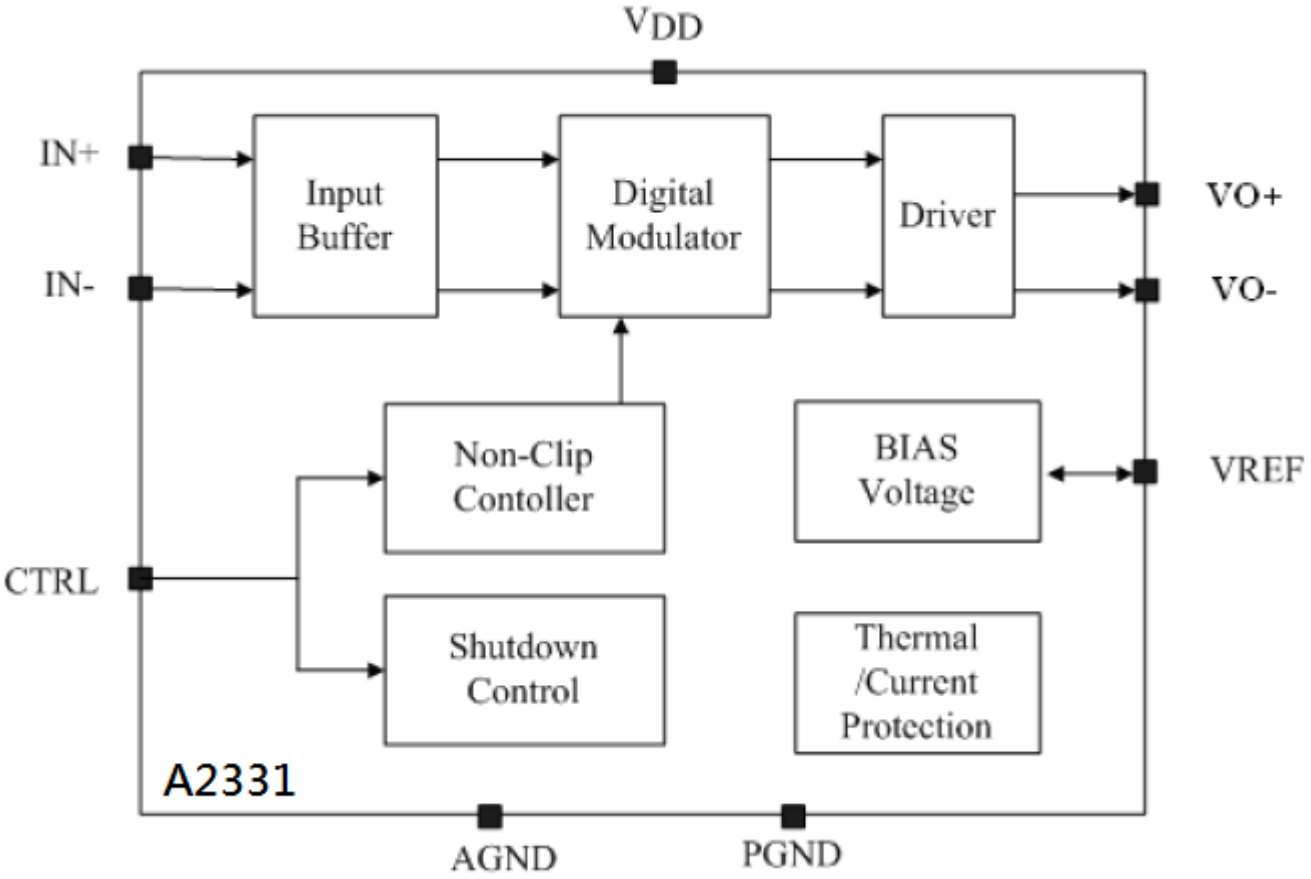
Parameter	Symbol	Min	Typ.	Max	Unit
Power Supply Voltage	V_{DD}	2.5	-	5.0	V
Operating Ambient Temperature	T_A	-20	-	85	℃
Speaker Impedance	R_L	4	-	-	Ω

ELECTRICAL CHARACTERISTICS

V_{DD} =2.5V to 5V, T_A =25°C, unless otherwise noted.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
DC Characteristics						
Power Supply Start-up threshold voltage	V_{UVLH}			2.5		V
Power Supply shut-down threshold voltage	V_{UVLL}			1.8		V
Anti-Clip1 mode setting threshold voltage	V_{MOD1}		1.3		V_{DD}	V
Anti-Clip2 mode setting threshold voltage	V_{MOD2}		0.85		1.15	V
Anti-Clip off mode setting threshold voltage	V_{MOD3}		0.5		0.72	V
Power-down mode setting threshold voltage	V_{MOD4}		V_{SS}		0.14	V
Consumption current	I_{DD}	V_{DD}=3.6V, no load, no signal input		5		mA
Consumption current in power-down mode	I_{PD}	CTRL<0.2V			1	μA
V_{REF} voltage	V_{REF}			V_{DD}/2		V
AC Characteristics						
Start-up time	t_{STUP}	V_{DD}=5V,Vr=1uF		38		ms
Input cut-off frequency	f_c	C_{IN}-33nF,Av=17.5dB		120		Hz
Attack time 1	t_{AT1}	V_{DD}=5V,g=10dB		45		ms
Release time 1	T_{RL1}	V_{DD}=5V,g=10dB		3.1		s
Attack time 2	t_{AT2}	V_{DD}=5V,g=10dB		10		ms
Release time 2	T_{RL2}	V_{DD}=5V,g=10dB		1.8		s
Each mode setting time(Except power down)	t_{MOD}		0.1			ms
ANALOG CHARACTERISTICS V_{DD} =3.6V, A_V=17.5dB,T_A =25°C, C_{IN}=100nF, Anti-Clip off, unless otherwise noted.						
Maximum output	P_O	R_L=4Ω,V_{DD}=5V f=1KHz,		3		W
		R_L=8Ω,V_{DD}=5V THD+N= 10%		1.8		W
Total Harmonic Distortion Rate	THD+N	R_L=4Ω, P_O =0.65W, f=1KHz		0.08		%
		R_L=8Ω, P_O =0.65W, f=1KHz		0.06		%
Residual Noise	N	Av=17.5dB A-Weighted		60		μVrms
Signal/Noise Ratio	SNR	Av=17.5dB A-Weighted		95		dB
Power supply rejection ratio	PSRR	217Hz		-80		dB
Maximum Efficiency	η	R_L=8Ω, P_O =0. 6W		85		%
		R_L=8Ω, P_O =0. 1W,		80		%
Output offset voltage	Vo			±10		mV
Frequency characteristics	f_{RES}	C_{IN}=0.1μF, f=100Hz to 20KHz	-3		1	dB
Closed Loop Gain	Gv	V_{DD}=5V Anti-Clip Off		17.5		dB

BLOCK DIAGRAM



DESCRIPTION

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, A2331 lowers the Gain of the amplifier to an appropriate value so as not to cause the clipping at the differential signal output. And, A2331 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 A2331 differential output terminal and V_{SS}, V_{DD}, 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 A2331 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 A2331 incorporates circuitry designed to detect low supply voltage. When the supply voltage drops to 1.8V or below, the A2331 outputs are disabled, and the device comes out of this state and starts to normal function when $V_{DD} \geqq 2.5V$.

VREF terminal output

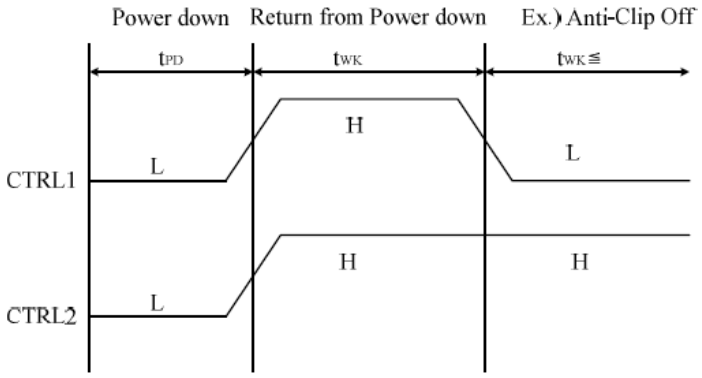
The voltage of $V_{DD}/2$ is output from the V_{REF} terminal. Capacitor (1uF) is connected between the V_{REF} terminal and GND for stabilization.

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}).

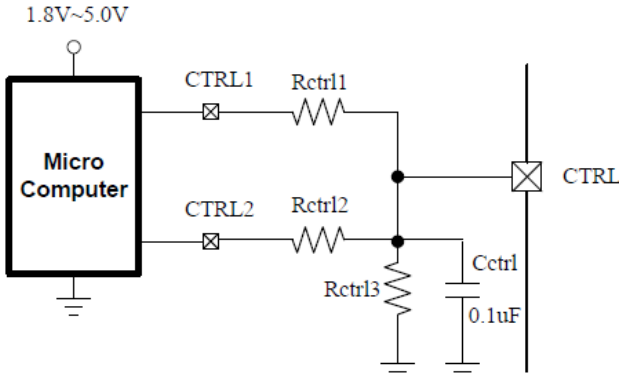
In order to return from the power-down mode a desired mode needs to be set after setting both CTRL1 and CTRL2 to H level during t_{WK}. In addition, at startup, cancel the power-down mode after supply voltages has been sufficiently stabilized.



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 A2331.

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

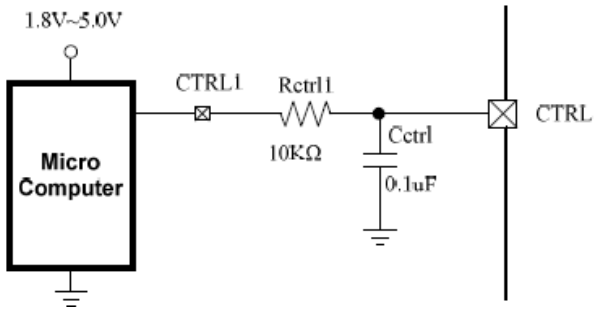
Set resistance constants according the I/O port H level output voltage of each microcomputer as shown below.

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 V_{MOD1} and V_{MOD4}, 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).



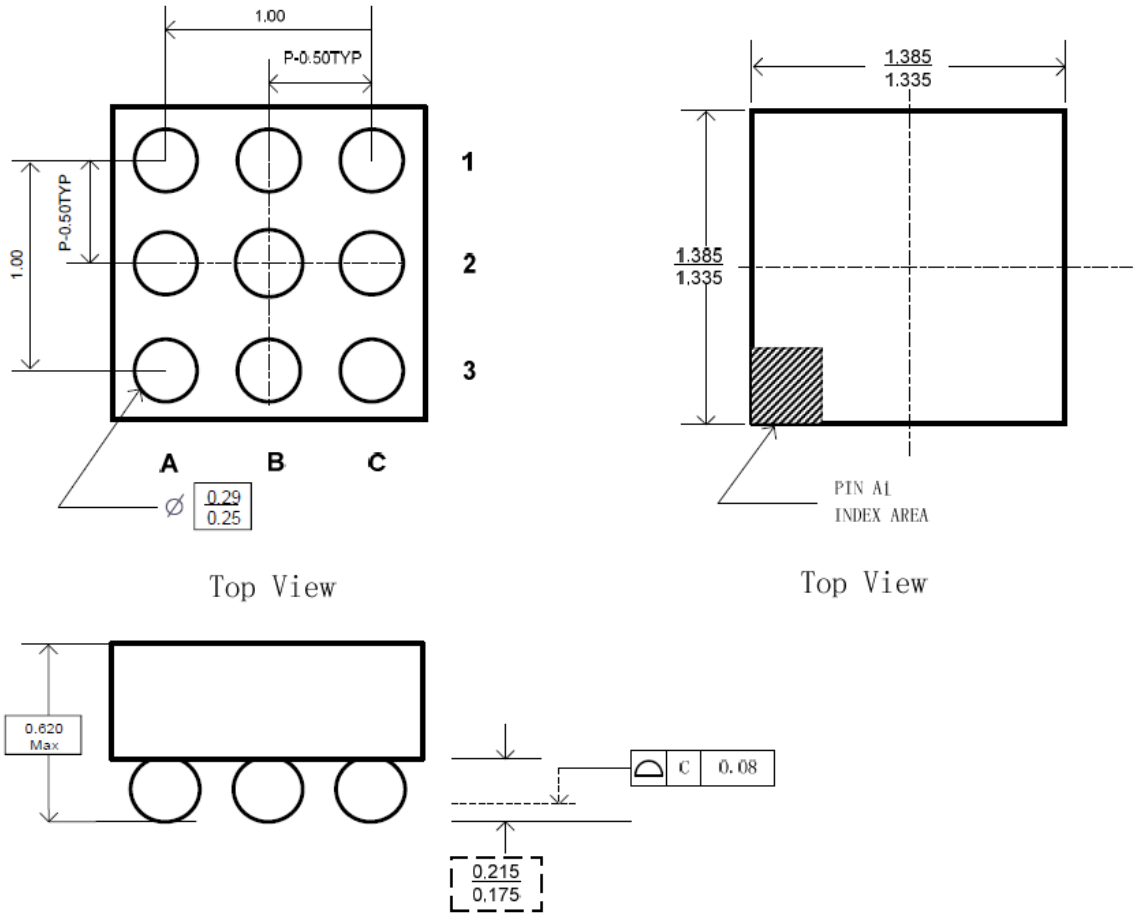
CTRL1	Function
H	Anti-Clip 1 mode
GND	Power-down mode

POP and Click Circuitry

The A2331 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

Dimension in CSP9 (Unit: mm)



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