

Ultra-Low-EMI, RNS, Mono, Filter-Free, Class-D Audio Amplifier

Features

- **EEE Function, Greatly reduces EMI over the full bandwidth**
- **Excellent Pop-Click Suppression**
- **RNS (RF-TDD Noise Suppression)**
- 0.1%THD+N (Pout=0.4W, VDD=4.2V)
- Filter-Free Class-D Architecture
- Up to 90% Efficiency
- High PSRR (70dB at 217Hz)
- Low Quiescent Current (2.6mA)
- Low Shutdown Current (<0.1μA)
- Power Supply Range: 2.5V~5.5V
- Over-Current Protection
- Over-Temperature Protection
- Small 1.5mm×1.5mm FC-9 Package
- RoHS compliant, lead-free packages

Applications

- Cellular Phones
- MP3/PMP
- GPS
- Digital Photo Frame

General Description

The AW8010A is a ultra-low-EMI,RNS, mono, filter-free, Class-D audio amplifier. Unique RNS, which effectively reduces RF energy, attenuate the RF TDD-noise, an acceptable audible level to the customer.

The AW8010A features the EEE (Enhanced Emission Elimination) function which greatly reduces EMI over the full bandwidth. The AW8010A achieves better than 20dB margin under FCC limits with 24 inch of cable.

The filter-free PWM architecture and internal gain setting reduces external components count, board area consumption, system cost and simplifies the design. In addition, The AW8010 offers efficiencies above 90%. The over-current, over-temperature and undervoltage protection is prepared inside of the device.

The AW8010A is available in an ultra small 1.5mm×1.5mm FC-9 package. The AW8010A is specified over the industrial temperature range of -40°C to +85°C.

Pin Configuration and Top Mark

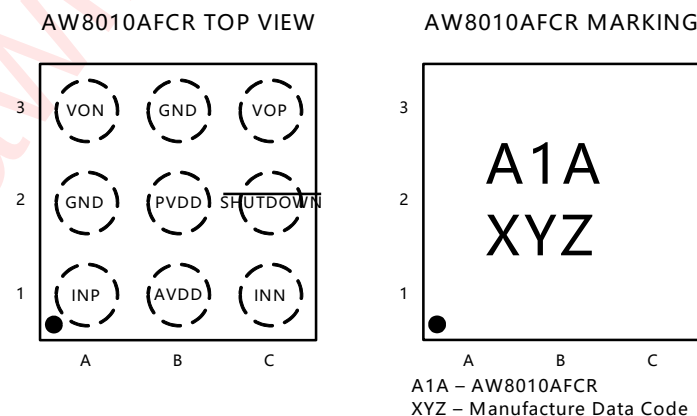


Figure 1 Pin Configuration and Top Mark of AW8010A

Pin Definition

No.	Symbol	Description
A1	INP	Positive audio input
A2	GND	Ground
A3	VON	Negative audio output
B1	AVDD	Power Supply
B2	PVDD	Power Supply
B3	GND	Ground
C1	INN	Negative audio input
C2	$\overline{\text{SHUTDOWN}}$	Shutdown pin
C3	VOP	Positive audio output

Typical Application

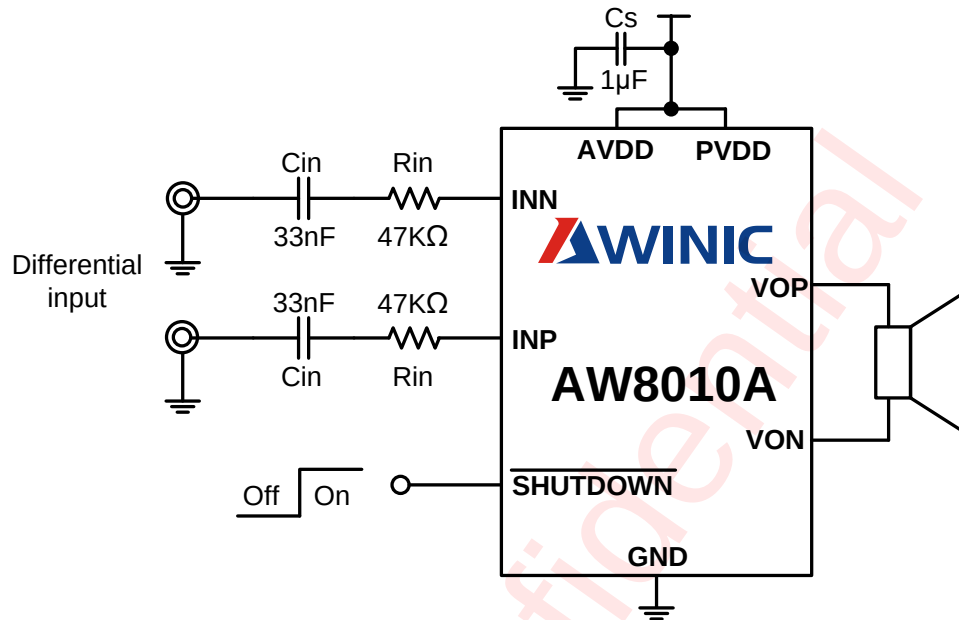


Figure 2 AW8010A Application Schematic With Differential Input

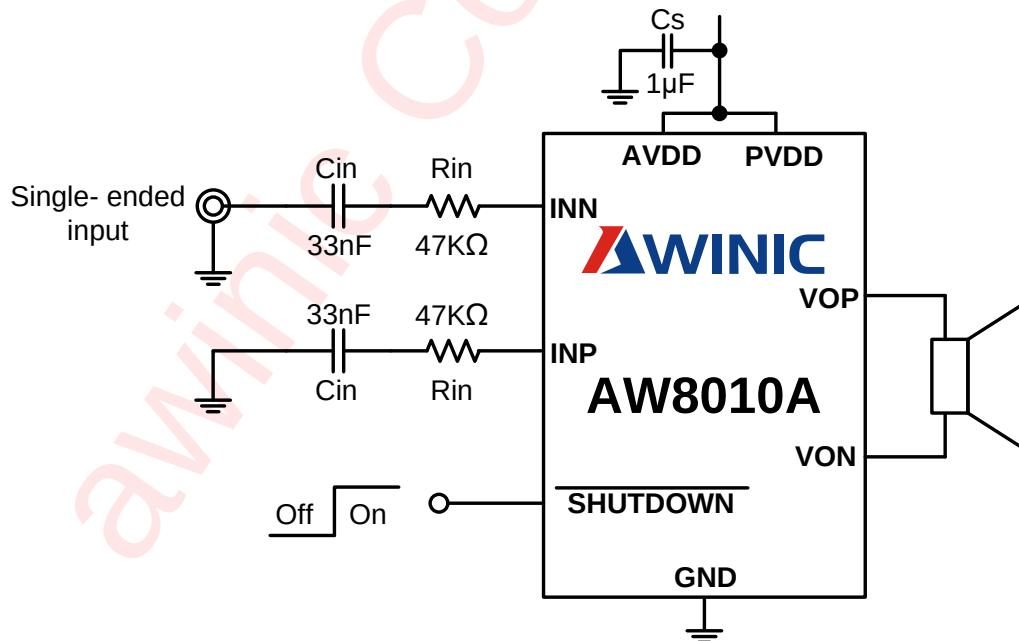
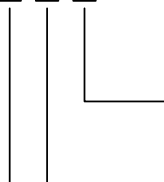


Figure 3 AW8010A Application Schematic With Single-Ended Input

Ordering Information

Part Number	Temperature	Package	Marking	Packing Type
AW8010AFCR	-40℃~85℃	FC-9	A1A	3000 units/Tape and Reel

AW8010A □ □ □



Shipping
R: Tape & Reel

Package Type
FC: FC-9

Absolute Maximum Ratings(1)

Parameter	Unit
Supply voltage V_{DD}	-0.3V to 6V
Input Voltage	-0.3V to $V_{DD}+0.3V$
Package Thermal Resistance θ_{JA}	90℃/W
Operating free-air temperature	-40℃ to 85℃
Maximum Junction Temperature T_{JMAX}	125℃
Storage Temperature Range T_{STG}	-65℃ to 150℃
Lead Temperature (Soldering 10 Seconds)	260℃
ESD Rating(2)	
HBM(human body model)	±6KV
Latch-up	
Test Condition :JEDEC STANDARD NO.78C SEPTEMBER 2010	+IT:450mA -IT:-450mA

note1: 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 conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure

to absolute-maximum-rated conditions for extended periods may affect device reliability.

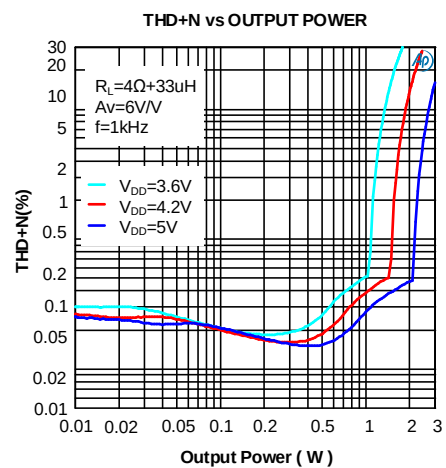
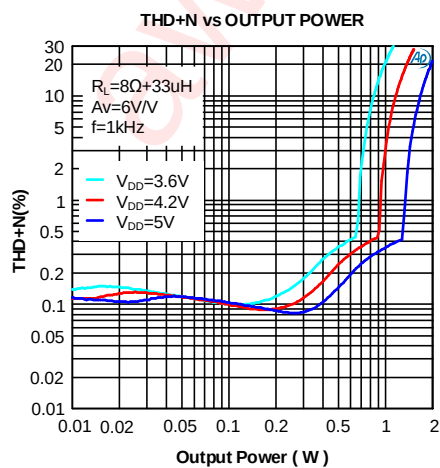
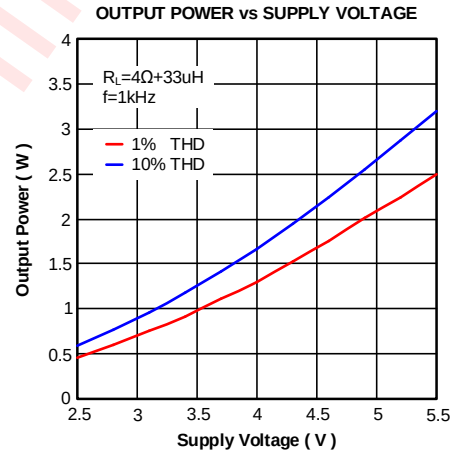
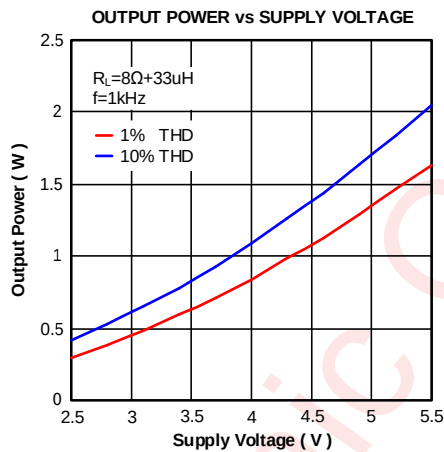
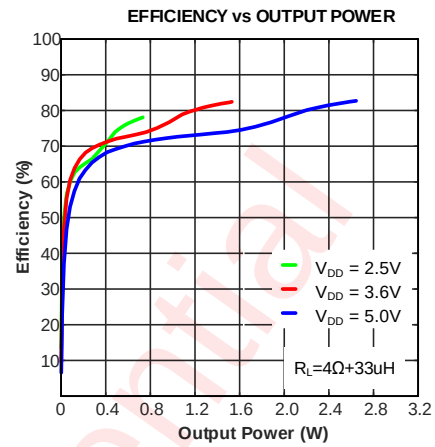
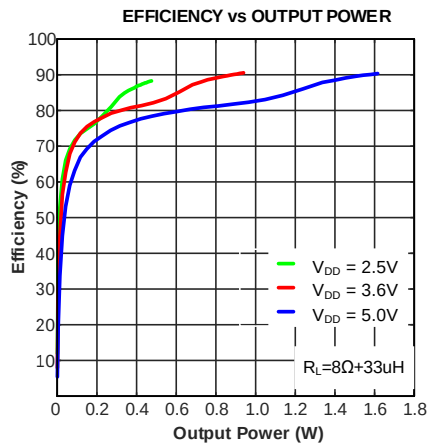
note2: The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: MIL-STD-883H Method 3015.8.

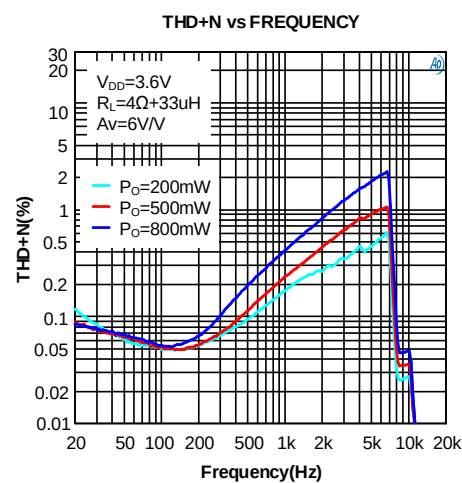
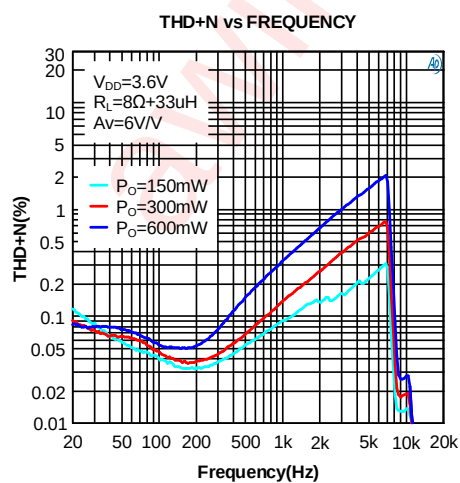
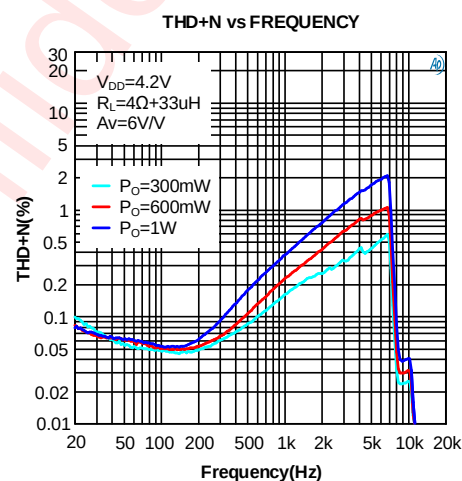
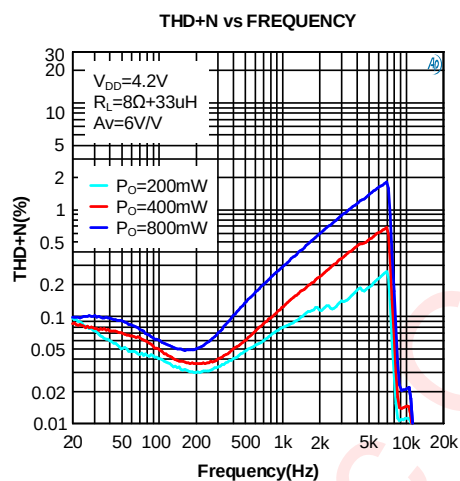
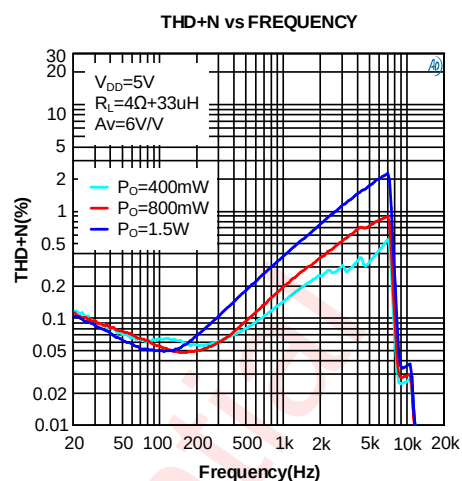
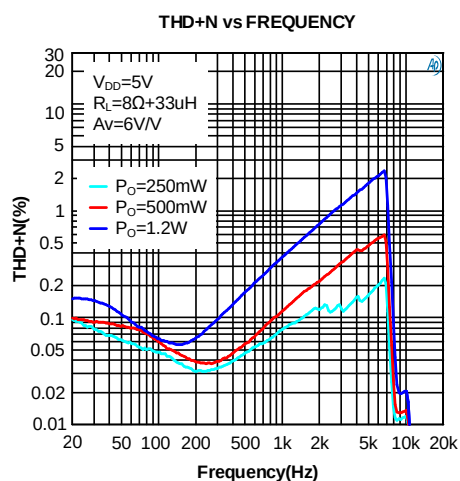
Electrical Characteristics

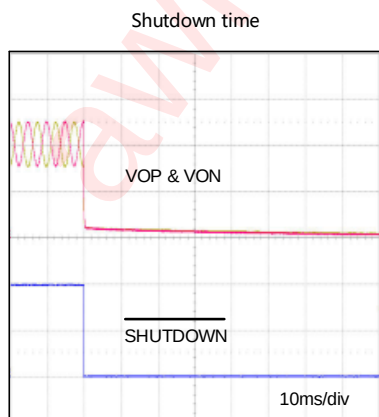
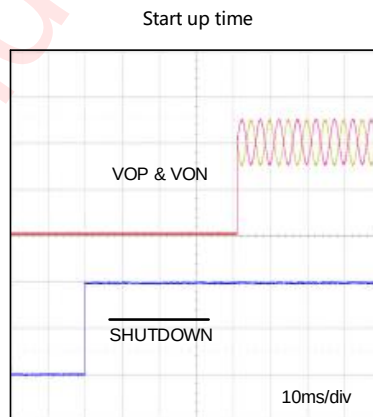
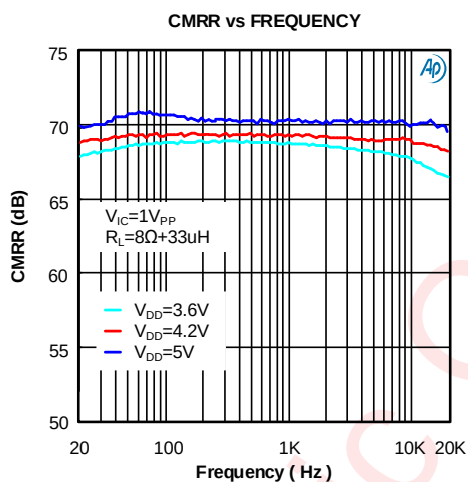
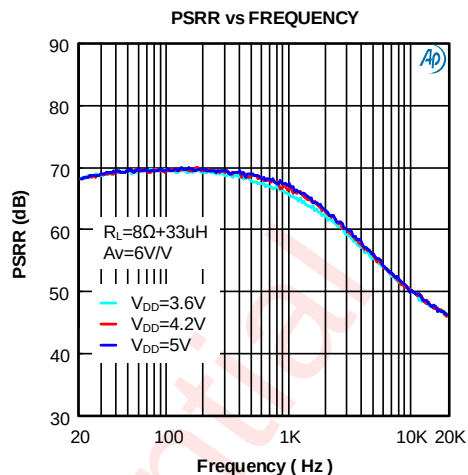
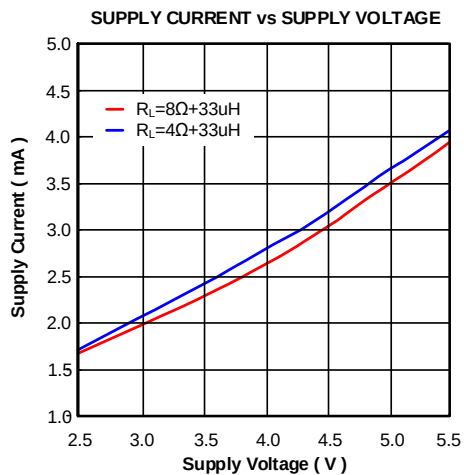
Test Condition: $V_{DD}=3.6V$, $T_A=25^{\circ}C$, $R_L=8\Omega+33\mu H$, $C_{in}=33nF$, $f=1kHz$ (Unless otherwise specified)

Parameter	Conditions	Min	Typ	Max	Units
Electrical Characteristics					
VDD Power voltage		2.5		5.5	V
V _{IH} High-level input voltage		1.3			V
V _{IL} Low-level input voltage				0.35	V
V _{OS} Output offset voltage	$V_{IN}=0V, A_V=2V/V, V_{DD}=2.5V$ to 5.5V		5	25	mV
I _Q Quiescent current	$V_{DD}=3.6V$		2.6		mA
I _{SD} Shutdown current	$V_{DD}=3.6V, \overline{SHUTDOWN}=0V$		0.1		μA
PSRR Power supply rejection ratio	217Hz		70		dB
CMRR Common mode rejection ratio			70		dB
f _{SW} Switching frequency	$V_{DD}=2.5V$ to 5.5V		800		kHz
A _V Gain			$\frac{315k\Omega}{R_{in}}$		V/V
Operating Characteristics					
P _O Output power (NCNOFF mode)	THD+N=10%, $R_L=4\Omega+33\mu H$, $V_{DD}=5V$		2.65		W
	THD+N=1%, $R_L=4\Omega+33\mu H$, $V_{DD}=5V$		2.15		W
	THD+N=10%, $R_L=8\Omega+33\mu H$, $V_{DD}=5V$		1.70		W
	THD+N=1%, $R_L=8\Omega+33\mu H$, $V_{DD}=5V$		1.35		W
	THD+N=10%, $R_L=4\Omega+33\mu H$, $V_{DD}=4.2V$		1.85		W
	THD+N=1%, $R_L=4\Omega+33\mu H$, $V_{DD}=4.2V$		1.50		W
	THD+N=10%, $R_L=8\Omega+33\mu H$, $V_{DD}=4.2V$		1.15		W
	THD+N=1%, $R_L=8\Omega+33\mu H$, $V_{DD}=4.2V$		0.90		W
	THD+N=10%, $R_L=4\Omega+33\mu H$, $V_{DD}=3.6V$		1.35		W
	THD+N=1%, $R_L=4\Omega+33\mu H$, $V_{DD}=3.6V$		1.05		W
	THD+N=10%, $R_L=8\Omega+33\mu H$, $V_{DD}=3.6V$		0.85		W
	THD+N=1%, $R_L=8\Omega+33\mu H$, $V_{DD}=3.6V$		0.65		W
E _N Output noise	Gain=6dB, 20Hz to 20kHz, input ac grounded, A-weighting		55		μV
THD+N Total harmonic distortion plus noise	$V_{DD}=5V$, $P_O=0.6W$, $R_L=8\Omega+33\mu H$		0.1		%
	$V_{DD}=4.2V$, $P_O=0.4W$, $R_L=8\Omega+33\mu H$		0.1		%
	$V_{DD}=3.6V$, $P_O=0.3W$, $R_L=8\Omega+33\mu H$		0.1		%
η Efficiency	$V_{DD}=5V, P_O=1W, R_L=8\Omega+33\mu H$		83		%
t _{ST} Start-up time			40		ms

Typical Operating Characteristics







Block Diagram

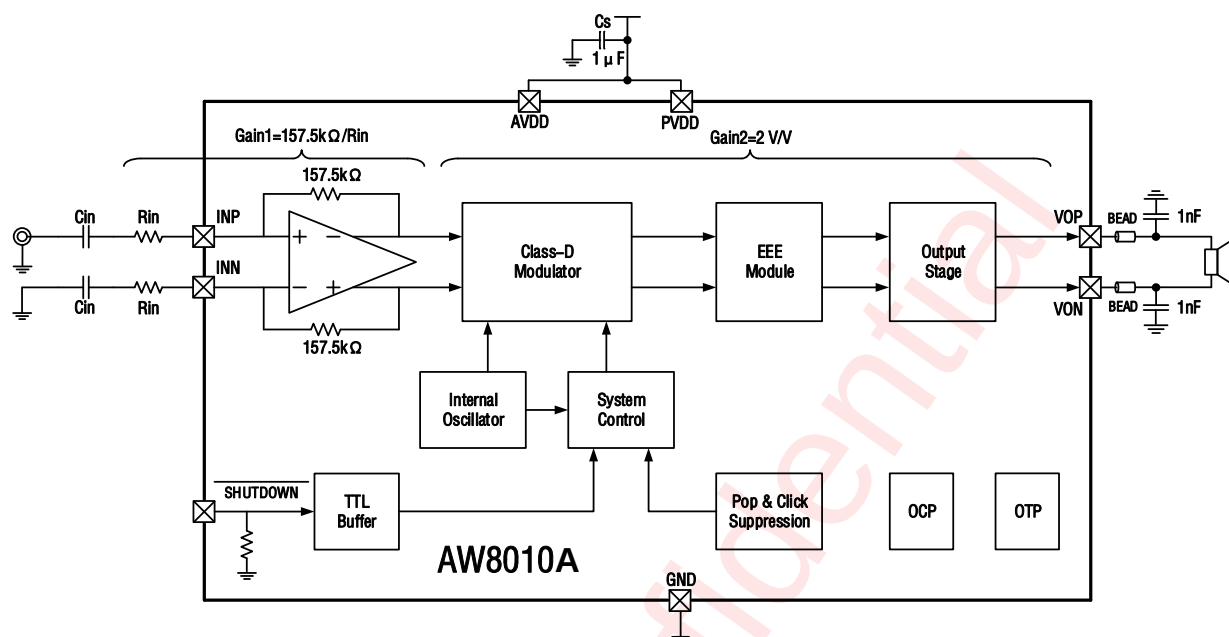


Figure 4 Functional Block Diagram of AW8010A

Operation

The AW8010A is a ultra-low-EMI,RNS, mono, filter-free, Class-D audio amplifier. Unique RNS, which effectively reduces RF energy, attenuate the RF TDD-noise, an acceptable audible level to the customer.

The AW8010A features the EEE (Enhanced Emission Elimination) function which greatly reduces EMI over the full bandwidth. The AW8010A achieves better than 20dB margin under FCC limits with 24 inch of cable.

The filter-free PWM architecture and internal gain setting reduces external components count, board area consumption, system cost and simplifies the design. The over-current, over-temperature and undervoltage protection is prepared inside of the device, which prevent the device from damage during fault conditions. When the fault condition is removed, the AW8010A reactivate itself again.

Filter-Free Modulation Scheme

The AW8010A features a filter-free PWM architecture that reduces the LC filter of the traditional Class-D amplifier, increasing efficiency, reducing board area consumption and system cost.

Pop-Click Suppression

The AW8010A features unique timing control circuit, that comprehensively suppresses pop-click noise, eliminates audible transients on shutdown, wakeup, and power-up/down

EEE Technology

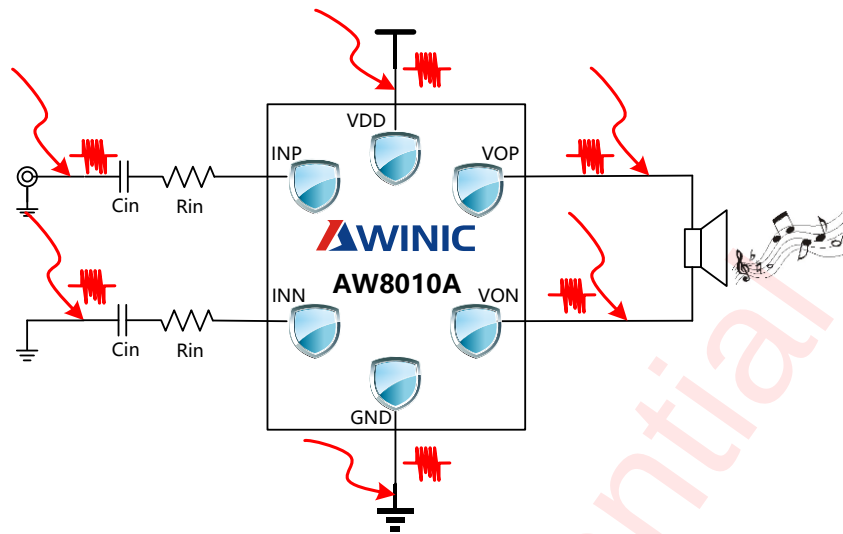
The AW8010A features a unique Enhanced Emission Elimination (EEE) technology, that controls fast transition on the output, greatly reduces EMI over the full bandwidth. The AW8010A achieves better than 20dB margin under FCC limits with 24 inch of cable, as shown in Figure 5.

RNS (RF TDD Noise Suppression)

GSM radios transmit using time-division multiple access with 217Hz intervals. The result is an RF signal with strong amplitude modulation at 217Hz and its harmonics that is easily demodulated by audio amplifiers.

In RF applications, improvements to both layout and component selection decrease the AW8010A's susceptibility to RF noise and prevent RF signals from being demodulated into audible noise. Minimizing the trace lengths prevents them from functioning as antennas and coupling RF signals into the AW8010A. Additional RF immunity can also be obtained from relying on the self-resonant frequency of capacitors as it exhibits the frequency response similar to a notch filter. Depending on the manufacturer, 10pF to 20pF capacitors typically exhibit self resonance at RF frequencies. These capacitors, when placed at the input pins, can effectively shunt the RF noise at the inputs of the AW8010A. For these capacitors to be effective, they must have a low-impedance, low-inductance path to the ground plane.

Some RF energy will couple onto audio traces regardless of the effort to prevent this phenomenon from occurring, form audible TDD Noise. The AW8010A features a unique RNS technology, which effectively reduces RF energy, attenuate the RF TDD-noise, an acceptable audible level to the customer.



RF Energy Coupling Diagram

Efficiency

Efficiency of a Class D amplifier is attributed to the switching operation of the output stage transistors. In a Class D amplifier, the output transistors act as current steering switches and consume negligible additional power. Any power loss associated with the Class D output stage is mostly due to the I^2R loss of the MOSFET on-resistance and supply current. The AW8010A features efficiency of 90%.

Protection Function

When a short-circuit occurs between VOP/VON pin and VDD/GND or VOP and VON, the over-current circuit shutdown the device, preventing the device from being damaged. When the condition is removed, the AW8010A reactivate itself. When the junction temperature is high, the over-temperature circuit shutdown the device. The circuit switches back to normal operation when the temperature decreases to safe levels.

Applications Information

Supply Decoupling Capacitor

The AW8010A is a high-performance class-D audio amplifier that requires adequate power supply decoupling to ensure the efficiency is high and total harmonic distortion (THD) is low. For higher frequency transients, a good low equivalent-series-resistance (ESR) ceramic capacitor, typically 1μF, placed as close as possible to the device VDD pin works best. For filtering lower-frequency noise signals, a 10 μF or greater capacitor placed near the audio power amplifier would also help.

Input Resistors

The input resistors set the gain of the amplifier according to equation as follow.

$$Gain = \frac{2 \times 157.5k\Omega}{R_{in}} \left(\frac{V}{V} \right)$$

The resistors matching is very important. CMRR, PSRR and THD diminish if resistor mismatch occurs. Therefore, it is recommended use 1% tolerance resistors or better to keep the performance optimized. Place the input resistors very close to the AW8010A to limit noise injection on the high-impedance nodes.

Input Capacitor

The input coupling capacitor blocks the DC voltage at the amplifier input terminal. The input ca-

pacitors and input resistors form a high-pass filter with the corner frequency, f_c .

$$f_c = \frac{1}{2\pi R_{in} C_{in}}$$

Setting the high-pass filter point high can block the 217Hz GSM noise coupled to inputs. Better matching of the input capacitors improves performance of the circuit and also help to suppress pop-click noise.

Ferrite Chip Bead and Capacitor

The AW8010A passed FCC and CE radiated emissions with no ferrite chip beads and capacitors with speaker trace wires 24 inch. Use ferrite chip beads and capacitors if device near the EMI sensitive circuits and/or there are long leads from amplifier to speaker, placed as close as possible to the output pin.

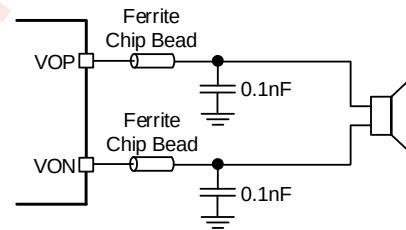
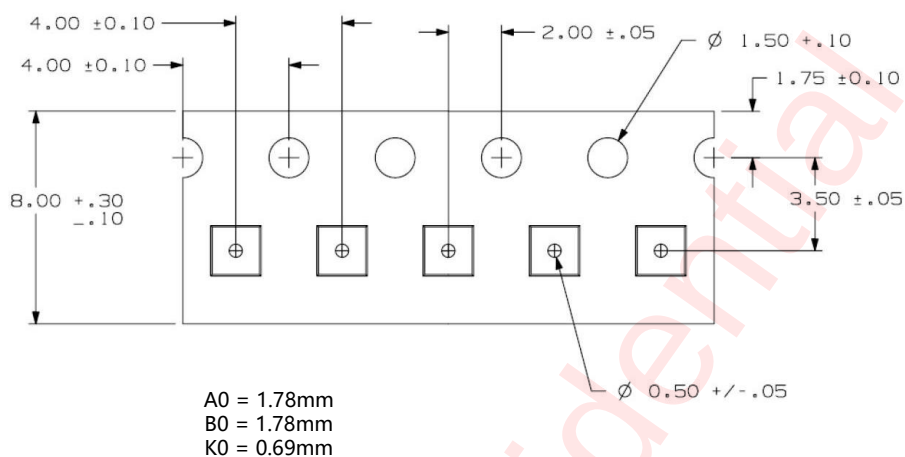


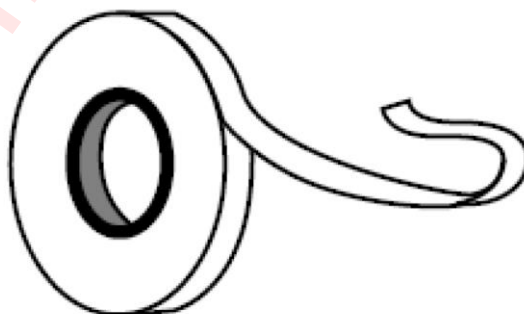
Figure 5 Ferrite Chip Bead and capacitor

Volume description

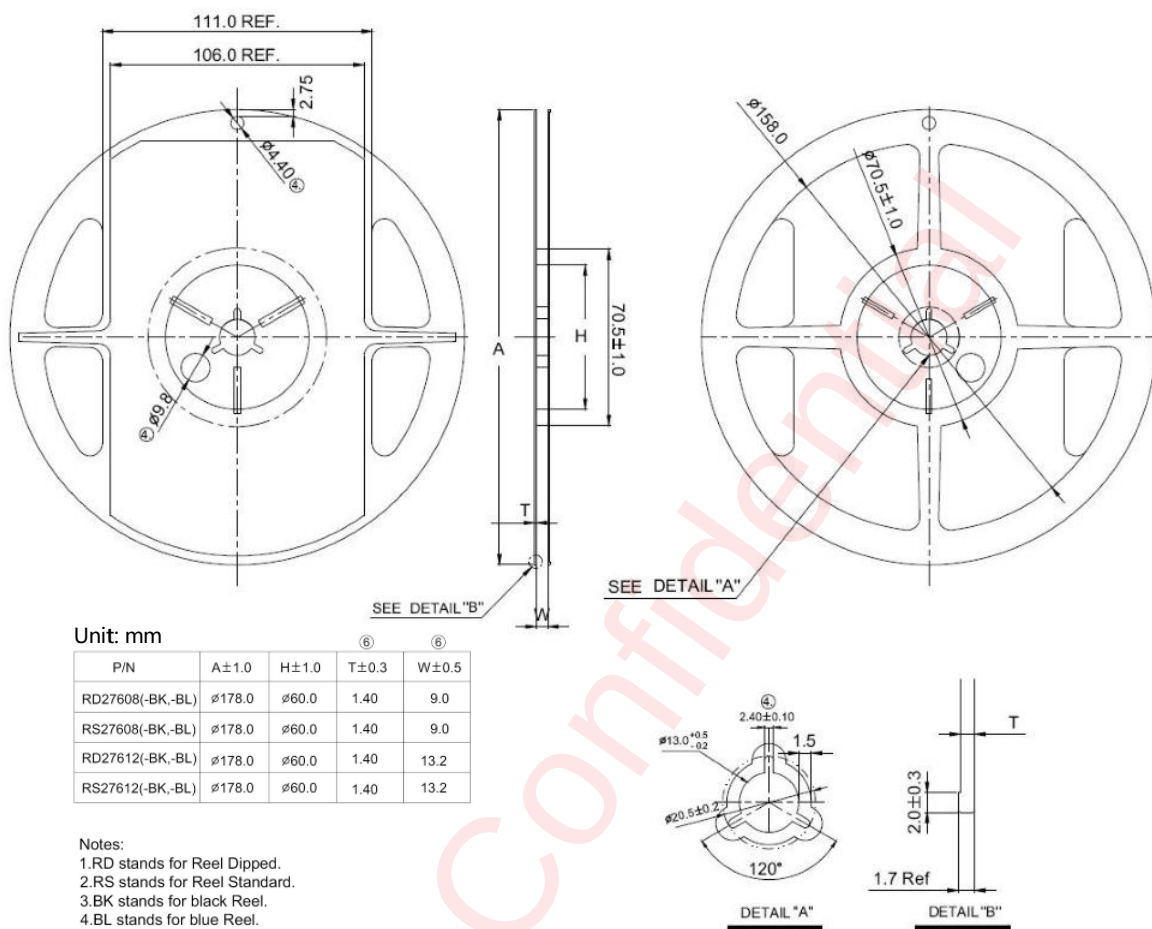
Carrier Tape



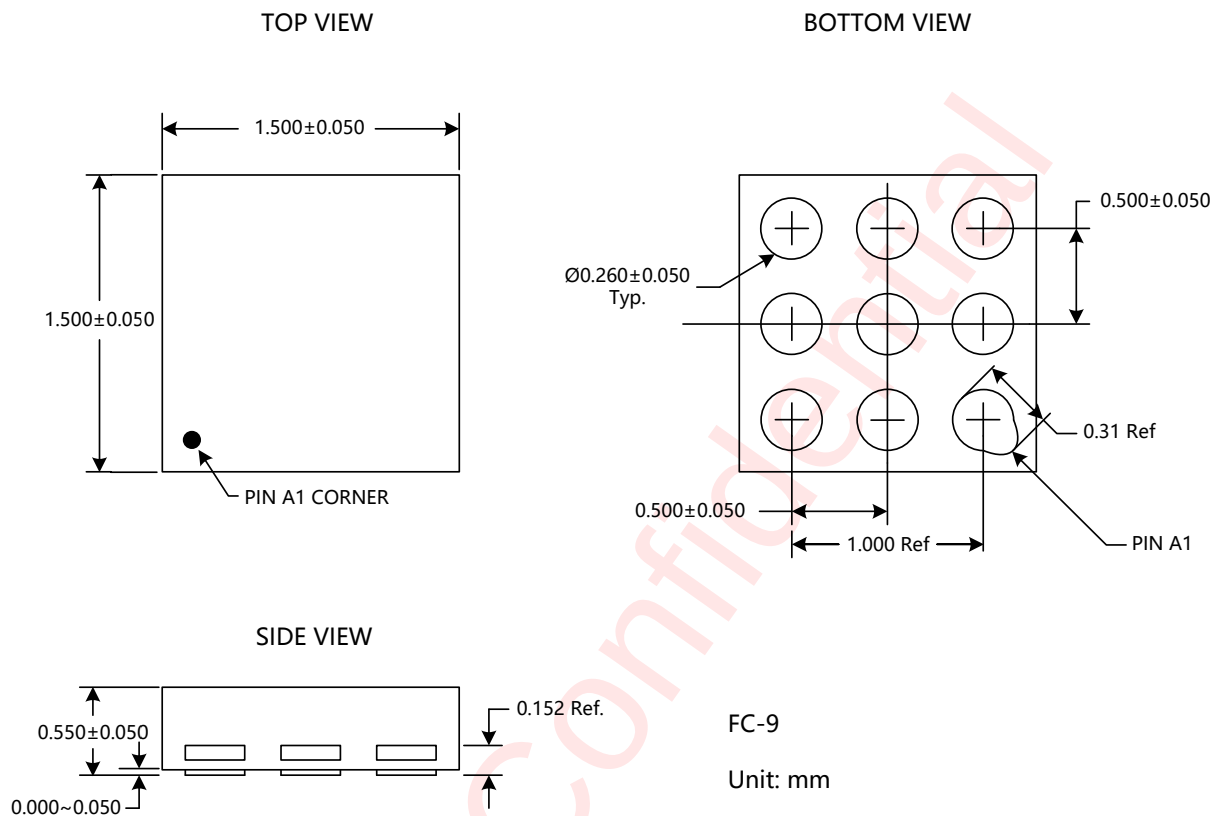
Cover Tape



Reel



Package Description



VERSION INFORMATION

Version	Release date	Description
V1.0	2012-02-11	Initial release
V1.1	2018-04-13	Modify the format
V1.2	2022-07-04	Update Efficiency information

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