高效率、低噪声、大音量、Multi-Level AGC 第八代 K 类音乐功放

特性

- **Multi-Level AGC 算法，有效消除杂音，纯净音质**
- **低噪声：40μV**
- **超低失真度：0.008%**
- **整体效率高达 83%**
- **喇叭保护功率可配：0.6W、0.8W、1W 和 1.2W**
- **锂电池电压范围内，保持恒定大音量**
- **支持 6 欧姆喇叭**
- **兼容 AW8736，AW8737**
- 超强 TDD-Noise 抑制
- 优异的 pop-click 抑制
- 一线脉冲控制
- 高 PSRR：-68dB（217Hz）
- ESD 保护：±8kV (HBM)
- 纤小的 2mm×2mm FC-16 封装

应用

- 智能手机

概要

AW8738 是专门针对消除智能机音乐杂音，提升整体音质而开发的高效率，低噪声，恒定大音量的第八代 K 类音乐功放。AW8738 集成艾为专有的 Multi-Level AGC 音效算法，有效消除音乐播放中的杂音，同时提升音质音量。AW8738 采用效率高达 93% 的 K-Chargepump 电荷泵升压技术，使功放整体效率高达 83%；AW8738 的底噪低至 40μV，具有高达 99.6dB 的信噪比(SNR)，0.008%的超低失真度和独特的 Multi-Level AGC 技术，带来高品质的音乐享受。

AW8738 有 0.6W，0.8W，1W 和 1.2W 四个喇叭保护功率等级，适合不同额定功率的喇叭，即大大提升音质音量，又有效保护喇叭，同时配合 Multi-Level AGC 算法，使音乐纯粹自然，悦耳动听。AW8738 兼容 AW8736，AW8737，输出功率不会随着锂电池电压的降低而下降，在手机的整个工作电压（3.3V-4.35V）内，功率保持恒定，防止手机使用过程中，声音越来越小。

AW8738 采用艾为专有的 TDD-Noise 抑制和 EMI 抑制技术，有效抑制 TDD-Noise 和 EMI 干扰。

AW8738 内置过流保护、过热保护和短路保护功能，有效地保护芯片。AW8738 采用纤小的 2mm×2mm FC-16 封装。

典型应用图

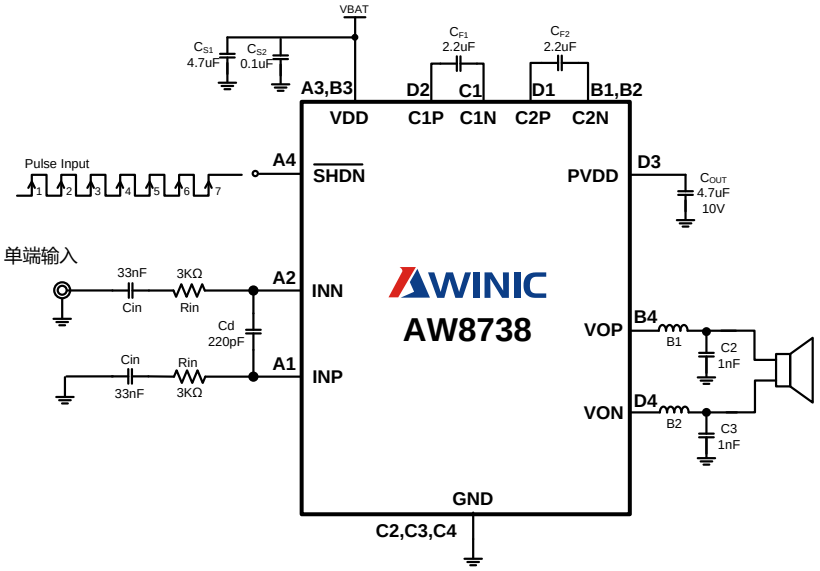

图 1　AW8738 单端输入方式应用图

High efficiency、Low noise、Constant large volume、Multi-level AGC Eighth generation Class K Audio Amplifier

FEATURES

- **Multi-Level AGC audio algorithm， effectively eliminate noise, make sound pure natural**
- **Low noise：40μV**
- **Ultra-low distortion：0.008%**
- **Power amplifier overall efficiency is up to 83%**
- **Selectable speaker-guard power level：0.6W、0.8W、1W、1.2W**
- **Within Lithium battery voltage range, maintained constant large volume**
- **Support 6ohm speaker**
- **Compatible with AW8736，AW8737**
- **Super TDD-Noise suppression**
- **Excellent pop-click suppression**
- One wire pulse control
- High PSRR：-68dB（217Hz）
- ESD protection：±8kV (HBM)
- Small 2mm×2mm FC-16package

APPLICATIONS

- **Smart phone**

DESCRIPTION

AW8738 is specifically designed to eliminate smart mobile phone music noise, to enhance overall sound quality, which is a new high efficiency, low noise, ultra-low distortion, constant large volume, eighth generation class K audio amplifiers. AW8738 integrated Awinic proprietary multi-level AGC audio algorithm, effectively eliminate music noise, improve sound quality and volume. Using a new generation 93% efficiency K-Chargepump, power amplifier's overall efficiency reaches 83%, greatly prolong the mobile phone usage time. AW8738 noise floor is as low as to 40uV, with 99.6dB high signal-to-noise-ratio(SNR). The ultra-low distortion 0.008% and unique multi-level AGC technology brings high quality music enjoyment.

AW8738 has 0.6W, 0.8W, 1W and 1.2W four selectable speaker-guard output power levels, which is suitable for different rated power speakers, greatly improve the volume, effectively protect speakers. With multi-level AGC audio algorithms, the music is pure natural and melodious. AW8738 is compatible with AW8736, AW8737, output power cannot drop along with lithium battery voltage lower down. Within lithium battery voltage range(3.3V-4.35V), output power is constant.

The AW8738 uses Awinic proprietary TDD-Noise suppression technology and EMI suppression technology, effectively restrain TDD-Noise and EMI interference.

AW8738 built-in over current protection, over-temperature protection and short circuit protection function, effectively protect the chip. The AW8736 uses small 2mmx2mm FC-16 package.

APPLICATION DIAGRAM

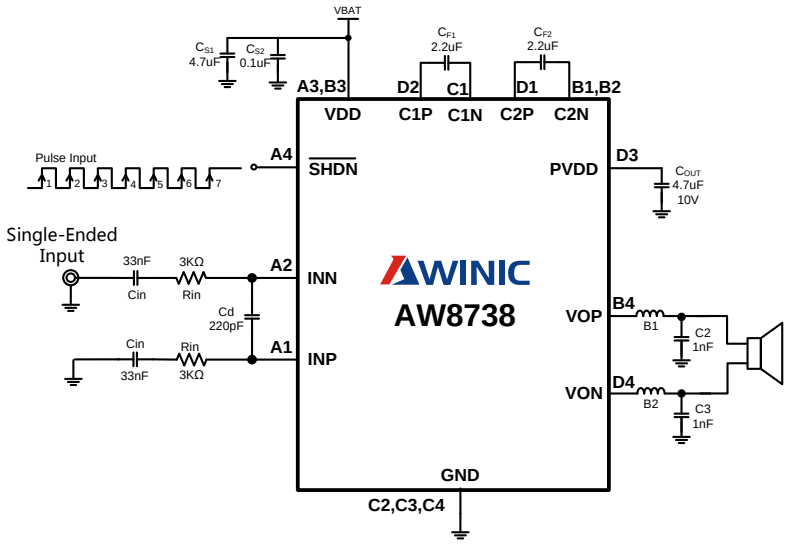

Figure1 AW8738 application diagram

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PIN CONFIGURATION ANG TOP MARK

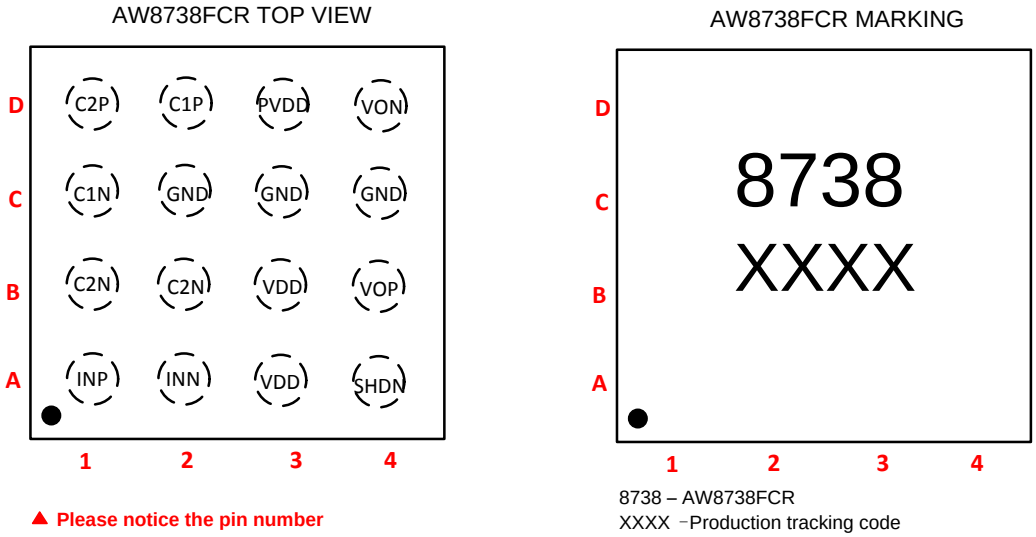


Figure 2 AW8738FCR pin diagram top view and device marking

PIN DESCRIPTION

Number	Symbol	Description
A1	INP	Positive audio input terminal
A2	INN	Negative audio input terminal
A3，B3	VDD	Power supply
A4	SHDN	Chip power down pin，active low；one wire pulse control；
B1	C2N	Negative side of the external charge pump flying capacitor C2
B2		
B4	VOP	Positive audio output terminal
C1	C1N	Negative side of the external charge pump flying capacitor C1
C2	GND	Ground
C3		
C4		
D1	C2P	Positive side of the external charge pump flying capacitor C2
D2	C1P	Positive side of the external charge pump flying capacitor C1
D3	PVDD	Boost charge pump output voltage
D4	VON	Negative audio output terminal

AWINIC CLASS K FAMILY

ITEM	TEST CONDITION	AW8736	AW8737	AW8738
PVDD(V)	VDD>3.8V(AW8736)，VDD>4V(AW8737/8738)	5.8	6.05	6.05
Ouput noise(μV)	VDD=4.2V，f=20Hz to 20kHz，input ac grounded，8V/V,A-weighting	125	52	40
Efficiency(%)	V_{DD}=3.6V，Po=1.0W，R_L=8Ω+33μH	75	80	83

FUNCTIONAL DIAGRAM

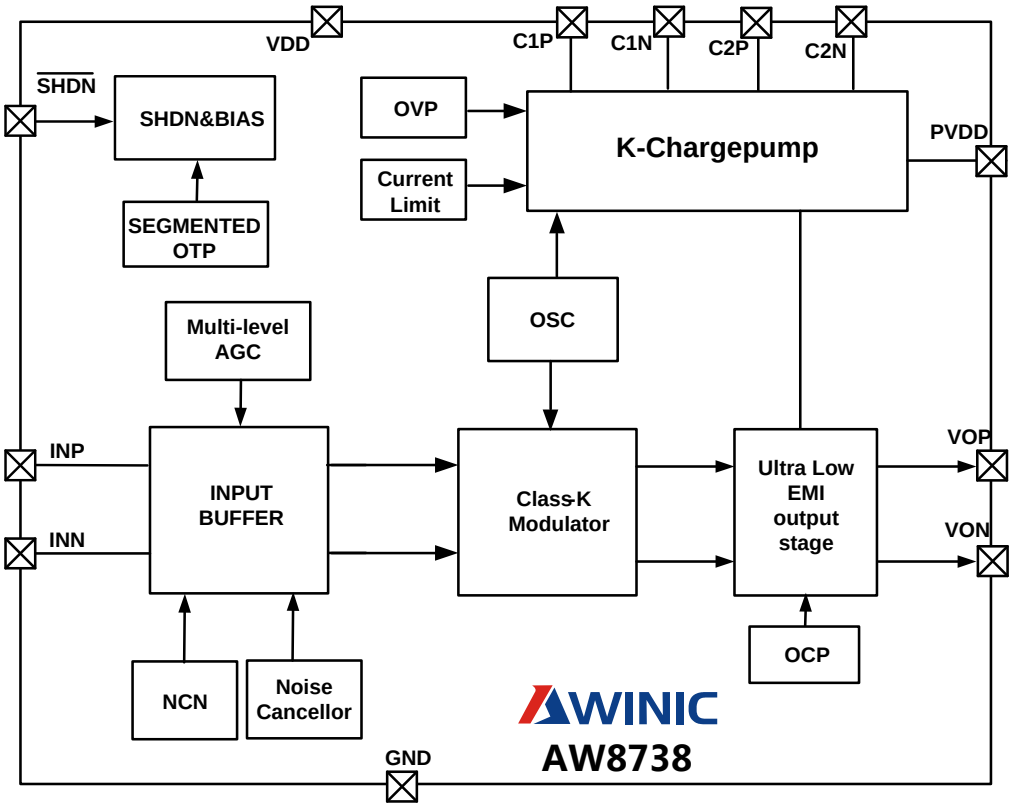


Figure 3 AW8738 functional diagram

APPLICATION DIAGRAM

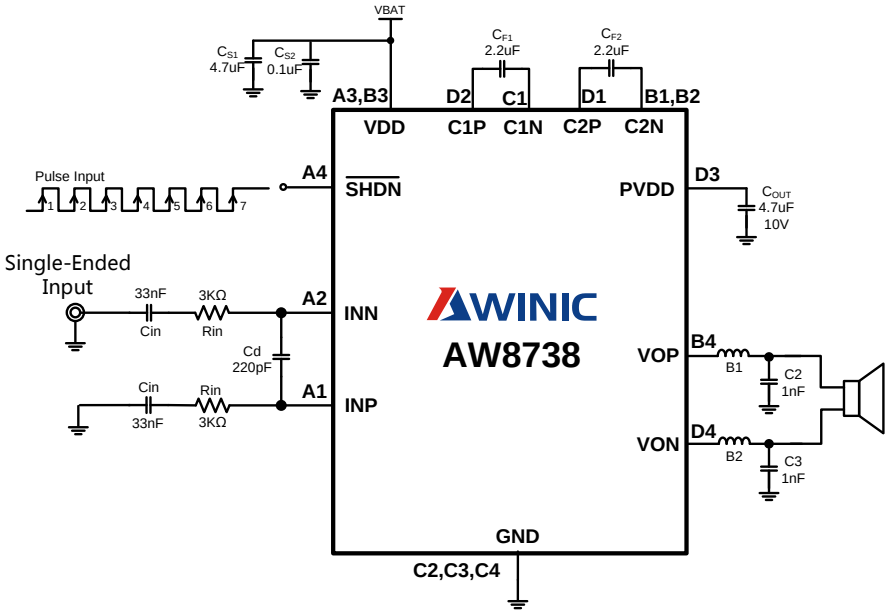


Figure 4 AW8738 single-ended input application diagram (Note 1)

Note1：*when single-ended input，input audio signal can arbitrarily connect to one of INN，INP input terminal，the other terminal connects to ground through input capacitor and resistance.*

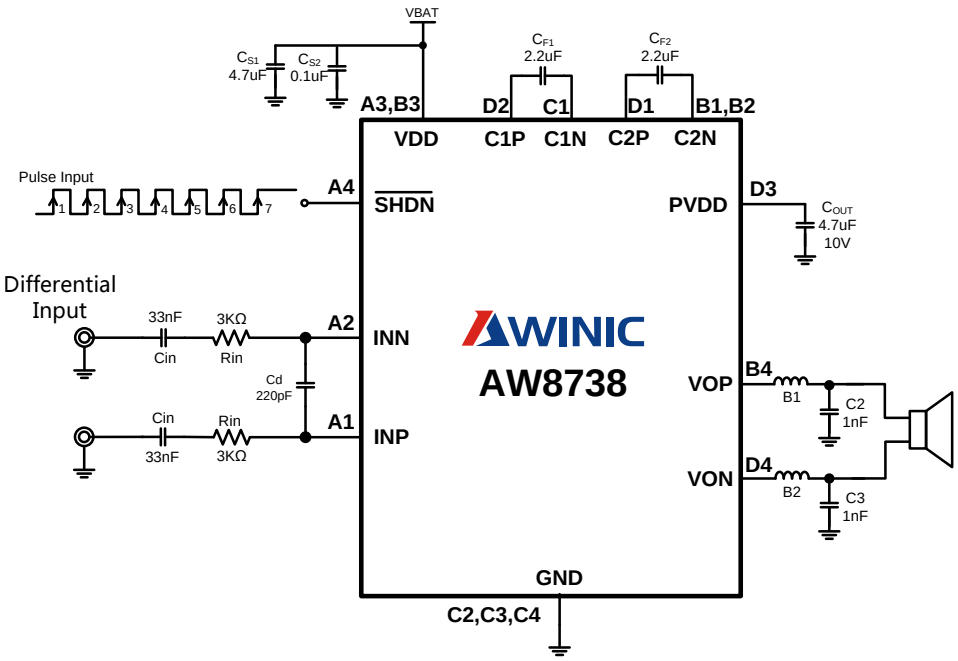
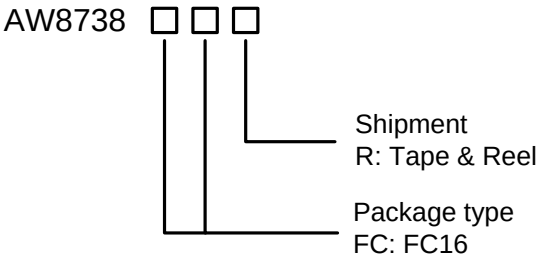


Figure 5 AW8738 differential input application diagram

ORDERING INFORMATION

Product Type	Operation temperature range	Package	Device Marking	Delivery Form
AW8738FCR	-40℃～85℃	FC-16	8738	Tape and Reel 3000 pcs



ABSOLUTE MAXIMUM RATING(Note2)

Parameter	Range
Supply Voltage V_{DD}	-0.3V to 6V
INP，INN Input Pin Voltage	-0.3V to V_{DD}+0.3V
Package Thermal Resistance θ_{JA}	69℃/W
Ambient Temperature Range	-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（Note 3）	
HBM（human body model）	±8KV
Latch-up	
Test Condition：JEDEC STANDARD NO.78B DECEMBER 2008	+IT：450mA -IT：-450mA

Note 2：*Stresses beyond those listed under "absolute maximum ratings" may cause permanent damageto 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.*

Note 3：*The human body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin. Test method: MIL-STD-883G Method 3015.7*

MODE DESCRIPTION（TA=25℃,VDD=4.2V）

AW8738 audio amplifier outer input capacitor is Cin，outer input resist is Rin，inner input resist is 6.6KΩ，gain Av is 159.5K/(Rin+6.6K). Recommended typical application is：

1、 Cin=33nF，Rin=3KΩ，Av=16.6V/V；

MODE	Enable Signal	Gain（V/V）	NCN Power（W）				NCN function	Multi-Level AGC function
			RL=8Ω+33μH	RL=6Ω+33μH	RL=4Ω+15μH	RL=3Ω+15μH		
MODE1		16.6	1.2	—	2.4	—	√	
MODE 2		16.6	1	—	2	—	√	
MODE 3		16.6	0.8	1	1.6	2	√	
MODE 4		16.6	0.6	0.8	1.2	1.6	√	
MODE 5		16.6	0.8	1	1.6	2		√
MODE 6		16.6	0.6	0.8	1.2	1.6		√
MODE 7		16.6	1.83W@ THD=1%	2.25W@ THD=1%	2.6W@ THD=1%			

ELECTRICAL CHARACTERISTICS

Test condition：T_A=25℃，VDD=3.6V，RL=8Ω+33μH，f=1kHz（unless otherwise noted）

Parameter		Test conditions	Min	Typ	Max	Units
V_{DD}	Power supply voltage		3.0		5.5	V
V_{IH}	$\overline{SHDN}$ high input voltage		1.3		V_{DD}	V
V_{IL}	$\overline{SHDN}$ low input voltage		0		0.35	V
$\|V_{OS}\|$	Output offset voltage	Vin=0V，V_{DD}=3.0V to 5.5V	-30	0	30	mV
I_{SD}	Shutdown current	V_{DD}=3.6V， $\overline{SHDN}$=0V			1	μA
T_{TG}	Thermal AGC start temperature threshold			150		℃
T_{TGR}	Thermal AGC exit temperature threshold			130		℃
T_{SD}	Over temperature protection threshold			160		℃
T_{SDR}	Over temperature protection recovery threshold			120		℃
T_{ON}	Start-up time			40		ms
K-Chargepump						
PVDD	Output voltage	V_{DD} =3.0V to 4.0V		1.5* VDD		V
		V_{DD} >4V		6.05		V
Vhys	OVP hysteresis	V_{DD} >4V		50		mV
F_{CP}	Charge Pump frequency	V_{DD}=3.0V to 5.5V	0.8	1.06	1.33	MHz
η_{CP}	Charge pump efficiency	V_{DD}=4.2V, I_{load}=200mA		93		%
T_{ST}	Soft-start time	No load，COUT=4.7μF	1	1.2	1.4	ms
I_L	Current limit when PVDD short to ground			350		mA
Class K power amplifier（mode1-mode4）						
I_q	Quiescent current	V_{DD}=3.6V，Vin=0，no load		12		mA
η	Efficiency	V_{DD}=3.6V，Po=1.0W，R_L=8Ω+33μH		83		%
		V_{DD}=3.6V，Po=1.0W，R_L=6Ω+33μH		84		%
Fosc	Modulation frequency	V_{DD}=3.0V to 5.5V	600	800	1000	kHz
Av	gain	Outside input resistance=3kΩ		16.6		V/V
Vin	Recommend input voltage	V_{DD}=3.0V to 5.5V			1	Vp
Rini	Inner input resistance			6.6		kΩ
Pncn	Mode1 NCN output power	V_{DD}=4.2V，R_L=8Ω+33μH		1.2		W
		V_{DD}=4.2V，R_L=4Ω+15μH		2.4		W
	Mode2 NCN output power	V_{DD}=4.2V，R_L=8Ω+33μH		1		W
		V_{DD}=4.2V，R_L=4Ω+15μH		2		W
	Mode3 NCN output power	V_{DD}=4.2V，R_L=8Ω+33μH		0.8		W
		V_{DD}=4.2V，R_L=6Ω+33μH		1		W
		V_{DD}=4.2V，R_L=4Ω+15μH		1.6		W

Parameter		Test conditions		Min	Typ	Max	Units
Pncn	Mode4 NCN output power	V_{DD}=4.2V，R_L=8Ω+33μH			0.6		W
		V_{DD}=4.2V，R_L=6Ω+33μH			0.8		W
		V_{DD}=4.2V，R_L=4Ω+15μH			1.2		W
	Mode5 Multi-level AGC output power	V_{DD}=4.2V，R_L=8Ω+33μH			0.8		W
		V_{DD}=4.2V，R_L=6Ω+33μH			1		W
		V_{DD}=4.2V，R_L=4Ω+15μH			1.6		W
	Mode6 Multi-level AGC output power	V_{DD}=4.2V，R_L=8Ω+33μH			0.6		W
		V_{DD}=4.2V，R_L=6Ω+33μH			0.8		W
		V_{DD}=4.2V，R_L=4Ω+15μH			1.2		W
PSRR	Power supply rejection ratio	V_{DD}=4.2V，Vp-p_sin=200mV	217Hz		-68	-58	dB
			1kHz		-68	-58	dB
SNR	Signal-to-noise ratio	V_{DD}=4.2V，Po=1.83W，THD=1%，R_L=8Ω+33μH，Av=8V/V			99.6		dB
		V_{DD}=4.2V，Po=2.25W，THD=1%，R_L=8Ω+33μH，Av=8V/V			99.3		dB
Vn	Output noise voltage	VDD=4.2V，f=20Hz to 20kHz，input ac grounded，Av=8V/V	A-weighting		40		μVrms
		VDD=4.2V，f=20Hz to 20kHz，input ac grounded，Av=12V/V			45		μVrms
		VDD=4.2V，f=20Hz to 20kHz，input ac grounded，Av=16V/V			56		μVrms
THD+N	Total harmonic distortion+noise	V_{DD}=4.2V,Po=1W,R_L=8Ω+33μH,f=1kHz,Mode7			0.008		%
		V_{DD}=4.2V,Po=1.2W,R_L=8Ω+33μH,f=1kHz,Mode7			0.009		%
P_O	Mode4 output power	THD+N=10%，f=1kHz，R_L=8Ω+33μH，V_{DD}=4.2V			2.3		W
		THD+N=1%，f=1kHz，R_L=8Ω+33μH，V_{DD}=4.2V			1.83		W
		THD+N=10%，f=1kHz，R_L=8Ω+33μH，V_{DD}=3.6V			1.6		W
		THD+N=1%，f=1kHz，R_L=8Ω+33μH，V_{DD}=3.6V			1.35		W
		THD+N=10%，f=1kHz，R_L=6Ω+33μH，V_{DD}=4.2V			2.77		W
		THD+N=1%，f=1kHz，R_L=6Ω+33μH，V_{DD}=4.2V			2.25		W
		THD+N=10%，f=1kHz，R_L=6Ω+33μH，V_{DD}=3.6V			2.05		W
		THD+N=1%，f=1kHz，R_L=6Ω+33μH，V_{DD}=3.6V			1.63		W
		THD+N=10%，f=1kHz，R_L=4Ω+15μH，V_{DD}=4.2V			3.2		W
		THD+N=1%，f=1kHz，R_L=4Ω+15μH，V_{DD}=4.2V			2.6		W
		THD+N=10%，f=1kHz，R_L=4Ω+15μH，V_{DD}=3.6V			2.35		W
		THD+N=1%，f=1kHz，R_L=4Ω+15μH，V_{DD}=3.6V			1.92		W
One wire pulse control							
T_H	$\overline{SHDN}$ high level duration time	V_{DD}=3.0V to 5.0V		0.75	2	10	μs
T_L	$\overline{SHDN}$ low level duration time	V_{DD}=3.0V to 5.0V		0.75	2	10	μs
T_{LATCH}	$\overline{SHDN}$ turn on delay time	V_{DD}=3.0V to 5.0V		150		500	μs
T_{OFF}	$\overline{SHDN}$ turn off delay time	V_{DD}=3.0V to 5.0V		150		500	μs

Parameter		Test conditions	Min	Typ	Max	Units
NCN (Note 4)						
T_{AT}	Attack time	-13.5dB gain attenuation completed		40		ms
T_{RL}	Release time	13.5dB gain release completed		1.2		s
A_{MAX}	Maximum attenuation			-13.5		dB
Dual Level Dual Rate AGC (Note 5)						
T_{ATF}	Fast attack time	-13.5dB gain attenuation completed		1.5		ms
T_{ATS}	Slow attack time	-13.5dB gain attenuation completed		6		ms
T_{ATT}	Total attack time	-13.5dB gain attenuation completed		7.5		ms
T_{RL}	Release time	13.5dB gain release completed		280		ms
A_{MAX}	Maximum attenuation			-13.5		dB

Note 4, Note 5：*Attack time points to 13.5dB gain attenuation time；Release time points to 13.5dB gain recovery time.*

MEASUREMENT SETUP

AW8738 features switching digital output, as shown in Figure 6. Need to connect a low pass filter to VOP/VON output respectively to filter out switch modulation frequency, then measure the differential output of filter to obtain analog output signal.

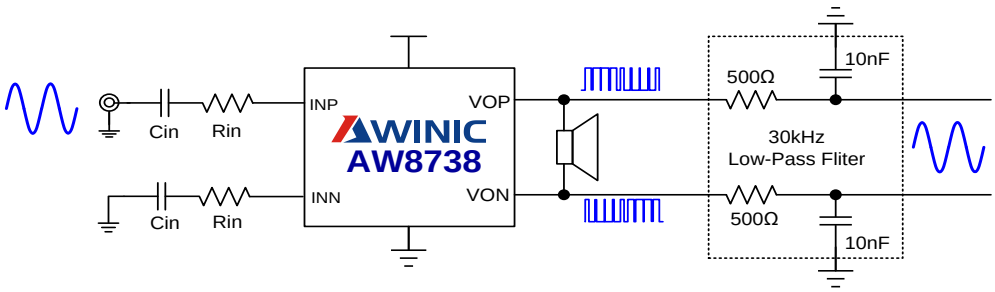


Figure 6 AW8738 test setup

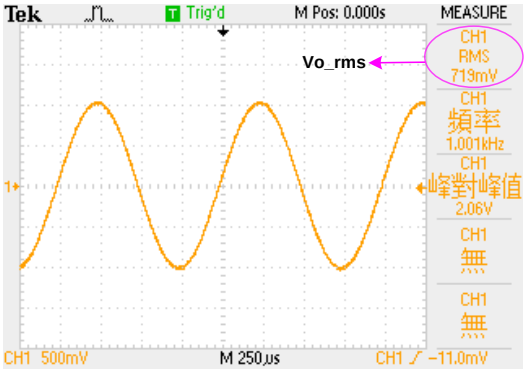
Low pass filter uses resistance and capacitor values listed in Table 1.

R_{filter}	C_{filter}	Low-pass cutoff frequency
500Ω	10nF	32kHz
1kΩ	4.7nF	34kHz

Table 1 AW8738 recommended values for low pass filter

Output Power Calculation

According to the above test methods, the differential analog output signal is obtained at the output of the low pass filter. The valid values Vo_rms of the differential signal as shown below:

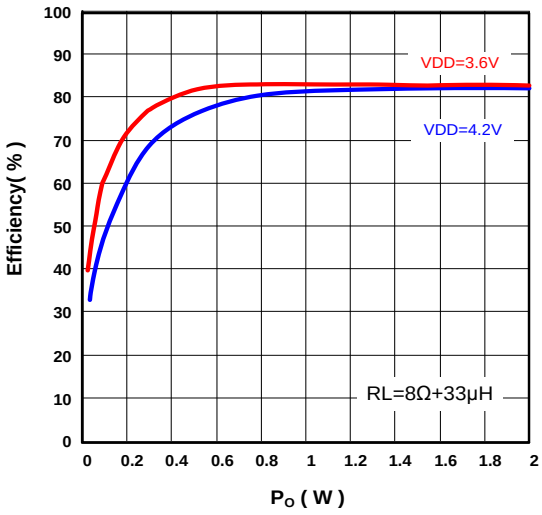


The power calculation of Speaker is as follows：

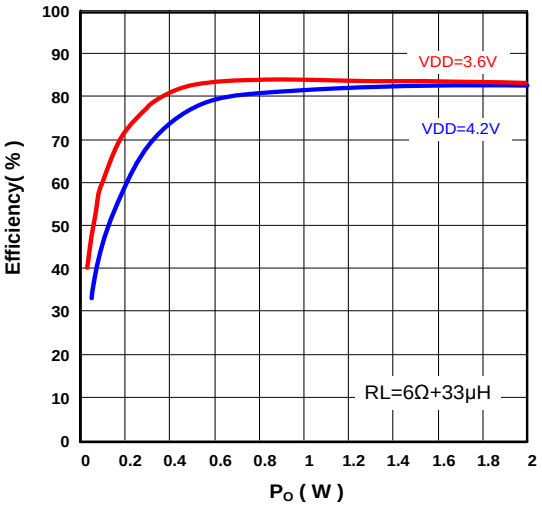
$$P_L = \frac{(Vo\_rms)^2}{R_L}$$ （R_L：load impedance of the speaker）

TYPICAL CHARACTERISTICS

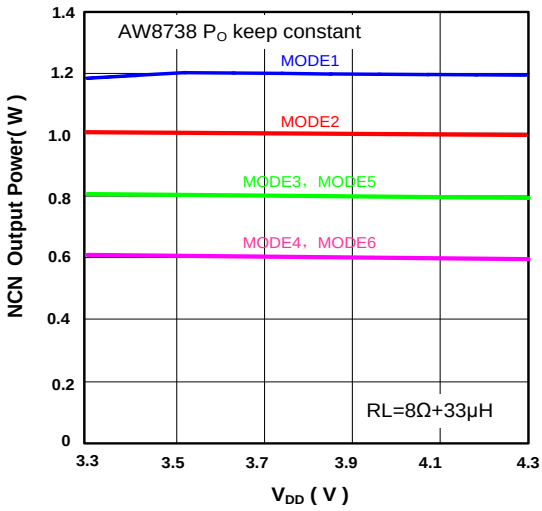
Efficiency vs P_O



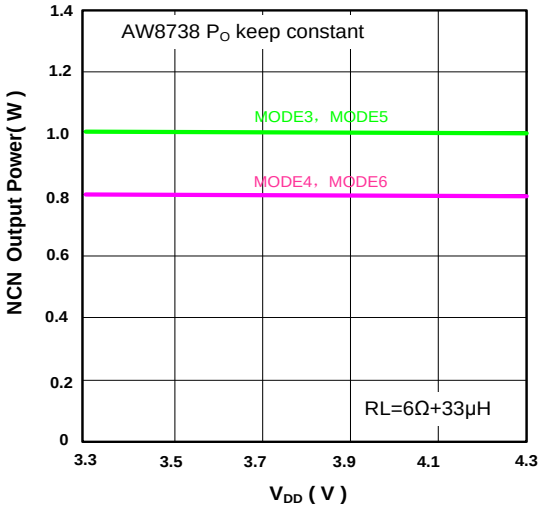
Efficiency vs P_O



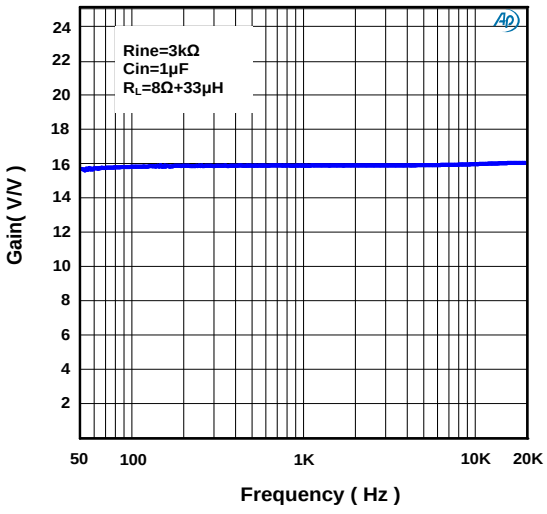
OUTPUT POWER vs V_{DD}



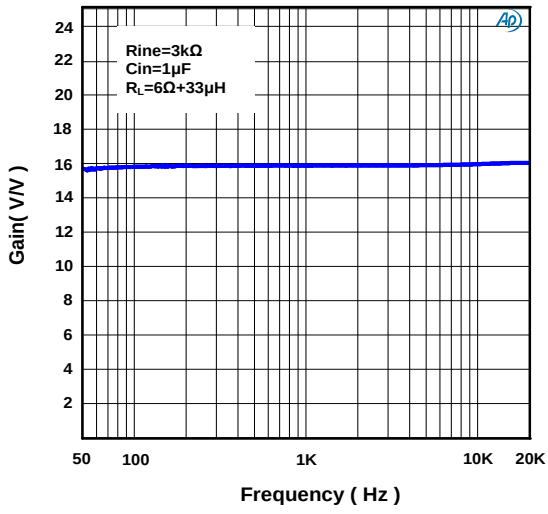
OUTPUT POWER vs V_{DD}



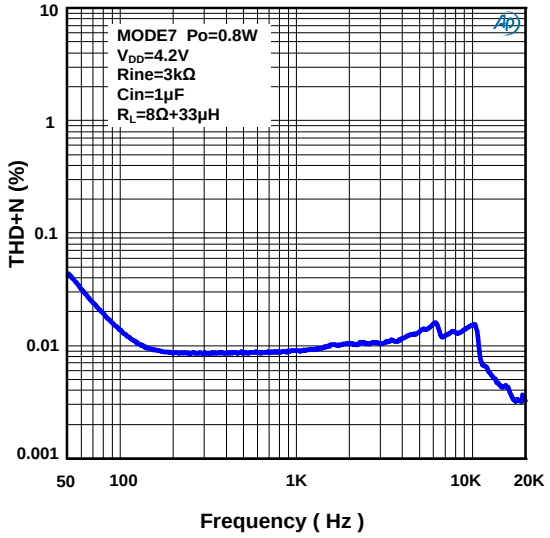
GAIN vs FREQUENCY



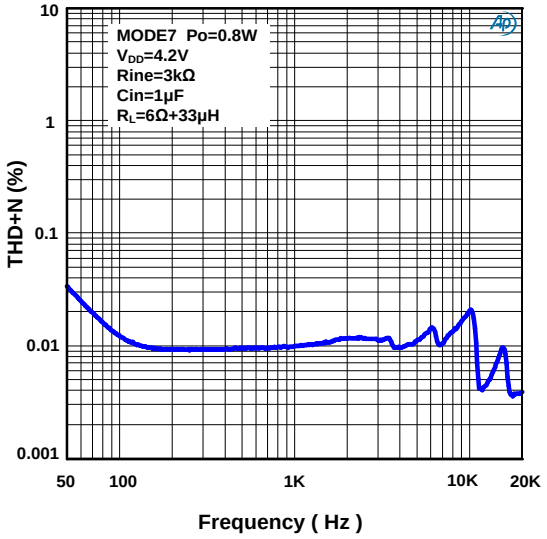
GAIN vs FREQUENCY



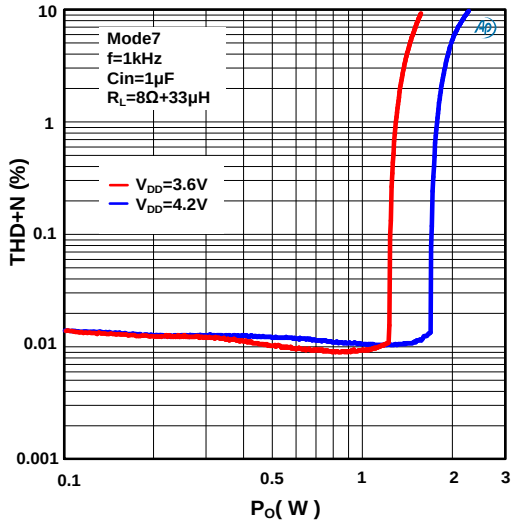
THD+N vs FREQUENCY



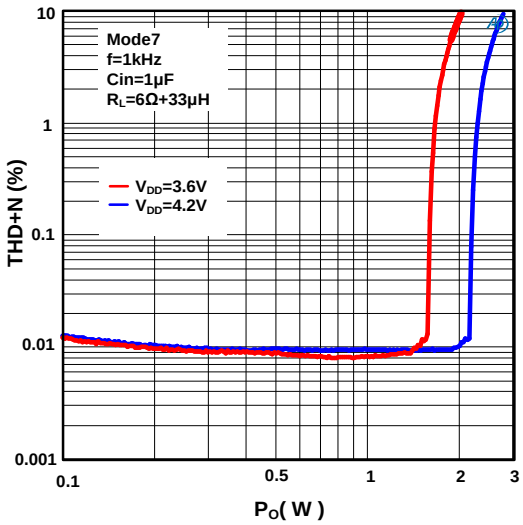
THD+N vs FREQUENCY



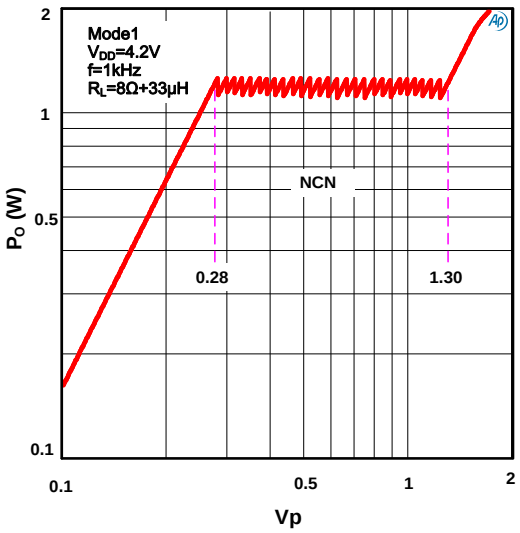
THD+N vs P_O



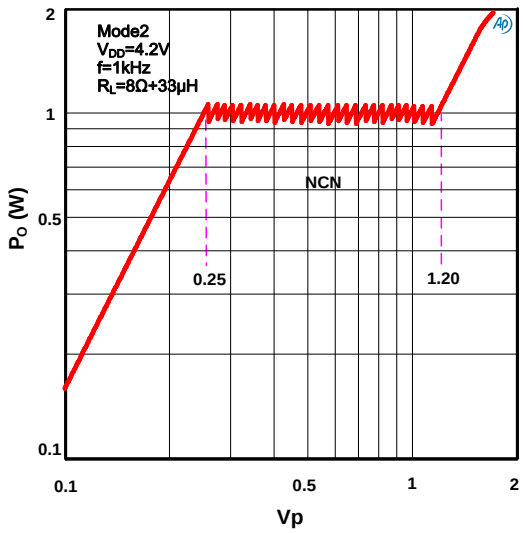
THD+N vs P_O

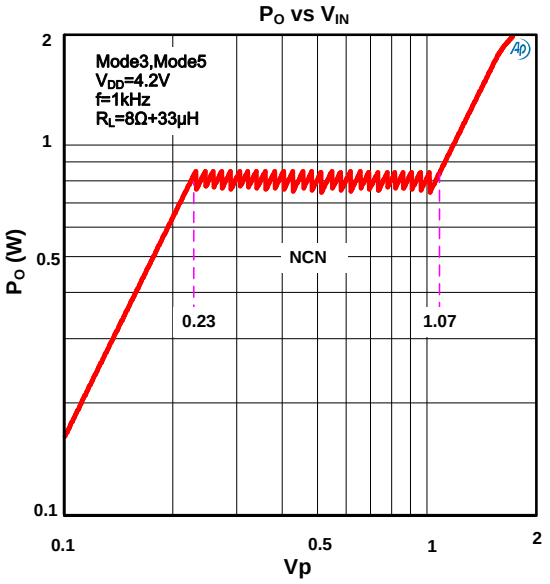


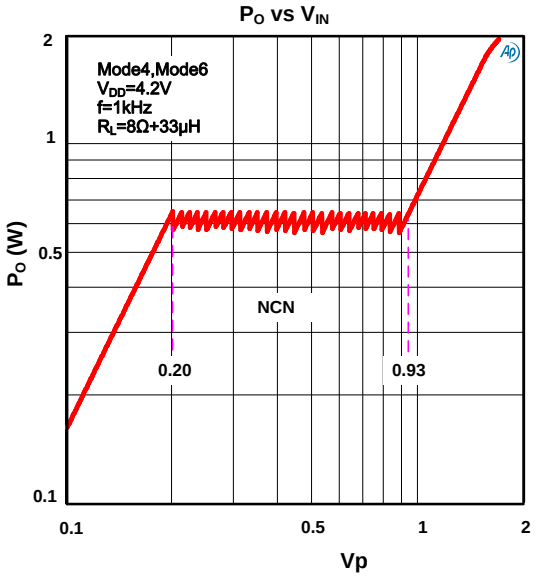
P_O vs V_{IN}

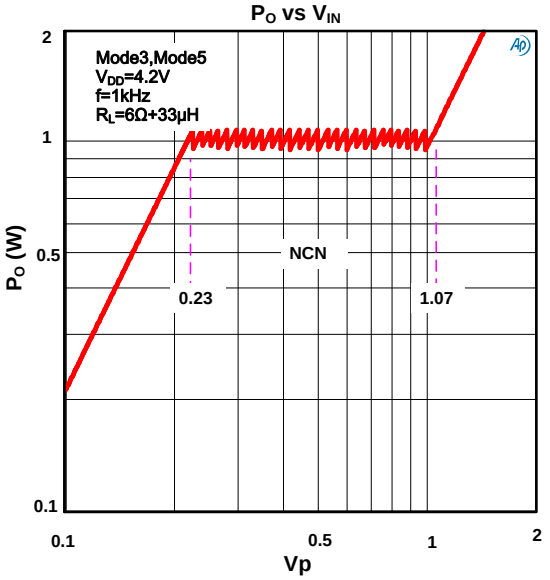


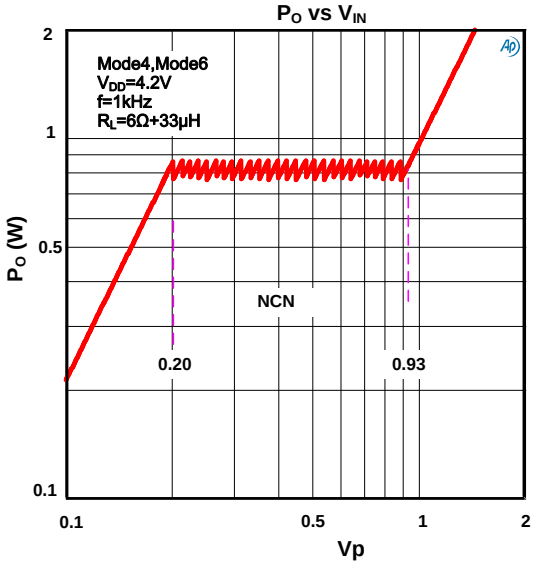
P_O vs V_{IN}

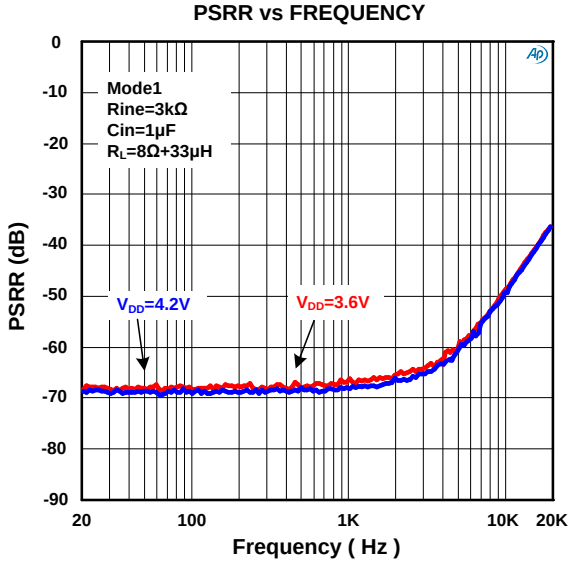


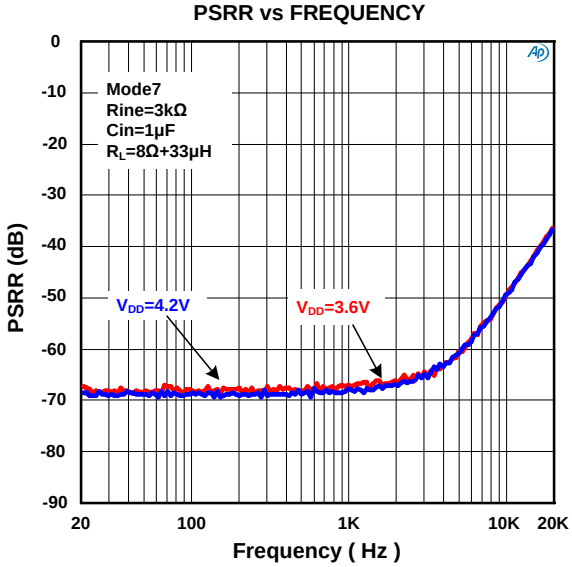




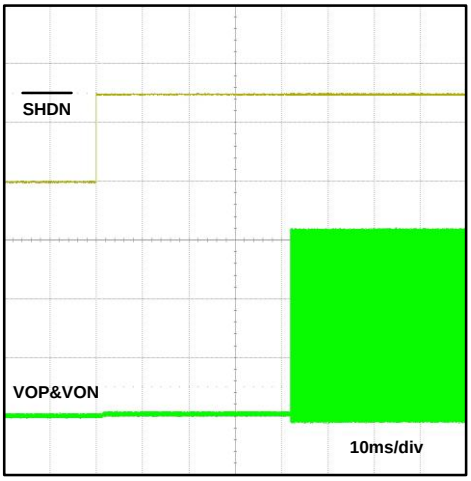




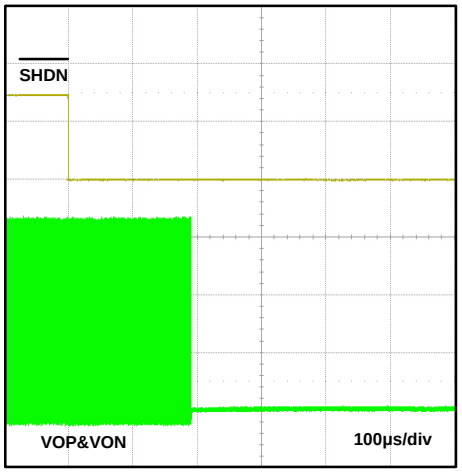




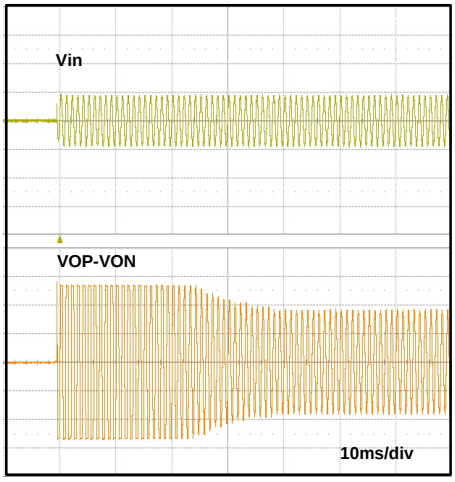
START-UP SEQUENCE



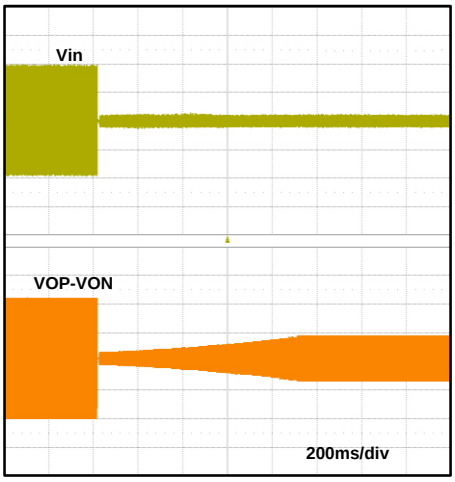
SHUTDOWN SEQUENCE



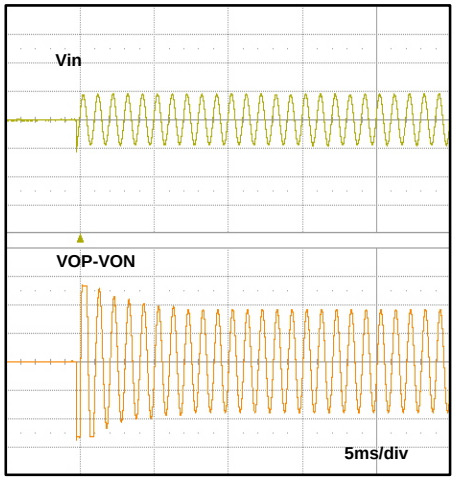
SINGLE-LEVEL-AGC



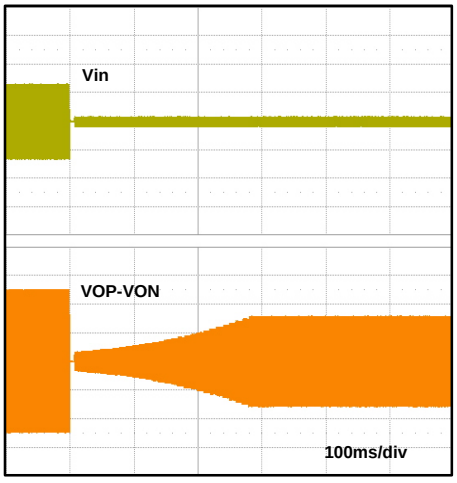
SINGLE-LEVEL-AGC



MULTI-LEVEL-AGC



MULTI-LEVEL-AGC



DETAILED FUNCTIONAL DESCRIPTION

AW8738 is specifically designed to eliminate smart mobile phone music noise, to enhance overall sound quality, which is a new high efficiency, low noise, ultra-low distortion, constant large volume, eighth generation class K audio amplifiers. AW8738 integrated Awinic proprietary multi-level AGC audio algorithm, effectively eliminate music noise, improve sound quality and volume. Using a new generation 93% efficiency K-Chargepump, power amplifier's overall efficiency reaches 83%, greatly prolong the mobile phone usage time. AW8738 noise floor is as low as to 40μV, with 99.6dB high signal-to-noise-ratio(SNR). The ultra-low distortion 0.008% and unique multi-level AGC technology brings high quality music enjoyment.

AW8738 has 0.6W, 0.8W, 1W and 1.2W four selectable speaker-guard output power levels, which is suitable for different rated power speakers, greatly improve the volume, effectively protect speakers. With multi-level AGC audio algorithms, the music is pure natural and melodious. AW8738 is compatible with AW8736, AW8737, output power cannot drop along with lithium battery voltage lower down. Within lithium battery voltage range(3.3V-4.35V), output power is constant.

The AW8738 built in excellent pop-click noise suppression circuit, effectively avoids pop-click noise during shutdown, wakeup, and power-up/down operation of AW8738.

The AW8738 uses Awinic proprietary TDD-Noise suppression technology and EMI suppression technology, effectively restrain TDD-Noise and EMI interference.

AW8738 built-in over current protection, over-temperature protection and short circuit protection function, effectively protect the chip. The AW8736 uses small 2mmx2mm FC-16 package.

CONSTANT OUTPUT POWER

In the mobile phone audio applications, the NCN function to promote music volume and quality is very attractive, but as the lithium battery voltage drops, general power amplifier output power will reduce gradually, leads to smaller and smaller music volume. So, it is hard to provide high quality music within the battery voltage range. The AW8738 uses unique second generation NCN technology, within lithium battery voltage range(3.3V-4.35V), output power is constant, the output power cannot drop along with lithium battery voltage lower down. Even if the battery voltage drops, AW8738 can still provide high quality large volume music enjoyment. There are seven AW8738 operation modes, first four modes have NCN function, the output power level is 1.2W,1W,0.8W, 0.6W,respectively. The five and six modes have Multi-level AGC function, the output power level is 0.8W, 0.6W,respectively.

Second Generation NCN technology

In audio application, output signal will be undesirable distortion caused by too large input and power supply voltage down with battery, and clipped output signal may cause permanent damage to the speaker. The traditional NCN function adjusts system gain automatically to generate desired output by detecting the "Crack" distortion of output signal, makes the output audio signal maintain smooth, not only can effectively avoid overloading output power to the damage of speaker, at the same time bring the constant shock of high quality music enjoyment. The traditional NCN function is shown below in figure 7.

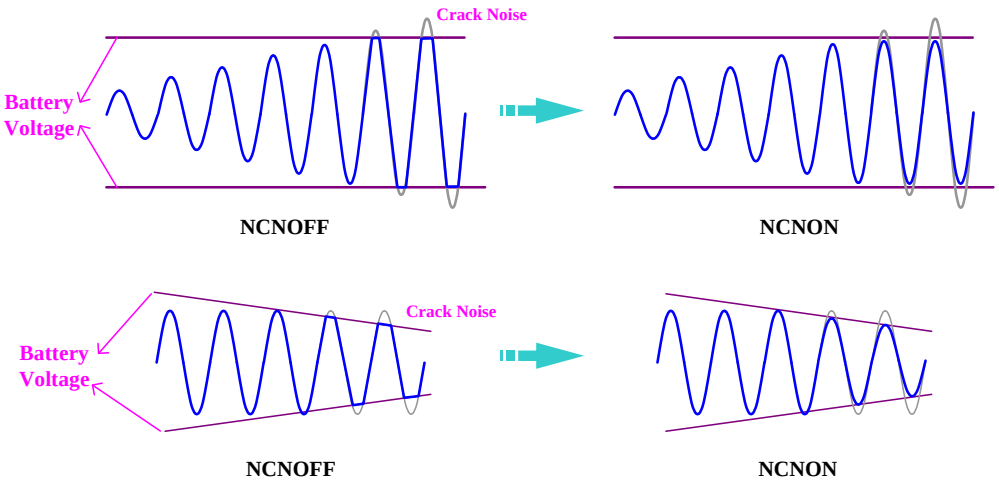


Figure 7 Traditional NCN Operation Principle

AW8738 adopts Awinic unique second generation NCN technology, the output signal is free from limitation of power rail. When battery voltage drops, NCN output signal will not distort, output amplitude remains unchanged, keeping constant output power, as shown in figure 8. Even if the battery voltage drops, AW8738 can still provide high quality large volume music enjoyment.

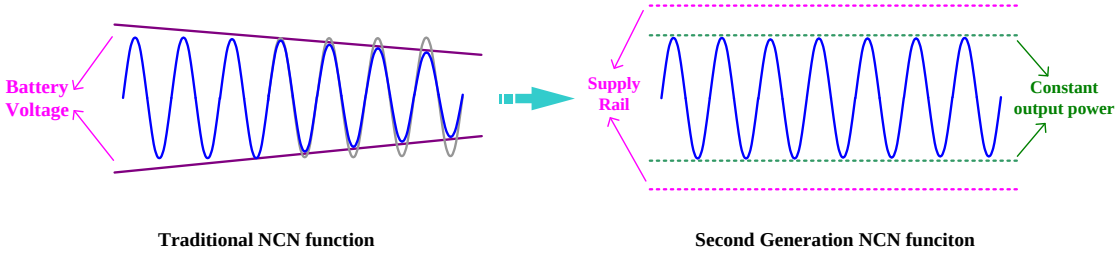


Figure 8 Second generation NCN Operation Principle

Attack time

Attack time is the time it takes for the gain to be attenuated -13.5dB once the audio signal exceeds the NCN threshold. Fast attack times allow the NCN to react quickly and prevent transients such as symbol crashes from being distorted. However, fast attack times can lead to volume pumping, where the gain reduction and release becomes noticeable, as the NCN cycles quickly. Slower attack times cause the NCN to ignore the fast transients, and instead act upon longer, louder passages. Selecting an attack time that is too slow can lead to increased distortion in the case of the No Clip function. According to mobile phone and portable equipment audio features, attack time of AW8738 is set to be 40ms, effectively keeping the music rhythm, and at the same time eliminating the crack distortion, protecting the speaker.

Release time

Release time is the time it takes for the gain to return to its normal level once the audio signal returns below the NCN threshold. A fast release time allows the NCN to react quickly to transients, preserving the original dynamics of the audio source. However, similar to a fast attack time, a fast release time contributes to volume pumping. A slow release time makes the music smooth and soft, it is better to suppress the crack distortion, but longer release time will make music sounds “boring” ,lack of impact. According to mobile phone and portable equipment audio features, release time of AW8738 is set to be 1.2s.

Multi-level AGC technology

In the actual audio application, system output power tends to be more than rated power of speaker, such as in the 5V power supply, as for 8ohms speaker, the maximum undistorted power is about 1.56W, but many speakers' rated power is about 0.5W, if there is no output power control, the overload signal can cause damage to the speaker. The audio power amplifier with NCN function (that is single-level AGC) can protect the speaker effectively, with the increase of input signal, the output power increases. When output power exceeds the setting threshold, the NCN function reduces the internal gain of amplifier and restricts the output power under the set threshold.

But the NCN function has the attack time setting, which is the tradeoff between auditory effect and crack distortion noise, if the attack time is longer, the audio volume will be greater, but crack distortion will also increase; if the attack time is shorter, the crack distortion will decrease, but the audio volume will be reduced. General music has large peak factor, which is in the range of about 40~60dB, when playing music, the big peak signal output exceeds the maximum output amplitude, there will be more crack distortion, and obvious noise will be heard in some music, so it is need to use multi-level AGC technology to dynamically adjust the audio power amplifier, to increase music volume, at the same time, eliminate the emergence of obvious noise in large volume music and improve sound quality.

AW8738 integrated Awinic proprietary multi-Level AGC algorithm technology, effectively eliminating the noise in the music, make sound pure natural, and greatly enhancing the sound volume. The single-level AGC function and multi-level AGC function is shown in figure 9.

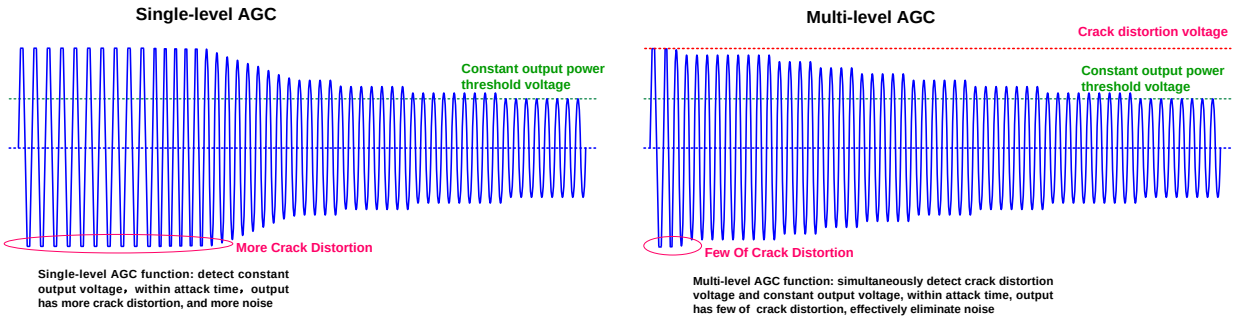


Figure 9 Single-level AGC/Multi-level AGC Operation Principle

Attack time

Attack time is the time multi-level AGC takes for the gain to be attenuated -13.5dB once the audio signal exceeds the constant output power threshold voltage. When the output signal crack noise occurred, the Fast AGC of Multi-level AGC launched, attenuated the gain with 10dB within 1.5ms. When the crack noise eliminated, the Slow AGC of Multi-level AGC launched, attenuated the gain slowly, with 3.5dB within 6ms. According to smart mobile phone music noise features and demands for improve music quality and volume, adoption of the Awinic proprietary technology 'Multi-level AGC' inside AW8738, which keeping the music rhythm effectively, and at the same time eliminating the crack distortion, protecting the speaker.

Release time

Release time is the time multi-level AGC takes for the gain to return to its normal level once the audio signal is smaller than crack distortion voltage or constant output power threshold voltage. According to smart mobile phone music noise features and demands for improve music quality and volume, release time of AW8738 is set to be 280ms, which can effectively eliminate the noise, make music sound pure natural.

K-Chargepump

AW8738 adopts a new generation of charge pump technology：K -Chargepump structure, it has high efficiency and large driving ability, working frequency is 1.1MHz，built in soft start circuit, current limiting control loop and over-voltage-protection(OVP) loop, guaranteeing system stable and reliable operation.

High Efficiency

AW8738 uses K-chargepump structure，booster output voltage PVDD is 1.5 times of supply voltage VDD, the ideal efficiency can reach 100%. K-chargepump efficiency is the ratio of output power to input power, that is

$$\eta = \frac{P_{OUT}}{P_{IN}} * 100\%$$

For example, in an ideal M times charge pump, the input current I_{IN} is M times of output current I_{OUT}，the efficiency formula can be written as：

$$\eta = \frac{P_{OUT}}{P_{IN}} * 100\% = \frac{V_{OUT} * I_{OUT}}{V_{IN} * M * I_{OUT}} * 100\% = \frac{V_{OUT}}{M * V_{IN}} * 100\%$$

M is charge pump work mode variable (1.5 times), VOUT is charge pump output voltage, VIN is power supply voltage, IOUT is load current. For K-chargepump, the output voltage is 1.5 times of the input voltage, due to the charge pump internal switch loss and IC static current loss, the actual efficiency will be up to 93%. Therefore, K-chargepump booster technology can greatly improve the power efficiency.

Charge Pump Structure

Figure 10 is charge pump basic principle diagram, the charge pump used in AW8738 has seven switches, the output voltage PVDD is 1.5 times as input voltage VDD through seven switches timing control.

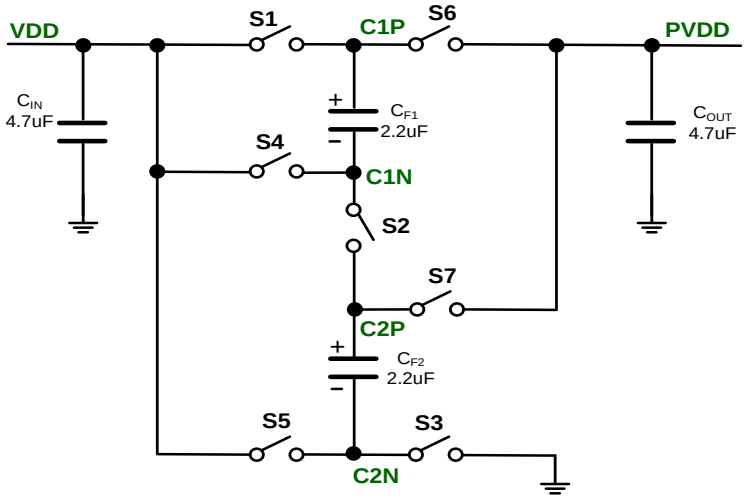


Figure 10 Charge Pump Principle Diagram

The operation of the charge pump has two phases. In Φ 1, as shown in figure 11, swtiches S1, S2 and S3 are closed, VDD charges to the flying capacitor CF1 CF2.

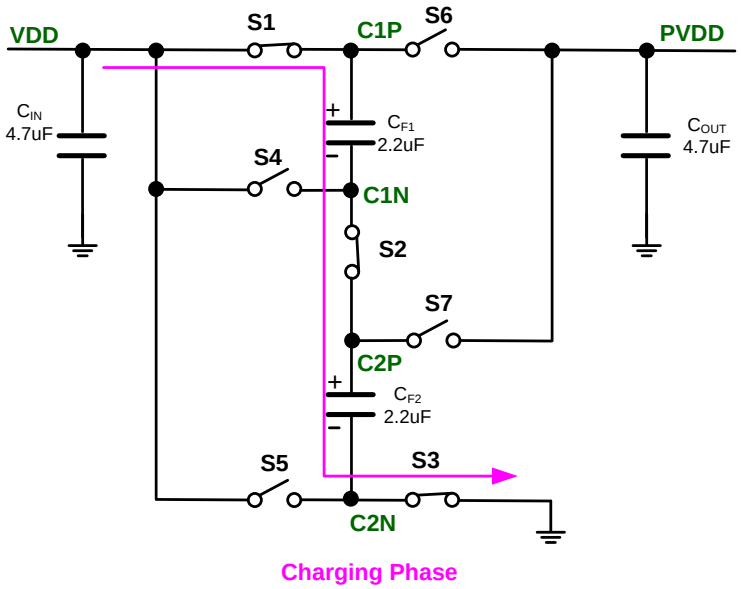


Figure 11 Φ1: Flying Capacitor Charging

In Φ 2, as shown in figure 12: switches S1, S2 and S3 are disconnected, switches S4, S5, S6 and S7 are closed. Because the voltage across the capacitor can't mutation, so the voltage on flying capacitor CF1 CF2, is added to the VDD, which make PVDD risen to a higher voltage.

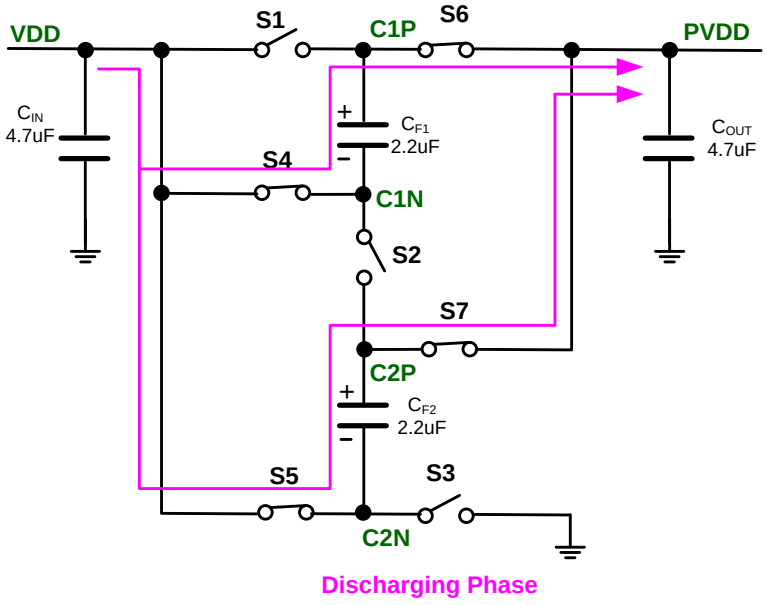


Figure 12 Φ2： Flying capacitor charge transfer to the output capacitance C_{OUT}

Soft start

K-chargepump has integrated soft start function in order to limit supply power inrush current during start-up. The supply current is limited to be 350 mA, and the soft start time is 1.2 ms.

Current Limitation Control

K-chargepump has integrated the current limitation control loop. In normal operation, when the heavy load or a situation that make charge pump flow through very large current, the current limitation control loop will control charge pump maximum output current capacity, that is 2A.

Over Voltage Protection(OVP)Control

K-chargepump's output voltage PVDD is a multiple of the input voltage VDD, which provide a high voltage rail for internal power amplifier circuits, allowing the amplifiers provide greater output dynamic range in the lithium battery voltage range, so as to realize the large volume, high quality class K audio enjoyment. K-chargepump has integrated the over voltage protection control loop, when the input voltage VDD is greater than 4V, the output voltage PVDD is no longer a multiple of VDD, but is controlled by over voltage protection(OVP) loop and is stable in 6.05V, and the hysteresis voltage is about 50mV.

One-wire pulse control

One wire pulse control technology only needs a single GPIO port to operate the chip, complete a variety of functions, it is very popular in the area of the GPIO port shortage and portable systems.
When the control signal line is longer, because of the signal integrity or radio frequency interference problem, it will produce the narrow glitch signal. Awinic one wire pulse control technology integrated the Deglitch circuit in internal control pin, which can effectively eliminate the influence of the glitch signal, as shown in figure 13.

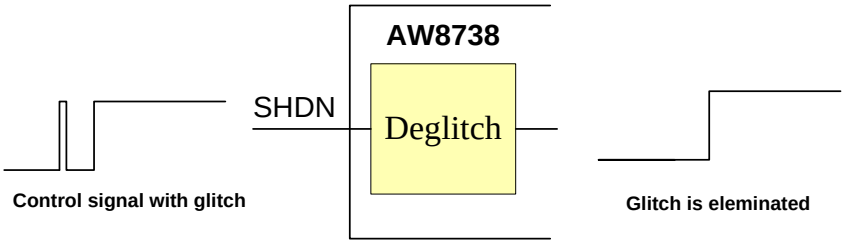


Figure 13 Awinic Deglitch function diagram

The traditional one wire pulse control technology still receives pulse signal from control port when chip is startup, so when the master control chip (such as mobile phone BB) sends wrong pulse during normal operation, the system will enter into error states. AW8738 uses one wire pulse latch technology, after the master control chip has sent pulses, the state will be latched, no longer receive the latter mis-sending pulse signals, as shown in figure 14.

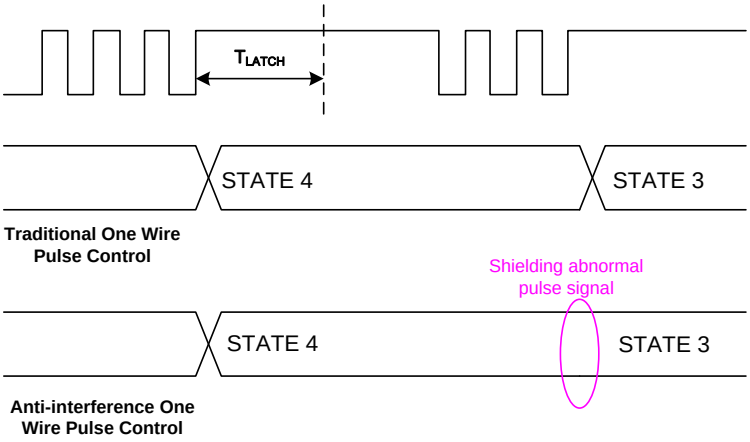


Figure 14 Anti-interference One Wire Pulse Control Function Diagram

One Wire Pulse Control

AW8738 select each mode through the detection of number of the pulse signal rising edge of SHDN pin, as shown in figure 15: When SHDN pin pull high from shutdown mode, there is only a rising edge, AW8738 enter into mode 1,NCN output power is 1.2W; When high-low-high signal set to SHDN pin, there

are two rising edges, AW8738 enter into mode 2, NCN output power is 1W; When there are three rising edges, AW8738 enter into mode 3,NCN output power is 0.8W; When there are four rising edges, AW8738 enter into mode 4, NCN output power is 0.6W…; AW8738 has seven operation modes, the number of the rising edges does not allow more than seven.

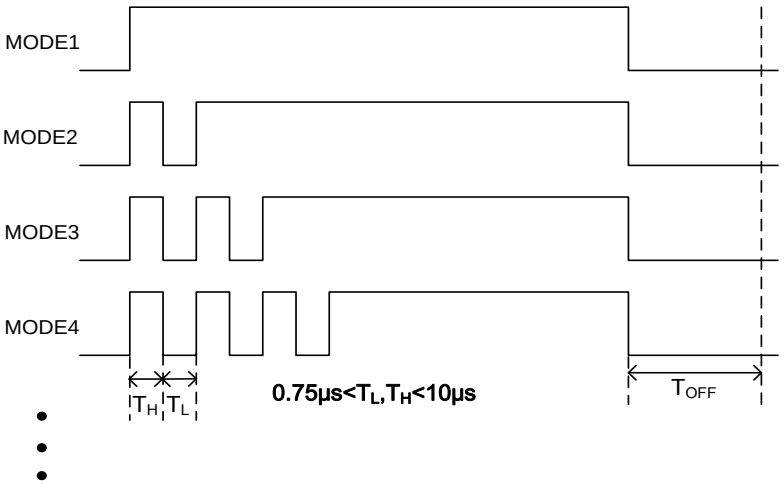


Figure 15 One Wire Pulse Control

When AW8738 needs to work in different mode, PIN SHDN should be pull low longer than T_{OFF} first(recommended 1ms) which make the AW8738 shut down, Then send series pulse make the AW8738 enter into right mode, as shown in figure 16.

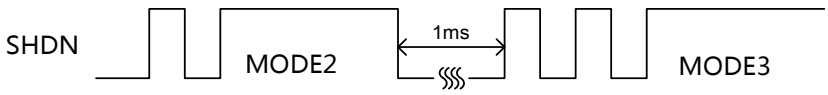


Figure 16 One Wire Pulse Control Switching Sequence

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 AW8738'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 AW8738. 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 AW8738. 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 AW8738 features a unique RNS technology, which effectively reduces RF energy, attenuate the RF TDD-noise, an acceptable audible level to the customer.

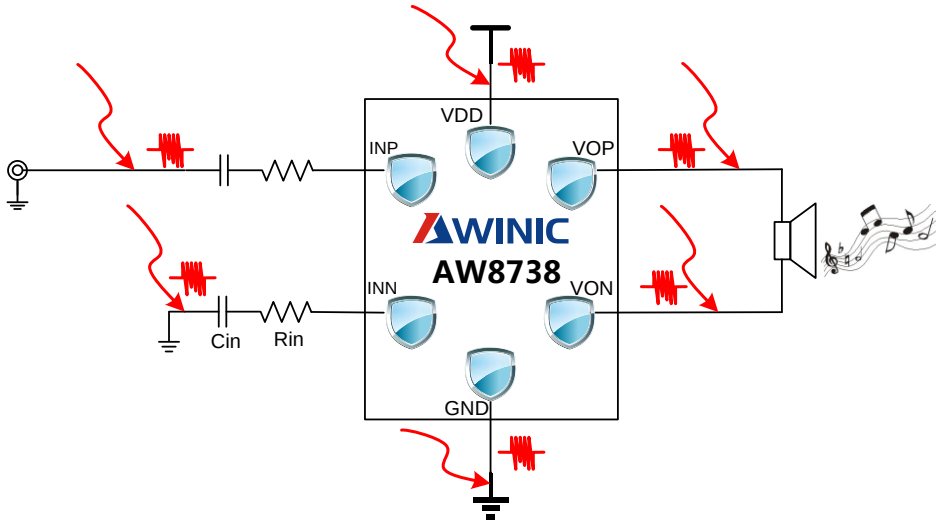


Figure 17 RF Radiation coupling schematic diagram

Filter-Free Modulation Scheme

The AW8738 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.

EEE

The AW8738 features a unique Enhanced Emission Elimination (EEE) technology, that controls fast transition on the output, greatly reduces EMI over the full bandwidth.

Pop-Click Suppression

The AW8738 features unique timing control circuit, that comprehensively suppresses pop-click noise, eliminates audible transients on shutdown, wakeup, and power-up/down.

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 AW8738 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.

APPLICATION INFORMATION

External Input Resistor-R_{ine}（Gain setting）

The AW8738 is a differential audio amplifier. The IC integrates two internal input resistors, which is R_{ini}=6.6kΩ. Take external input resistor R_{ine}=3kΩ for an example, gain setting as follows：

$$A_V = \frac{159.5k\Omega}{R_{ine} + R_{ini}} = \frac{159.5k\Omega}{3k\Omega + 6.6k\Omega} = 16.6V/V$$

Input Capacitor-C_{in}（input high-pass cutoff frequency）

The input coupling capacitor blocks the DC voltage at the amplifier input terminal. The input capacitors and input resistors form a high-pass filter with the corner frequency:

$$f_H(-3dB) = \frac{1}{2*\pi*R_{intotal}*C_{in}}(Hz)$$

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 helps to suppress pop-click noise.

Take typical application in Figure 1 as an example:

$$f_H(-3dB) = \frac{1}{2*\pi*R_{intotal}*C_{in}}(Hz) = \frac{1}{2*\pi*9.6k\Omega*33nF}(Hz) = 502Hz$$

Differential input filter capacitor Cd (input low-pass cutoff frequency)

Input differential input filter capacitor and input resistor together to form a low-pass filter, could be used to attenuate high frequency components of the input signal. When the musical sounds screechy, this low-pass filter can be appropriately attenuate the high frequency part of the input signal, so that the music signal sounds soft and comfortable. -3dB cutoff frequency of the low-pass filter is as follows:

$$f_L(-3dB) = \frac{1}{2*\pi*(R_{ini}//R_{ine})*2*C_d}(Hz)$$

With input resistance Rine = 3kΩ, differential capacitance 220pF,for example, the low-pass cutoff frequency is as follows:

$$f_L(-3dB) = \frac{1}{2*\pi*(R_{ini}//R_{ine})*2*C_d}(Hz) = \frac{1}{2*\pi*2.06k\Omega*2*220pF}(Hz) = 175.7kHz$$

Supply Decoupling Capacitor（C_S）

The AW8738 is a high-performance audio amplifier that requires adequate power supply decoupling. Place a low equivalent-series-resistance (ESR) ceramic capacitor, typically 0.1μF. This choice of capacitor and placement helps with higher frequency transients, spikes, or digital hash on the line. Additionally, placing this decoupling capacitor close to the AW8738 is important, as any parasitic resistance or inductance between the device and the capacitor causes efficiency loss. In addition to the 0.1μF ceramic capacitor, place a 10μF capacitor on the VBAT supply trace. This larger capacitor acts as

a charge reservoir, providing energy faster than the board supply, thus helping to prevent any droop in the supply voltage.

Flying Capacitor（C_F）

The value of the flying capacitor (C_F) affects the load regulation and output resistance of the charge pump. A C_F value that is too small degrades the device's ability to provide sufficient current drive. Increasing the value of C_F improves load regulation and reduces the charge pump output resistance to an extent. A 2.2μF@10V capacitor is recommended.

Output Capacitor（C_{OUT}）

The output capacitor value and ESR directly affect the ripple at PVDD. Increasing C_{OUT} reduces output ripple. Likewise, decreasing the ESR of C_{OUT} reduces both ripple and output resistance. A 4.7μF@10V capacitor is recommended.

Optional Ferrite Bead Filter

The AW8738 passed FCC and CE radiated emissions with no ferrite chip beads and capacitors. 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.

In the K class mode, the output is a square wave signal, which causing switch current at the output capacitor, increasing static power consumption, and therefore output capacitor should not be too large, 1nF ceramic capacitors is recommended.

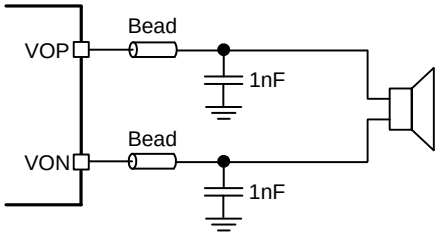
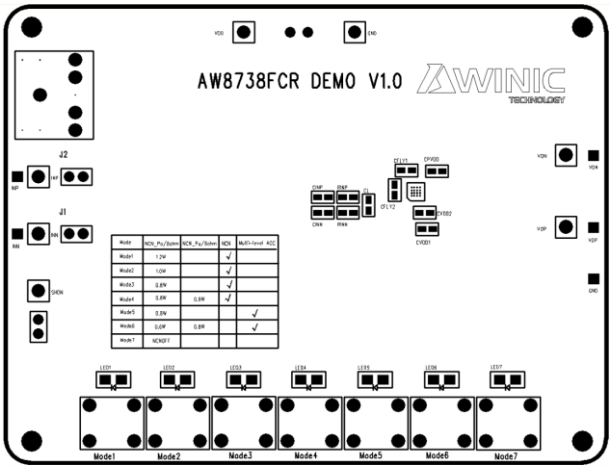
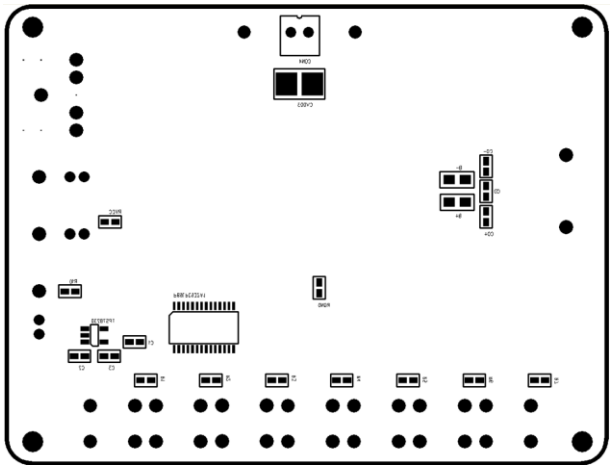


Figure 18　Ferrite Chip Bead and capacitor

DEMO PCB

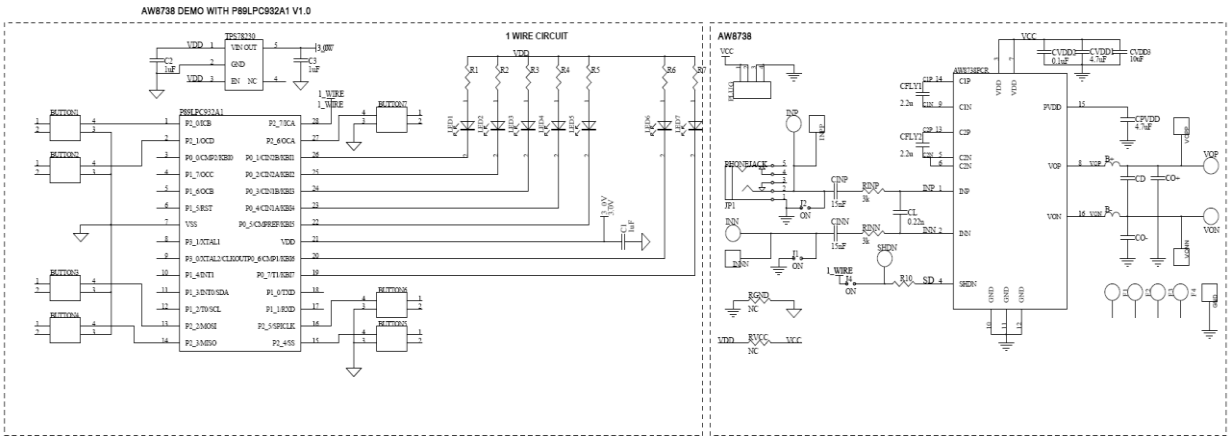


Top Layer



Bottom Layer

DEMO PCB SCHEMATIC



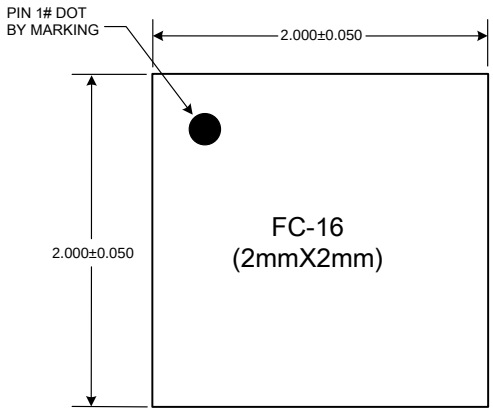
PCB AND DEVICE LAYOUT CONSIDERATION

In order to obtain excellent performance of AW8738, PCB layout must be carefully considered. The design consideration should follow the following principles:

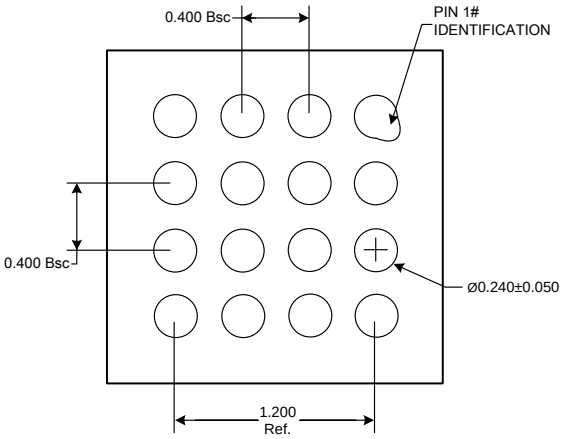
1. Try to provide a separate short and thick power line to AW8738, the copper width is recommended to be larger than 0.75mm. The decoupling capacitors should be placed as close as possible to power supply pin.
2. The flying capacitors C_{F1}, C_{F2} should be placed as close as possible to C1N, C1P and C2N, C2P, so the same to the output capacitor C_{OUT}, it should be close to PVDD pin. The connection from capacitor to PVDD pin should be short and thick.
3. The input capacitors and resistors should be close to AW8738 INN and INP input pin, the input line should be parallel to suppress noise coupling.
4. The beads and capacitor should be placed near to AW8738 VON and VOP pin. The output line from AW8738 to speaker should be as short and thick as possible. The width is recommended to be larger than 0.5mm.

PACKAGE DESCRIPTION

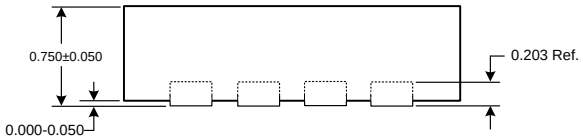
TOP VIEW



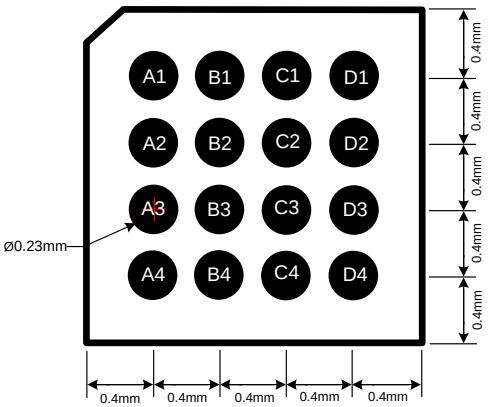
BOTTOM VIEW



SIDE VIEW



LAND PATTERN

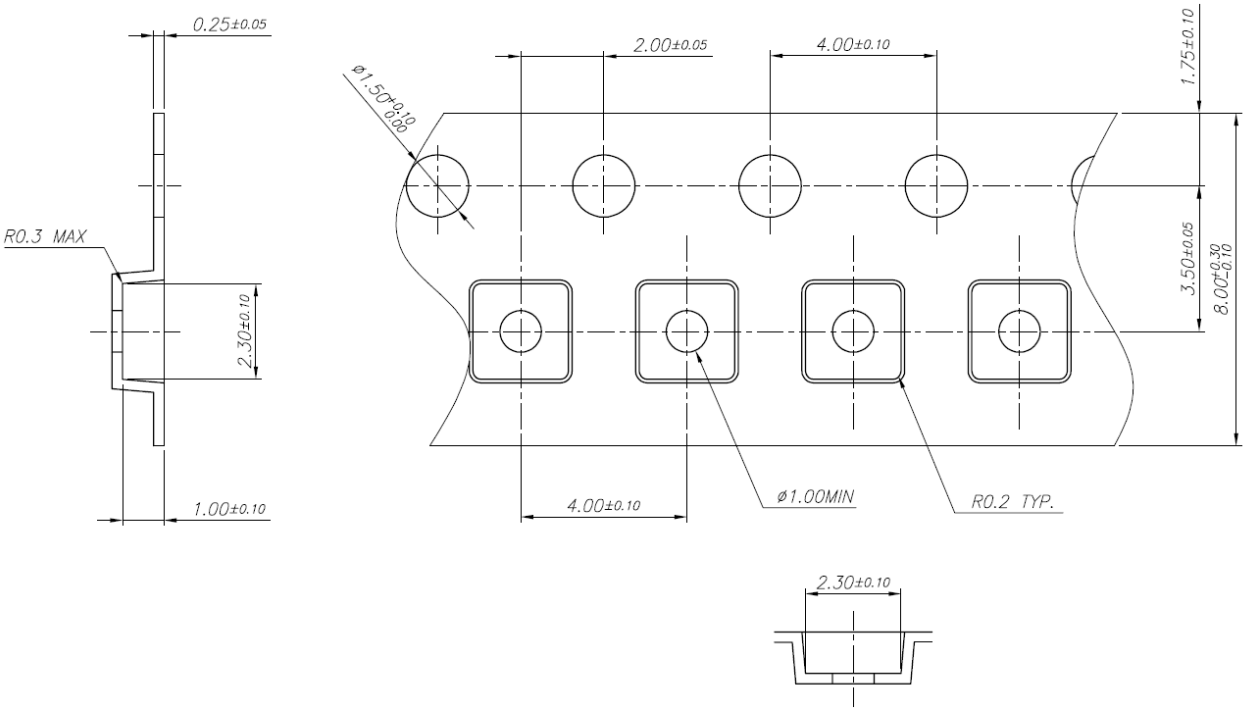


FC-16

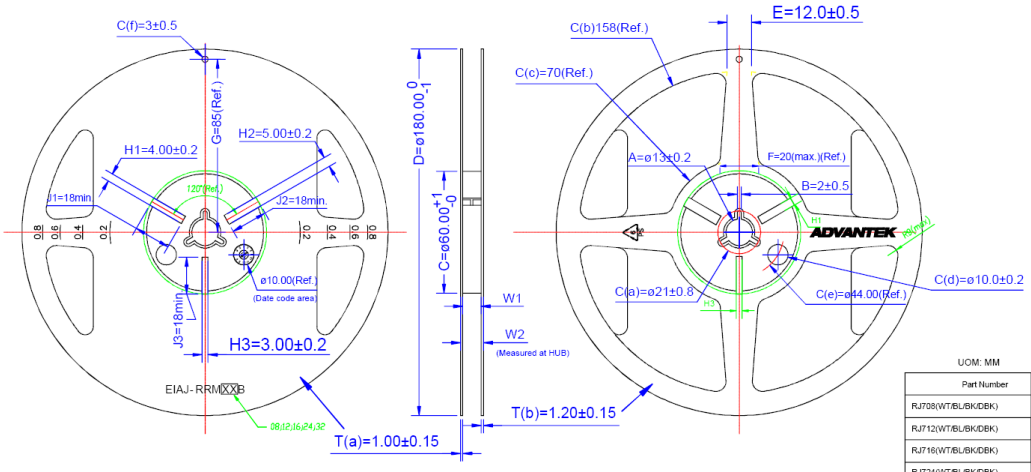
Unit: mm

TAPE&REEL DESCRIPTION

Carrier Tape



Reel



UOM: MM

Part Number	HUB (Width)	W1 +1 -0	W2 +1 -0
RJ708(WT/BL/BK/DBK)	8	9	11.4
RJ712(WT/BL/BK/DBK)	12	13	15.4
RJ716(WT/BL/BK/DBK)	16	17	19.4
RJ724(WT/BL/BK/DBK)	24	25	27.4
RJ732(WT/BL/BK/DBK)	32	33	35.4

Notes:
1. Suffix with "WT" : standard for White Reel
2. Suffix with "BL" : standard for Blue Reel
3. Suffix with "BK" : standard for Black Reel
4. Suffix with "DBK": conductive black with1 X 10E5 ohms/sq ≤ SR <1 X 10E9 ohms/sq
5. Please refer to Tech bulletins for related property
6. Dimension unit: mm

VERSION INFORMATION

Version	Date	Description
V1.0	2014-05-03	AW8738FCR datasheet V1.0
V1.1	2015-06-16	Add tape & reel description; change C1 to Cd in application diagram;