

High efficiency, Low noise, Ultralow distortion, Constant large volume, Upgrade Seventh generation Class K Audio Amplifier

FEATURES

- ◆ Low noise: 53 μ V
- ◆ Power amplifier overall efficiency 80%
- ◆ Ultra-low distortion: 0.008%
- ◆ Within Lithium battery voltage range, output power is maintained constant
- ◆ Selectable speaker-guard power level: 0.6W, 0.8W, 1W, 1.2W
- ◆ No-crack-noise (NCN) technology
- ◆ Super TDD-Noise suppression
- ◆ Excellent pop-click suppression
- ◆ One wire pulse control
- ◆ High PSRR: -68dB (217Hz)
- ◆ ESD protection: \pm 6kV (HBM)
- ◆ Small 0.4mm pitch 1.6mm \times 1.68mm CSP-14package

APPLICATIONS

- ◆ Smart phone

DESCRIPTION

AW8737S is designed to enhance smart mobile phone sound quality, which is a new high efficiency, low noise, ultra-low distortion, constant large volume, upgrading seventh generation class K audio amplifier. Using a new generation K-Chargepump technology, efficiency reaches 93%, power amplifier's overall efficiency is up to 80%, greatly prolong the mobile phone usage time. The AW8737S noise floor is as low as to 53 μ V, with 97dB high signal-to-noise-ratio(SNR). The ultra-low distortion 0.008% and unique no-crack-noise (NCN) technology brings high quality music enjoyment.

AW8737S has 0.6W, 0.8W, 1W and 1.2W four selectable speaker-guard output power levels, recommended using rated power of 0.5W and above speakers. AW8737S integrated unique NCN technology, the output power cannot drop along with lithium battery voltage lower down. Within lithium battery voltage range (3.3V--4.35V), output power is constant, preventing the voice becomes smaller and smaller during usage of cell phone.

The AW8737S uses Awinic proprietary TDD-Noise suppression technology and EMI suppression technology, effectively restrain TDD-Noise and EMI interference.

AW8737S has built-in over current protection, over-temperature protection and short circuit protection function, effectively protect the chip. The AW8737S uses small 0.4mm pitch 1.6mm \times 1.68mm CSP-14 package.

APPLICATION DIAGRAM

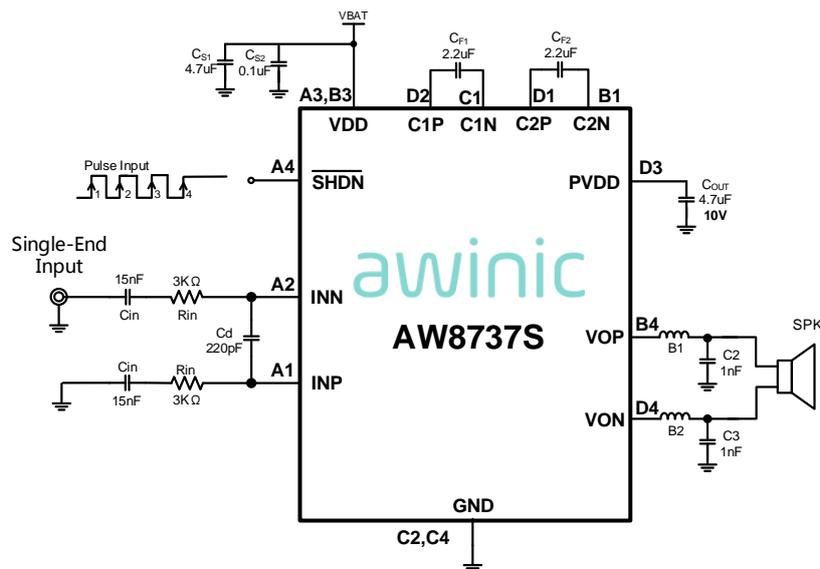


Figure 1 AW8737S single-ended input application diagram

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PIN CONFIGURATION AND TOP MARK

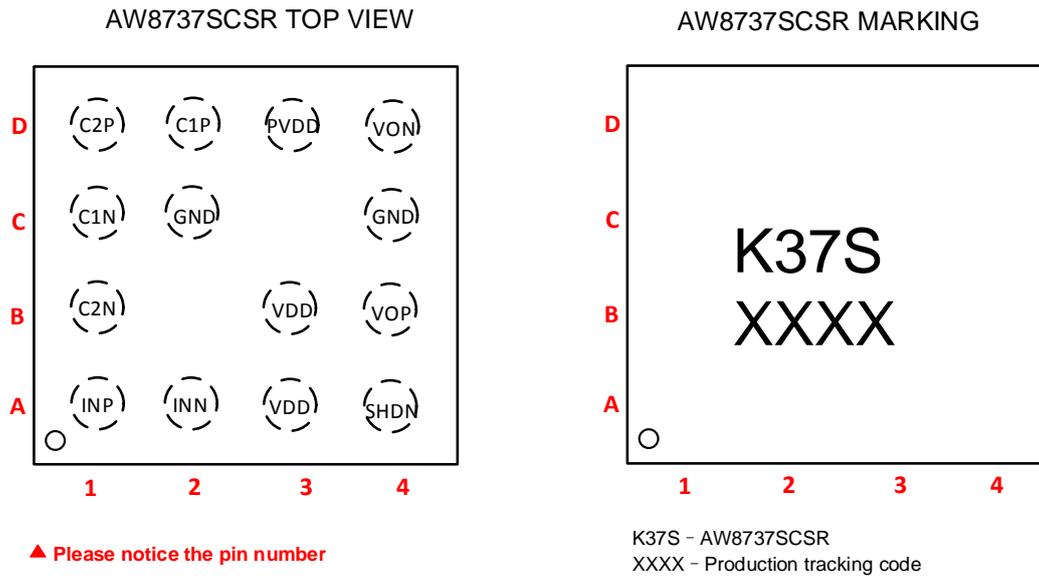


Figure 2 AW8737S pin diagram top view and device marking

PIN DESCRIPTION

Number	Symbol	Description
A1	INP	Positive audio input terminal
A2	INN	Negative audio input terminal
A3	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
B3	VDD	Power supply
B4	VOP	Positive audio output terminal
C1	C1N	Negative side of the external charge pump flying capacitor C1
C2, C4	GND	Ground
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	AW8737S	AW8738
PVDD(V)	VDD=4.2V	5.8	6.05	6.05	6.05
Ouput noise(μ V)	VDD=4.2V, f=20Hz to 20kHz, input ac grounded, 8V/V,A-weighting	125	52	53	40
Efficiency(%)	V _{DD} =3.6V, P _O =1.0W, R _L =8 Ω +33 μ H	75	80	80	83

FUNCTIONAL DIAGRAM

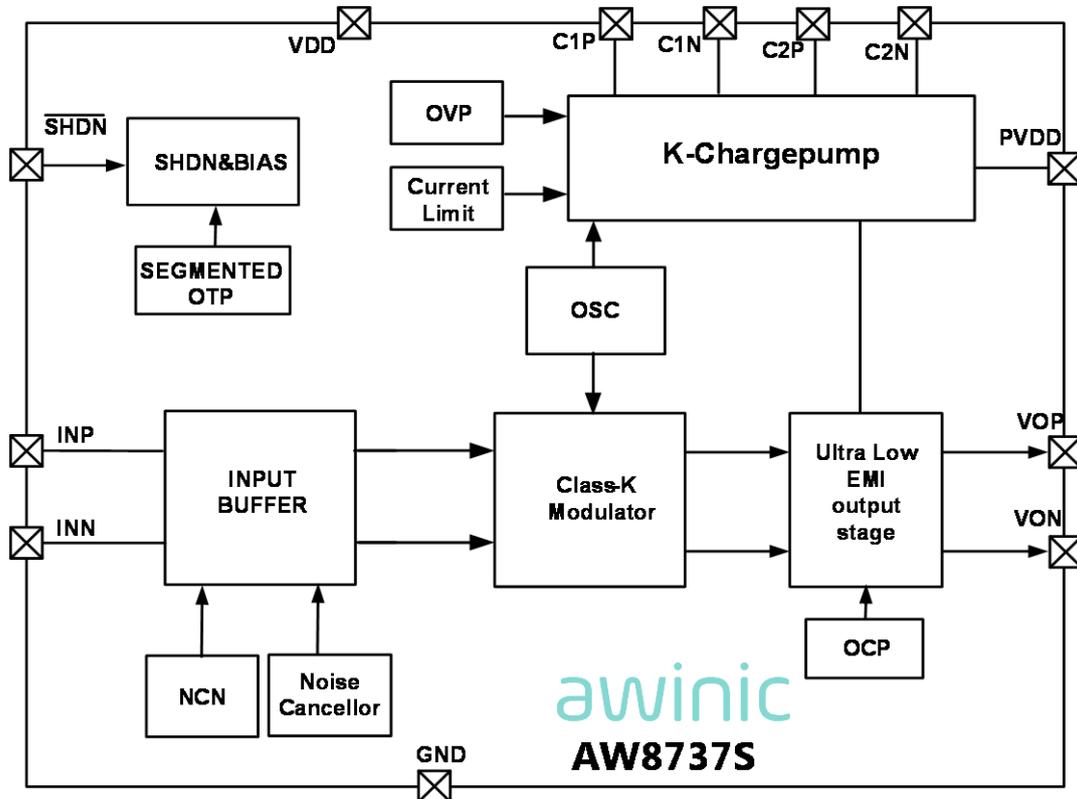


Figure 3 AW8737S functional diagram

APPLICATION DIAGRAM

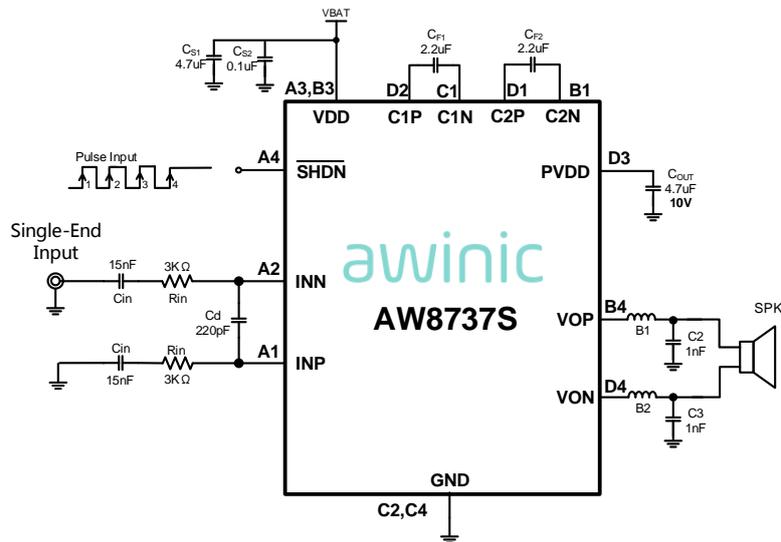


Figure 4 AW8737S single-ended input application diagram (Note 1)

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.

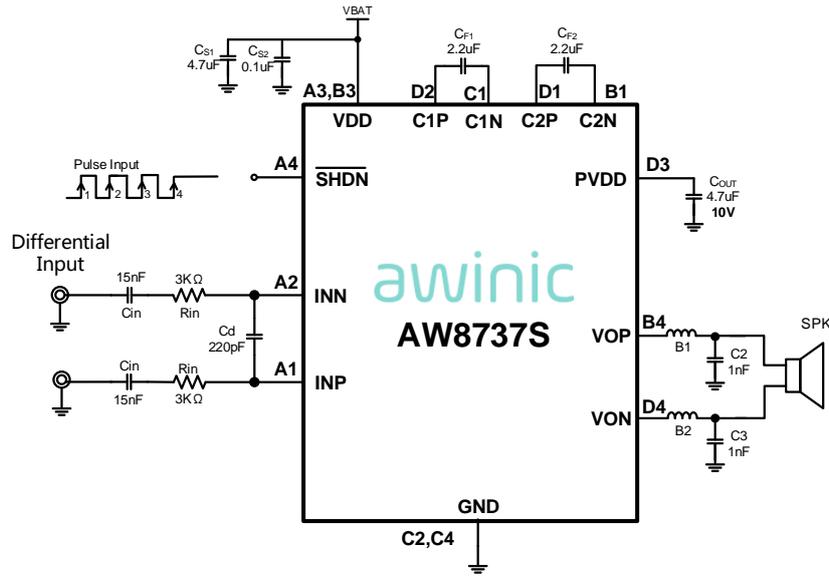
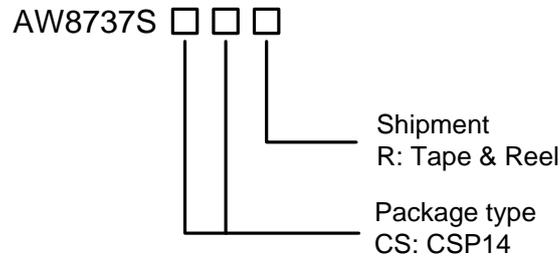


Figure 5 AW8737S differential input application diagram

ORDERING INFORMATION

Product Type	Operation temperature range	Package	Device Marking	Moisture Sensitivity Level	Environmental Information	Delivery Form
AW8737SCSR	-40°C ~ 85°C	CSP-14	K37S	MSL1	ROHS+HF	Tape and Reel 3000 pcs



ABSOLUTE MAXIMUM RATING(Note2)

Parameter	Range
Supply Voltage VDD	-0.3V to 6V
Chargepump output voltage PVDD	-0.3V to 7V
VOP, VON	-0.3V to PVDD+0.3V
C1P, C2P	-0.3V to PVDD+0.3V
C1N, C2N	-0.3V to VDD+0.3V
INP, INN Input Pin Voltage	-0.3V to VDD+0.3V

Package Thermal Resistance θ_{JA}	84.9°C/W
Ambient Temperature Range	-40°C to 85°C
Maximum Junction Temperature T_{JMAX}	165°C
Storage Temperature Range T_{STG}	-65°C to 150°C
Lead Temperature (Soldering 10 Seconds)	260°C
ESD Rating ^(Note 3)	
HBM (human body model)	±6KV
CDM	±1.5KV
MM	±250V
Latch-up	
Test Condition: JEDEC STANDARD NO.78D NOVEMBER 2011	+IT: 450mA -IT: -450mA

Note 2: 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.

Note 3: 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

MODE DESCRIPTION (TA=25°C, VDD=4.2V)

AW8737S audio amplifier outer input capacitor is C_{in} , outer input resist is R_{in} , inner input resist is 16.6KΩ, gain A_v is $319.5K/(R_{in}+16.6K)$. Recommended typical application is:

- 1、 $C_{in}=15nF$, $R_{in}=3K\Omega$, $A_v=16.3V/V$;
- 2、 $C_{in}=15nF$, $R_{in}=10K\Omega$, $A_v=12V/V$;

Mode	Enable Signal	Gain (V/V)		NCN Power (W)		NCN Function
		$R_{in}=3K\Omega$	$R_{in}=10K\Omega$	$R_L=8\Omega+33\mu H$	$R_L=6\Omega+33\mu H$	
Mode1		16.3	12	1.2	1.6	√
Mode2		16.3	12	1	1.3	√
Mode3		16.3	12	0.8	1.0	√
Mode4		16.3	12	0.6	0.8	√

ELECTRICAL CHARACTERISTICSTest condition: $T_A=25^{\circ}\text{C}$, $V_{DD}=3.6\text{V}$, $R_L=8\Omega+33\mu\text{H}$, $f=1\text{kHz}$ (unless otherwise noted)

Parameter		Test conditions	Min	Typ	Max	Units
V_{DD}	Power supply voltage		3.0		5.5	V
V_{IH}	$\overline{\text{SHDN}}$ high input voltage		1.3		V_{DD}	V
V_{IL}	$\overline{\text{SHDN}}$ low input voltage		0		0.35	V
$ V_{OS} $	Output offset voltage	$V_{in}=0\text{V}$, $V_{DD}=3.0\text{V}$ to 5.5V	-30	0	30	mV
I_{SD}	Shutdown current	$V_{DD}=3.6\text{V}$, $\overline{\text{SHDN}}=0\text{V}$			1	μA
T_{TG}	Thermal AGC start temperature threshold			150		$^{\circ}\text{C}$
T_{TGR}	Thermal AGC exit temperature threshold			130		$^{\circ}\text{C}$
T_{SD}	Over temperature protection threshold			160		$^{\circ}\text{C}$
T_{SDR}	Over temperature protection recovery threshold			120		$^{\circ}\text{C}$
T_{ON}	Start-up time			40		ms
K-Chargepump						
$PVDD$	Output voltage	$V_{DD}=3.0\text{V}$ to 4V		1.5* V_{DD}		V
		$V_{DD}>4\text{V}$		6.05		V
V_{HYS}	OVP hysteresis	$V_{DD}>4\text{V}$		50		mV
F_{CP}	Charge Pump frequency	$V_{DD}=3.0\text{V}$ to 5.5V	0.8	1.06	1.33	MHz
η_{CP}	Charge pump efficiency	$V_{DD}=3.6\text{V}$, $I_{load}=200\text{mA}$		93		%
T_{ST}	Soft-start time	No load, $C_{OUT}=4.7\mu\text{F}$	1	1.2	1.4	ms
I_L	Current limit when $PVDD$ short to ground		200	300	400	mA
Class K power amplifier (Mode1-Mode4)						
I_q	Quiescent current	$V_{DD}=4.2\text{V}$, $V_{in}=0$, no load		10	15	mA
η	Efficiency	$V_{DD}=3.6\text{V}$, $P_o=1.0\text{W}$, $R_L=8\Omega+33\mu\text{H}$		80		%
F_{osc}	Modulation frequency	$V_{DD}=3.0\text{V}$ to 5.5V	600	800	1000	kHz
A_v	gain	external input resistance= $3\text{k}\Omega$		16.3		V/V
V_{in}	Recommend input voltage	$V_{DD}=3.0\text{V}$ to 5.5V			1	Vp
R_{in}	Inner input resistance	Mode1~Mode4		16.6		$\text{k}\Omega$
F_{hin}	Input high pass filter corner frequency	$C_{in}=15\text{nF}$, external input resistance= $3\text{k}\Omega$		542		Hz
P_{ncn}	Mode1 NCN output power	$V_{DD}=4.2\text{V}$, $R_L=8\Omega+33\mu\text{H}$	1.08	1.2	1.32	W
		$V_{DD}=4.2\text{V}$, $R_L=6\Omega+33\mu\text{H}$	1.44	1.6	1.76	W
		$V_{DD}=4.2\text{V}$, $R_L=4\Omega+15\mu\text{H}$	2.16	2.4	2.64	W
		$V_{DD}=4.2\text{V}$, $R_L=3\Omega+15\mu\text{H}$	2.16	2.4	2.64	W
	Mode2 NCN output power	$V_{DD}=4.2\text{V}$, $R_L=8\Omega+33\mu\text{H}$	0.9	1	1.1	W
		$V_{DD}=4.2\text{V}$, $R_L=6\Omega+33\mu\text{H}$	1.17	1.3	1.43	W
$V_{DD}=4.2\text{V}$, $R_L=4\Omega+15\mu\text{H}$		1.8	2	2.2	W	

Parameter		Test conditions		Min	Typ	Max	Units
		V _{DD} =4.2V, R _L =3Ω+15μH		2.16	2.4	2.64	W
P _{ncn}	Mode3 NCN output power	V _{DD} =4.2V, R _L =8Ω+33μH		0.72	0.8	0.88	W
		V _{DD} =4.2V, R _L =6Ω+33μH		0.9	1.0	1.1	W
		V _{DD} =4.2V, R _L =4Ω+15μH		1.44	1.6	1.76	W
		V _{DD} =4.2V, R _L =3Ω+15μH		1.8	2.0	2.2	W
	Mode4 NCN output power	V _{DD} =4.2V, R _L =8Ω+33μH		0.54	0.6	0.66	W
		V _{DD} =4.2V, R _L =6Ω+33μH		0.72	0.8	0.88	W
		V _{DD} =4.2V, R _L =4Ω+15μH		1.08	1.2	1.32	W
		V _{DD} =4.2V, R _L =3Ω+15μH		1.44	1.6	1.76	W
PSRR	Power supply rejection ratio	V _{DD} =4.2V, V _{p-p_sine} =200mV	217Hz		-68		dB
		V _{DD} =4.2V, V _{p-p_sine} =200mV	1kHz		-68		dB
SNR	Signal-to-noise ratio	V _{DD} =4.2V, P _o =1.75W, THD+N=1%, R _L =8Ω+33μH, A _v =8V/V			97		dB
V _n	Output noise voltage	V _{DD} =4.2V, f=20Hz to 20kHz, input ac grounded, A _v =8V/V	A-weighting		53		μVrms
		V _{DD} =4.2V, f=20Hz to 20kHz, input ac grounded, 12V/V			58		μVrms
		V _{DD} =4.2V, f=20Hz to 20kHz, input ac grounded, 16V/V			68		μVrms
THD+N	Total harmonic distortion+noise	V _{DD} =3.6V, P _o =1W, R _L =8Ω+33μH, f=1kHz, Mode1			0.008		%
		V _{DD} =3.6V, P _o =1W, R _L =6Ω+33μH, f=1kHz, Mode1			0.008		%
One wire pulse control							
T _H	$\overline{\text{SHDN}}$ high level duration time	V _{DD} =3.0V to 5.5V		0.75	2	10	μs
T _L	$\overline{\text{SHDN}}$ low level duration time	V _{DD} =3.0V to 5.5V		0.75	2	10	μs
T _{LATCH}	$\overline{\text{SHDN}}$ turn on delay time	V _{DD} =3.0V to 5.5V		150		500	μs
T _{OFF}	$\overline{\text{SHDN}}$ turn off delay time	V _{DD} =3.0V to 5.5V		150		500	μs
NCN <small>(Note 4)</small>							
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

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

MEASUREMENT SETUP

AW8737S 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.

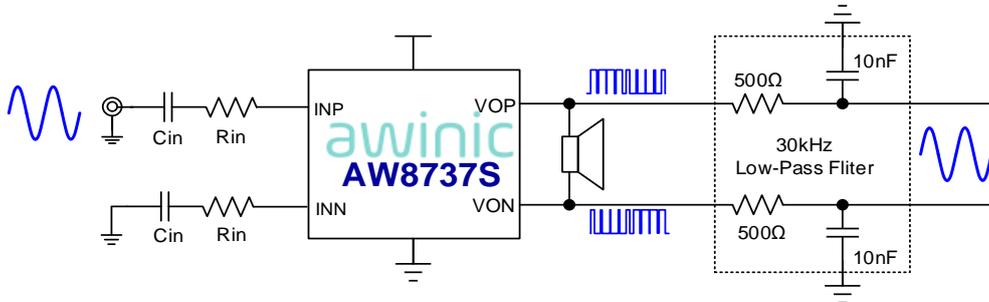


Figure 6 AW8737S test setup

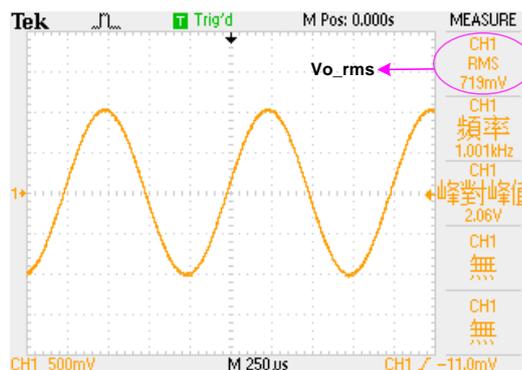
Low pass filter uses resistance and capacitor values listed in Table 1.

R _{filter}	C _{filter}	Low-pass cutoff frequency
500Ω	10nF	32kHz
1kΩ	4.7nF	34kHz

Table 1 AW8737S recommended values for low pass filter

Output Power Calculation

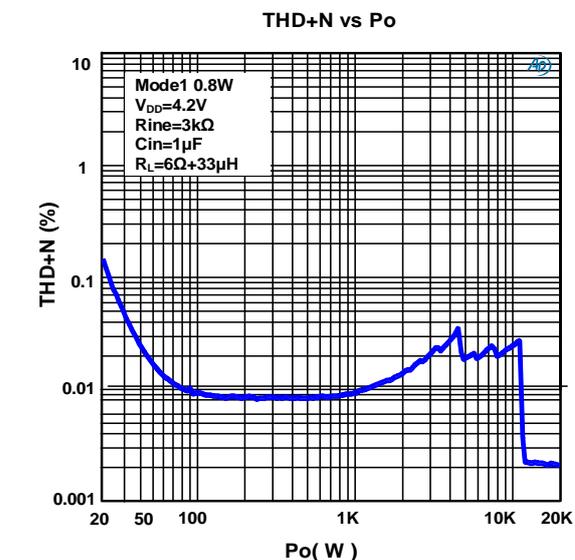
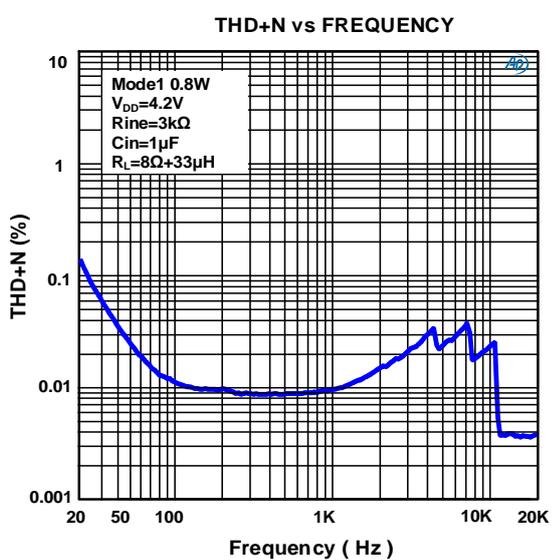
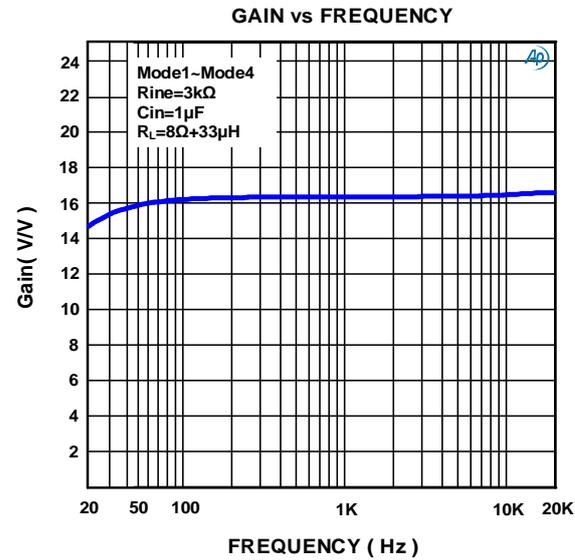
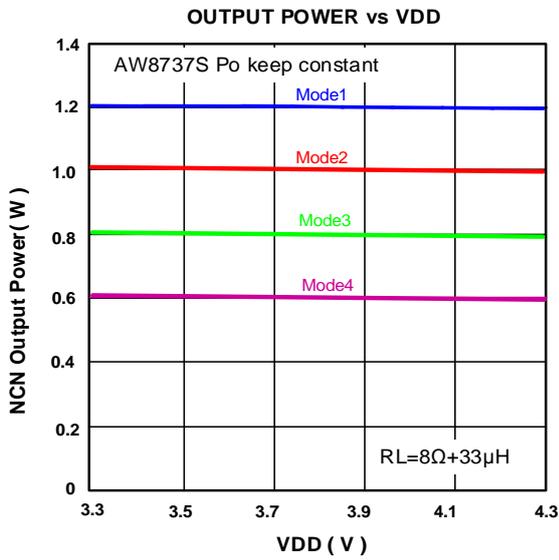
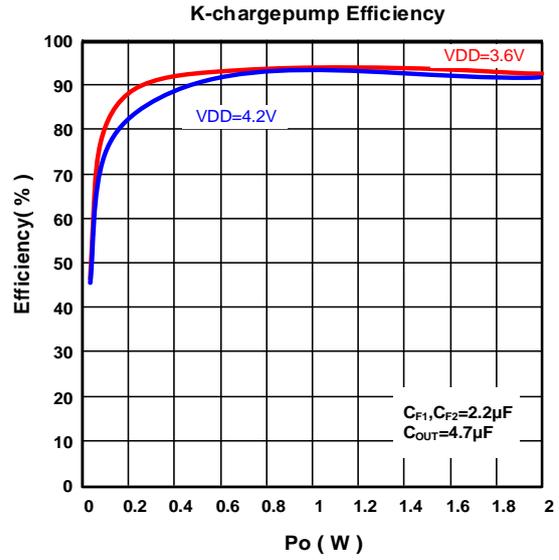
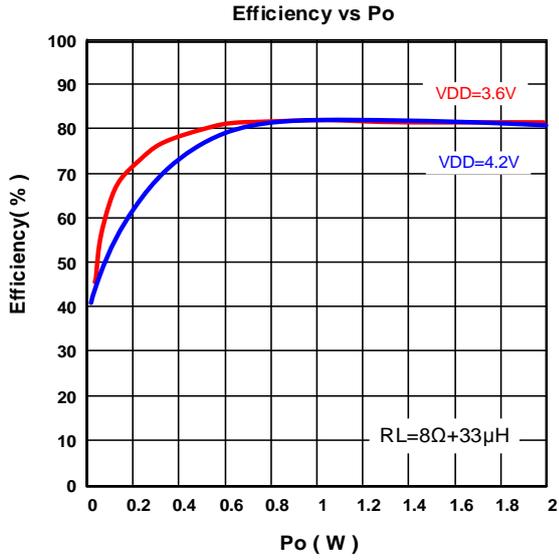
According to the above test methods, the differential analog output signal is obtained at the output of the low pass filter. The valid values Vo_{rms} of the differential signal as shown below:

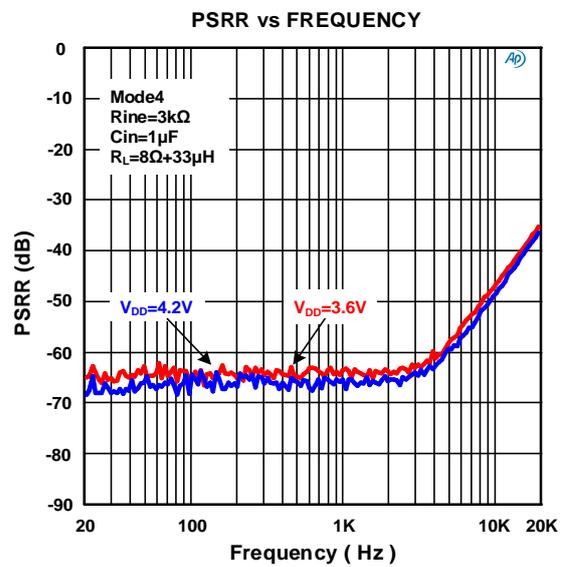
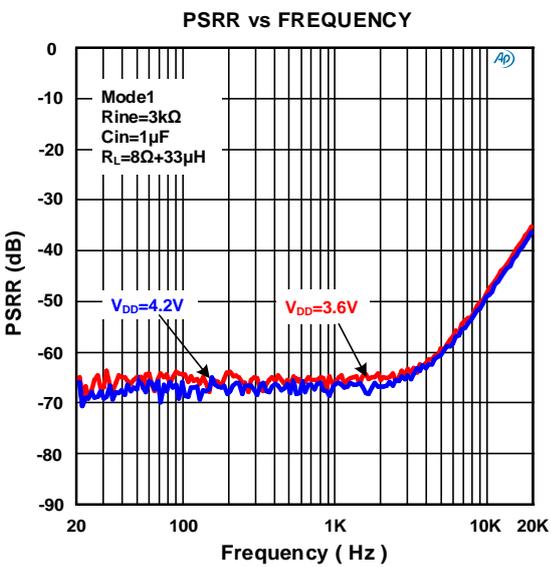
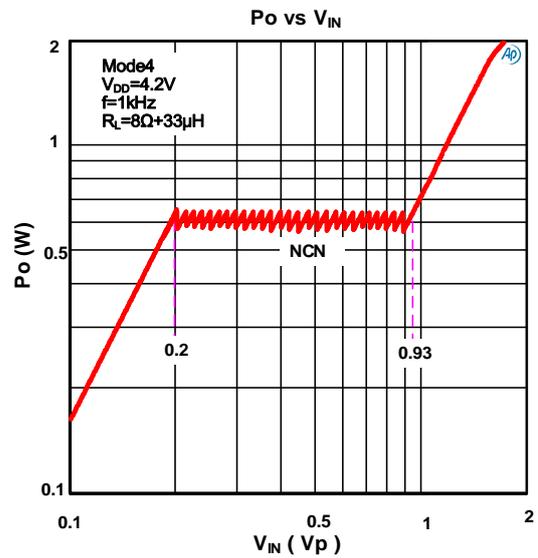
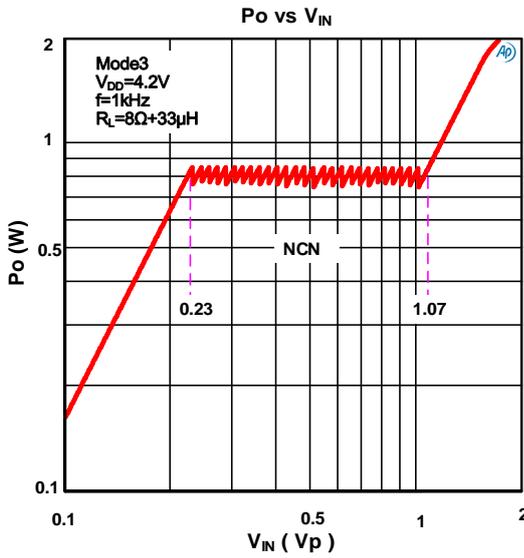
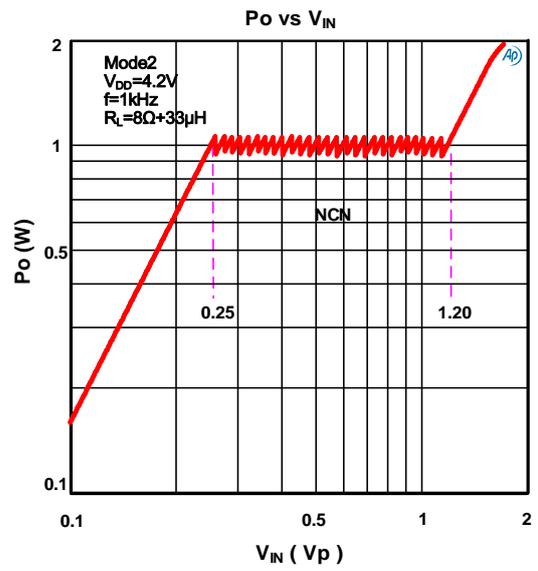
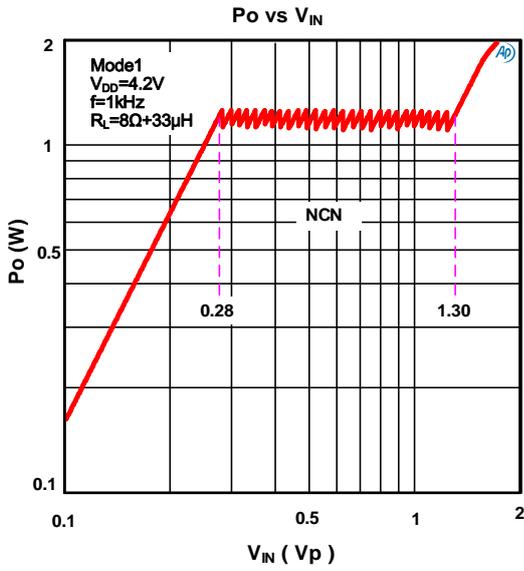


The power calculation of Speaker is as follows:

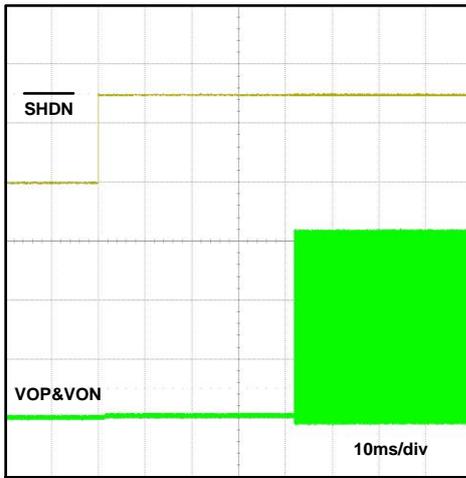
$$P_L = \frac{(V_{o_rms})^2}{R_L} \quad (R_L: \text{load impedance of the speaker})$$

TYPICAL CHARACTERISTICS

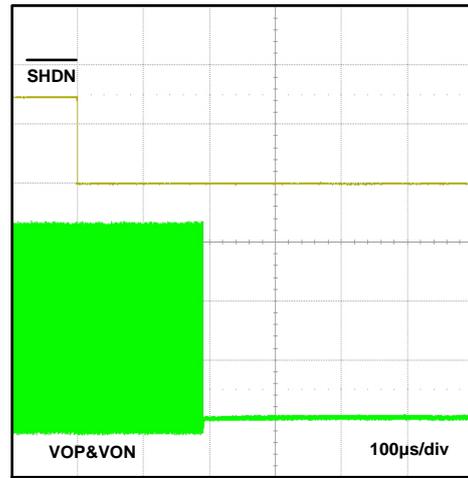




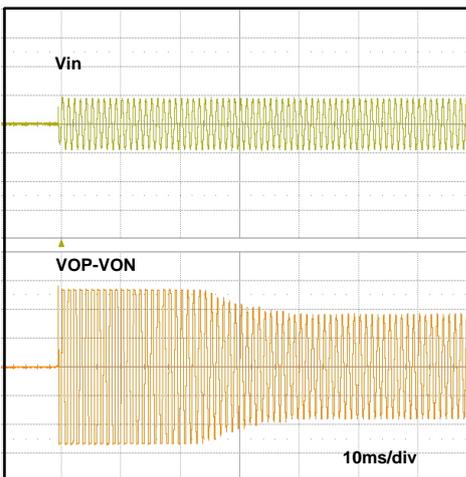
STARTUP SEQUENCE



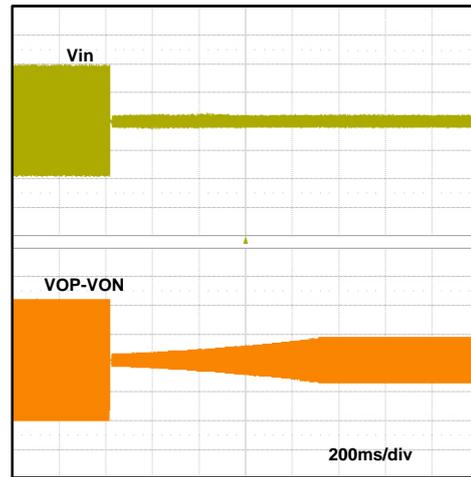
SHUTDOWN SEQUENCE



NCN ATTACK SEQUENCE



NCN RELEASE SEQUENCE



DETAILED FUNCTIONAL DESCRIPTION

AW8737S is designed to enhance smart mobile phone sound quality, which is a new high efficiency, low noise, ultra-low distortion, constant large volume, upgrading seventh generation class K audio amplifier, referred to as K7S. Using a new generation K-Chargepump technology, efficiency reaches 93%, power amplifier's overall efficiency is up to 80%, greatly prolong the mobile phone usage time. The AW8737S noise floor is as low as to 53 μ V, with 97dB high signal-to-noise-ratio(SNR). The ultra-low distortion 0.008% and unique no-crack-noise (NCN) technology brings high quality music enjoyment.

AW8737S has 0.6W, 0.8W, 1W and 1.2W four selectable speaker-guard output power levels, recommended using rated power of 0.5W and above speakers. AW8737S integrated unique NCN technology, the output power cannot drop along with lithium battery voltage lower down. Within lithium battery voltage range (3.3V--4.35V), output power is constant, preventing the voice becomes smaller and smaller during usage of cell phone.

The AW8737S built in excellent pop-click noise suppression circuit, effectively avoids pop-click noise during shutdown, wakeup, and power-up/down operation of AW8737S.

The AW8737S uses awinic proprietary TDD-Noise suppression technology and EMI suppression technology, effectively restrain TDD-Noise and EMI interference.

AW8737S has built-in over current protection, over-temperature protection and short circuit protection function, effectively protect the chip. The AW8737S uses small 0.4mm pitch 1.6mmx1.68mm CSP-14 package. The AW8737S is specified over the industrial temperature range of -40°C to 85°C.

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 AW8737S 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, AW8737S can still provide high quality large volume music enjoyment. AW8737S has four operation modes, the four modes have NCN function, the output power level is 1.2W,1W,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.

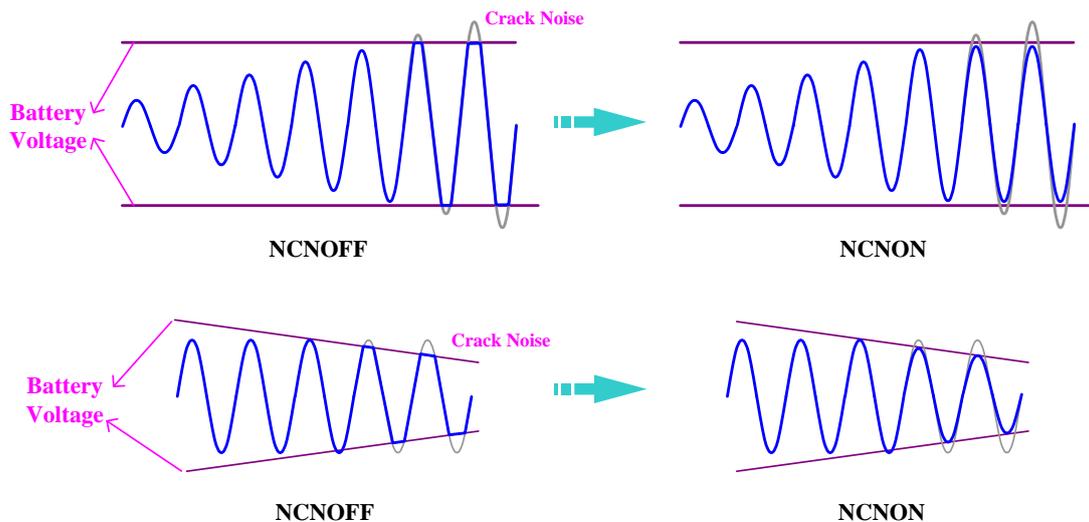


Figure 7 Traditional NCN Operation Principle

AW8737S 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, AW8737S can still provide high quality large volume music enjoyment.

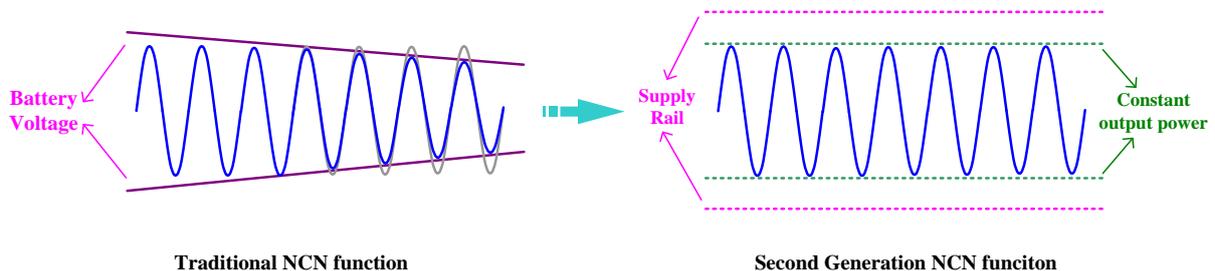


Figure 8 Second generation NCN Operation Principle

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 AW8737S 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 AW8737S is set to be 1.2s.

K-Chargepump

AW8737S 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

AW8737S 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 chargepump, 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), V_{OUT} is charge pump output voltage, V_{IN} is power supply voltage, I_{OUT} 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 9 is charge pump basic principle diagram, the charge pump used in AW8737S has seven switches, the output voltage PVDD is 1.5 times as input voltage VDD through seven switches timing control.

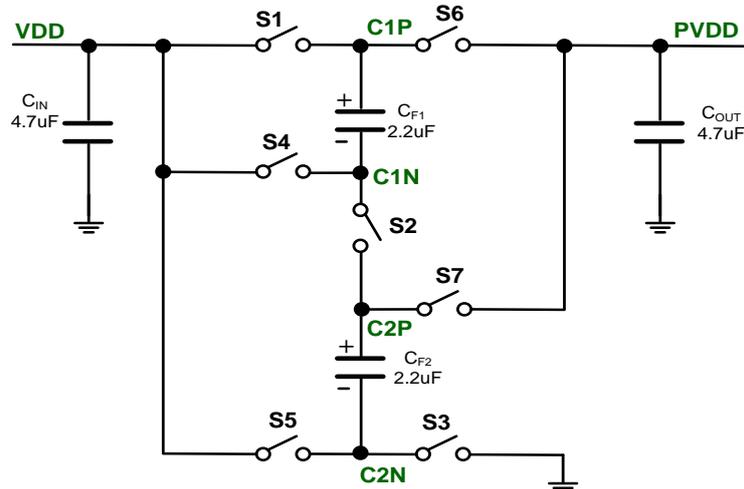
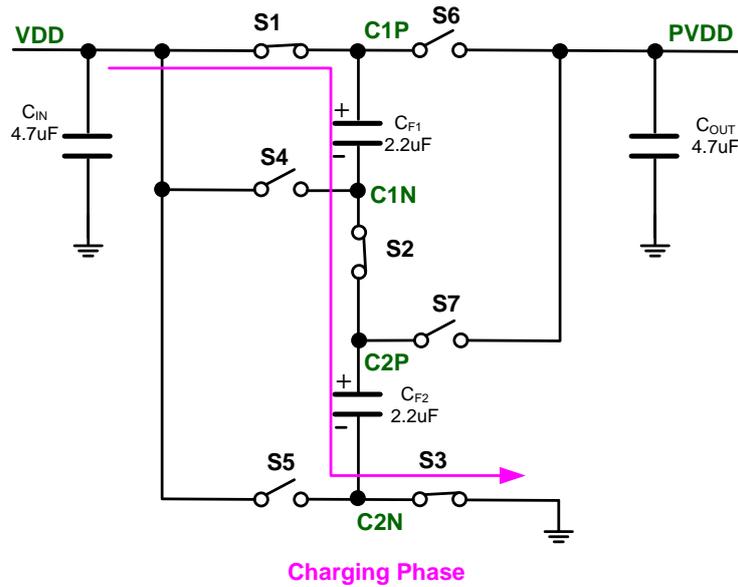
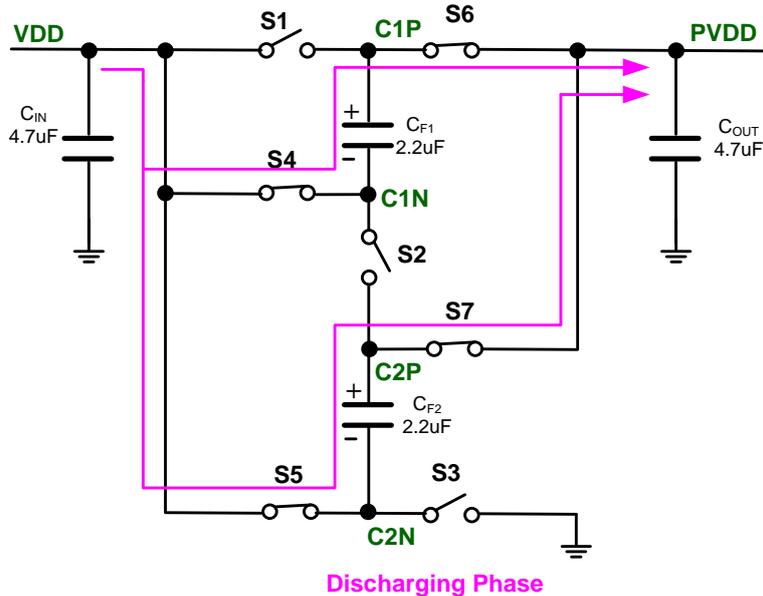


Figure 9 Charge Pump Principle Diagram

The operation of the charge pump has two phases. In $\Phi 1$, as shown in figure 10, switches S1, S2 and S3 are closed, VDD charges to the flying capacitor CF1 CF2.

Figure 10 $\Phi 1$: Flying Capacitor Charging

In $\Phi 2$, as shown in figure 11: 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 11 $\Phi 2$: 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 12.

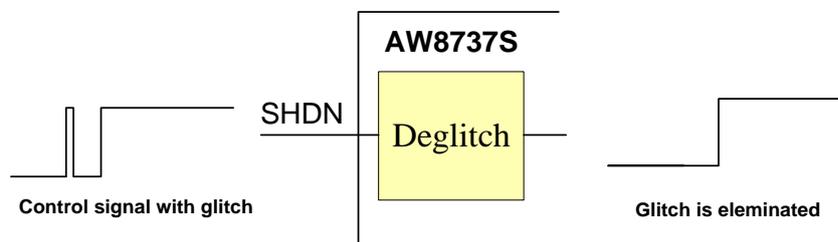


Figure 12 Awinic Deglitch function diagram

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. AW8737S 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 13.

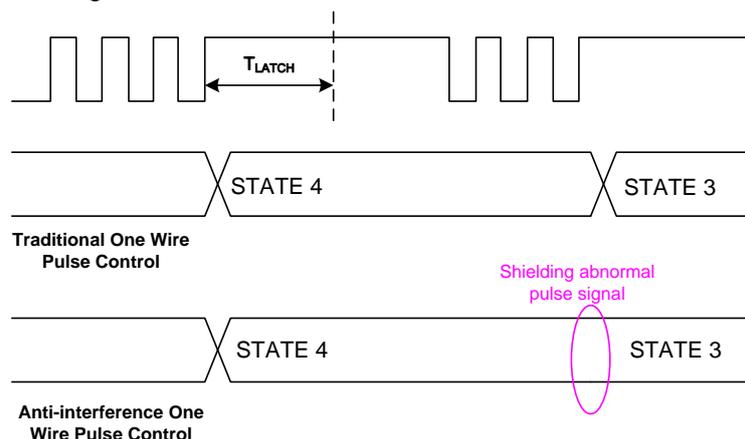


Figure 13 Anti-interference One Wire Pulse Control Function Diagram

One Wire Pulse Control

AW8737S select each mode through the detection of number of the pulse signal rising edge of SHDN pin, as shown in figure 14: When SHDN pin pull high from shutdown mode, there is only a rising edge, AW8737S enter into mode 1,NCN output power is 1.2W; When high-low-high signal set to SHDN pin,

there are two rising edges, AW8737S enter into mode 2, NCN output power is 1W; When there are three rising edges, AW8737S enter into mode 3, NCN output power is 0.8W; When there are four rising edges, AW8737S enter into mode 4, NCN function is turned off; AW8737S has four operation modes, the number of the rising edges does not allow more than four.

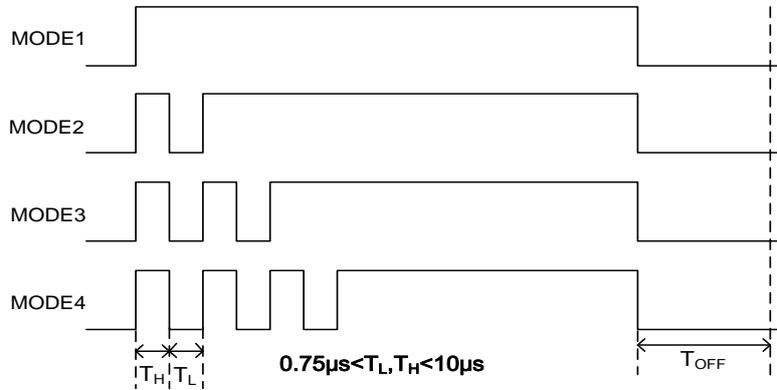


Figure 14 One Wire Pulse Control

When AW8737S needs to work in different mode, PIN SHDN should be pull low longer than T_{OFF} first (recommended 1ms) which make the AW8737S shut down, Then send series pulse make the AW8737S enter into right mode, as shown in figure 15.

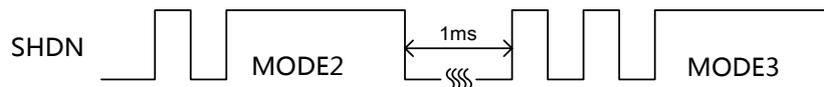


Figure 15 One Wire Pulse Control Switching Sequence

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 AW8737S'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 AW8737S. 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 AW8737S. 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 AW8737S features a unique RNS technology, which effectively reduces RF energy, attenuate the RF TDD-noise, an acceptable audible level to the customer.

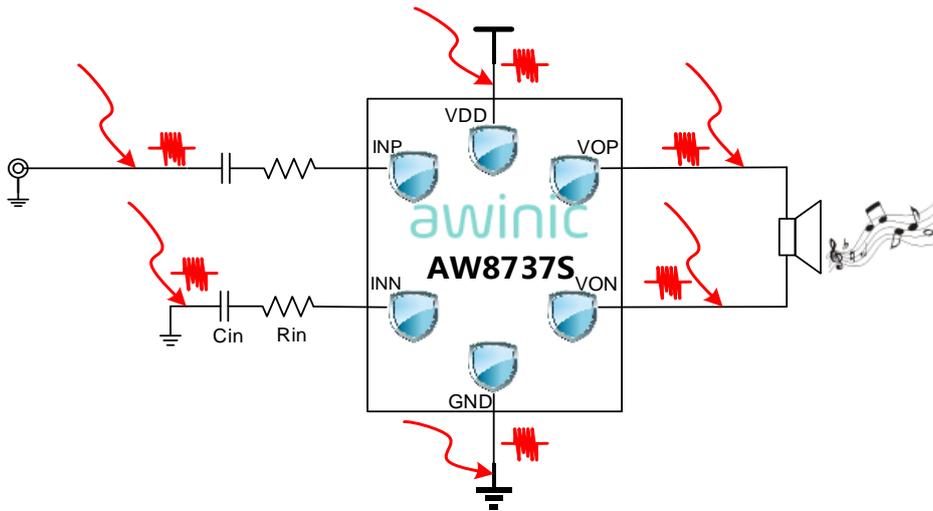


Figure 16 RF Radiation coupling schematic diagram

Filter-Free Modulation Scheme

The AW8737S 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 AW8737S 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 AW8737S 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 AW8737S 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 AW8737S is a differential audio amplifier. The IC integrates two internal input resistors, which is $R_{ini}=16.6k\Omega$. Take external input resistor $R_{ine}=3k\Omega$ for an example, gain setting as follows:

$$\text{Class K mode: } A_V = \frac{319.5k\Omega}{R_{ine} + R_{ini}} = \frac{319.5k\Omega}{3k\Omega + 16.6k\Omega} = 16.3V/V$$

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:

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

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:

$$f_H(-3dB) = \frac{1}{2 * \pi * R_{intotal} * C_{in}} \text{ (Hz)} = \frac{1}{2 * \pi * 19.6k\Omega * 15nF} \text{ (Hz)} = 542\text{Hz}$$

Differential input filter capacitor C_d (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:

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

With input resistance $R_{ine} = 3k\Omega$, differential capacitance 220pF, for example, the low-pass cutoff frequency is as follows:

$$f_L(-3dB) = \frac{1}{2 * \pi * (R_{ini} // R_{ine}) * 2 * C_d} \text{ (Hz)} = \frac{1}{2 * \pi * 2.54k\Omega * 2 * 220pF} \text{ (Hz)} = 142.5\text{kHz}$$

Supply Decoupling Capacitor (C_s)

The AW8737S is a high-performance audio amplifier that requires adequate power supply decoupling. Place a low equivalent-series-resistance (ESR) ceramic capacitor, typically 0.1 μ F. 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 AW8737S is important, as any parasitic resistance or inductance between the device and the capacitor causes efficiency loss. In addition to the 0.1 μ F ceramic capacitor, place a 10 μ F 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 $2.2\mu\text{F}@10\text{V}$ 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 $4.7\mu\text{F}@10\text{V}$ capacitor is recommended.

Optional Ferrite Bead Filter

The AW8737S 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.

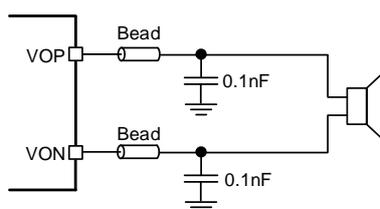
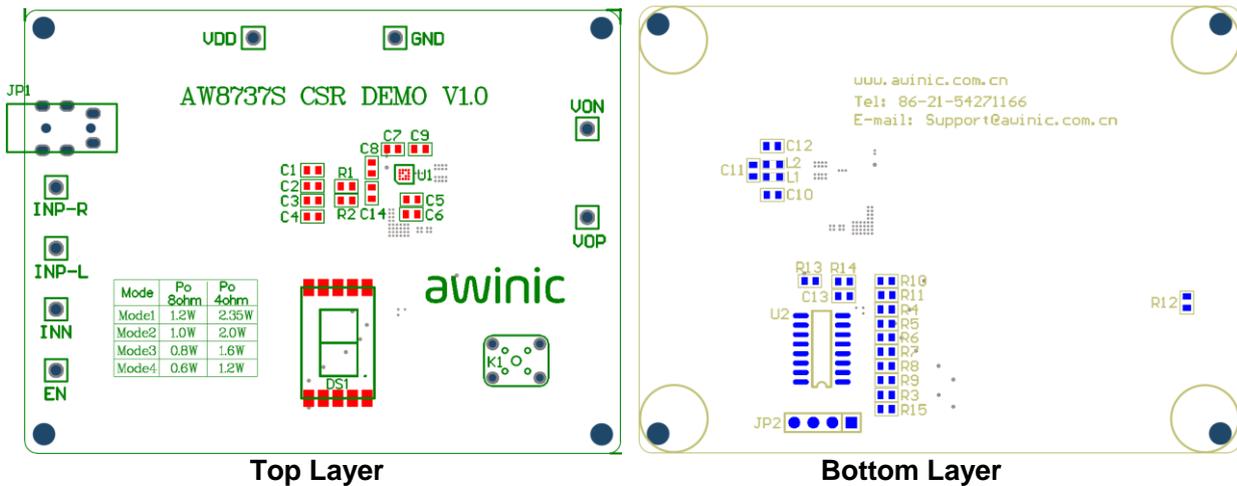
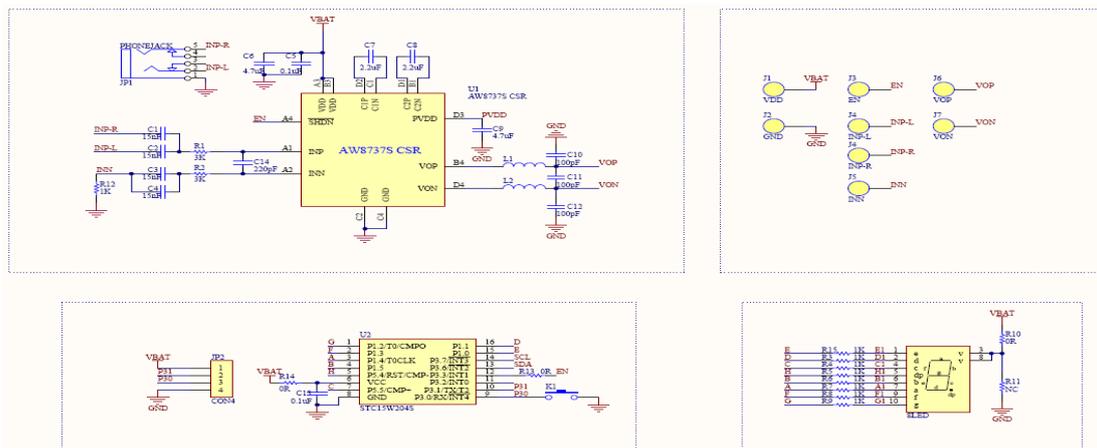


Figure 17 Ferrite Chip Bead and capacitor

DEMO PCB



DEMO PCB SCHEMATIC



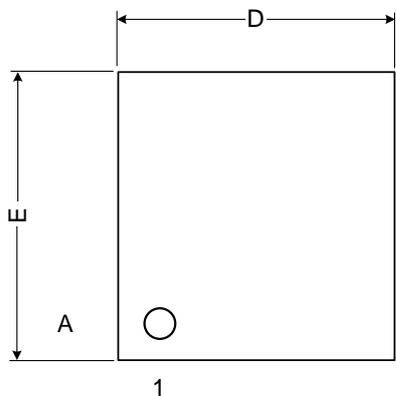
PCB AND DEVICE LAYOUT CONSIDERATION

In order to obtain excellent performance of AW8737S, PCB layout must be carefully considered. The design consideration should follow the following principles:

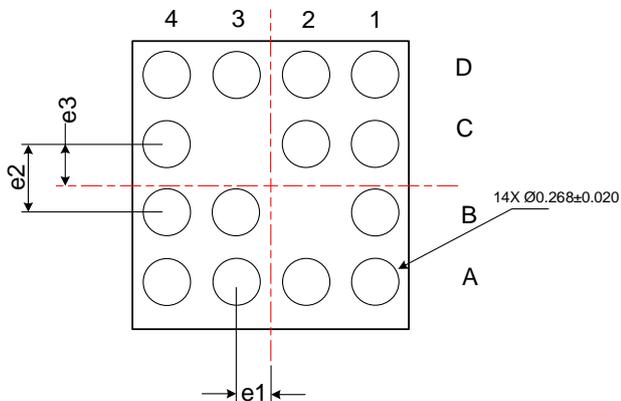
1. Try to provide a separate short and thick power line to AW8737S, the copper width is recommended to be larger than 0.75mm. The decoupling capacitors should be placed as close as possible to power supply pin.
2. The flying capacitors C_{F1} , C_{F2} should be placed as close as possible to C_{1N} , C_{1P} and C_{2N} , C_{2P} , 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 AW8737S 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 AW8737S VON and VOP pin. The output line from AW8737S to speaker should be as short and thick as possible. The width is recommended to be larger than 0.5mm.

PACKAGE DESCRIPTION

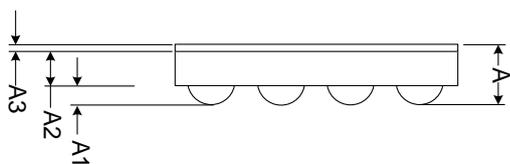
TOP VIEW



BOTTOM VIEW



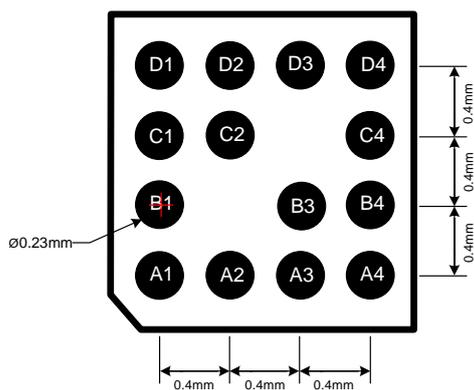
SIDE VIEW



Symbol	NOM	Tolerance
A	0.575	±0.055
A1	0.195	±0.020
A2	0.340	±0.025
A3	0.040	±0.010
D	1.600	±0.025
E	1.680	±0.025
e1	0.200	NA
e2	0.400	NA
e3	0.240	NA

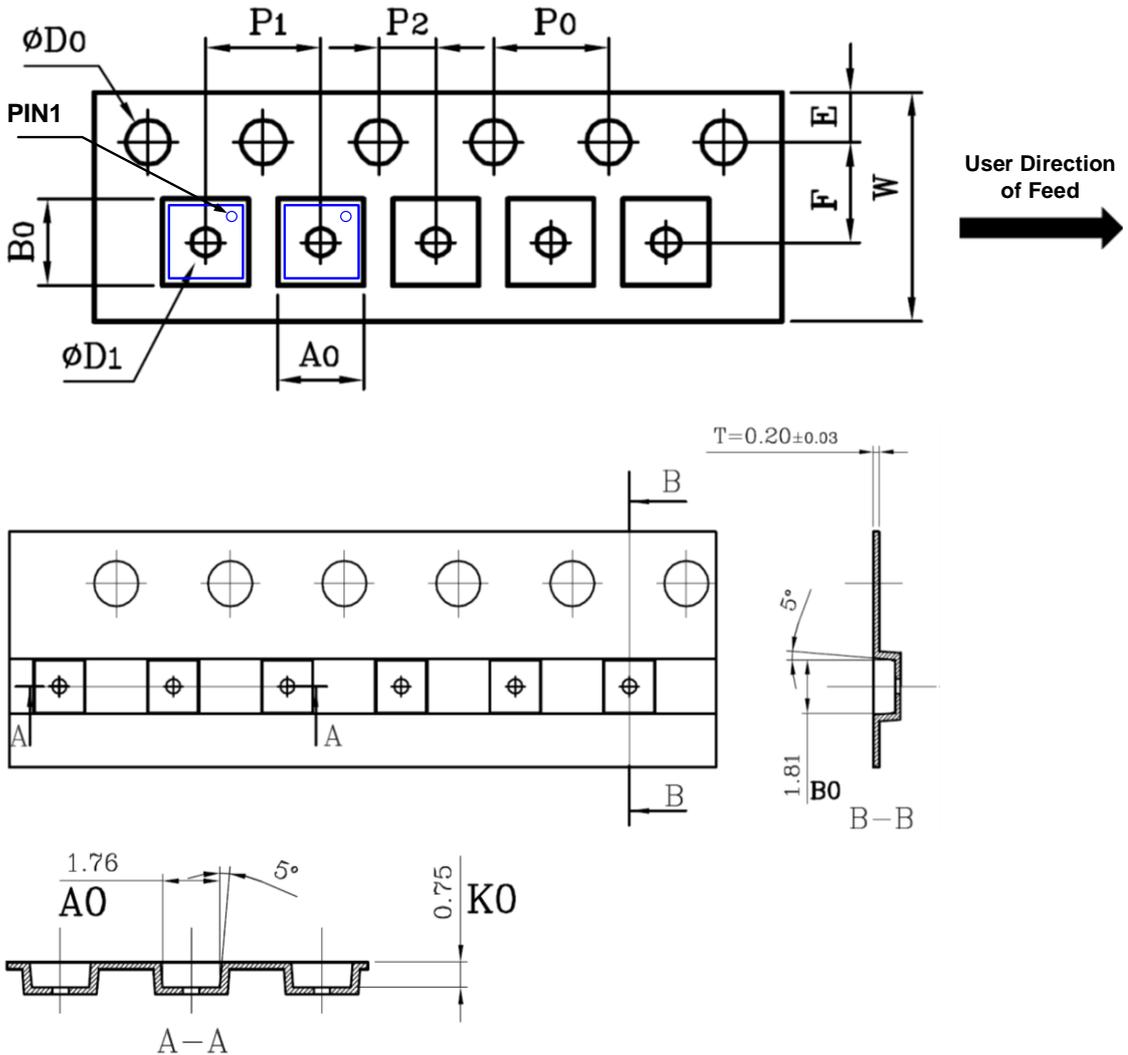
Unit: mm

LAND PATTERN

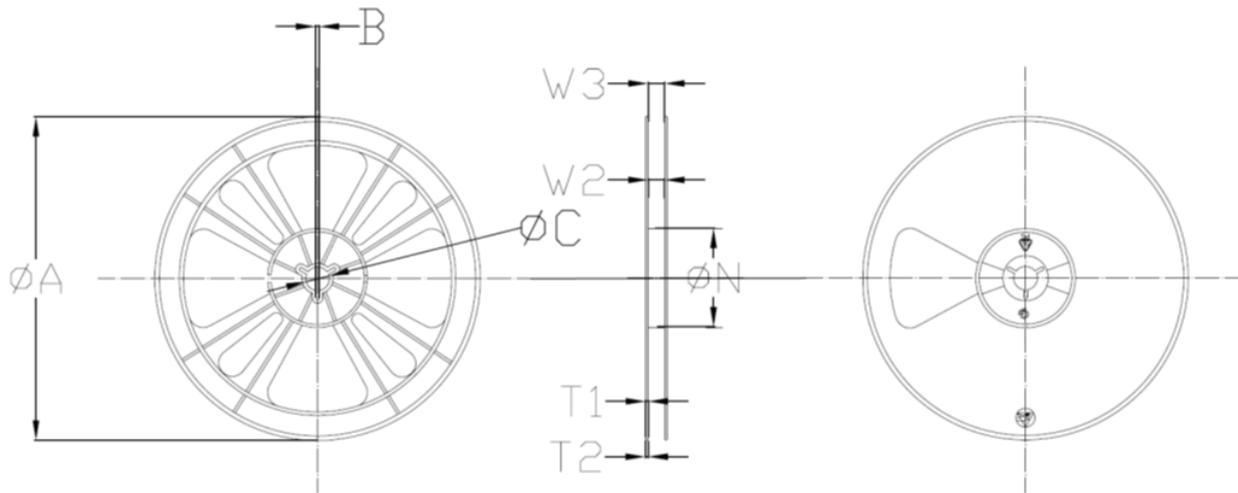


TAPE DESCRIPTION

PRODUCT SIZE (UNIT : mm)									
SPEC	W	P1	E	F	D0	D1	P0	P2	10P0
SIZE	8.00 ^{+0.30} _{-0.10}	4.0±0.1	1.75±0.1	3.5±0.05	1.50 ^{+0.10} ₋₀	0.5±0.05	4.0±0.1	2.0±0.05	40±0.2
SPEC	A0	A1	B0	B1	K0	K1	T		
SIZE	1.76±0.05		1.81±0.05		0.75±0.05		0.20±0.03		



REEL DESCRIPTION



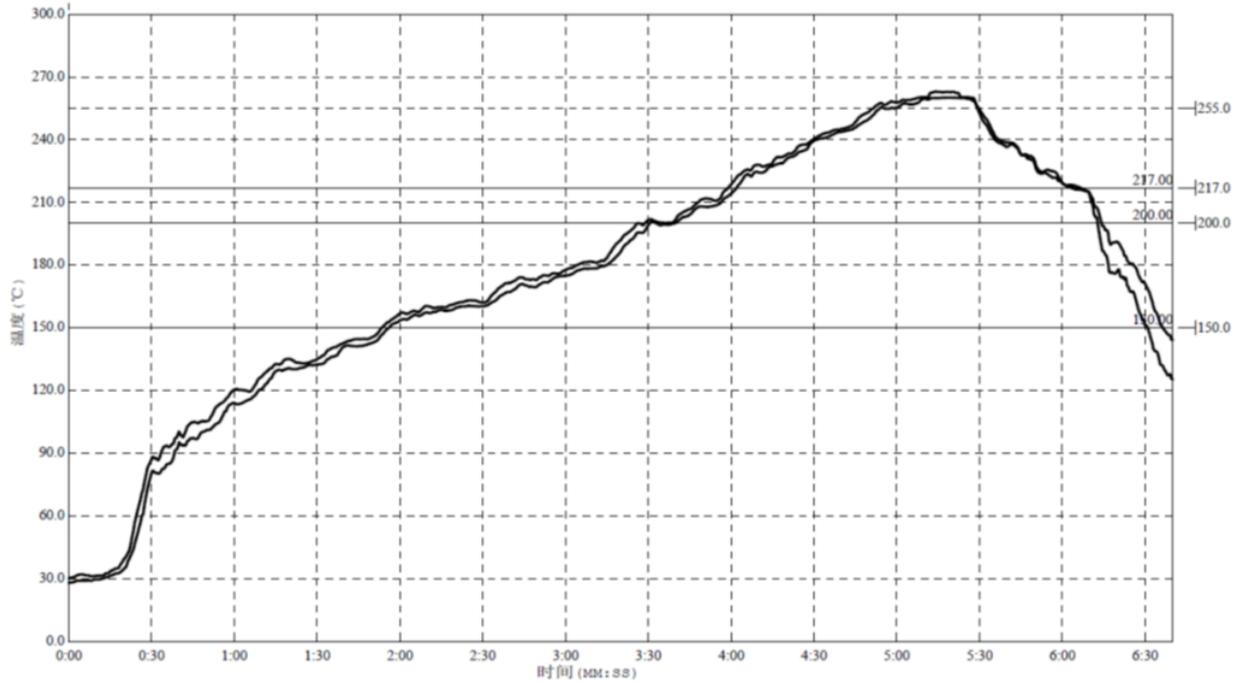
Unit: mm

Item	Value&Tolerance
A	179±1.0
B	2.0±0.1
C	13.5±0.2
N	54.8±0.2
W2	9.0±0.2
W3	9.2±1.0
T1	1.2±0.2
T2	1.5±0.2

Note:

1. Surface resistivity: 10^5 to 10^{11} ohms/sq.
2. Restriction criterion of hazardous substance for packing material follow GP-M001.

REFLOW



Reflow Note	Spec
Average ramp-up rate (217°C to peak)	Max. 3°C/sec
Time of Preheat temp. (from 150°C to 200°C)	60-120sec
Time to be maintained above 217°C	60-150sec
Peak Temperature	>260°C
Time within 5°C of actual peak temp	20-40sec
Ramp-down rate	Max. 6°C/sec
Time from 25°C to peak temp	Max. 8min

VERSION INFORMATION

Version	Date	Description
V1.0	2015-12-11	AW8737SCSR datasheet V1.0
V1.1	2017-11-10	Add LAND PATTERN description, and MSL type, tape and reel description, add PIN1 direction in tape, and feed direction, add reflow curve.

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