矽源特科技
ChipSourceTek

XS9971
User Manual

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V1.0

XS9971 5.5W LOW-EMI Class AB/D Audio Power Amplifier

XS9971General Description

The XS9971 is an audio power amplifier primarily designed for demanding applications in low-power portable systems. It is capable of delivering 5.5 watts of continuous average power to a 2Ω BTL load with less than 10% distortion (THD) from a 5.5VDC power supply.

The XS9971 does not require output coupling capacitors or bootstrap capacitors, and therefore is ideally suited for mobile phone and other low voltage applications where minimal power consumption is a primary requirement.

The XS9971 contains advanced pop & click circuitry which eliminates noise which would otherwise occur during turn-on and turn-off transitions. The XS9971 is unity-gain stable and can be configured by external gain-setting resistors. The XS9971 integrates overheating protection mechanism, The XS9971 is unity-gain stable and can be configured by external gain-setting resistors.

The XS9971 can provide your USB subwoofer, radio, MP3 player, and loudspeaker perfect solution.

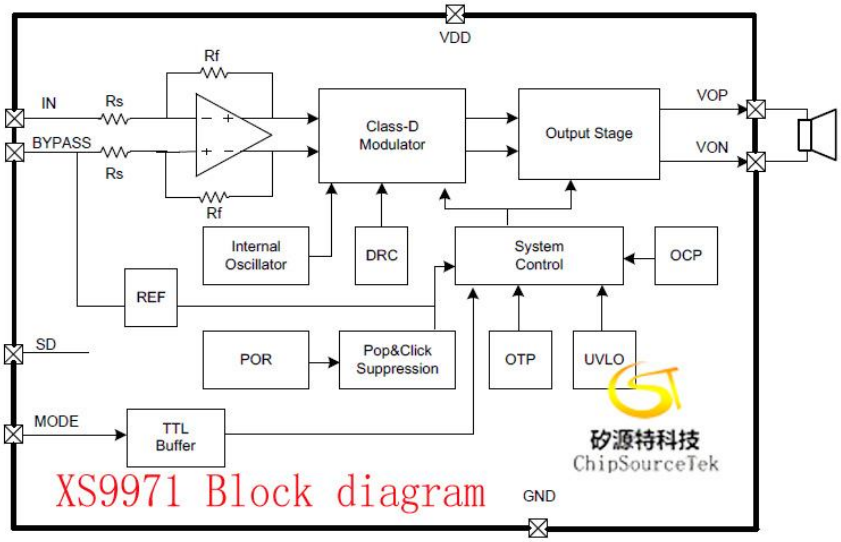
XS9971 Features

- Available in space-saving packages: ESOP8,
- Class AB/D Mode Selectable
- VDD=5.5V，RL=2Ω，Po=5.5W，THD+N≤10%
  VDD=5V，RL=4Ω，Po=3W，THD+N≤10%
- Wide operating voltage range: 2V~7V
- Improved pop & click circuitry eliminates noise during turn-on and turn-off transitions
- Overheating protection

XS9971 Applications

·Card inserting speaker, Bluetooth speaker, Mobile phone
·Low voltage audio system,USB,2.1/2.0 multimedia
·Radio
·MP3/MP4/MP5/CD
·Digital camera
·Tablet PC, Handheld game machine

XS9971 Block diagram



XS9971 Ordering Information

Part Number	Package Type	Shipping Package（PCS）	Note
XS9971ESO	ESOP8	100 Units/real	
		4000 Units/tape	

XS9971 Typical Application Circuit

Fig1. The XS9971 Typical Application Circuit

XS9971 Pin Distribution

Figure 2 XS9971 Terminal definition

XS9971 Pin description

Pin Number	Symbol	Description
1	SD	Shutdown Control Input(active with high logic level), the amplifier is turned off by default when the SD pin is floating
2	BYP	Internal common-mode voltage
3	MODE	Mode Select: AB/D(0: Class AB; 1: Class D)
4	IN	The input
5	VON	The negative phase output
6	VDD	Power
7	GND	Ground
8	VOP	The positive phase output

XS9971 Absolute Maximum Ratings

Absolute Maximum Ratings

parameter	Min	Max	Units	说明
supply voltage	2.5	7	V	
Storage Temperature	-65	150	°C	
Input voltage	-0.3	VDD	V	
ESD voltage resistant	1000	4000	V	HBM
Temperature saving	150		°C	representative value 150
Recommended working voltage	2.5	6.5	V	
热阻				
JC(SOP)		35	°C/W	
JA(SOP)		140	°C/W	
Welding temperature		250	°C	Within 15 seconds

Note: In any other conditions beyond the limit value, the performance is not guaranteed.

XS9971 Recommended operating conditions

Recommended operating conditions

Name	Test Conditions		Min	Max	Units
VDD	Supply Voltage			6.5	V
VIH	High-level input voltage	SD	1.3		V
		MODE	1.6		
VIL	Low-level input voltage	SD		1	V
		MODE		1.3	
TA	Operating free-air temperature range		-40	85	℃

XS9971 Electrical Characteristics

Chip characteristics TA = 25°C (Unless otherwise noted)								
Symbol	**Parameter**	**Test Conditions**		**Min**	**Typical**		**Max**	**Units**
					Class AB	**Class D**		
VDD	Input voltage range			2.5	6.0		6.5	V
Rdson	Drain-source on-state resistance	VDD=5V			200			mΩ
I(Q)	Quiescent Power Supply Current	VDD= 5V, no load			8	6		mA
I(SD)	Shutdown Current	VDD=2V to 5.5V			0.5			μA
VOS	Output Offset Voltage	VIN = 0V			10	10	50	mV
f(sw)	Switching frequency	VDD= 2V to 5.5V	frequency		-	360		kHz
			duty cycle		-	50		%
Po	Output Power	THD+N=10%,f=1kHz, RL=2Ω	5.5V		5	5.5		W
		THD+N=1%,f=1kHz, RL=2Ω	VDD=5V		4.8	4.8		
		THD+N=10%,f=1kHz, RL=2Ω			4	4		
		THD+N=1%,f=1kHz, RL=4Ω			3	3		
		THD+N=10%,f=1kHz, RL=4Ω			2.4	2.4		
		THD+N=1%,f=1kHz, RL=4Ω	3.7V		1.8	1.8		
THD+N	Total Harmonic Distortion+Noise	VDD=5V,PO=1W, RL=4Ω, f=1kHz			0.1	0.12		%

XS9971 The input resistance (Ri) selection

The XS9971 contains two stage gains, the first stage gain can be configured by an external input resistor, and the second stage gain is the internal fixation. By choosing the input resistance value can set the gain of the amplifier:

$$Gain = \frac{2 \times 200K\Omega}{6K\Omega + Ri} \quad (1)$$

Any mismatch between the resistors results in a differential gain error that leads to an increase in THD+N, decrease in PSRR and CMRR, as well as an increase in output offset voltage. Resistors with a tolerance of 1% or better are recommended. The gain setting resistors should be placed as close to the device as possible. Keeping the input traces close can increases noise rejection in noisy environments. Noise coupled onto the input traces which are physically close to each other will be common mode and easily rejected. Low gain and high voltage signal can make the chip performance more prominent.

XS9971 The input capacitor Ci selection

In the typical application, an input capacitor (Ci) is required to allow the amplifier to bias the input signal to the proper dc level for optimum operation. In this case, Ci and the input impedance of the amplifier (Zi) form a high-pass filter with the corner frequency determined in Equation 5.

$$f_c = \frac{1}{2\pi RiCi} \quad (2)$$

The value of Ci is important, as it directly affects the bass (low-frequency) performance of the circuit. Consider the example where Zi is 20kΩ and the specification calls for a flat bass response down to 20Hz. Equation 5 is reconfigured as Equation 6.

$$Ci = \frac{1}{2\pi Rifc} \quad (3)$$

In this example, Ci is 56.8nF, so one would likely choose a value in the range of 56nF to 1μF. A further consideration for this capacitor is the leakage path from the input source through the input network (Ci) and the feedback network to the load. This leakage current creates a dc offset voltage at the input to the amplifier that reduces useful headroom, especially in high gain applications. For this reason, a low-leakage tantalum or ceramic capacitor is the best choice. When polarized capacitors are used, the positive side of the capacitor should face the amplifier input in most applications as the dc level there is held at VDD/2, which is likely higher than the source dc level. Note that it is important to confirm the capacitor polarity in the application.

XS9971 The bypass capacitor (CBYP) selection

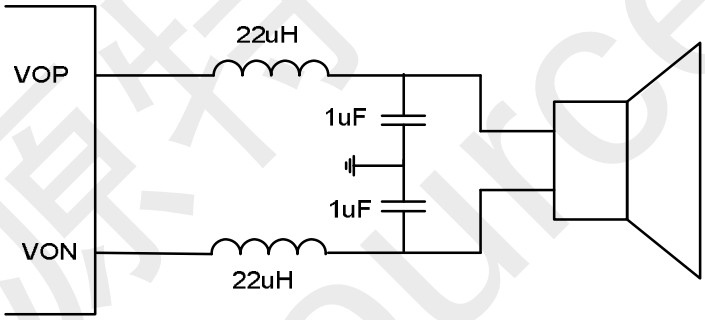
In XS9971, a capacitor CB (connected to the VBYP pin) is very crucial; it can affect the PSRR and switching noise performance. Generally, the capacitance of the ceramic capacitor CB is 0.1uF ~ 1uF.

In addition to minimize the input and output capacitor size, the bypass capacitor size should also be considered in detail. The bypass capacitor CB is used to minimize the system noise.

The selection of the capacitor value on the VBYP terminal is critical for achieving the best device performance. During power up or recovery from the shutdown state, the VBYP capacitor determines the rate at which the amplifier starts up. When the voltage on the VBYP capacitor equals VBYP, the device starts a 70-ms timer. When this timer completes, the outputs start switching. The charge rate of the capacitor is calculated using the standard charging formula for a capacitor, I=C×dV/dT. For example, a 1-μF capacitor on VBYP would take 80ms to reach the value of VBYP and begin a 70ms count before the outputs turn on. This equates to a turn-on time of 150ms for a 1-μF capacitor on the VBYP terminal.

XS9971 When to use an output filter for EMI suppression

Design the XS9971 without the filter if the traces from amplifier to speaker are short (<10cm). Most applications require a ferrite bead filter. The ferrite filter reduces EMI around 1MHz and higher (FCC and CE only test radiated emissions greater than 30MHz).When selecting a ferrite bead, choose one with high impedance at high frequencies, but low impedance at low frequencies. Use an LC output filter if there are low frequency (<1MHz) EMI-sensitive circuits and/or there are long wires from the amplifier to the speaker. When both an LC filter and a ferrite bead filter are used, the LC filter should be placed as close as possible to the IC followed by the ferrite bead filter.



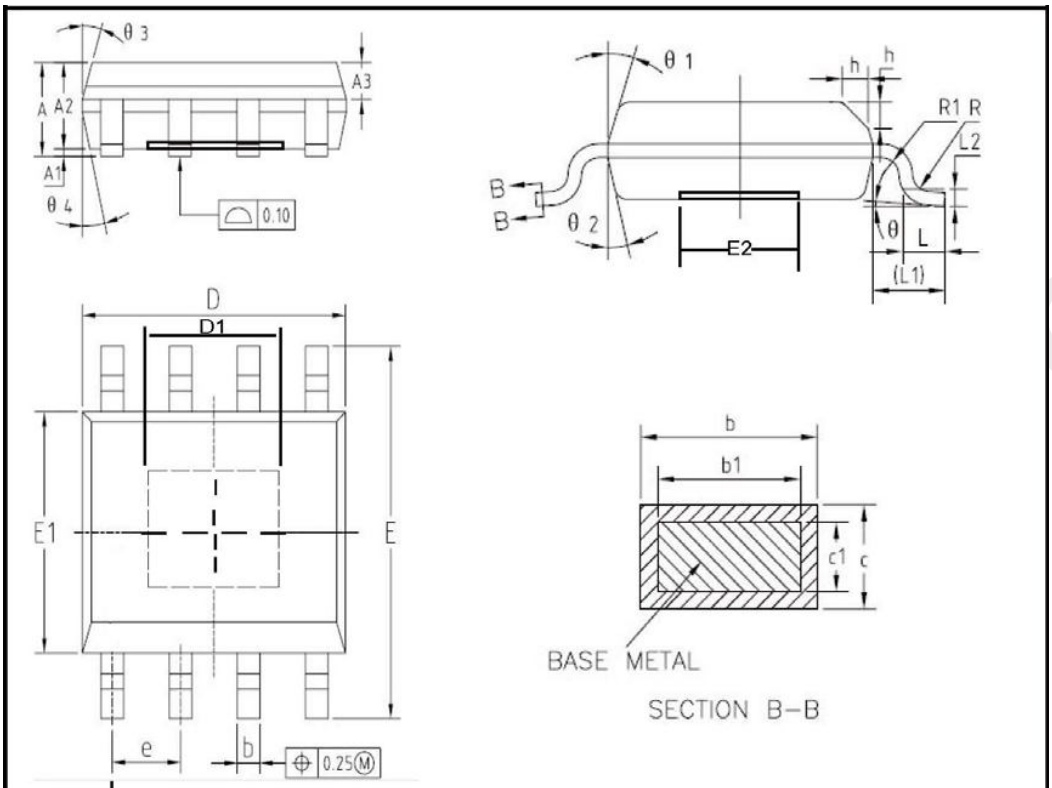
Typical application circuit of output plus LC filter (off frequency 27KHz)

Overview of the protection function mode

The XS9971 is an AB / D class audio power amplifier with built-in overheating protection features. Effectively protect the chip from damage in abnormal working conditions.

XS9971Package Information

ESOP8



	MIN	NOM	MAX		MIN	NOM	MAX
A	1.450	1.550	1.650	e		1.270	
A1	0.100	0.150	0.200	L	0.450	0.600	0.750
A2	1.250	1.400	1.650	L1		1.040	
A3	0.550	0.600	0.650	L2		0.250	
b	0.380	–	0.510	R	0.070	–	–
b1	0.370	0.420	0.470	R1	0.070	–	–
c	0.170	–	0.250	h	0.300	0.400	0.500
c1	0.170	0.200	0.230	θ	0.000	–	6.000
D	4.850	4.900	4.950	θ1	15.000	17.000	19.000
E	5.850	6.000	6.150	θ2	11.000	13.000	15.000
E1	3.850	3.900	3.950	θ3	15.000	17.000	19.000
E2	1.9	2.0	2.2	θ4	11.000	13.000	15.000
D1	1.9	2.0	2.2				

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