CS4871
3W Audio Power Amplifier with Shutdown Mode

Product Specification

Specification Revision History ：

Version	Data	Description
2010-01-A1	2010-01	Update the new template
2012-01-B1	2012-01	Increase the manual number and release history
2019-04-B2	2019-04	Replace the new template
2022-01-B3	2022-01	Modify Ordering Information
2023-11-B4	2023-11	Modify Ordering Information
2023-12-B5	2023-12	Modify the title

1、General Description

The CS4871 is a mono bridged audio power amplifier capable of delivering 3W of continuous average power into a 3Ω load with less than 10% THD when powered by a 5V power supply. To conserve power in portable applications, the CS4871's micro-power shutdown mode (IQ =0.6μA, typ) is activated when VDD is applied to the SHUTDOWN pin.

Boomer audio power amplifiers are designed specifically to provide high power, high fidelity audio output. They require few external components and operate on low supply voltages from 2.0V to 5.5V. Since the CS4871 does not require output coupling capacitors, bootstrap capacitors, or snubber networks, it is ideally suited for low-power portable systems that require minimum volume and weight. Additional CS4871 features include thermal shutdown protection, unity-gain stability, and external gain set.

Features:

- No output coupling capacitors, bootstrap capacitors, or snubber circuits required
- Unity-gain stable and external gain configuration capability
- Pin compatible with the LM4861、LM4871
- DIP8 / SOP8 / MSOP8 / ESOP8

Key Specifications

- PO at 10% THD+N, 1KHz
  3Ω loads 3W (typ)
  4Ω loads 2.5W (typ)
  8Ωload 1.5W (typ)
- Shutdown current 0.6μA (typ)
- Supply voltage range 2.0V to 5.0V
- THD at 1KHz at 1W continuous average output power into 8Ω load is 0.5% (max)

Ordering Information:

Tube packing specifications:

Part number	Packaging form	Marking code	Tube quantity	Boxed tube quantity	Boxed quantity	Notes
CS4871DA8.TB	DIP8	4871	50 PCS/tube	40 tube/box	2000 PCS/box	Dimensions of plastic enclosure: 9.2mm×6.4mm Pin spacing:2.54mm
CS4871SA8.TB	SOP8	4871	100 PCS/tube	100 tube/box	10000 PCS/box	Dimensions of plastic enclosure: 4.9mm×3.9mm Pin spacing:1.27mm
CS4871MA8.TB	MSOP8	4871	100 PCS/tube	100 tube/box	10000 PCS/box	Dimensions of plastic enclosure: 3mm×3mm Pin spacing:0.65mm
CS4871SE8.TB	ESOP8	4871	100 PCS/tube	100 tube/box	10000 PCS/box	Dimensions of plastic enclosure: 4.9mm×3.9mm Pin spacing:1.27mm

Reel packing specifications:

Part number	Packaging form	Marking code	Reel quantity	Boxed reel quantity	Notes
CS4871SA8.TR	SOP8	4871	4000 PCS/reel	8000 PCS/box	Dimensions of plastic enclosure: 4.9mm×3.9mm Pin spacing:1.27mm
CS4871MA8.TR	MSOP8	4871	5000 PCS/reel	10000 PCS/box	Dimensions of plastic enclosure: 3mm×3mm Pin spacing: 0.65mm
CS4871SE8.TR	ESOP8	4871	4000 PCS/reel	8000 PCS/box	Dimensions of plastic enclosure: 4.9mm×3.9mm Pin spacing:1.27mm

Note：If the physical information is inconsistent with the ordering information, please refer to the actual product.

2、Pin Configurations

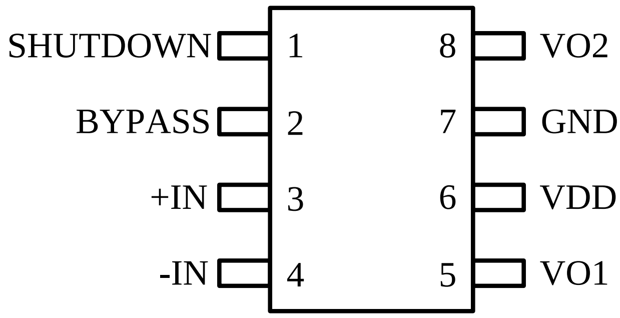


Figure1. Pin Configurations

Pin No.	Pin Name	Description
1	SHUTDOWN	Enable Pin, when SHUTDOWN is “H”, the micro-power mode is activated. When SHUTDOWN is “L”, the 4871 is working normally.
2	BYPASS	Bias voltage pin
3	+IN	Non-inverting input
4	-IN	Inverted input
5	VO1	VO1 output
6	VDD	Power
7	GND	Ground
8	VO2	VO2 output

3、Electrical Parameter

3.1、 Absolute Maximum Ratings (Tamb=25℃)

Characteristic	Symbol	Conditions	Value	Unit
Supply Voltage	VDD	-	6.0	V
Input Voltage	VIN	-	-0.3～V_{DD}+0.3	V
Supply Temperature	Ts	-	-40~+85	℃
Junction Temperature	Tj	-	150	℃
Soldering Information Small Outline Package	-	DIP	250	℃
		SOP/MSOP/ESOP	260	℃

3.2、Recommended conditions

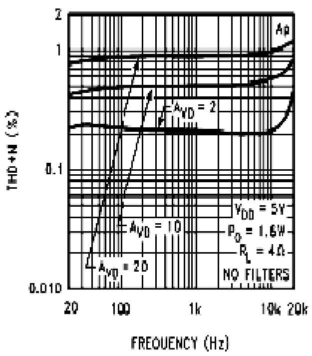
Parameter	Symbol	Recommended value			Unit
		Min.	Typ.	Max.	
Temperature Range	T_A	-40	-	85	℃
Supply Voltage	V_{DD}	2.0	-	5.0	V

3.3、Electrical Characteristics

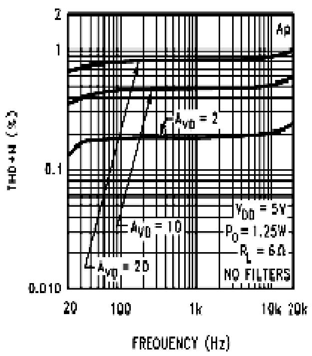
Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Supply Voltage	V_{DD}	-		2	-	5	V
Quiescent Power Supply Current	I_{DD}	VIN=0V，Io=0A		-	6.5	10	mA
Shutdown Current	I_{SD}	V_{PIN1}=VDD		-	0.6	2	μA
Output Offset Voltage	V_{OS}	VIN=0V		-	5	50	mV
Output Power	P_O	THD=1%, f=1KHz	R_L=3Ω	-	2.38	-	W
			R_L=4Ω	-	2	-	
			R_L=8Ω	-	1.2	-	
		THD+N=10%, f=1KHz	R_L=3Ω	-	3	-	
			R_L=4Ω	-	2.5	-	
			R_L=8Ω	-	1.5	-	
Total Harmonic Distortion + Noise	THD+N	20Hz≤f≤20KHz ,A_{VD}=2	R_L=4Ω,P_O=1W	-	0.13	-	%
			R_L=8Ω,P_O=1W	-	0.25	-	%
Power Supply Rejection Ratio	PSRR	VDD=4.9V～5.1V		-	60	-	dB

4、Typical Performance Characteristics

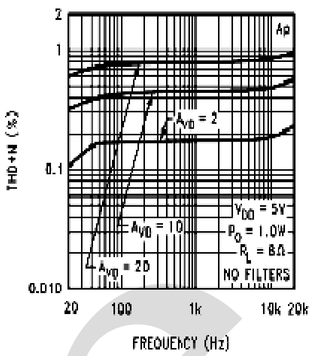
THD+N vs Frequency



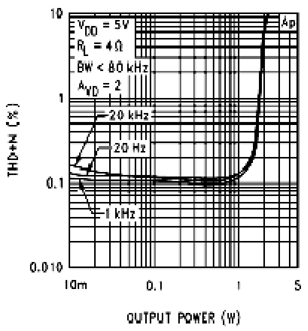
THD+N vs Frequency



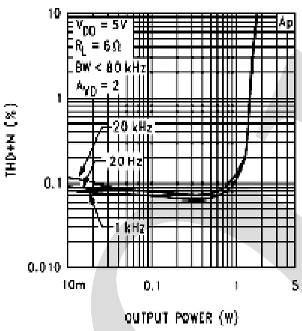
THD+N vs Frequency



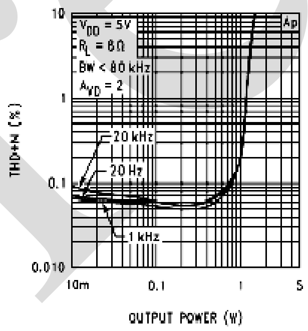
THD+N vs Output Power



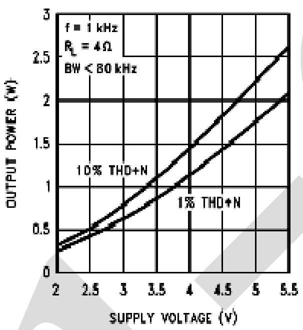
THD+N vs Output Power



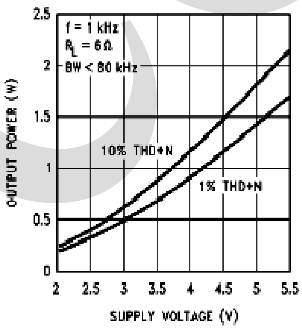
THD+N vs Output Power



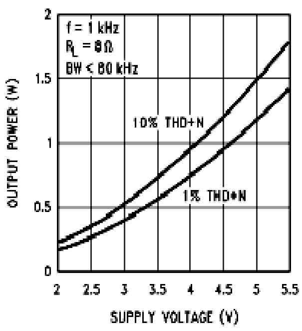
Output Power vs Supply Voltage



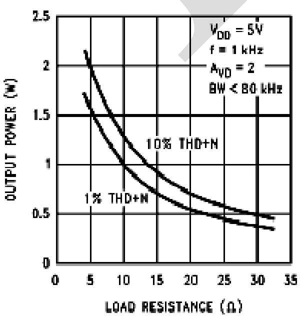
Output Power vs Supply Voltage



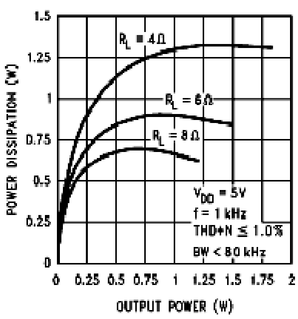
Output Power vs Supply Voltage



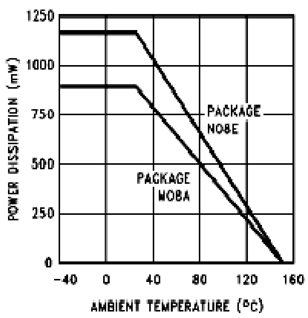
Output Power vs Load Resistance



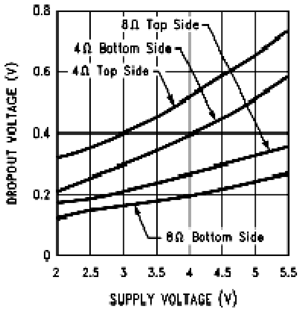
Power Dissipation vs Output Power



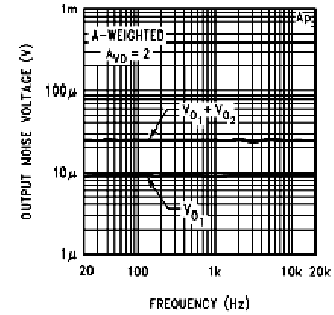
Power Derating Curve



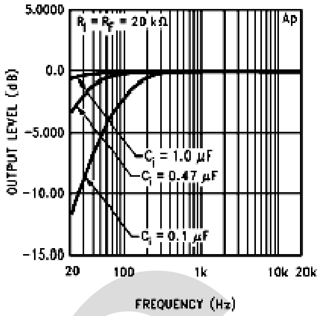
Clipping Voltage vs Supply Voltage



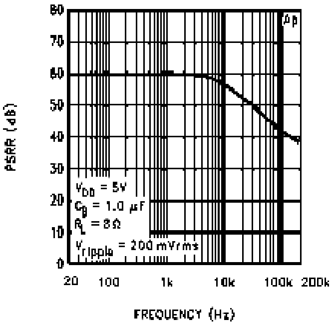
Noise Floor



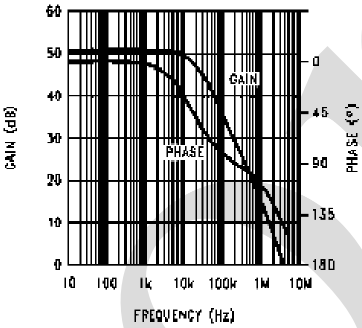
Frequency Response vs Input Capacitor Size



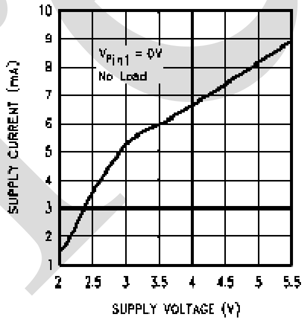
Power Supply Rejection Ratio



Open Loop Frequency Response



Supply Current vs Supply Voltage



5、Typical Application and Application Notes

5.1、Typical Application

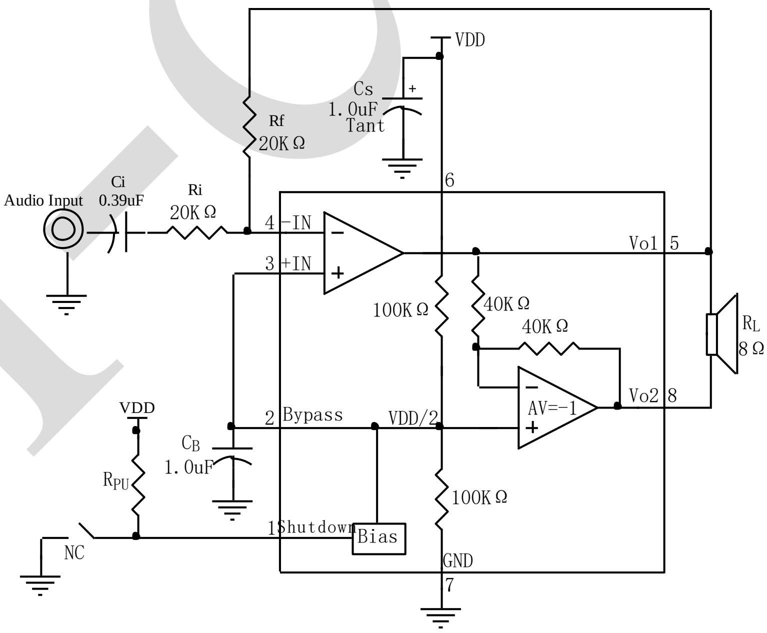


Figure2. Typical Application

5.2、Application Notes

External Components and Functions

Components		Functions
1	R_I	Reverse input resistor，together with R_f set the closing gain，At the same time with the input capacitor Ci constitute a high-pass filter, turning frequency is $fc = \frac{1}{2\pi R_I C_I}$
2	C_I	Input coupling capacitor, to prevent the input DC voltage on the front level having an impact, At the same time with the input capacitor Ri constitute a high-pass filter, turning frequency is $fc = \frac{1}{2\pi R_I C_I}$
3	R_f	Feedback resistor, together with R_I set the amplifier closing gain
4	C_S	Power supply filter capacitor
5	C_B	Bias voltage filter capacitor
6	R_{PU}	Pull up resistor, 47K(typ)

6、Application Information

6.1、Bridge Configuration Explanation

As shown in Figure2, the CS4871 has two operational amplifiers internally, allowing for a few different amplifier configurations. The first amplifier’s gain is externally configurable; the second amplifier is internally fixed in a unity-gain, inverting configuration. The closed-loop gain of the first amplifier is set by selecting the ratio of Rf to Ri while the second amplifier’s gain is fixed by the two internal 40KΩ resistors. Figure 1shows that the output of amplifier one serves as the input to amplifier two, which results in both amplifiers producing signals identical in magnitude, but 180°out of phase. Consequently, the differential gain for the IC is

$$A_{VD} = 2 * (Rf/Ri)$$

By driving the load differentially through outputs VO1 and VO2, an amplifier configuration commonly referred to as “bridged mode” is established. Bridged mode operation is different from the classical single-ended amplifier configuration where one side of its load is connected to ground. A bridge amplifier design has a few distinct advantages over the single-ended configuration, as it provides differential drive to the load, thus doubling output swing for a specified supply voltage. Four times the output power is possible as compared to a single-ended amplifier under the same conditions. This increase in attainable output power assumes that the amplifier is not current limited or clipped. In order to choose an amplifier’s closed-loop gain without causing excessive clipping, please refer to the Audio Power Amplifier Design section.

Another advantage of the differential bridge output is no net DC voltage across load. This results from biasing VO1 and VO2 at the same DC voltage, in this case $V_{DD}/2$. This eliminates the coupling capacitor that single supply, single-ended amplifiers require. Eliminating an output coupling capacitor in a single-ended configuration forces a single supply amplifier’s half-supply bias voltage across the load. The current flow created by the half-supply bias voltage increases internal IC power dissipation and my permanently damage loads such as speakers.

6.2、Power Supply Bypassing

As with any amplifier, proper supply bypassing is critical for low noise performance and high power supply rejection. The capacitor location on both the bypass and power supply pins should be as close to the CS4871 as possible. The capacitor connected between the bypass pin and ground improves the internal bias voltage's stability, producing improved PSRR.

The improvements to PSRR increase as the bypass pin capacitor increases. Typical applications employ a 5V regulator with 10μF and a 0.1μF bypass capacitors which aid in supply stability. This does not eliminate the need for bypassing the supply nodes of the CS4871 with a 1μF tantalum capacitor. The selection of bypass capacitors, especially C_B, is dependent upon PSRR requirements, click and pop performance as explained in the section, Proper Selection of External Components, system cost, and size constraints.

6.3、Shutdown Function

In order to reduce power consumption while not in use, the CS4871 contains a shutdown pin to externally turn off the amplifier's bias circuitry. This shutdown feature turns the amplifier off when a logic high is placed on the shutdown pin. The trigger point between a logic low and logic high level is typically half-supply. It is best to switch between ground and supply to provide maximum device performance. By switching the shutdown pin to VDD, the CS4871 supply current draw will be minimized in idle mode. While the device will be disabled with shutdown pin voltages less then VDD, the idle current may be greater than the typical value of 0.6μA. In either case, the shutdown pin should be tied to a definite voltage to avoid unwanted state changes. In many applications, a micro-controller or microprocessor output is used to control the shutdown circuitry which provides a quick, smooth transition into shutdown.

Another solution is to use a single-pole, single-throw switch in conjunction with an external pull-up resistor. When the switch is closed, the shutdown pin is connected to ground and enables the amplifier. If the switch is open, then the external pull-up resistor will disable the CS4871. This scheme guarantees that the shutdown pin will not float thus preventing unwanted state changes.

6.4、Design a 1W/8Ω Audio Amplifier

Given:

Power Output	1 Wrms
Load Impedance	8Ω
Input Level	1 Vrms
Input Impedance	20K
Bandwidth	100 Hz–20 KHz ±0.25 dB

A designer must first determine the minimum supply rail to obtain the specified output power. By extrapolating from the Output Power vs Supply Voltage graphs in the Typical Performance Characteristics section, the supply rail can be easily found. A second way to determine the minimum supply rail is to calculate the required Vopeak using Equation 3

and add the output voltage. Using this method, the minimum supply voltage would be (Vopeak + (VODTOP + VODBOT)), where VODBOT and VODTOP are extrapolated from the Dropout Voltage vs Supply Voltage curve in the Typical Performance Characteristics section.

$$V_{OPEAK} = \sqrt{(2RL * PO)} \qquad (3)$$

Using the Output Power vs Supply Voltage graph for an 8Ω load, the minimum supply rail is 4.6V. But since 5V is a standard voltage in most applications, it is chosen for the supply Rail. Extra supply voltage creates headroom that allows the CS4871 to reproduce peaks in excess of 1W without producing audible distortion. At this time, the designer must make sure that the power supply choice along with the output impedance does not violate the conditions explained in the Power Dissipation section.

Once the power dissipation equations have been addressed, the required differential gain can be determined from Equation 4.

$$AVD \geq \sqrt{(PO * RL)} /(VIN) = Vorms/Vinrms \qquad (4)$$

$$Rf/Ri = A_{VD}/2 \qquad (5)$$

From Equation 4, the minimum A_{VD} is 2.83; use A_{VD} = 3. Since the desired input impedance was 20 KΩ, and with a A_{VD} impedance of 2, a ratio of 1.5:1 of Rf to Ri results in an allocation of Ri = 20KΩ and Rf = 30KΩ. The final design step is to address the bandwidth requirements which must be stated as a pair of −3 dB frequency points. Five times away from a −3 dB point is 0.17 dB down from pass-band response which is better than the required ±0.25 dB specified.

fL = 100 Hz/5 = 20 Hz ; fH = 20 KHz * 5 = 100 KHz

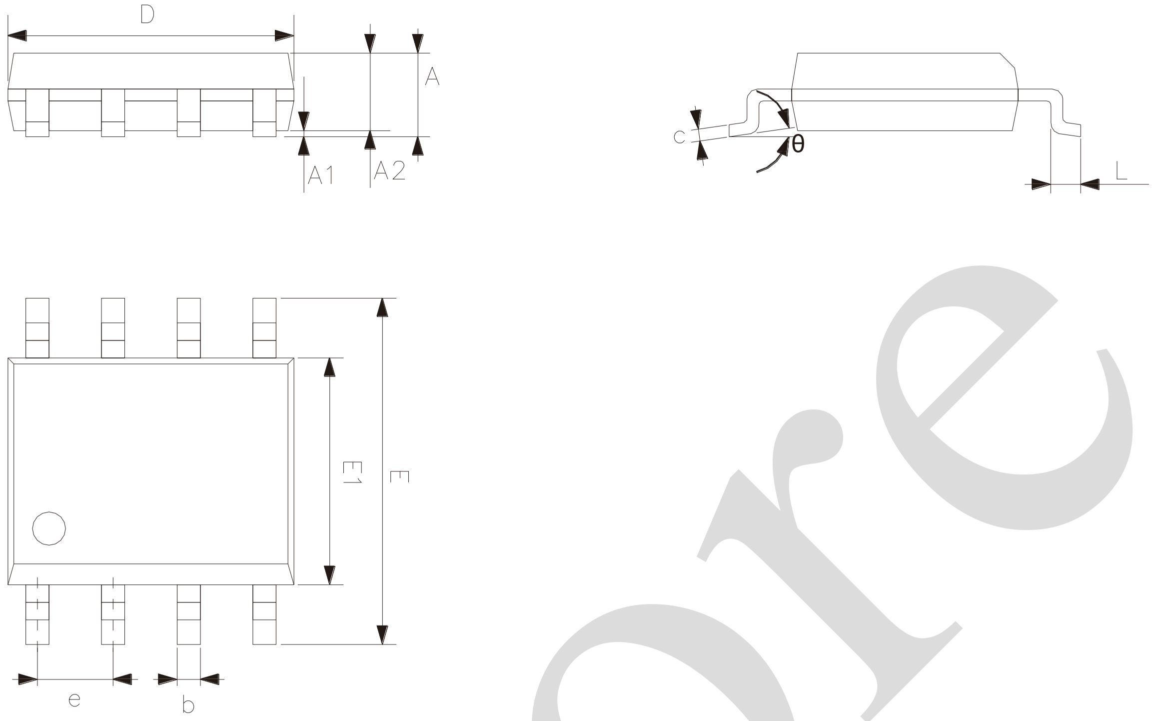
As stated in the External Components section, Ri in conjunction with Ci creates a high-pass filter.

Ci ≥1/(2π*20 KΩ*20 Hz) = 0.397 μF; use 0.39 μF

The high frequency pole is determined by the product of the desired frequency pole, fH, and the differential gain, A_{VD}. With a A_{VD}=3 and fH=100 KHz, the resulting GBWP =150 KHz which is much smaller than the CS4871 GBWP of 4 MHz. This figure displays that if a designer has a need to design an amplifier with a higher differential gain, the CS4871 can still be used without running into bandwidth limitations.

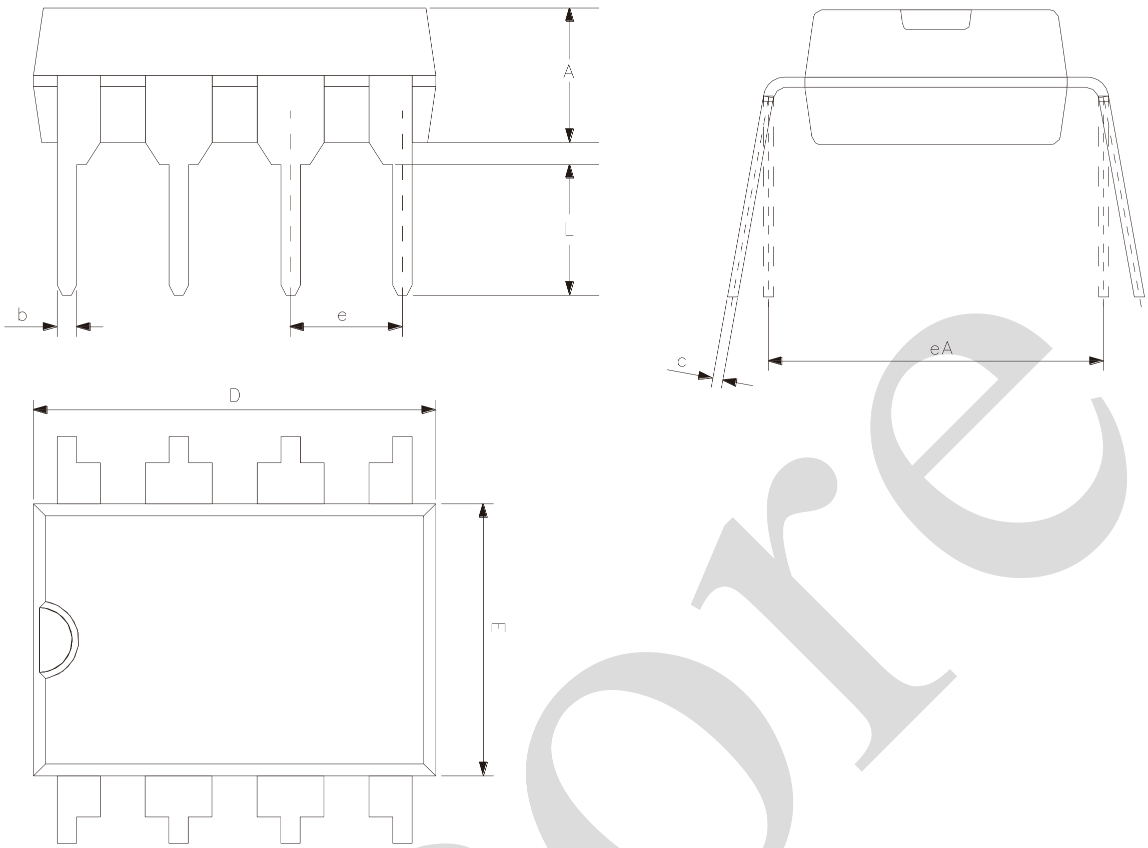
7、Package Information

7.1、SOP8



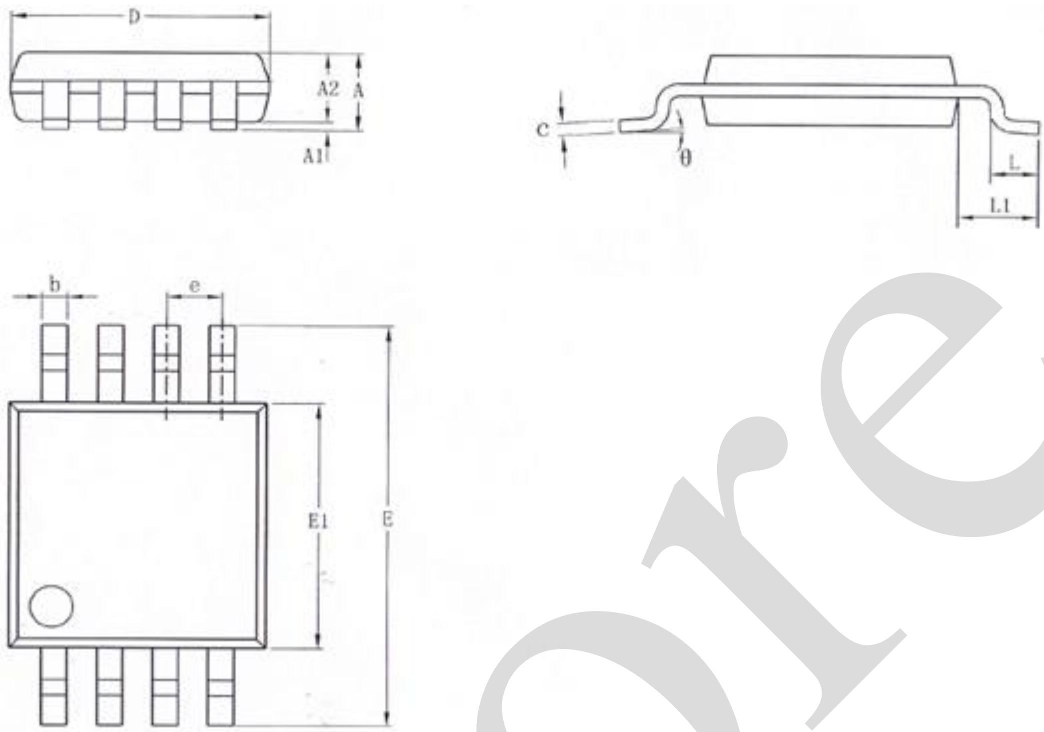
Symbol	Dimensions (mm)	
	Min.	Max.
A	1.35	1.80
A1	0.05	0.25
A2	1.25	1.55
D	4.70	5.10
E	5.80	6.30
E1	3.70	4.10
b	0.306	0.51
c	0.19	0.25
e	1.27	
L	0.40	0.89
θ	0°	8°

7.2、DIP8



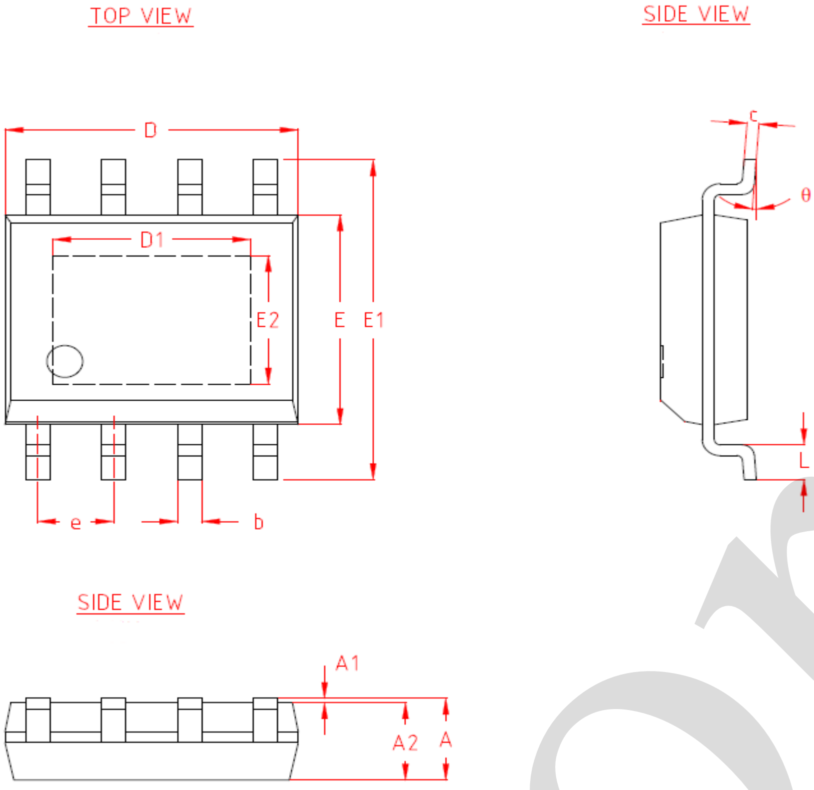
Symbol	Dimensions (mm)	
	Min.	**Max.**
A	3.00	3.60
b	0.36	0.56
c	0.20	0.36
D	9.00	9.45
E	6.15	6.60
e	2.54	
eA	7.62	9.30
L	3.00	—

7.3、MSOP8



Symbol	Dimensions (mm)	
	Min.	**Max.**
A	—	1.10
A1	0.05	0.15
A2	0.75	0.95
b	0.22	0.38
c	0.08	0.23
D	2.90	3.10
E	4.70	5.10
E1	2.90	3.10
e	0.65	
L	0.40	0.80
L1	0.95	
θ	0°	8°

7.4、ESOP8



符 号	尺寸（mm）	
	最小	最大
A	1.42	1.70
A1	0.02	0.13
A2	1.30	—
b	0.31	0.51
c	0.19	0.25
D	4.70	5.10
D1	3.20	3.40
E	3.80	4.02
E1	5.80	6.25
E2	2.30	2.50
e	1.27	
L	0.40	0.90
θ	0°	8°

8、Statements And Notes:

8.1、The name and content of Hazardous substances or Elements in the product

Part name	Hazardous substances or Elements									
	Lead and lead compounds	Mercury and mercury compounds	Cadmium and cadmium compounds	Hexavalent chromium compounds	Polybrominated biphenyls	Polybrominated biphenyl ethers	Dibutyl phthalate	Butylbenzyl phthalate	Di-2-ethylhexyl phthalate	Diisobutyl phthalate
Lead frame	○	○	○	○	○	○	○	○	○	○
Plastic resin	○	○	○	○	○	○	○	○	○	○
Chip	○	○	○	○	○	○	○	○	○	○
The lead	○	○	○	○	○	○	○	○	○	○
Plastic sheet installed	○	○	○	○	○	○	○	○	○	○
explanation	○: Indicates that the content of hazardous substances or elements in the detection limit of the following the SJ/T11363-2006 standard. ×: Indicates that the content of hazardous substances or elements exceeding the SJ/T11363-2006 Standard limit requirements.									

8.2、Notion:

Recommended carefully reading this information before the use of this product;

The information in this document are subject to change without notice;

This information is using to the reference only, the company is not responsible for any loss;

The company is not responsible for the any infringement of the third party patents or other rights of the responsibility.