Mono 1W Filterless Non-Clip class-D Audio Power Amplifier

General Description

LN2011 is a 1W (RL=8Ω) Class-D audio power amplifier. LN2011 uses the filter-less method allowing the speaker to be directly connected to the output and features low-level distortion and noise characteristics.

LN2011 has non-clip function to control gain automatically and prevent output signal from being clipped at the supply voltage.

LN2011 has over-current and over-temperature protection function, under-voltage locked function, as well as EMI noise and pop noise reduction functions.

The LN2011 is available in MSOP8, SOP8 and SOT-23-6L packages.

Application

- Wireless or Cellular Handsets and PDAs
- Personal Navigation devices
- General Portable Audio devices

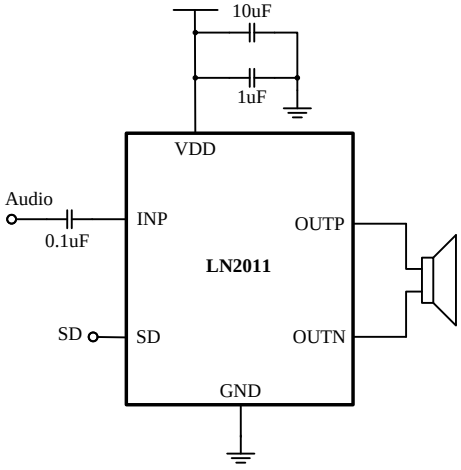
Features

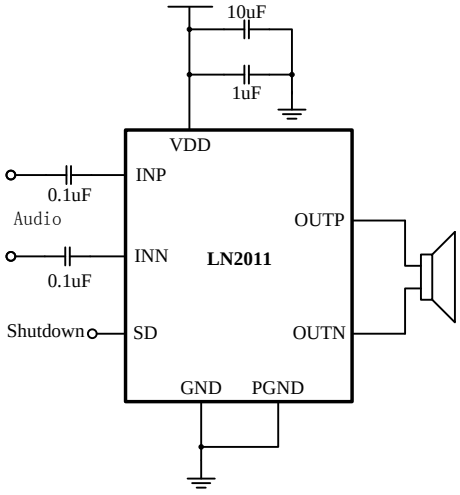
- 1.0W Output at 1% THD with 8Ωload at 5V Power Supply
- Filterless, Low Quiescent Current and Low EMI
- High Efficiency up to 89%
- Soft Start Function
- VULO and OCP Protection
- Thermal Shutdown
- Pb-Free Package

Package

- SOT-23-6L
- MSOP8
- SOP8

Application Information



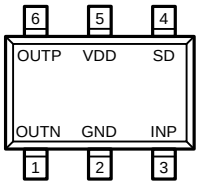


■ Ordering Information

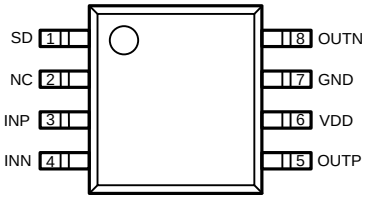
LN2011 ①②

Item	Symbol	Description
①		Package type:
	M	SOT-23-6L
	A	MSOP8
	S	SOP8
②		Device orientation:
	R	Embossed Tape: Standard Feed
	L	Embossed Tape: Reverse Feed

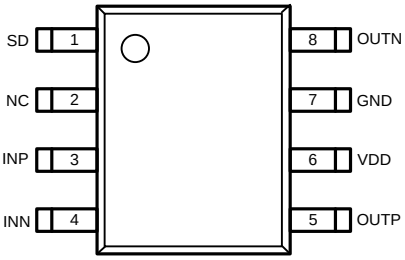
■ Pin Configuration



SOT-23-6L
(TOP VIEW)



MSOP8
(TOP VIEW)



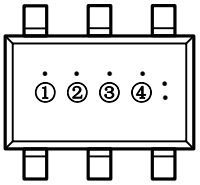
SOP8
(TOP VIEW)

■ Functional Pin Description

Pin Number			Pin Name	Function Description
SOT-23-6L	MSOP8	SOP8		
4	1	1	SD	Chip Enable
-	2	2	NC	Not connected
3	3	3	INP	Positive Input
-	4	4	INN	Negative Input
6	5	5	OUTP	Positive Output
5	6	6	VDD	Power Supply
2	7	7	GND	Ground
1	8	8	OUTN	Negative Output

■ Marking Information

- **SOT-23-6L**



SOT-23-6L
(TOP VIEW)

① Represent the product name

符号	描述
D	Product Name ： LN2011

② Represent the output power

符号	描述
1	Output Power 1W

③ Represent the input single

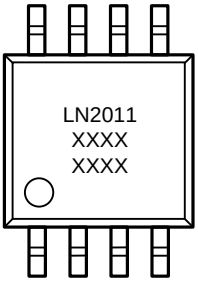
符号	描述
A	Single Audio Input
B	Full Differential Input

④ Represent the process change

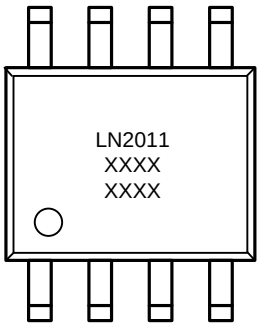
0～9，A～Z repeated (G，I，J，O，Q，W are excepted)

Notes: "• "represents the batch number. "• "says" 1 ", dot not said "0"; For example: dot on the top of the "③", and the top right of the "④", said "010010", used to track the product batch.

- **MSOP8/ SOP8**



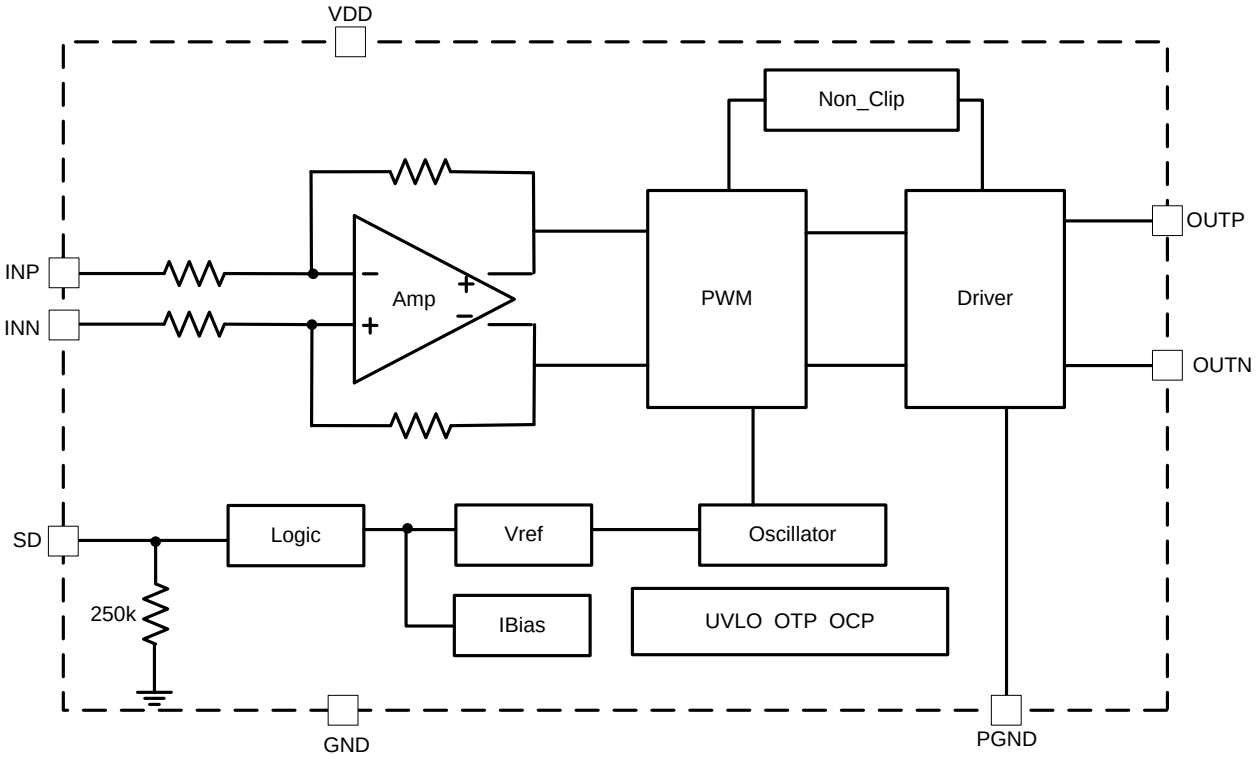
MSOP8
(TOP VIEW)



SOP8
(TOP VIEW)

The second and line the third line stand for the company's quality tracking information.

Function Block Diagram



Absolute Maximum Ratings

Parameter	Symbol	Max	Unit
Supply Voltage	VDD	VSS-0.3～VSS+6	V
Enable Voltage	SD	VSS-0.3～VIN+0.3	
Power Dissipation	PD@TA=25℃ SOT-23-6L	-	W
	PD@TA=25℃ SOP8	-	
	PD@TA=25℃ MSOP8		
Package Thermal Resistance	SOT23-6	-	℃/W
	MSOP8	-	
	SOP8		
Lead Temperature	-	260	°C
Ambient Temperature	Topa	-40～+85	
Storage Temperature	Tstr	-65～+125	
ESD Susceptibility	HBM	4000	V

■ Electrical Characteristics

(V_{EN}= V_{DD} =3.6V, Gain=24dB, R_L=8Ω,T_A=25℃,unless otherwise specification)

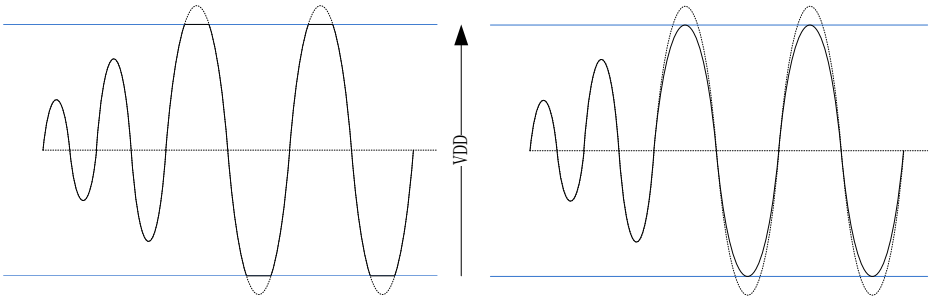
Parameter	Symbol	Test Conditions		Min	Typ	Max	Unit
Supply Voltage Range	V_{DD}	-		2.5	-	5.5	V
Quiescent Current	I_Q	V_{SD}=3.6V, No load		-	2.6	8	mA
Shutdown Current	I_{SHDN}	V_{EN}=0V		-	-	1	uA
High-level input voltage	SD	-		1.3	-	-	V
Low-level input voltage	SD	-		-	-	0.4	
Drain-Source On-State Resistance	$R_{DS(ON)}$	I_{DS}=100mA	P MOSFET	-	450	-	mΩ
			N MOSFET	-	300	-	
Output offset voltage	V_{OS}			-	±8	-	mV
Output Power	P_O	V_{DD}=3.6V, THD+N=1%, f=1kHz		-	0.65	-	W
		V_{DD}=4.2V, THD+N=1%, f=1kHz		-	0.80	-	
		V_{DD}=5.5V, THD+N=1%, f=1kHz		-	1.1	-	
Total Harmonic Distortion Plus Noise	THD+N	R_L=8Ω, P_O=200mW		-	0.2	-	%
		R_L=8Ω, P_O=500mW		-	0.3	-	
Peak Efficiency	η	-		-	89	-	%
AC Power Supply Ripple Rejection Gain	PSRR	No input, f=1kHz, V_{PP}=200mV		-	24	-	dB
Oscillator Frequency	f_{OSC}	-		-	300	-	kHz
UVLO Threshold	V_{UVLO}	Wake up		2.0	2.15	2.3	V
		Hysteresis		-	50	-	mV
Logic Input Leak Current	I_{LKC_EN}	A 250kΩresistor connected SD from GND		6	-	40	uA
Thermal Shutdown	T_{SD}	Shutdown Temperature		-	160	-	℃
		Hysteresis		-	25	-	℃
Non-Clip Attack Time	T_{ATA}	-		-	40	-	ms
Non-Clip Release Time	T_{RLA}	-		-	1.2	-	s
Start Time	T_{STUP}	-		-	200	-	ms
Power-down Time	T_{PD}	-		-	15	-	ms

■ Application Information

The LN2011 is a fully differential amplifier with differential inputs and outputs. The fully differential amplifier consists of a differential amplifier and a common-mode amplifier. The differential amplifier ensures that the amplifier outputs a differential voltage on the output that is equal to the differential input times the gain. The common-mode voltage at the output is biased around $V_{DD}/2$ regardless of the common-mode voltage at the input.

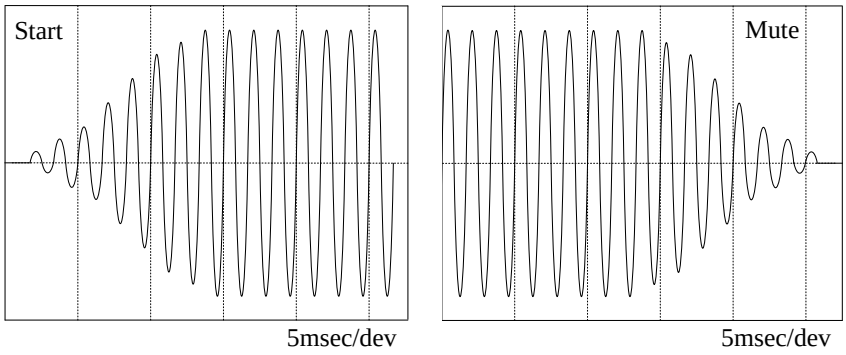
Non-Clip Function

Non-Clip function automatically controls the PWM amplifier gain so as not to clip the output signals even if the speaker output is clipped at the supply voltage.



Quick Start/Quick Mute Function

Pop noise reduction circuit operates at startup or shutdown of the speaker amplifier. This function reduces intermittent sound considerably and eliminates uncomfortable feeling. Quick Start/Quick Mute is a pop noise reduction function with the gain controlling of the first amplifier stage.



Maximum Gain

The LN2011 has two internal amplifier stages. The first stage's gain is externally configurable, while the second stage's is internally fixed. The gain of the first stage is set by selecting the ratio of RF to RI while the second stage's gain is fixed at 2x. The differential total gain for IC is

$$A_{VD} = 20 * \log\left[\left(\frac{R_F}{R_I}\right) * 2\right]$$

The LN2011 sets maximum R_F=160kΩ, minimum R_I=20kΩ, so the maximum closed-gain is 24dB.

Input Capacitor C_I

In typical application, an input capacitor, CI, is required to allow the amplifier to bias input signals to a proper DC level for optimum operation. A high pass filter with a corner frequency determined by CI and the minimum input impedance RI.

$$f_C = \frac{1}{2\pi * R_I * C_I}$$

Further consideration for capacitor is the leakage path from the input source through the input network (R_I, R_F, C_I) to the load. This leakage current creates a DC offset voltage at the input to the amplifier that reduces useful headroom. For this reason, a low leakage tantalum or ceramic capacitor is the best choice.

Power Supply Decoupling C_S

The LN2011 requires adequate power supply decoupling to ensure the THD and PSRR as low as possible. Optimum decoupling is achieved by using two capacitors of different types that target different types of noise on the power supply leads. For higher frequency transients, a low equivalent-series-resistance (ESR) ceramic capacitor (1uF) is good, placing it as close as possible to the device V_{DD} terminal. For filtering lower-frequency noise signals, capacitor of 10uF or larger, closely located to near the audio power amplifier is recommended.

Shutdown Operation

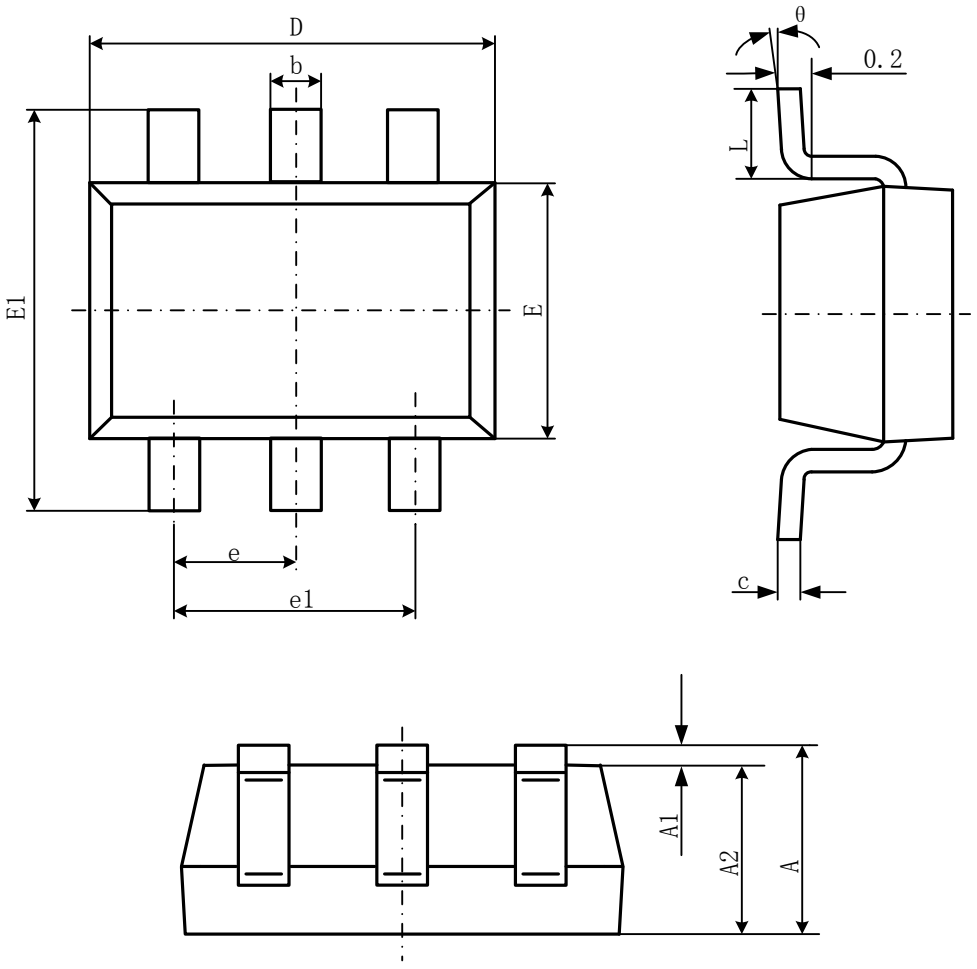
The shutdown feature of the LN2011 turns the amplifier off when a logic low is applied on the SD pin. A 250kΩ resistor is connected from the SD pin to Pin GND. For the best power on/off pop performance, the amplifier should be set in the shutdown mode prior to power on/off operation.

Under Voltage Lock-Out

The LN2011 incorporates circuitry to direct low on or off voltage. When the supply voltage drops to 2.1V or below, the LN2011 goes into a state of shutdown, and the device comes out of its shutdown state and starts to normal operation by reset the power supply or SD pin.

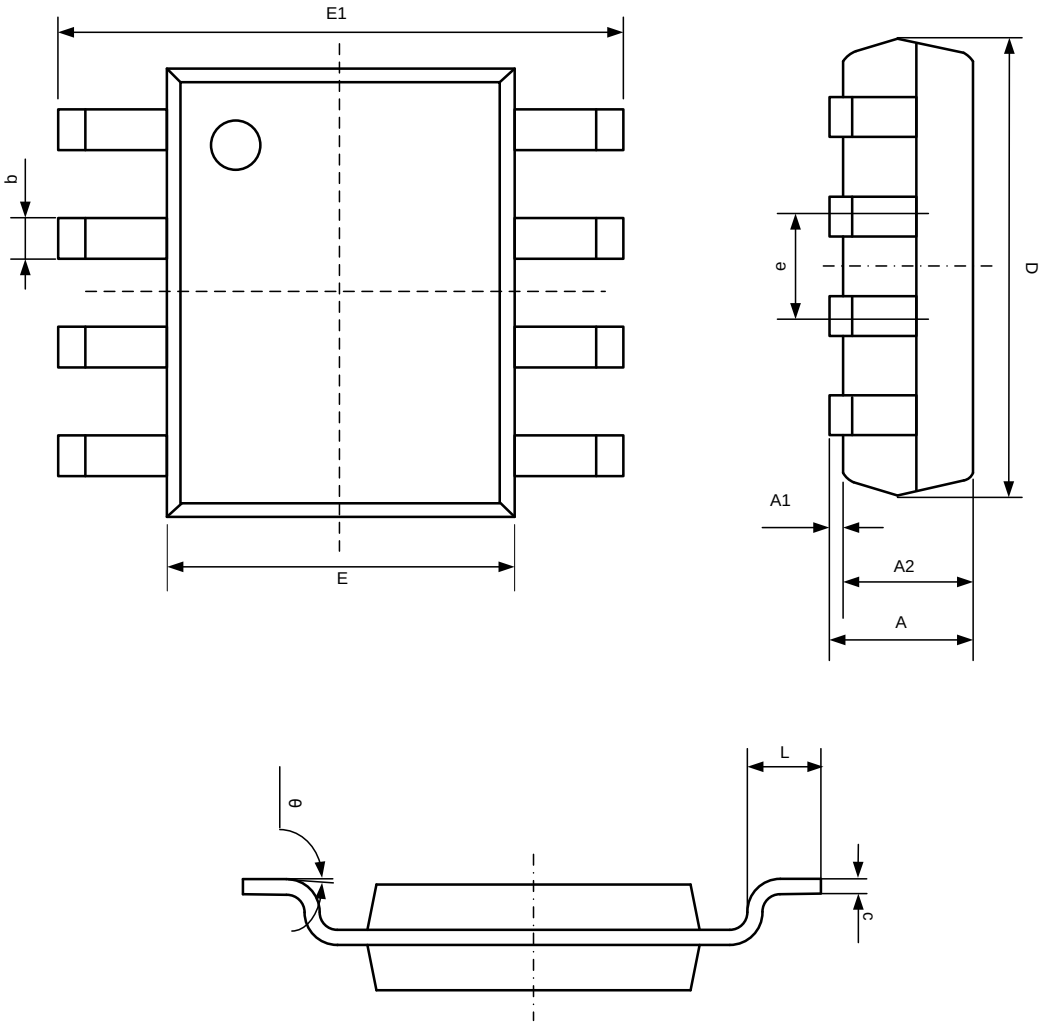
■ Package Information

- **SOT-23-6L**



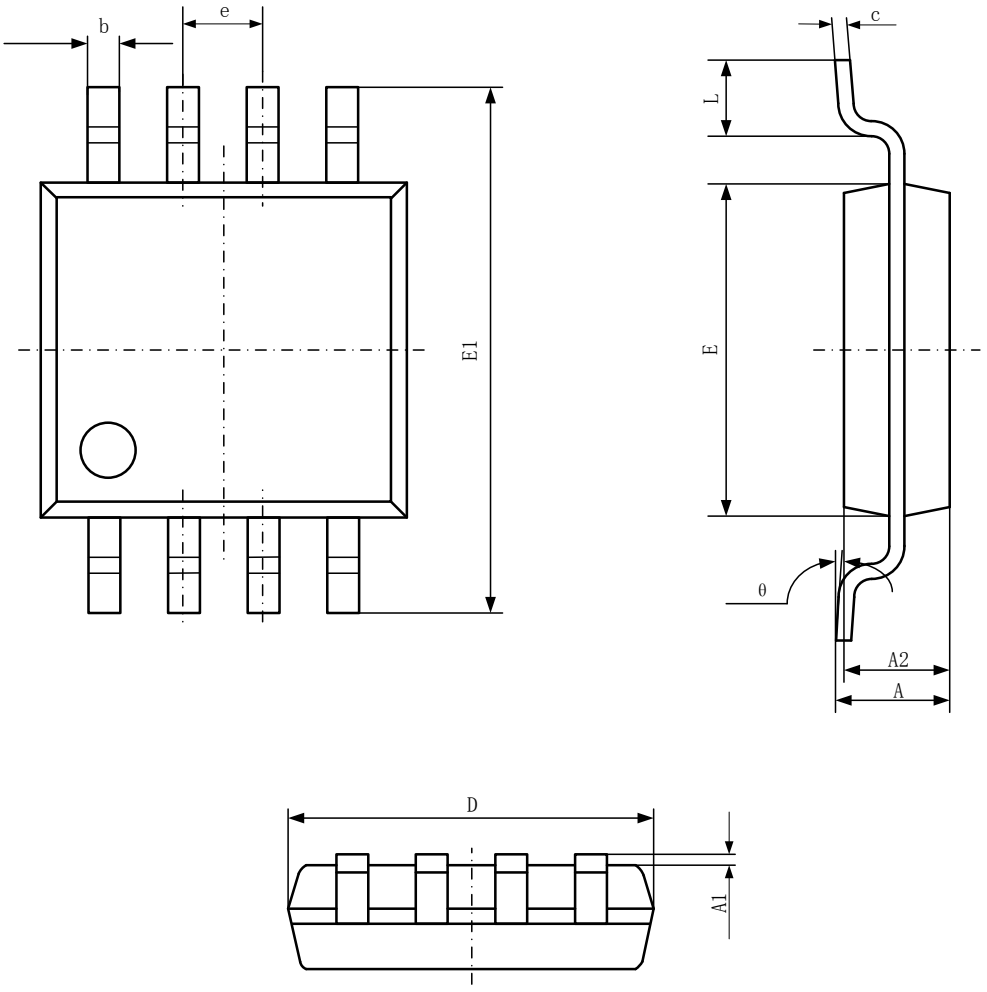
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

- **SOP8**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.002	0.006
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

- **MSOP8**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650(BSC)		0.026(BSC)	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°