General Description

The EC5912 is wideband, low-noise, low-distortion operational amplifier, that offer rail-to-rail output and single-supply operation down to 2.2V. They draw 5.6mA of quiescent supply current, as well as low input voltage-noise density (13nV/√Hz) and low input current-noise density (400fA/√Hz). These features make the devices an ideal choice for applications that require low distortion and low noise. The EC5912 has output which swing rail-to-rail and their input common-mode voltage range includes ground and offer wide bandwidth to 200MHz (G=+1) .They are specified over the extended industrial temperature range (-45℃ ~ 125℃).The single EC5912 is available in space-saving, MSOP-8 and SOP-8 packages.

Features

- Single-Supply Operation from +2.2V ~ +5.5V
- Rail-to-Rail Input / Output
- Gain-Bandwidth Product: 200MHz
- Low Input Bias Current: 10pA
- Low Offset Voltage: 1mV
- Quiescent Current: 5.6mA
- Available in MSOP-8 and SOP-8 Packages

Applications

- Portable Equipment
- Mobile Communications
- Smoke Detector
- Sensor interface
- Medical Instrumentation
- Handheld Test Equipment
- imaging / video

Pin Configurations(Top View)

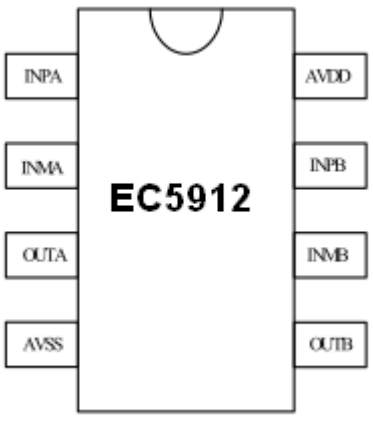
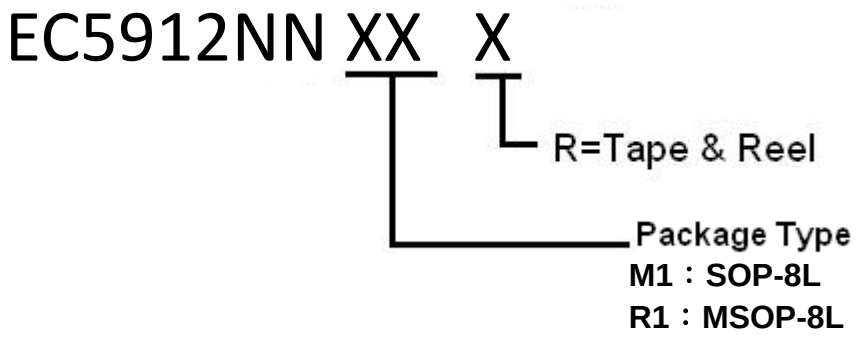


Figure 1. Pin Assignment Diagram (MSOP-8 and SOP-8 Package)

Ordering Information



Part Number	Package	Marking	Marking Information
EC5912NNR1R	MSOP-8L	5912 LLLL YYWW	1. LLLL：Last four Number of Lot No 2. YY：Year Code 3. WW：Week Code
EC5912NNM1R	SOP-8L	EC5912 LLLLL YYWWT	1. LLLLL：Last five Number of Lot No 2. YY：Year Code 3. WW：Week Code 4. T：Internal Tracking Code

Absolute Maximum Ratings

Note: Stress greater than those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions outside those indicated in the operational sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Condition	Min	Max
Power Supply Voltage (V_{DD} to Vss)	-0.5V	+7V
Analog Input Voltage (IN+ or IN-)	Vss-0.5V	V_{DD}+0.5V
Operating Temperature Range	-40°C	+125°C
Junction Temperature	+150°C	
Storage Temperature Range	-65°C	+150°C
Lead Temperature (soldering, 10sec)	+300°C	
Package Thermal Resistance (T_A=+25°C)		
MSOP-8, θ_{JA}	210°C	
SOP-8, θ_{JA}	130°C	

Electrical Characteristic

(V_{DD} = +5V, Vss = 0V, V_{CM} = 0V, V_{OUT} = V_{DD}/2, R_L tied to V_{DD}/2, SHDNB = V_{DD}, T_A = -40°C to +125°C, unless otherwise noted. Typical values are at T_A =+25°C.) (Notes 1,2)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Supply-Voltage Range	V_{DD}	Guaranteed by the PSRR test	2.2	-	5.5	V
Quiescent Supply Current (per Amplifier)	I_Q	V_{DD} = 5V	-	7	8.4	mA
Input Offset Voltage	V_{OS}	T_A=25°C	-	±1	-	mV
		T_A=-40°C~+85°C	-	±8	-	
		T_A=-40°C~+125°C	-	-	±10	
Input Offset Voltage Tempco	$\Delta V_{OS}/\Delta T$		-	±2	-	µV/°C
Input Bias Current	I_B	(Note 3)	-	±10	±100	pA
Input Offset Current	I_{OS}	(Note 3)	-	±10	±100	pA
Input Common-Mode Voltage Range	V_{CM}	Guaranteed by the T_A = 25°C CMRR test, T_A = -40°C ~ +125°C	-0.1	-	V_{DD}+0.1.5	V
Common-Mode Rejection Ratio	CMRR	Vss-0.1V≤V_{CM}≤V_{DD}+0.1V T_A = 25°C	-	75	-	dB
		Vss≤V_{CM}≤V_{DD} T_A = 25°C	72	90	-	
		Vss-0.1V≤V_{CM}≤V_{DD}+0.1V T_A = -40°C ~ +125°C	-	68	-	
Power-Supply Rejection Ratio	PSRR	V_{DD} = +2.2V to +5.5V	75	90	-	dB
Open-Loop Voltage Gain	A_V	R_L = 10kΩ to V_{DD}/2 V_{OUT} = 100mV to V_{DD}-125mV	90	100	-	dB
		R_L = 1kΩ to V_{DD}/2 V_{OUT} = 200mV to V_{DD}-250mV	80	95	-	
		R_L = 500Ω to V_{DD}/2 V_{OUT} = 350mV to V_{DD}-500mV	70	80	-	
Output Voltage Swing	V_{OUT}	|V_{IN+}-V_{IN-}| ≥ 10mV V_{DD}-V_{OH}	-	10	35	mV
		R_L = 10kΩ to V_{DD}/2 V_{OL}-V_{SS}	-	10	30	
		|V_{IN+}-V_{IN-}| ≥ 10mV V_{DD}-V_{OH}	-	80	50	
		R_L = 1kΩ to V_{DD}/2 V_{OL}-V_{SS}	-	30	50	
		|V_{IN+}-V_{IN-}| ≥ 10mV V_{DD}-V_{OH}	-	100	140	
		R_L = 500Ω to V_{DD}/2 V_{OL}-V_{SS}	-	100	140	
Output Short-Circuit Current	I_{SC}	Sinking or Sourcing	-	±60	-	mA
Input Capacitance	C_{IN}			1.5		pF
Bandwidth	GBW	A_V = +1V/V	-	200	-	MHz
Slew Rate	SR	A_V = +1V/V	-	125	-	V/µs

Electrical Characteristic

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Differential Phase error (NTSC)	DP	G=2,R_L=150Ω	-	0.03	-	deg
Differential Gain error (NTSC)	DG	G=2,R_L=150Ω	-	0.09	-	dB
Settling Time	t_S	To 0.01%, V_{OUT} = 2V step A_V = +1V/V	-	52	-	ns
Capacitive-Load Stability	C_{LOAD}	No sustained oscilliations A_V = +1V/V		200		pF
Input Voltage Noise Density	e_n	f = 1kHz	-	15	-	nV/√Hz
		f = 30kHz	-	13	-	
Input Current Noise Density	i_n	f = 1kHz	-	400	-	fA/√Hz
Total Harmonic Distortion plus Noise	THD+N	f_C=5MHZ,V_{OUT}=2Vp-p,G=+2	-	-60	-	dB

Note 1: All devices are 100% production tested at T_A = +25°C; all specifications over the automotive temperature range is guaranteed by design, not production tested.
Note 2: Parameter is guaranteed by design.
Note 3: Peak-to-peak input noise voltage is defined as six times rms value of input noise voltage.

APPLICATION INFORMATION

Size

EC5912 series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the EC5912 series packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

EC5912 series operates from a single 2.5V to 5.5V supply or dual ±1.25V to ±2.75V supplies. For best performance, a 0.1μF ceramic capacitor should be placed close to the V_{DD} pin in single supply operation. For dual supply operation, both V_{DD} and V_{SS} supplies should be bypassed to ground with separate 0.1μF ceramic capacitors.

Low Supply Current

The low supply current (7mA) of EC5912 series will help to maximize battery life. They are ideal for battery powered systems

Operating Voltage

EC5912 series operate under wide input supply voltage(2.5V to5.5V). In addition, all Temperature specifications apply from -40℃ to +125℃ Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime

Rail-to-Rail Input

The input common-mode range of EC5912 series extends 100mV beyond the negative fsupply rail (V_{SS}-0.1V to V_{DD}-1.5V). This is achieved by using complementary input stage. For normal operation, inputs should be limited to this range.

Rail-to-Rail Output

Rail-to-Rail output swing provides maximum possible dynamic range at the output. This is particularly important when operating in low supply voltages. The output voltage of EC5912 series can typically swing to less than 10mV from supply rail in light resistive loads (>100kΩ), and 60mV of supply rail in moderate resistive loads (10kΩ).

Capacitive Load Tolerance

The EC5912 series can directly drive 200pF capacitive load in unity-gain without oscillation. Increasing the gain enhances the amplifier's ability to drive greater capacitive loads. In unity-gain configurations, the capacitive load drive can be improved by inserting an isolation resistor RISO in series with the capacitive load, as shown in Figure 1.

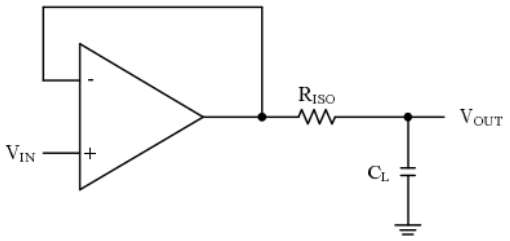


Figure 1. Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. However, if there is a resistive load RL in parallel with the capacitive load, a voltage divider (proportional to R_{ISO}/R_L) is formed, this will result in a gain error. The circuit in Figure 2 is an improvement to the one in Figure 1. RF provides the DC accuracy by feed-forward the V_{IN} to R_L. C_F and R_{ISO} serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving the phase margin in the overall feedback loop. Capacitive drive can be increased by increasing the value of C_F. This in turn will slow down the pulse response.

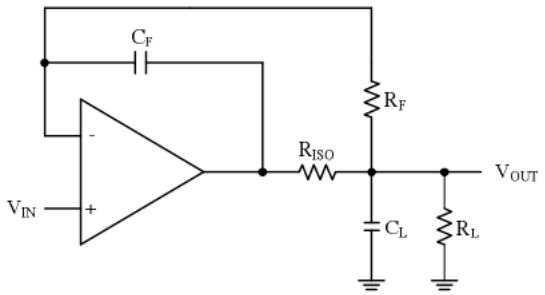


Figure 2. Indirectly Driving a Capacitive Load With DC Accuracy

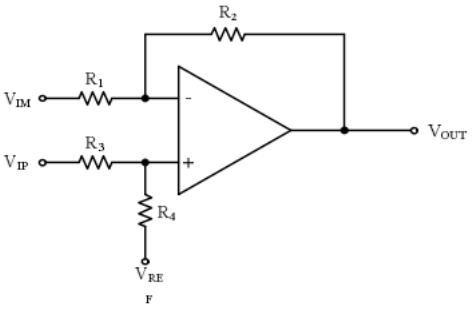


Figure 3. Differential Amplifier

Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common the two inputs. It is useful asa computational amplifier in making a differential To single-end conversion or in rejecting a common mode signal. Figure 3 shown the differential amplifier using EC5912

$$V_{out}=\left(\frac{R1+R2}{R3+R4}\right)\frac{R4}{R1}V_2-\frac{R2}{R1}V_1+\left(\frac{R1+R2}{R3+R4}\right)\frac{R3}{R1}\frac{V^+}{2}$$

If the resistor ratios are equal (i.e. $R_1=R_3$ and $R_2=R_4$), then

$$V_{out}=\frac{R_2}{R_1}(V_2-V_1)+\frac{V^+}{2}$$

Instrumentation Amplifier

The input impedance of the previous differential amplifier is set by the resistors R_1, R_2, R_3, and R_4. To maintain the high input impedance, one can use a voltage follower in front of each input as shown in the following two instrumentation amplifiers.

Three-Op-Amp Instrumentation Amplifier

The triple EC5912 can be used to build a three-op-amp instrumentation amplifier as shown in Figure 4. The amplifier in Figure 4 is a high input impedance differential amplifier with gain of R_2/R_1. The two differential voltage followers assure the high input impedance of the amplifier.

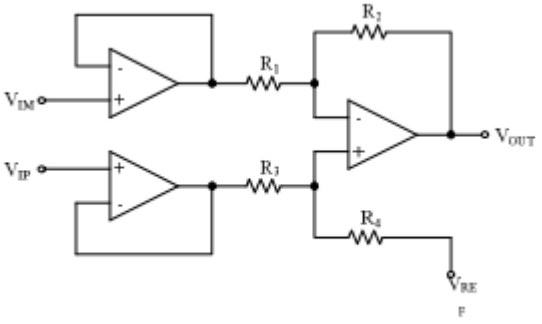


Figure 4. Three-Op-Amp Instrumentation Amplifier

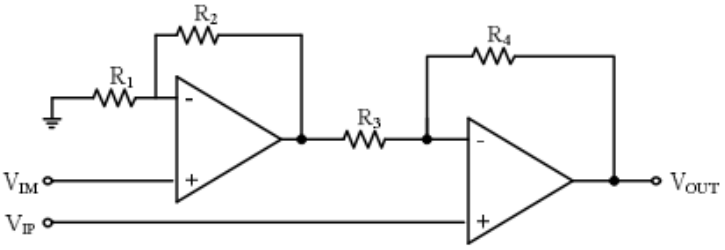


Figure 5. Two-Op-Amp Instrumentation Amplifier

Two-Op-Amp Instrumentation Amplifier

EC5912 can also be used to make a high input impedance two-op-amp instrumentation amplifier as shown in Figure 5.

$$V_o = (1+\frac{R_4}{R_3})(V_2 - V_1)$$

Where R_1=R_3 and R_2=R_4. If all resistors are equal,then Vo=2(V_2-V_1)

Single-Supply Inverting Amplifier

The inverting amplifier is shown in Figure 6. The capacitor C_1 is used to block the DC signal going into the AC signal source V_{IN}. The value of R_1 and C_1 set the cut-off frequency to f_C=1/(2πR_1C_1). The DC gain is defined by V_{OUT}=-(R_2/R_1)V_{IN}

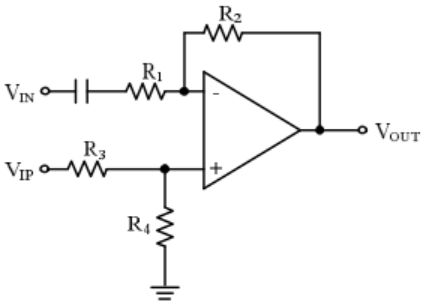


Figure 6. Single Supply Inverting Amplifier

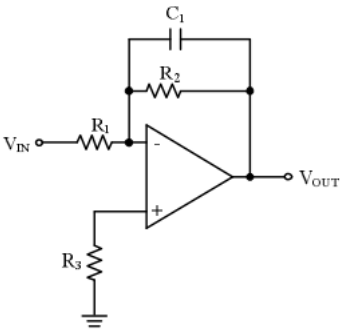


Figure 7. Low Pass Active Filter

Sallen-Key 2nd Order Active Low-Pass Filter

EC4912 can be used to form a 2nd order Sallen-Key active low-pass filter as shown in Figure 8. The transfer function from V_{IN} to V_{OUT} is given by

$$\frac{V_{OUT}}{V_{in}}(S) = \frac{\frac{1}{C_1C_2R_1R_2}A_{LP}}{S^2 + S(\frac{1}{C_1R_1} + \frac{1}{C_1R_2} + \frac{1}{C_2R_2} - \frac{A_{LP}}{C_2R_2}) + \frac{1}{C_1C_2R_1R_2}}$$

Where the DC gain is defined by A_{LP}=1+R_3/R_4, and the corner frequency is given by

$$\omega C = \sqrt{\frac{1}{C_1C_2R_1R_2}}$$

The pole quality factor is given by

$$\frac{\omega C}{Q} = \frac{1}{C_1 R_1} + \frac{1}{C_1 R_2} + \frac{1}{C_2 R_2} - \frac{A_{LP}}{C_2 R_2}$$

Let $R_1=R_2=R$ and $C_1=C_2=C$, the corner frequency and the pole quality factor can be simplified as below

$$\omega_C = \frac{1}{CR}$$

And $Q=2-R_3/R_4$

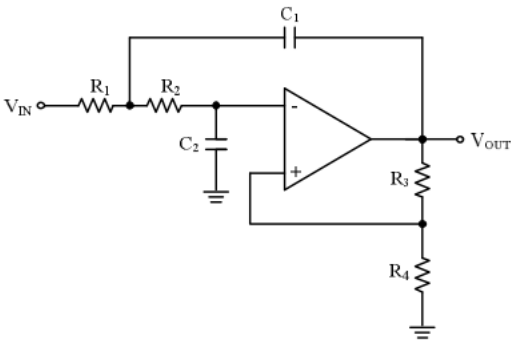


Figure 8. Sanllen-Key 2nd Order Active Low-Pass Filter

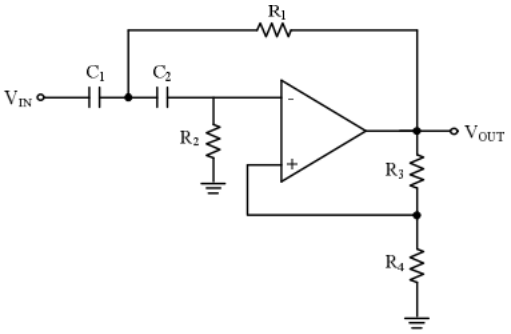


Figure 9. Sanllen-Key 2nd Order Active High-Pass Filter

Sallen-Key 2nd Order high-Pass Active Filter

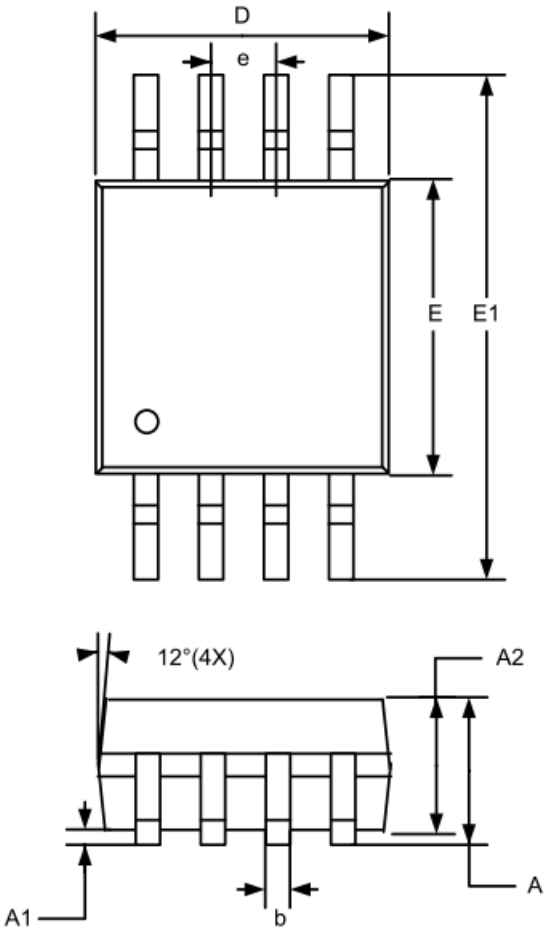
The 2 nd order Sallen-key high-pass filter can be built by simply interchanging those frequency selective components R_1, R_2, C_1, and C_2 as shown in Figure 9.

$$\frac{V_{OUT}}{V_{IN}}(S) = \frac{S^2 A_{HP}}{S^2 + S\left(\frac{1}{C_1 R_1} + \frac{1}{C_2 R_2} + \frac{1-A_{HP}}{C_1 R_1}\right) + \frac{1}{C_1 C_2 R_1 R_2}}$$

Where $A_{HP}=1+R_3/R_4$

Package Information

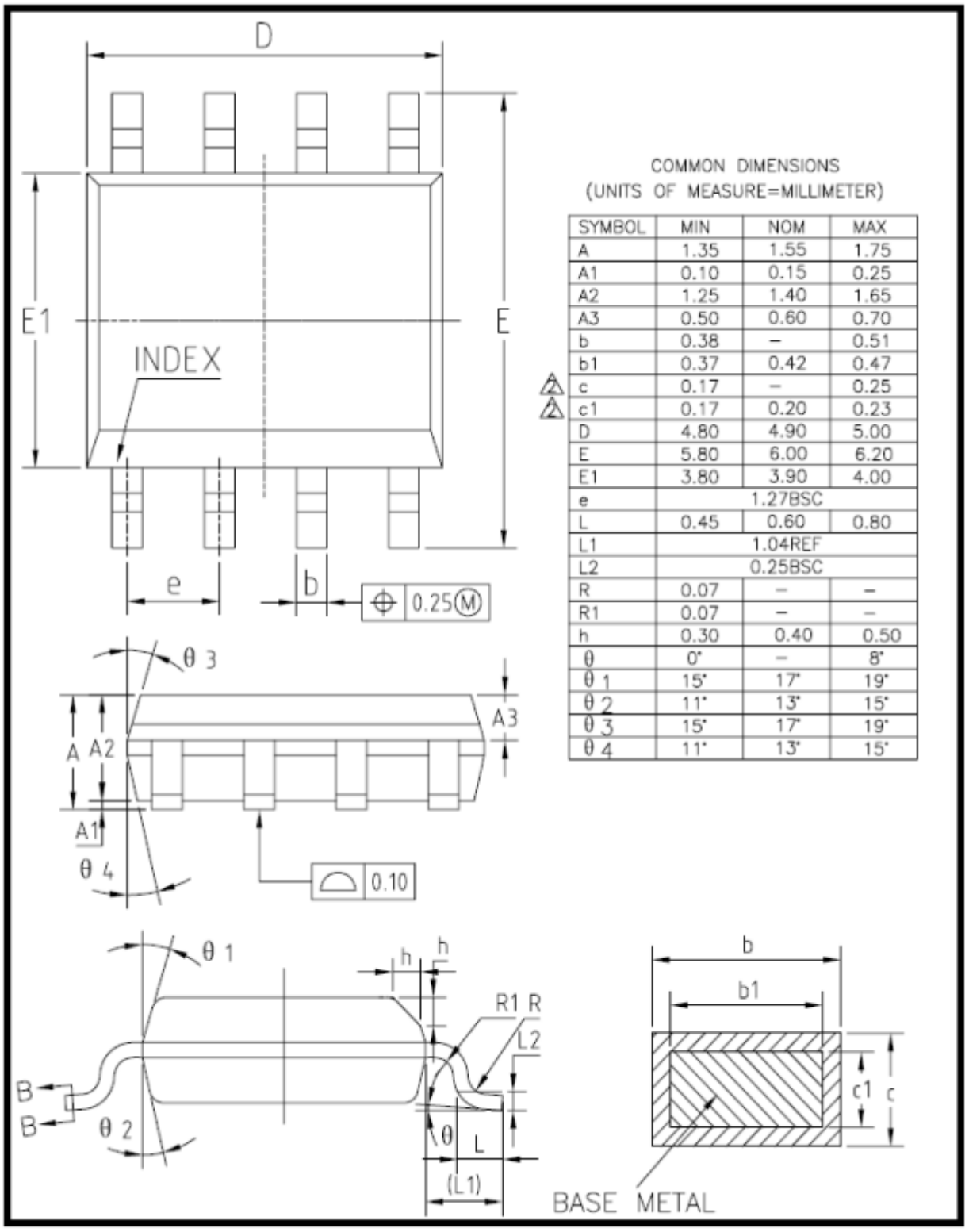
MSOP-8



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	--	--	1.10	--	--	0.043
A1	0.05	--	0.15	0.002	--	0.006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.25	--	0.40	0.010	--	0.016
C	0.13	--	0.23	0.005	--	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	2.90	3.00	3.10	0.114	0.118	0.122
E1	4.90 BSC			0.193 BSC		
e	0.65 BSC			0.026 BSC		
L	--	--	0.55	--	--	0.022
Θ	0	--	7°	0	--	7°

Note:
1. Controlling Dimension: MM
2. Dimension D and E1 do not include Mold protrusion
3. Refer to Jedec standard MO187
4. Drawing is not to scale

SOP8



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	1.35	1.55	1.75
A1	0.10	0.15	0.25
A2	1.25	1.40	1.65
A3	0.50	0.60	0.70
b	0.38	–	0.51
b1	0.37	0.42	0.47
⚠2 c	0.17	–	0.25
⚠2 c1	0.17	0.20	0.23
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e		1.27BSC	
L	0.45	0.60	0.80
L1		1.04REF	
L2		0.25BSC	
R	0.07	–	–
R1	0.07	–	–
h	0.30	0.40	0.50
θ	0°	–	8°
θ 1	15°	17°	19°
θ 2	11°	13°	15°
θ 3	15°	17°	19°
θ 4	11°	13°	15°