Features

- **Single-Supply Operation from +1.8V ~ +5.5V**
- **Rail-to-Rail Input / Output**
- **Gain-Bandwidth Product: 1MHz (Typ)**
- **Low Input Bias Current: 10pA (Typ)**
- **Low Offset Voltage: 0.6mV (Typ)**
- **Quiescent Current: 44μA per Amplifier (Typ)**
- **Embedded RF Anti-EMI Filter**
- **Embedded RF Anti-EMI Filter**
- **Operating Temperature: -40°C ~ +125°C**
- **Small Package:**

LMV358B Available in SOP-8 and MSOP-8 Packages

LMV324B Available in SOP-14 and TSSOP-14 Packages

General Description

The LMV358B/324B have a high gain-bandwidth product of 1MHz, a slew rate of 0.6V/μs, and a quiescent current of 44 μA/amplifier at 5V. The LMV358B/324B is designed to provide optimal performance in low voltage and low noise systems. They provide rail-to-rail output swing into heavy loads. The input common mode voltage range includes ground, and the input offset voltage range is 0.4mV~0.8mV for LMV358B/324B. They are specified over the extended industrial temperature range (-40℃ to +125℃). The operating range is from 1.8V to 5.5V. The LMV358B dual is available in Green SOP-8 and MSOP-8 packages. The LMV324B Quad is available in Green SOP-14 and TSSOP-14 packages.

Applications

- ASIC Input or Output Amplifier
- Sensor Interface
- Medical Communication
- Smoke Detectors
- Audio Output
- Piezoelectric Transducer Amplifier
- Medical Instrumentation
- Portable Systems

Pin Configuration

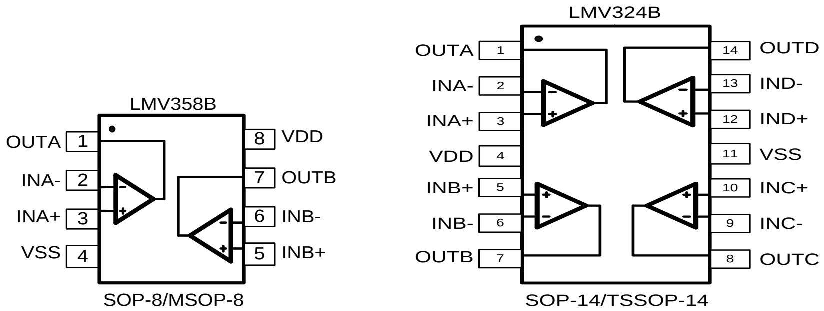


Figure 1. Pin Assignment Diagram

Absolute Maximum Ratings

Condition	Min	Max
Power Supply Voltage (V_{DD} to Vss)	-0.5V	+8V
Analog Input Voltage (IN+ or IN-)	Vss-0.5V	V_{DD}+0.5V
PDB Input Voltage	Vss-0.5V	+7V
Operating Temperature Range	-40°C	+125°C
Junction Temperature	+160°C	
Storage Temperature Range	-55°C	+150°C
Lead Temperature (soldering, 10sec)	+260°C	
Package Thermal Resistance (T_A=+25℃)		
SOP-14, θ_{JA}	120°C/W	
TSSOP-14, θ_{JA}	180°C/W	
SOP-8, θ_{JA}	125°C/W	
MSOP-8, θ_{JA}	216°C/W	
ESD Susceptibility		
HBM①	±5KV	
CDM	±2KV	
Latch up	±350mA	

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. ① OUT to VDD+ only pass 2kV.

Package/Ordering Information

MODEL	CHANNEL	ORDER NUMBER	PACKAGE DESCRIPTION	PACKAGE OPTION	MARKING INFORMATION
LMV358B	**Dual**	**LMV358B-SR**	**SOP-8**	**Tape and Reel,4000**	**358B**
		LMV358B -MR	**MSOP-8**	**Tape and Reel,3000**	**358B**
LMV324B	**Quad**	**LMV324B-TR**	**TSSOP-14**	**Tape and Reel,3000**	**LMV324B**
		LMV324B-SR	**SOP-14**	**Tape and Reel,2500**	**LMV324B**

Electrical Characteristics

(At V_S = +5V, R_L = 100kΩ connected to V_S/2, and V_{OUT} = V_S/2, T_A = 25℃， unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TYP	MAX	MIN	UNITS
INPUT CHARACTERISTICS						
Input Offset Voltage	V_{OS}	V_{CM} = 0V to (Vs-1.2V)	0.6	0.8	0.4	mV
Input Bias Current	I_B		10			pA
Input Offset Current	I_{OS}		1			pA
Common-Mode Voltage Range	V_{CM}	V_S = 5.5V	-0.1 to +5.6			V
Common-Mode Rejection Ratio	CMRR	V_S = 5.5V, V_{CM} = -0.1V to 4V	70		62	dB
		V_S = 5.5V, V_{CM} = -0.1V to 5.6V	68		56	
Open-Loop Voltage Gain	A_{OL}	R_L = 5kΩ, V_O = +0.1V to +4.9V	80		70	dB
		R_L = 10kΩ, V_O = +0.1V to +4.9V	100		94	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta_T$		2.7			μV/℃
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	V_{OH}	R_L = 100kΩ	4.997			mV
	V_{OL}	R_L = 100kΩ	5	30		mV
	V_{OH}	R_L = 10kΩ	4.992			mV
	V_{OL}	R_L = 10kΩ	8	30		mV
Output Current	I_{SINK}	R_L = 10Ω to V_S/2	60		40	mA
	I_{Source}		60		40	
POWER SUPPLY						
Operating Voltage Range					1.8	V
				5.5		V
Power Supply Rejection Ratio	PSRR	V_S = +2V to +5V, V_{CM} = +0.5V	82		60	dB
Quiescent Current / Amplifier	I_Q		44	75	30	μA
DYNAMIC PERFORMANCE (CL = 100pF)						
Gain-Bandwidth Product	GBP		1			MHz
Slew Rate	SR	G = +1, 2V Output Step	0.6			V/μs
Settling Time to 0.1%	t_S	G = +1, 2V Output Step	5.3			μs
Overload Recovery Time		V_{IN} ·Gain = V_S	2.6			μs
NOISE PERFORMANCE						
Voltage Noise Density	e_n	f = 1kHz	150			$nV/\sqrt{Hz}$
		f = 10kHz	70			$nV/\sqrt{Hz}$

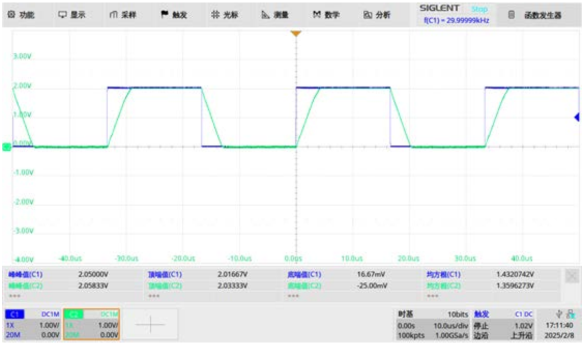
Typical Performance characteristics

At T_A=+25°C, Vs=5V, R_L=100KΩ connected to V_S/2 and V_{OUT}= V_S/2, unless otherwise noted.

Large Signal Transient Response

C_L=100Pf R_L=100kΩ

Output Voltage (250mV/div)

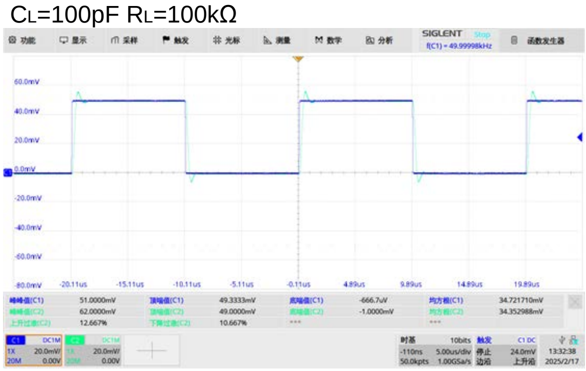


Time(10µs/div)

Small Signal Transient Response

C_L=100pF R_L=100kΩ

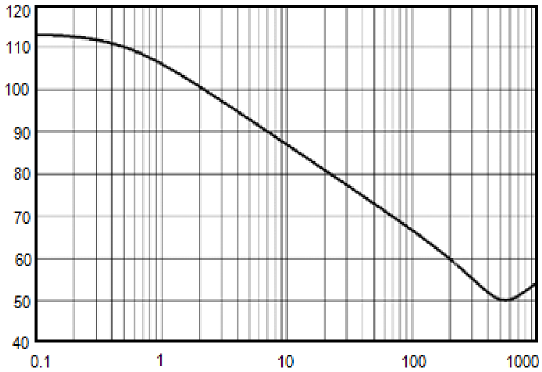
Output Voltage (50mV/div)



Time(5µs/div)

CMRR vs. Frequency

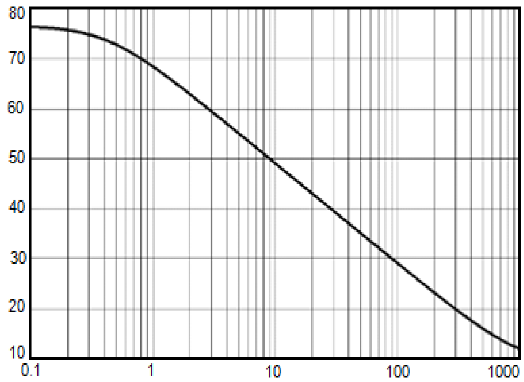
CMRR (dB)



Frequency (kHz)

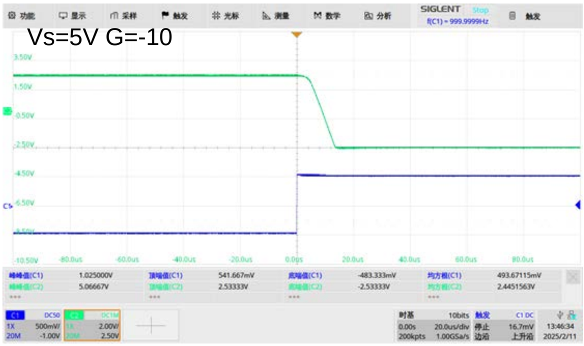
PSRR vs. Frequency

PSRR (dB)



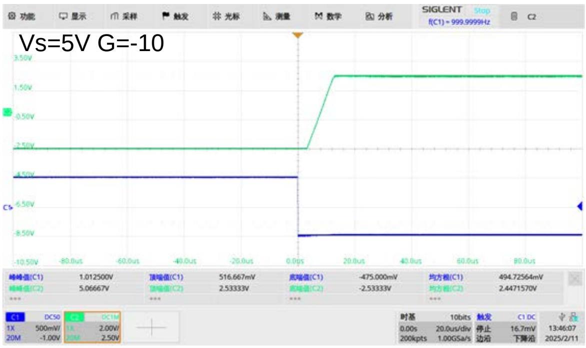
Frequency (kHz)

Overload Recovery Time



Time(20µs/div)

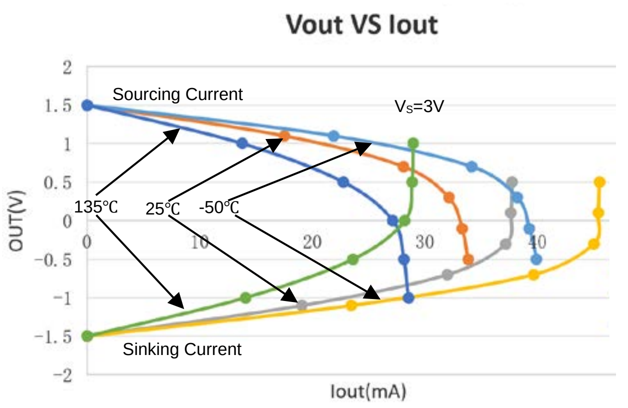
Overload Recovery Time

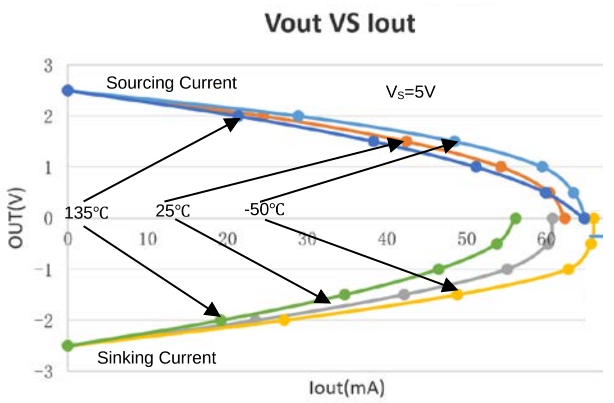


Time(20µs/div)

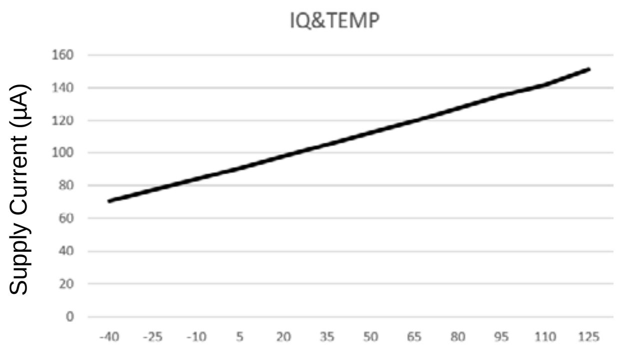
Typical Performance characteristics

At T_A=+25ºC, R_L=100KΩ connected to V_S/2 and V_{OUT}= V_S/2, unless otherwise noted.



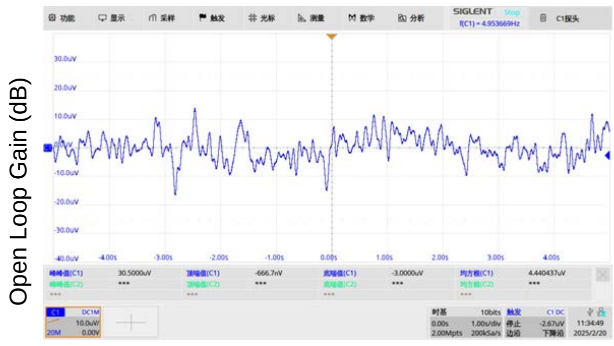


Supply Current vs. Temperature



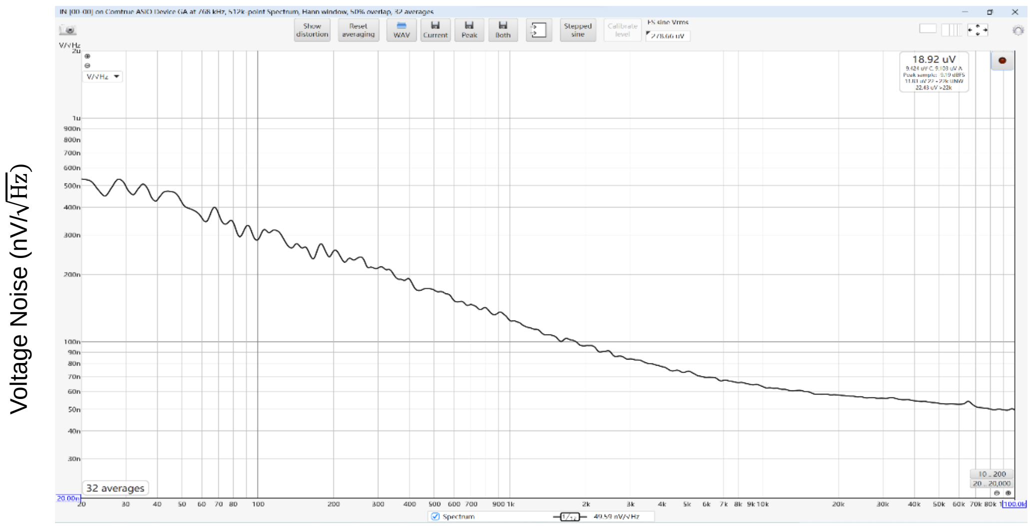
Temperature（℃）

Open Loop Gain, Phase Shift vs. Frequency



Frequency (kHz)

Input Voltage Noise Spectral Density vs. Frequency



Frequency (kHz)

Application Note

Size

LMV358B/324B series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the LMV358B/324B packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout

LMV358B/324B series operates from a single 1.8V to 5.5V supply or dual ±0.9V 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 (typical 44μA per channel) of LMV358B/324B will help to maximize battery life. They are ideal for battery powered systems.

Operating Voltage

LMV358B/324B operates under wide input supply voltage (1.8V to 5.5V). In addition, all temperature specifications apply from -40 ºC to +125 ºC. 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 LMV358B/324B extends 100mV beyond the supply rails (V_{SS}-0.1V to V_{DD}+0.1V). 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 LMV358B/324B can typically swing to less than 10mV from supply rail in light resistive loads (>100kΩ), and 30mV of supply rail in moderate resistive loads (10kΩ).

Capacitive Load Tolerance

The LMV358B/324B is optimized for bandwidth and speed, not for driving capacitive loads. Output capacitance will create a pole in the amplifier's feedback path, leading to excessive peaking and potential oscillation. If dealing with load capacitance is a requirement of the application, the two strategies to consider are (1) using a small resistor in series with the amplifier's output and the load capacitance and (2) reducing the bandwidth of the amplifier's feedback loop by increasing the overall noise gain. Figure 2 shows a unity gain follower using the series resistor strategy. The resistor isolates the output from the capacitance and, more importantly, creates a zero in the feedback path that compensates for the pole created by the output capacitance.

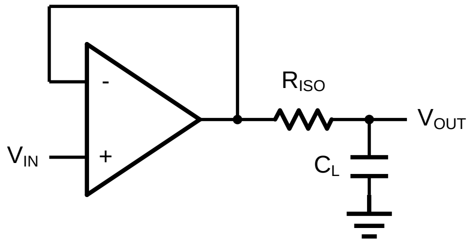


Figure 2 Indirectly Driving a Capacitive Load Using Isolation Resistor

The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. However, if there is a resistive load R_L 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 3 is an improvement to the one in Figure 2. R_F 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.

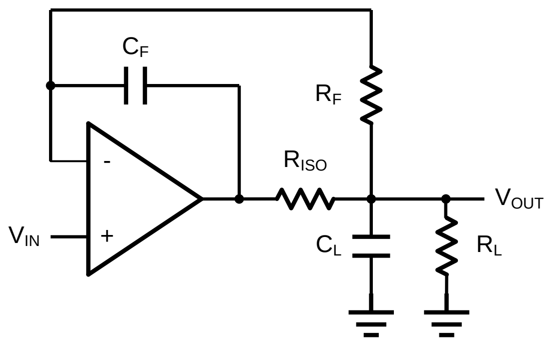


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy

Typical Application Circuits

Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common the two inputs. It is useful as a computational amplifier in making a differential to single-end conversion or in rejecting a common mode signal. Figure 4. shown the differential amplifier using LMV358B/324B.

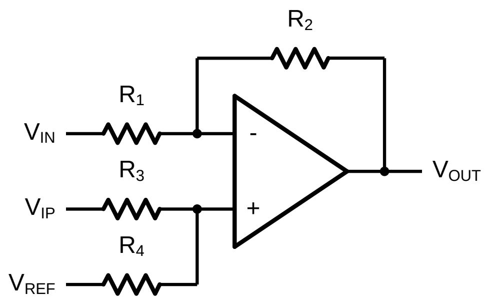


Figure 4. Differential Amplifier

$$V_{OUT} = \left(\frac{R_1+R_2}{R_3+R_4}\right)\frac{R_4}{R_1}V_{IN} - \frac{R2}{R1}V_{IP} + \left(\frac{R_1+R_2}{R_3+R_4}\right)\frac{R_3}{R_1}V_{REF}$$

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

$$V_{OUT} = \frac{R_2}{R_1}(V_{IP} - V_{IN}) + V_{REF}$$

Low Pass Active Filter

The low pass active filter is shown in Figure 5. The DC gain is defined by $-R_2/R_1$. The filter has a -20dB/decade roll-off after its corner frequency $f_C=1/(2\pi R_3C_1)$.

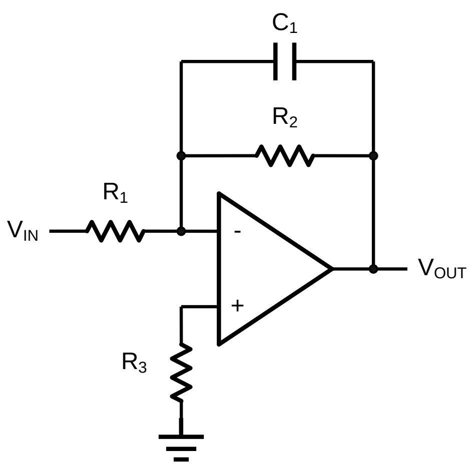


Figure 5. Low Pass Active Filter

Instrumentation Amplifier

The triple LMV358B/324B can be used to build a three-op-amp instrumentation amplifier as shown in Figure 6. The amplifier in Figure 6 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.

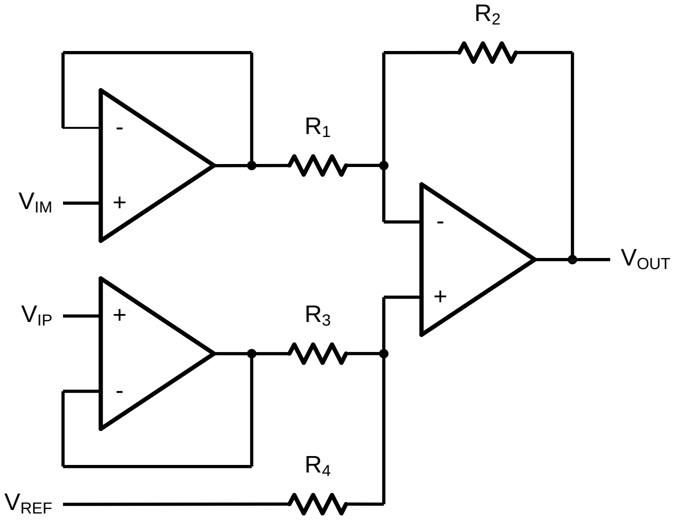


Figure 6. Instrument Amplifier

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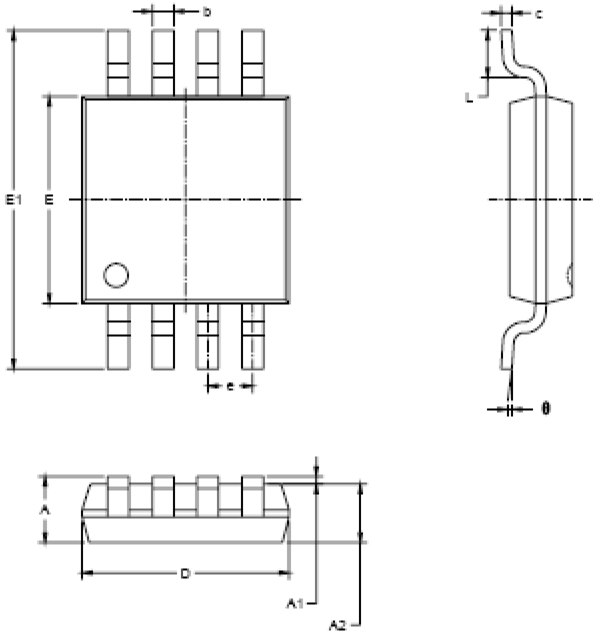
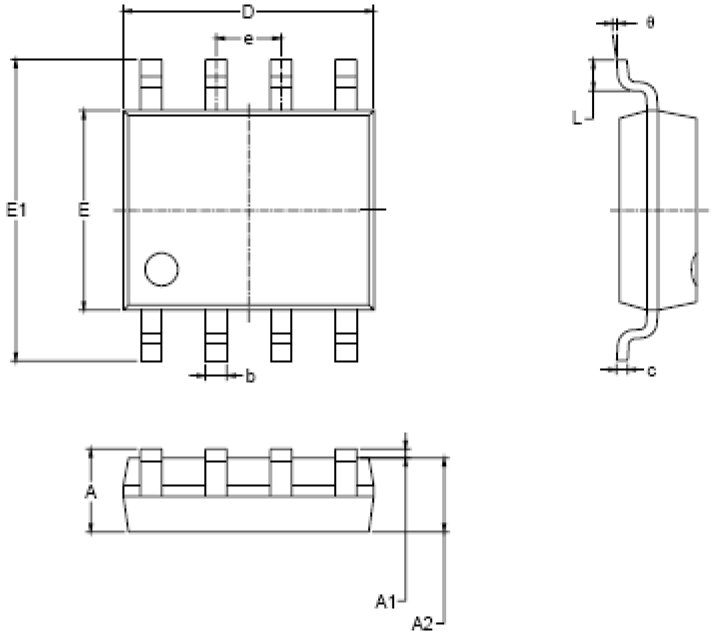
Package Information

MSOP-8



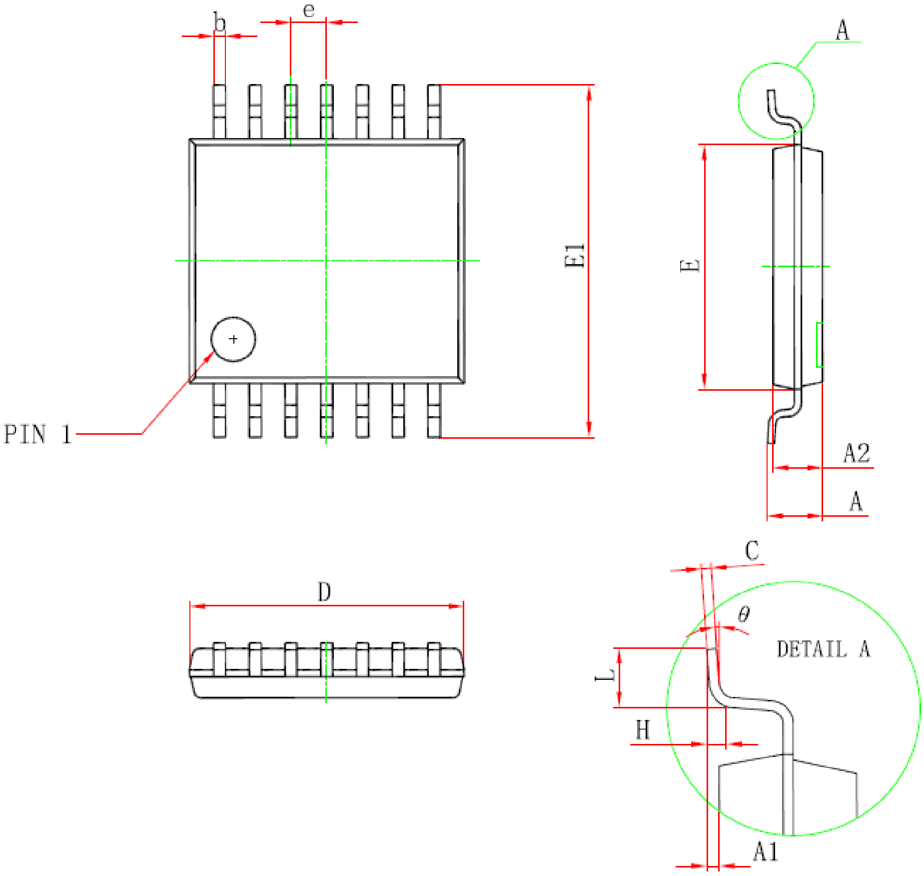
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

SOP-8



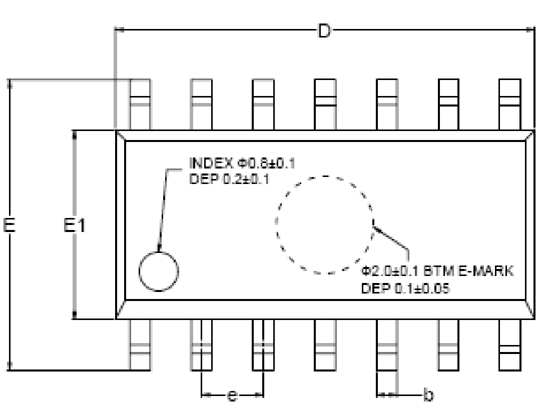
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

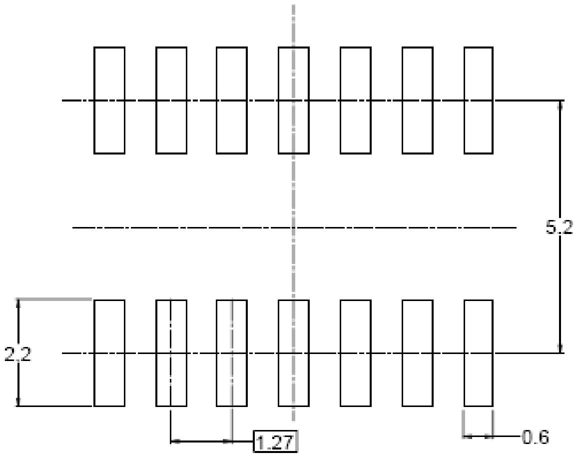
TSSOP-14



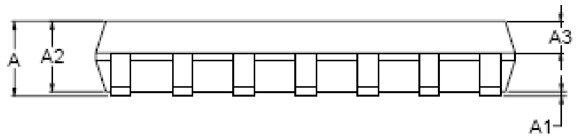
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65 (BSC)		0.026 (BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

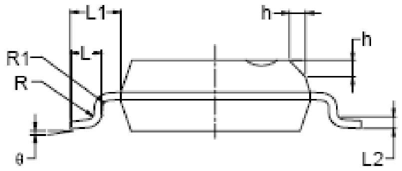
SOP-14





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Dimensions In Millimeters			Dimensions In Inches		
	MIN	MOD	MAX	MIN	MOD	MAX
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.25		1.65	0.049		0.065
A3	0.55		0.75	0.022		0.030
b	0.36		0.49	0.014		0.019
D	8.53		8.73	0.336		0.344
E	5.80		6.20	0.228		0.244
E1	3.80		4.00	0.150		0.157
e	1.27 BSC			0.050 BSC		
L	0.45		0.80	0.018		0.032
L1	1.04 REF			0.040 REF		
L2	0.25 BSC			0.01 BSC		
R	0.07			0.003		
R1	0.07			0.003		
h	0.30		0.50	0.012		0.020
θ	0°		8°	0°		8°