



钰地半导体  
Tudi Semiconductor

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## Product Specification

TUDI-LMV321/LMV358/LMV324

LMV3xx Low-voltage rail-to-rail output operational amplifier

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- Design
- research and development
- production
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## Features

- 2.7V and 5V performance
- Operating temperature range:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
- No cross-over distortion
- Low supply current
  - LMV321:  $130\mu\text{A}$  (typical)
  - LMV358:  $210\mu\text{A}$  (typical)
  - LMV324:  $410\mu\text{A}$  (typical)
- Rail-to-rail output swing
- ESD protection performance exceeds JESD 22 specification requirements
  - 2000V human body discharge model
  - 1000V charged device model

## Description

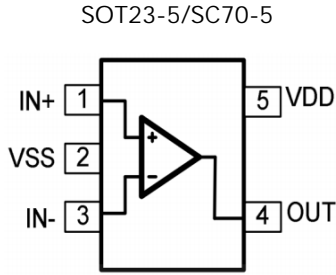
The LMV321, LMV358, and LMV324 devices are single-, dual-, and quad-, low-voltage (2.7V to 5.5V) operational amplifiers with rail-to-rail output swing. These devices are cost-effective solutions for applications low operating voltage, space savings, and low cost. These amplifiers are specifically designed for low operating voltage (2.7V to 5V) and achieve performance specifications meet or exceed the LM358 and LM324 devices (with operating voltage range of 5V to 30V). The package size of these devices can reduced to half the size of the DBV (SOT-23) package, making them suitable for a variety of applications.

## Applications

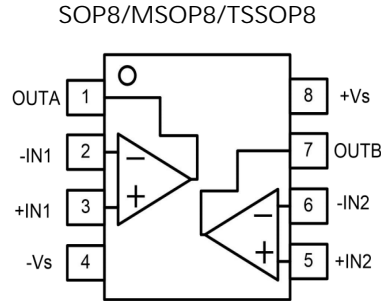
- Smoke detector
- Motion detector
- Wearable device
- Large and small household appliances
- EPOS
- Barcode scanner
- Motor control: AC induction
- Sensor signal conditioning
- Power module
- Personal electronics
- Active filter
- HVAC: Heating, ventilation, air conditioning
- Lowside current sensing



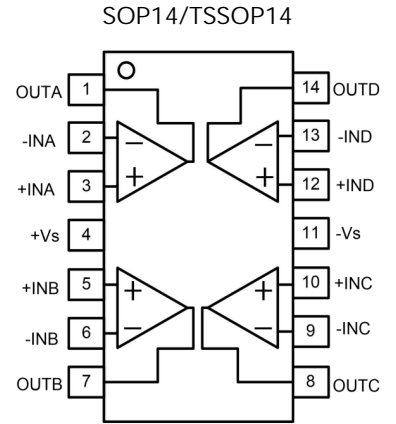
## Pin Diagram And Pin Functions



LMV321



LMV358



LMV324

Name	Description	Note
+Vs	Positive power supply	A bypass capacitor of 0.1 $\mu$ F as close to the part as possible should be placed between power supply pins or between supply pins and ground.
-Vs	Negative power supply or ground	If it is not connected to ground, bypass it with a capacitor of 0.1 $\mu$ F as close to the part as possible
-IN	Negative input	Inverting input of the amplifier. Voltage range of this pin can go from -Vs-0.3V to +Vs-1V.
+IN	Positive input	Non-inverting input of the amplifier. This pin has the same voltage range as -IN.
OUT	Output	The output voltage range extends to within millivolts of each supply rail.
NC	No connection	

## Product Specification

### Recommended Operating Conditions

Parameter	Rating	Unit
DC Supply Voltage	2.7V ~ 5V	V
Input common-mode voltage range	-Vs ~ +Vs	V
Operating ambient temperature	- 40°C to 125°C	



## Electrical Characteristics

(+Vs=+5V,-Vs=0,VeM=Vs/2,TA=+25°C,RL=10kQto Vs/2,unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>Input Characteristics</b>						
Input Offset Voltage	Vos			1.0	5.0	mV
Input Offset Voltage Drift	$\Delta V_{os}/\Delta T$	-40 to 125°C		5		$\mu V/^{\circ}C$
Input Bias Current	IB			2.5		pA
Input Offset Current	Ios			2.5		pA
Common-Mode Voltage Range	VcM	Vs=5.5V	-0.1		4.5	V
Common-Mode Rejection Ratio	CMRR	VCM=0.1V to 4.5V		125		dB
Open-Loop Voltage Gain	AOL	Vo=0.2V to 4.5V		120		dB
<b>Output Characteristics</b>						
Output Voltage Swing from Rail		RL=100k $\Omega$		1		mV
		RL=10k $\Omega$		10		mV
		RL=2k $\Omega$		40		mV
Short-Circuit Current	IsR	Sourcing		45		mA
	Isk	Sinking		50		mA
<b>Power Supply</b>						
Operating Voltage Range			2.7		5	V
Power Supply Rejection Ratio	PSRR	Vs=+1.8V to +5.5V	80	100		dB
Quiescent Current /Amplifier	IQ			85		$\mu A$
<b>Dynamic Performance</b>						
Gain Bandwidth Product	GBWP	G=+1		1.5		MHz
Slew Rate	SR	G=+1,2V Output Step		1		V/ $\mu s$
<b>Noise Performance</b>						
Voltage Noise Density	en	f=1kHz		28		nV/ $\sqrt{Hz}$



### Absolute Maximum Ratings

Parameter	Rating	Units
Power Supply:+Vs to-Vs	6.0	V
Input Voltage	-Vs -0.5V to+Vs+0.5V	V
Input Current(2)	10	mA
Storage Temperature Range	-65 to 150	°C
Junction Temperature	150	°C
Operating Temperature Range	-40 to 125	°C
ESD Susceptibility,HBM	2000	V

(1) Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

(2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current-limited to 10mA or less.

## Application Notes

### Driving Capacitive Loads

Driving large capacitive loads can cause stability problems for voltage feedback op amps. As the load capacitance increases, the feedback loop's phase margin decreases, and the closed loop bandwidth is reduced. This produces gain peaking in the frequency response, with overshoot and ringing in the step response. A unity gain buffer ( $G = +1$ ) is the most sensitive to capacitive loads, but all gains show the same general behavior.

When driving large capacitive loads with these op amps (e.g.,  $> 100$  pF when  $G = +1$ ), a small series resistor at the output ( $R_{iso}$  in Figure 1) improves the feedback loop's phase margin (stability) by making the output load resistive at higher frequencies. It does not, however, improve the bandwidth. To select  $R_{iso}$ , check the frequency response peaking (or step response overshoot) on the bench. If the response is reasonable, you do not need  $R_{iso}$ . Otherwise, start  $R_{iso}$  at 1k and modify its value until the response is reasonable.

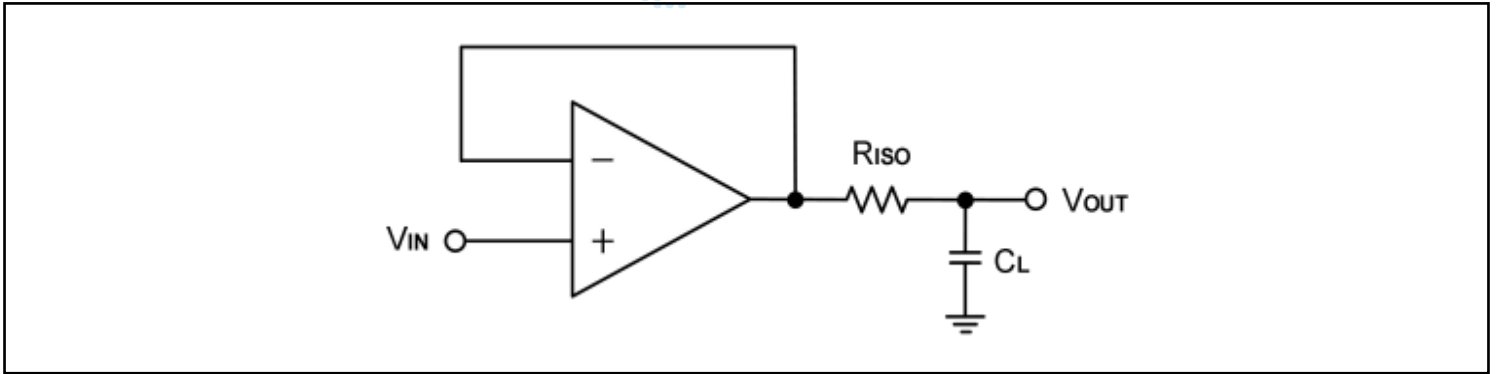


Figure 1. Indirectly Driving Heavy Capacitive Load

An improvement circuit is shown in Figure 2. It provides DC accuracy as well as AC stability.  $R_F$  provides the DC accuracy by connecting the inverting signal with the output,  $C_F$  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 phase margin in the overall feedback loop.

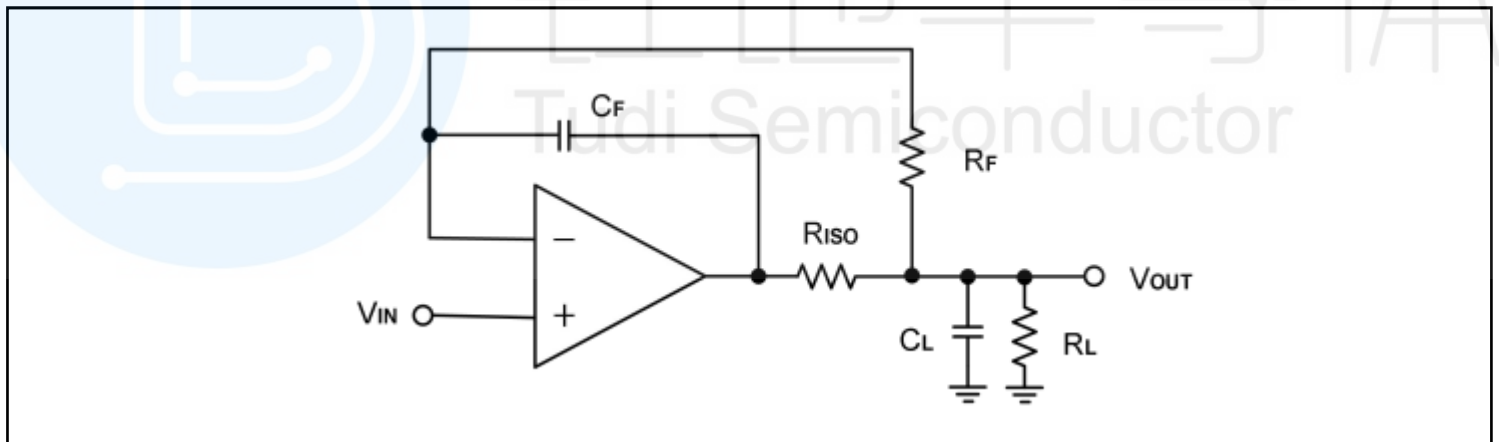


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For non-inverting configuration, there are two other ways to increase the phase margin:  
(a) by increasing the amplifier's gain or  
(b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node, as shown in Figure 3.

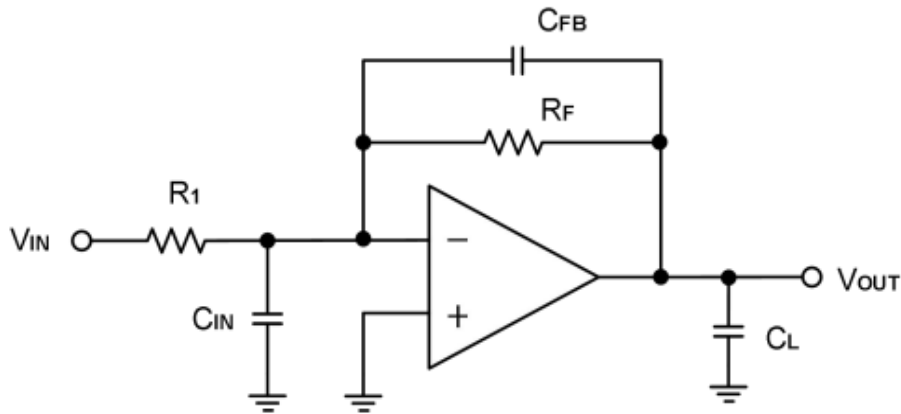


Figure 3. Adding a Feedback Capacitor in the Non-inverting Configuration

### Power-Supply Bypassing and Layout

The LMV321/2/4 operates from a single +2.7V to +5V supply or dual  $\pm 1.05\text{V}$  to  $\pm 2.75\text{V}$  supplies. For single-supply operation, bypass the power supply +Vs with a  $0.1\ \mu\text{F}$  ceramic capacitor which should be placed close to the +Vs pin. For dual-supply operation, both the +Vs and the -Vs supplies should be bypassed to ground with separate  $0.1\ \mu\text{F}$  ceramic capacitors.  $2.2\ \mu\text{F}$  tantalum capacitor can be added for better performance.

The length of the current path is directly proportional to the magnitude of parasitic inductances and thus the high frequency impedance of the path. High speed currents in an inductive ground return create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance. Thus a ground plane layer is important for high speed circuit design.

### Typical Application Circuits

#### Differential Amplifier

The circuit shown in Figure 4 performs the differential function. If the resistors ratios are equal ( $R_4/R_3 = R_2/R_1$ ), then  $V_{OUT} = (V_{IP} - V_{IN}) \times R_2/R_1 + V_{REF}$ .

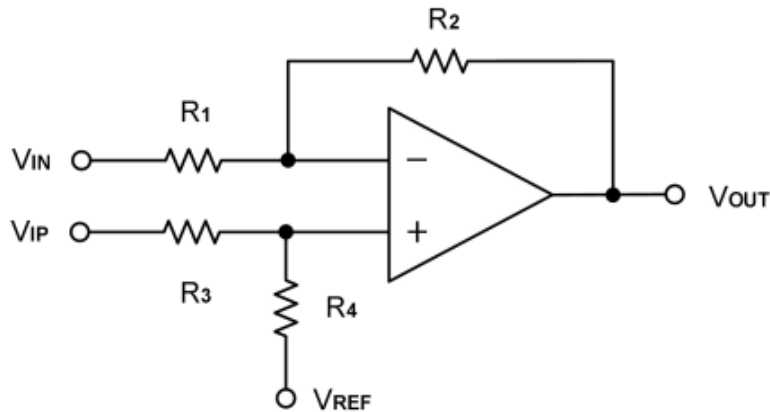


Figure 4. Differential Amplifier

### Low Pass Active Filter

When receiving low-level signals, limiting the bandwidth of the incoming signals into the system is often required. The simplest way to establish this limited bandwidth is to place an RC filter at the noninverting terminal of the amplifier. If even more attenuation is needed, a multiple pole filter is required. The Sallen-Key filter can be used for this task, as Figure 5. For best results, the amplifier should have a bandwidth that is 8 to 10 times the filter frequency bandwidth. Failure to follow this guideline can result in reduction of phase margin. The large values of feedback resistors can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistors value as low as possible and consistent with output loading consideration.

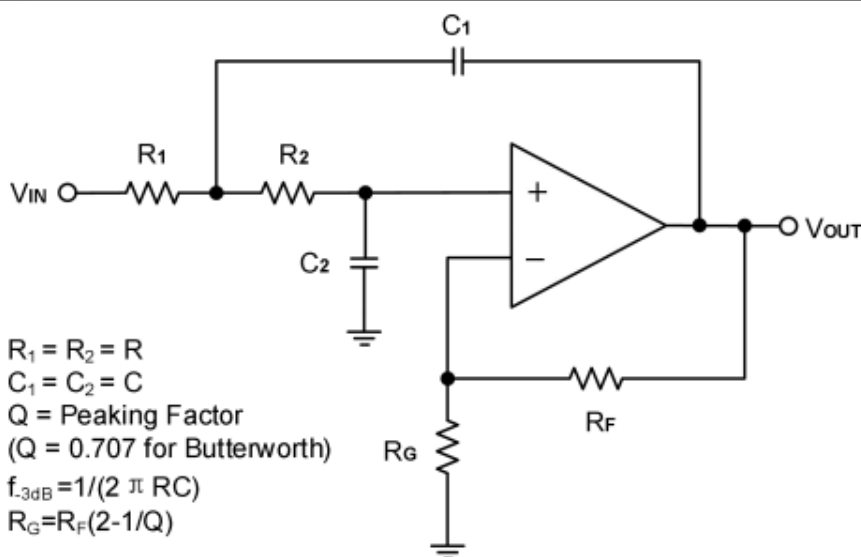
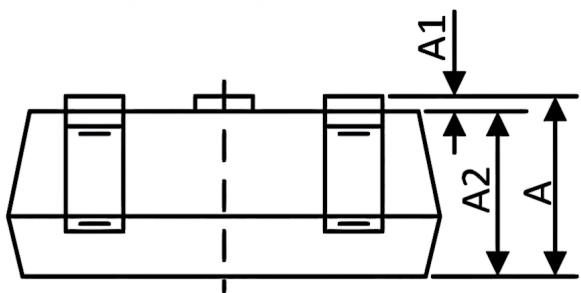
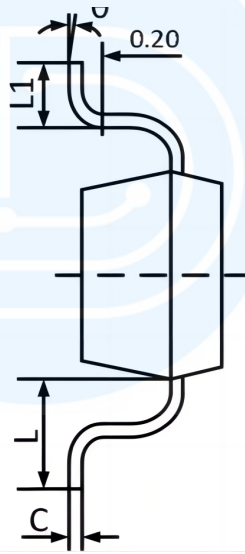
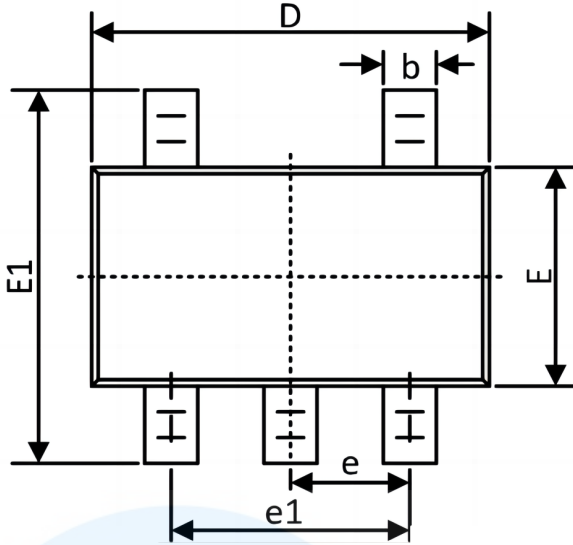


Figure 5. Two-Pole Low-Pass Sallen-Key Active Filter



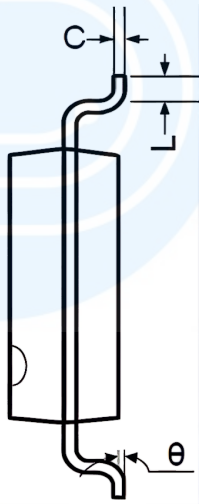
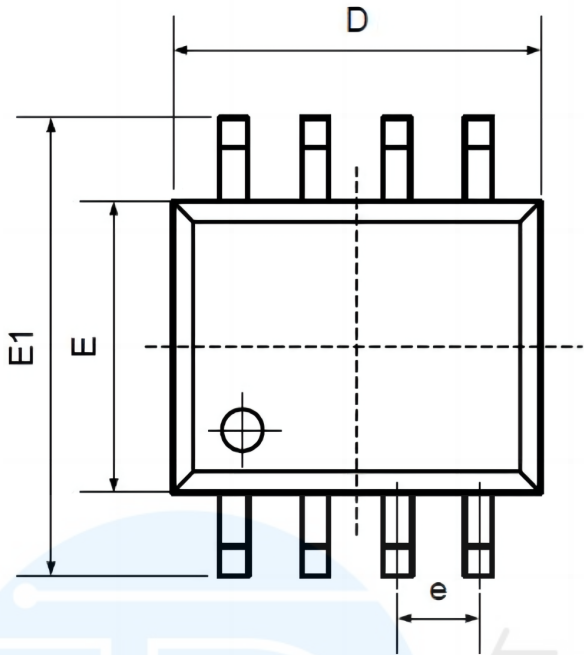
Package SOT23-5



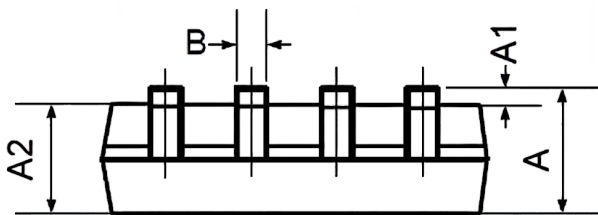
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
C	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°



Package SOP8

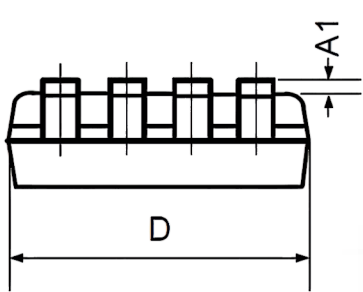
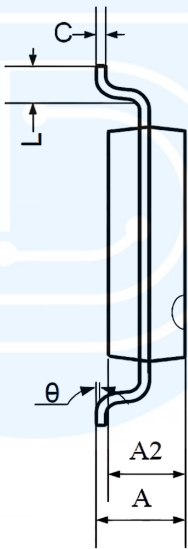
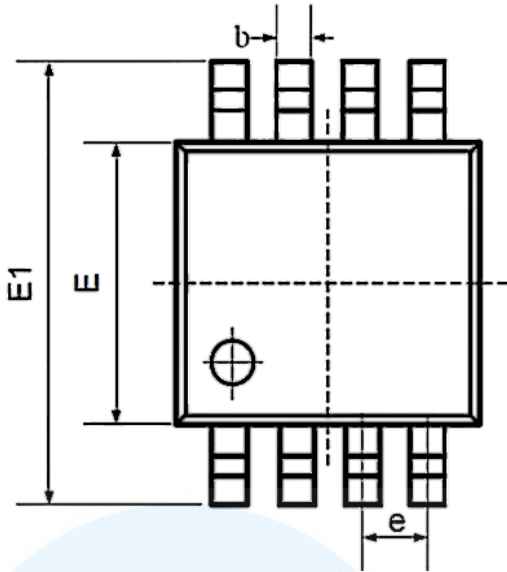


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°





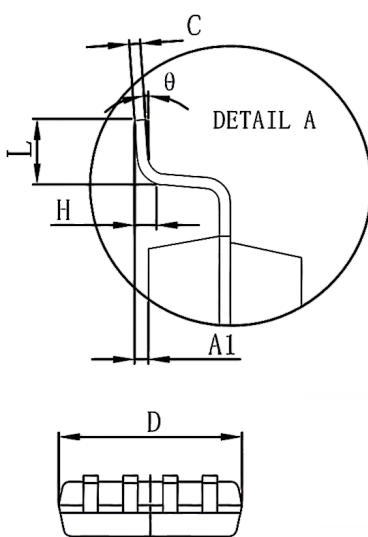
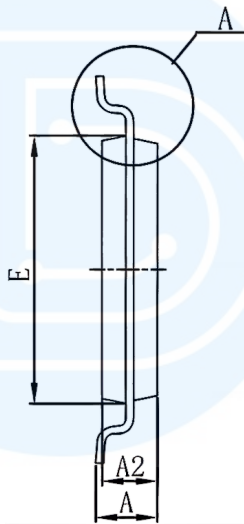
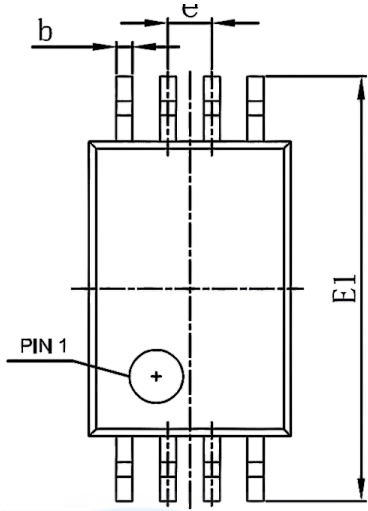
Package MSOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
C	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026 TYP	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L	0.410	0.650	0.016	0.026
θ	0°	6°	0°	6°



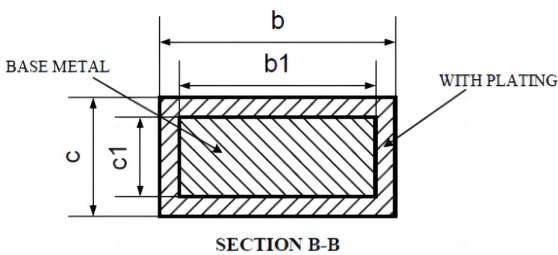
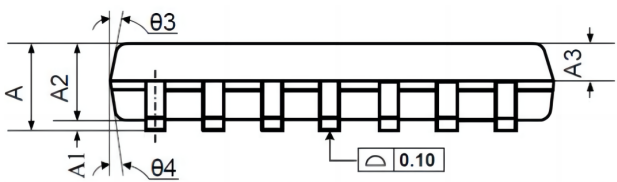
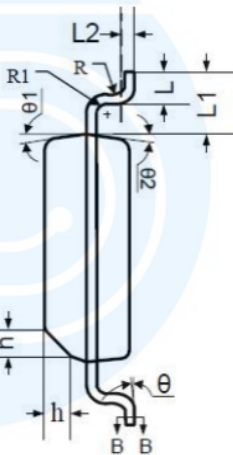
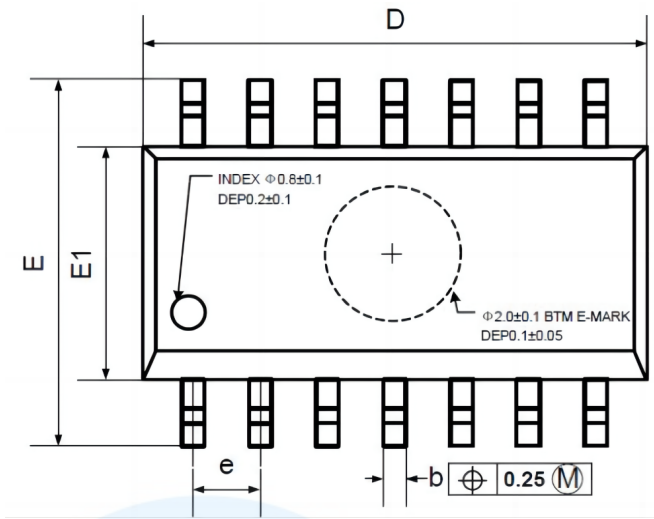
Package TSSOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	2.900	3.100	0.114	0.122
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)	
$\theta$	1°		1°	



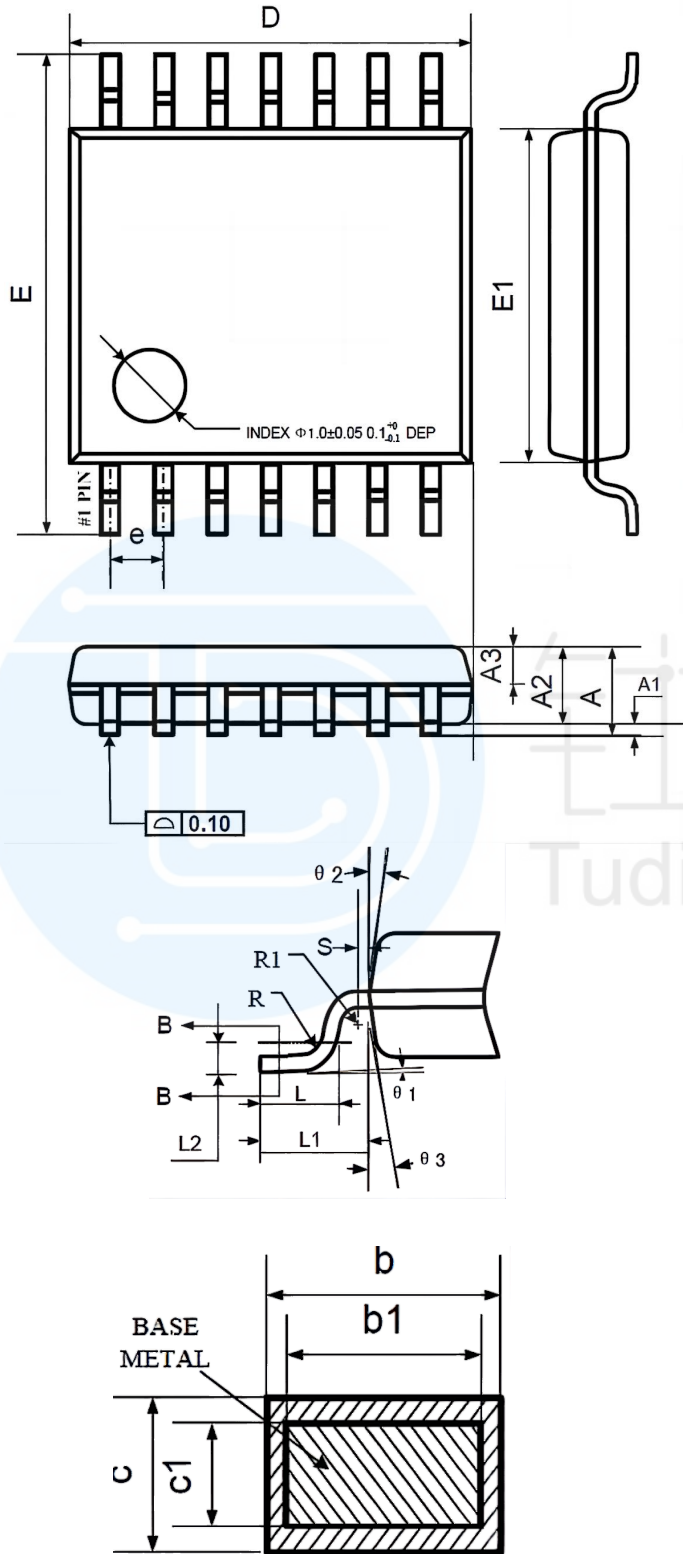
Package SOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36		0.49
b1	0.35	0.40	0.45
C	0.16		0.25
c1	0.15	0.20	0.25
D	8.53	8.63	8.73
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30	0.40	0.50
θ	0°		8°
θ1	6°	8°	10°
θ2	6°	8°	10°
θ3	5°	7°	9°
θ4	5°	7°	9°



Package TSSOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	—	0.28
b1	0.20	0.22	0.24
C	0.10	—	0.19
c1	0.10	0.13	0.15
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	—	—
R1	0.09	—	—
S	0.20	—	—
$\theta 1$	0°	—	8°
$\theta 2$	10°	12°	14°
$\theta 3$	10°	12°	14°



## Order information

Order Number	Package	Package Quantity	Marking On The park	Temperature
LMV321IDBVR-TUDI	SOT23-5	Tape,Reel,3000	RC1F	- 40°C to 125°C
LMV321IDCKR-TUDI	SC70-5	Tape,Reel,3000	R3F	
LMV324IDR-TUDI	SOP14	Tape,Reel,2500	LMV324I	
LMV324IPWR-TUDI	TSSOP14	Tape,Reel,2500	MV324I	
LMV358IDGKR-TUDI	MSOP8	Tape,Reel,2500	R5B	
LMV358IDR-TUDI	SOP8	Tape,Reel,2500	MV358I	
LMV358IPWR-TUDI	TSSOP8	Tape,Reel,2500	MV358I	



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