

# 1.1MHz, Precision, Rail-to-Rail I/O CMOS Operational Amplifier

## FEATURES

- **HIGH GAIN BANDWIDTH:**1.1MHz
- **RAIL-TO-RAIL INPUT AND OUTPUT**  
 $\pm 4.5\text{mV Max } V_{os}$
- **INPUT VOLTAGE RANGE:** -0.1V to +5.6V  
with  $V_s = 5.5\text{V}$
- **SUPPLY RANGE:** +2.5V to +5.5V
- **SPECIFIED UP TO +125°C**
- *Micro* **SIZE PACKAGES:** SOIC-8

## APPLICATIONS

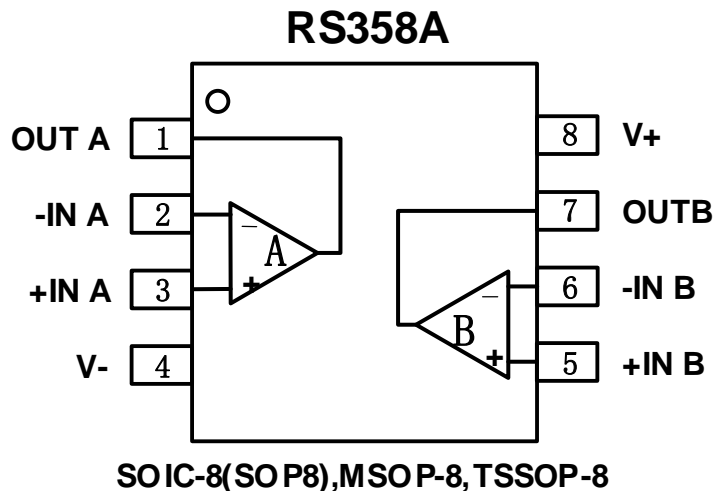
- **SENSORS**
- **PHOTODIODE AMPLIFICATION**
- **ACTIVE FILTERS**
- **TEST EQUIPMENT**
- **DRIVING A/D CONVERTERS**

## DESCRIPTION

The RS358A products offer low voltage operation and rail-to-rail input and output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (1.1MHz) and slew rate of 0.5V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.

The RS358A has lower offset, which is guaranteed not upper than  $\pm 4.5\text{mV}$  at 25°C with  $V_s = 5\text{V}$ ,  $V_{CM} = V_s/2$ .

The devices are ideal for sensor interfaces, active filters and portable applications. The RS358A families of operational amplifiers are specified at the full temperature range of -40°C to +125°C under single or dual power supplies of 2.5V to 5.5V.



**ABSOLUTE MAXIMUM RATINGS <sup>(1)</sup>**

Supply Voltage, V+ to V-.....	7.0V
Input Terminals, Voltage <sup>(2)</sup> .....	- 0.5 to (V+) + 0.5V
Current <sup>(2)</sup> .....	±10mA
Storage Temperature .....	-65°C to +150°C
Operating Temperature .....	-40°C to +125°C
Junction Temperature.....	150°C
Package Thermal Resistance @ T <sub>A</sub> = +25°C	
SOT23-5, SOT23-6.....	200°C/W
MSOP-10, SOIC-8, TSSOP-8.....	150°C/W
SOIC-14, TSSOP-14.....	100°C/W
Lead Temperature (Soldering, 10s) .....	260°C
ESD Susceptibility	
HBM .....	3000V
MM .....	200V

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

(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.


**ESD SENSITIVITY CAUTION**

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

**PACKAGE/ORDERING INFORMATION**

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING	PACKAGE OPTION
RS358A	RS358AXK	-40°C~125°C	SOIC-8(SOP8)	RS358A	Tape and Reel,2500
	RS358AXM	-40°C~125°C	MSOP-8	RS358A	Tape and Reel,3000
	RS358AXQ	-40°C~125°C	TSSOP-8	RS358A	Tape and Reel,3000

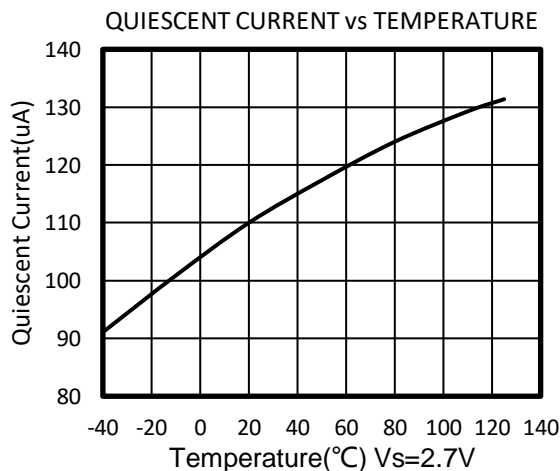
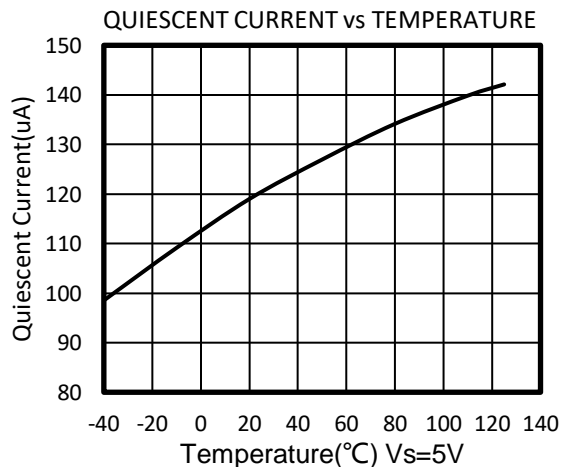
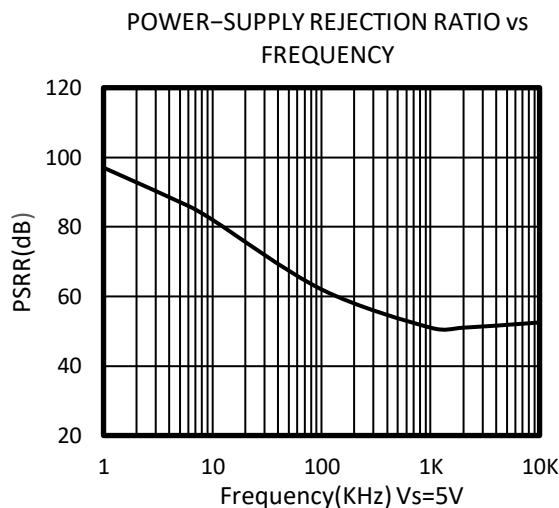
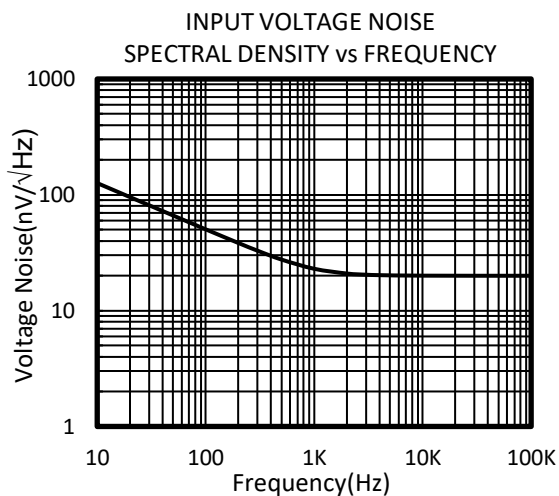
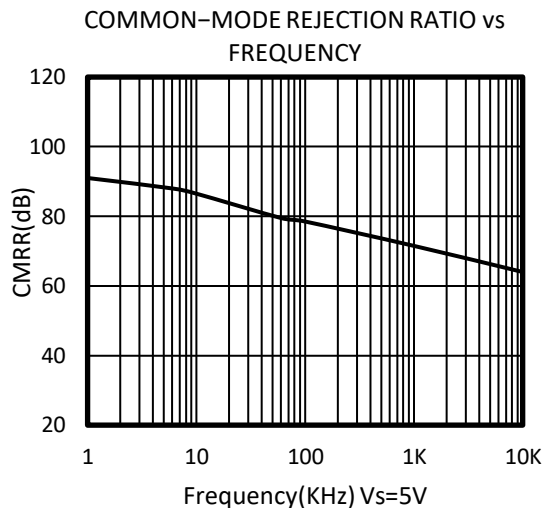
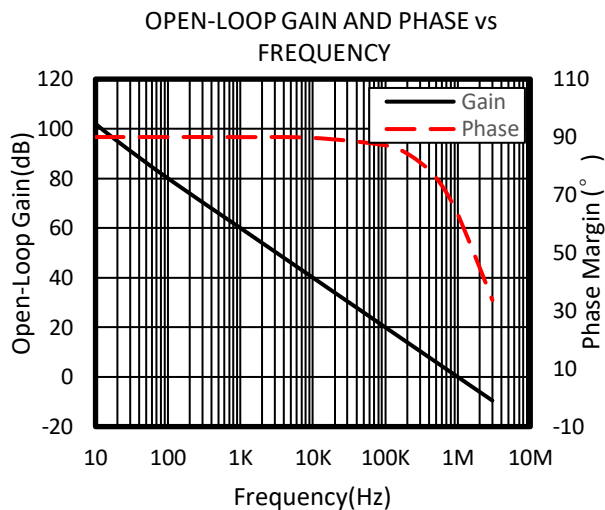
**ELECTRICAL CHARACTERISTICS**

 (At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ , unless otherwise noted.)

PARAMETER		CONDITIONS	$T_J$	RS358A			UNITS
				MIN	TYP	MAX	
<b>POWER SUPPLY</b>							
$V_S$	Operating Voltage Range		$25^\circ\text{C}$	2.5		5.5	V
$I_Q$	Quiescent Current/Amplifier		$25^\circ\text{C}$		120	220	$\mu\text{A}$
PSRR	Power-Supply Rejection Ratio	$V_S = 2.5\text{V to } 5.5\text{V}$ , $V_{CM} = (V_-) + 0.5\text{V}$	$25^\circ\text{C}$	74	90		dB
			$-40^\circ\text{C to } 125^\circ\text{C}$	65			
<b>INPUT</b>							
$V_{OS}$	Input Offset Voltage	$V_{CM} = 0\text{V to } 3.5\text{V}$	$25^\circ\text{C}$	-4.5	$\pm 0.8$	4.5	mV
$V_{OS\ TC}$	Input Offset Voltage Average Drift	$-40^\circ\text{C to } 125^\circ\text{C}$			2		$\mu\text{V}/^\circ\text{C}$
$I_B$	Input Bias Current		$25^\circ\text{C}$		10	100	$\text{pA}$
$I_{OS}$	Input Offset Current		$25^\circ\text{C}$		1	10	$\text{pA}$
$V_{CM}$	Common-Mode Voltage Range	$V_S = 5.5\text{V}$	$25^\circ\text{C}$	-0.1		5.6	V
CMRR	Common-Mode Rejection Ratio	$V_S = 5.5\text{V}$ , $V_{CM} = -0.1\text{V to } 4\text{V}$	$25^\circ\text{C}$	74	90		dB
			$-40^\circ\text{C to } 125^\circ\text{C}$	68			
			$25^\circ\text{C}$	63	80		
			$-40^\circ\text{C to } 125^\circ\text{C}$	57			
<b>OUTPUT</b>							
$A_{OL}$	Open-Loop Voltage Gain	$R_L = 2\text{k}\Omega$ , $V_O = 0.15\text{V to } 4.85\text{V}$	$25^\circ\text{C}$	85	105		dB
			$-40^\circ\text{C to } 125^\circ\text{C}$	80			
			$25^\circ\text{C}$	88	110		
			$-40^\circ\text{C to } 125^\circ\text{C}$	83			
	Output Swing From Rail	$R_L = 2\text{k}\Omega$	$25^\circ\text{C}$		25		mV
		$R_L = 10\text{k}\Omega$			8		
$I_{OUT}$	Output Current Source		$25^\circ\text{C}$		130		mA
<b>FREQUENCY RESPONSE</b>							
SR	Slew Rate		$25^\circ\text{C}$		0.5		V/ $\mu\text{s}$
GBP	Gain-Bandwidth Product		$25^\circ\text{C}$		1.1		MHz
PM	Phase Margin		$25^\circ\text{C}$		64		$^\circ$
$t_s$	Setting Time, 0.1%				1.3		$\mu\text{s}$
	Overload Recovery Time	$V_{IN} \cdot \text{Gain} \geq V_S$			2.3		$\mu\text{s}$
<b>NOISE</b>							
$e_n$	Input Voltage Noise Density	$f = 1\text{KHz}$	$25^\circ\text{C}$		22		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 10\text{KHz}$	$25^\circ\text{C}$		20		$\text{nV}/\sqrt{\text{Hz}}$

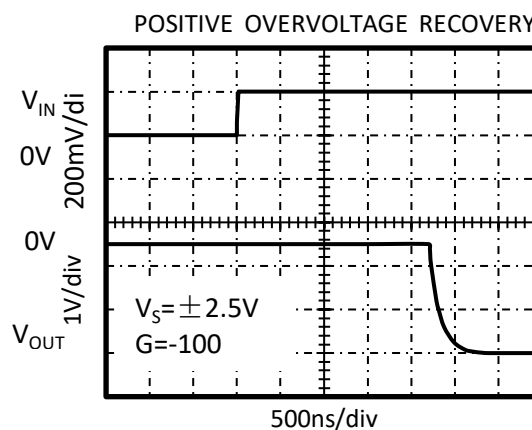
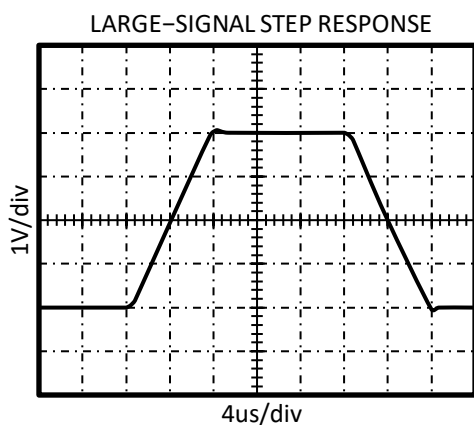
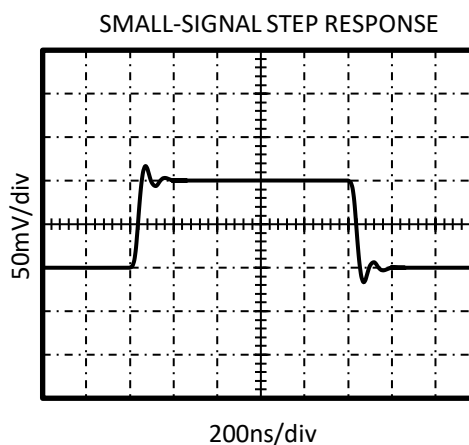
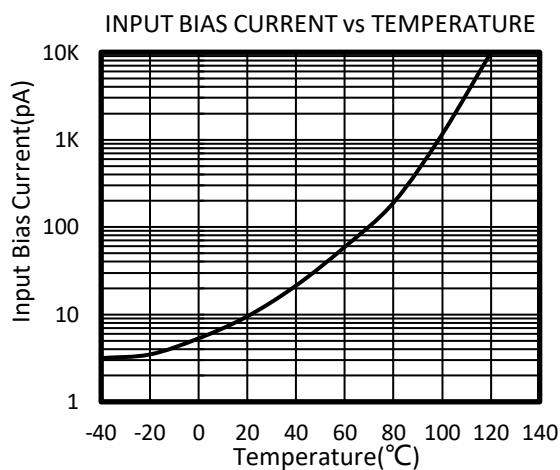
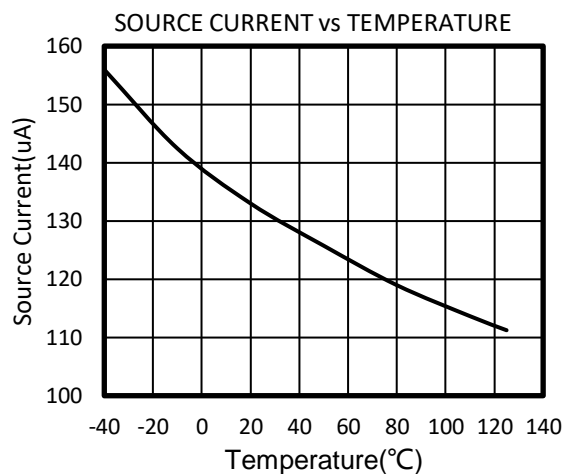
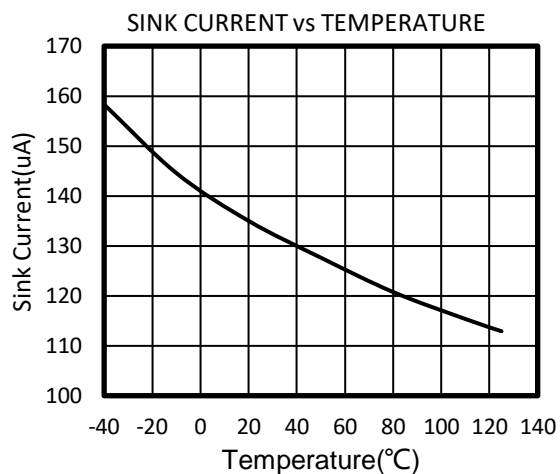
### TYPICAL CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_S=5\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ ,  $V_{OUT} = V_S/2$ , unless otherwise noted.



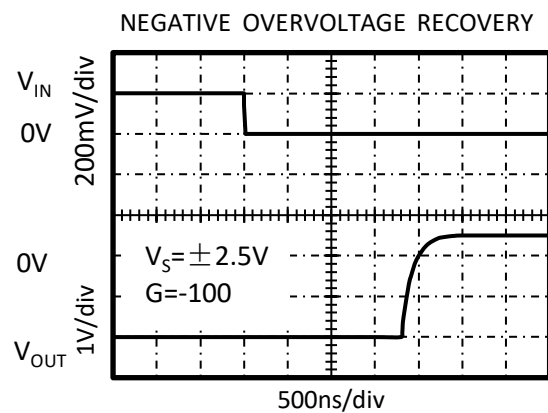
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## APPLICATION NOTES

The RS358A is high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.5V to 5.5V ( $\pm 1.25V$  to  $\pm 2.75V$ ). Supply voltages higher than 7V (absolute maximum) can permanently damage the amplifier.

Rail-to-rail input and output swing significantly increases dynamic range, especially in low-supply applications.

Good layout practice mandates use of a 0.1uF capacitor place closely across the supply pins.

## LAYOUT GUIDELINS

Attention to good layout practices is always recommended. Keep traces short. When possible, use a PCB ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1uF capacitor closely across the supply pins.

These guidelines should be applied throughout the analog circuit to improve performance and provide benefits such as reducing the EMI susceptibility.

## INSTRUMENTATION AMPLIFIER

In the three-op amp, instrumentation amplifier configuration shown in Figure2,

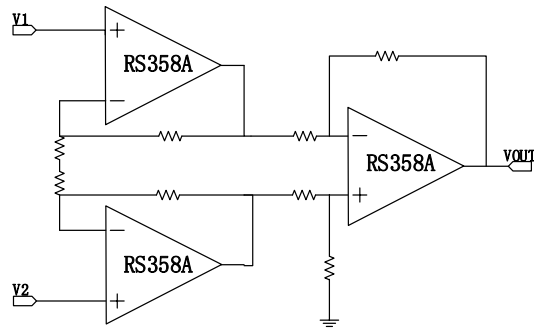


Figure2. Amplifier instrumentation amplifier

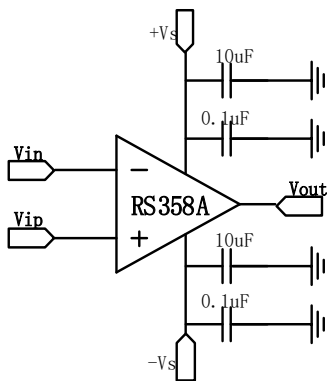
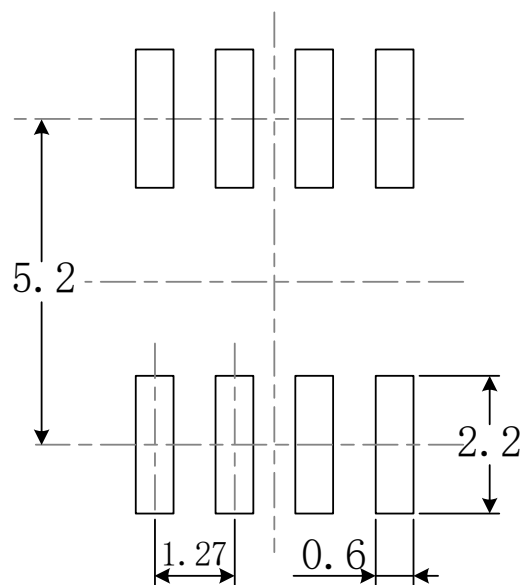
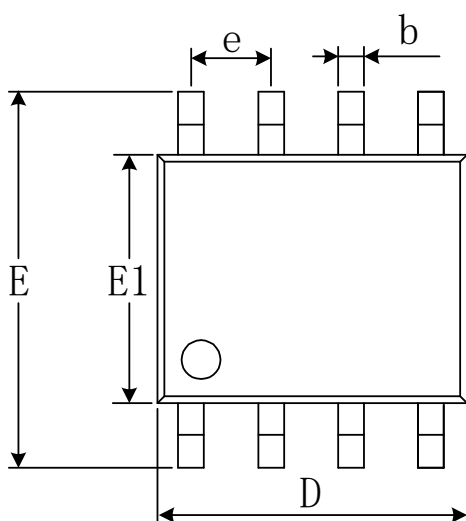


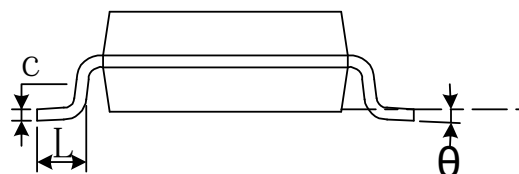
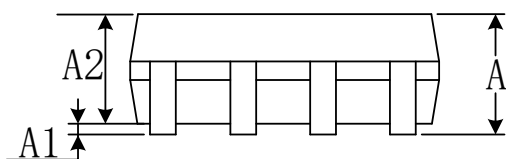
Figure1. Amplifier with Bypass Capacitors

# PACKAGE OUTLINE DIMENSIONS

## SOIC-8



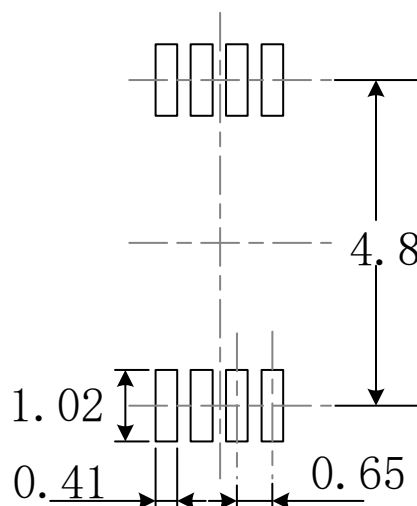
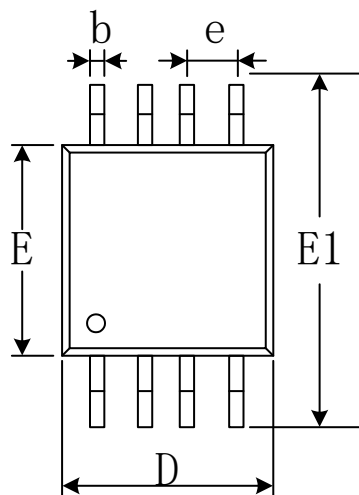
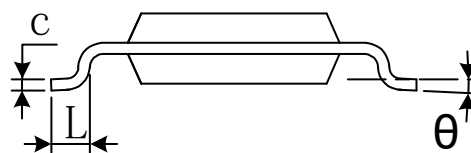
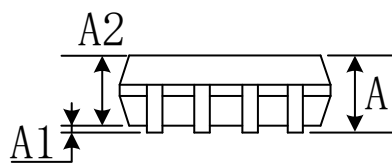
RECOMMENDED LAND PATTERN (Unit: mm)



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	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
$\theta$	0°	8°	0°	8°

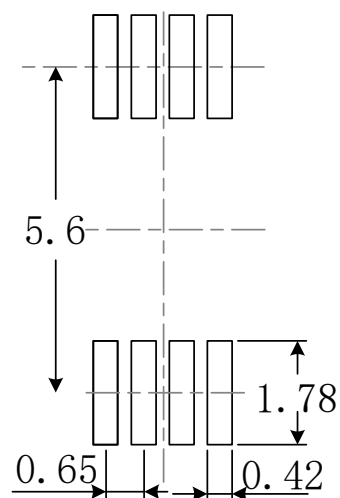
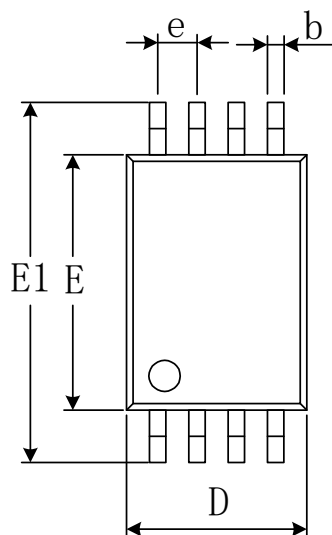
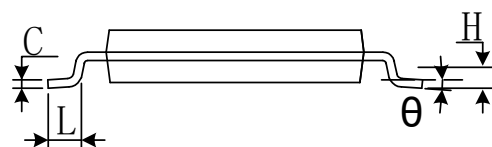
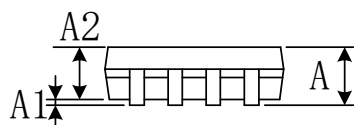


# MSOP-8


**RECOMMENDED LAND PATTERN (Unit: mm)**


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	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
$\theta$	0°	6°	0°	6°

# TSSOP-8


**RECOMMENDED LAND PATTERN** (Unit: mm)


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
$\theta$	1°	7°	1°	7°