

# 7MHz, 500 $\mu$ V Offset, Rail-to-Rail I/O CMOS Operational Amplifier

## FEATURES

- **HIGH GAIN BANDWIDTH: 7MHz**
- **RAIL-TO-RAIL INPUT AND OUTPUT**  
 **$\pm 0.5\text{mV}$  Max Vos**
- **INPUT VOLTAGE RANGE: -0.1V to +5.6V**  
**with Vs = 5.5V**
- **SUPPLY RANGE: +2.5V to +5.5V**
- **SHUTDOWN: RS621S/RS622S**
- **SPECIFIED UP TO +125°C**
- **MicroSIZE PACKAGES: SOT23-5**

## APPLICATIONS

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

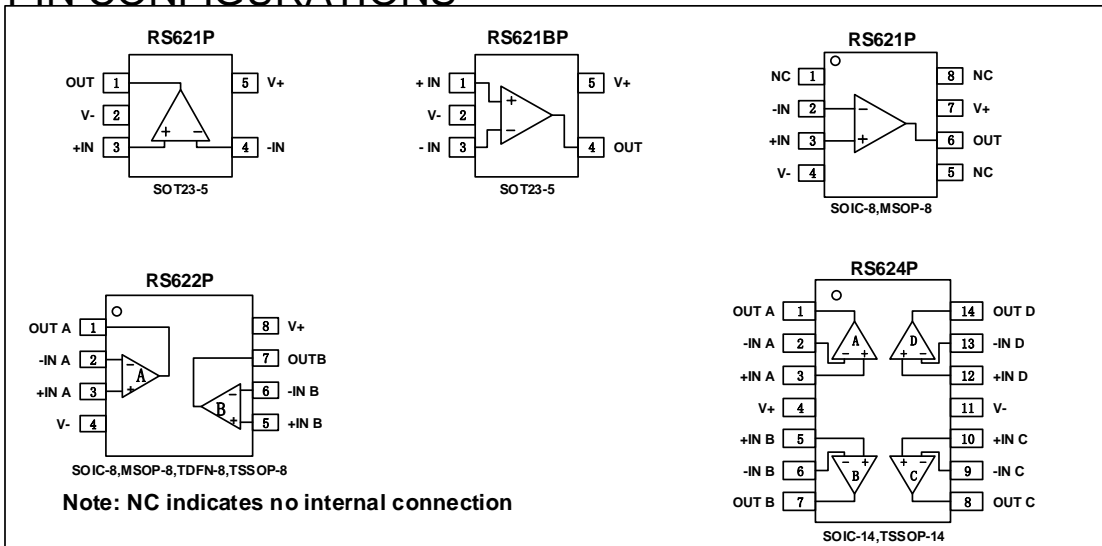
## DESCRIPTION

The RS62XP families of products offer low voltage operation and rail-to-rail input and output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (7MHz) and slew rate of 3.7V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.

The RS621P, RS622P and RS624P has lower offset, which is guaranteed not upper than  $\pm 0.5\text{mV}$  at 25°C with Vs = 5V, Vcm = Vs/2.

The devices are ideal for sensor interfaces, active filters and portable applications. The RS62X 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.

## PIN CONFIGURATIONS



**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-8, SOIC-8, TSSOP-8	150°C/W
SOIC-14, TSSOP-14	100°C/W
Lead Temperature (Soldering, 10s)	260°C
ESD Susceptibility	
HBM	5000V
MM	400V


**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.

(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.

**PACKAGE/ORDERING INFORMATION**

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING	PACKAGE OPTION
RS621P	RS621PXK	-40°C~125°C	SOIC-8	RS621	Tape and Reel,2500
	RS621PXF	-40°C~125°C	SOT23-5	621	Tape and Reel,3000
	RS621BPXF	-40°C~125°C	SOT23-5	621B	Tape and Reel,3000
	RS621PXM	-40°C~125°C	MSOP-8	RS621	Tape and Reel,3000
RS622P	RS622PXK	-40°C~125°C	SOIC-8	RS622	Tape and Reel,2500
	RS622PXM	-40°C~125°C	MSOP-8	RS622	Tape and Reel,3000
	RS622PXT	-40°C~125°C	TDFN-8	RS622	Tape and Reel,3000
	RS622PXQ	-40°C~125°C	TSSOP-8	RS622	Tape and Reel,3000
RS624P	RS624PXP	-40°C~125°C	SOIC -14	RS624	Tape and Reel,2500
	RS624PXQ	-40°C~125°C	TSSOP-14	RS624	Tape and Reel,3000

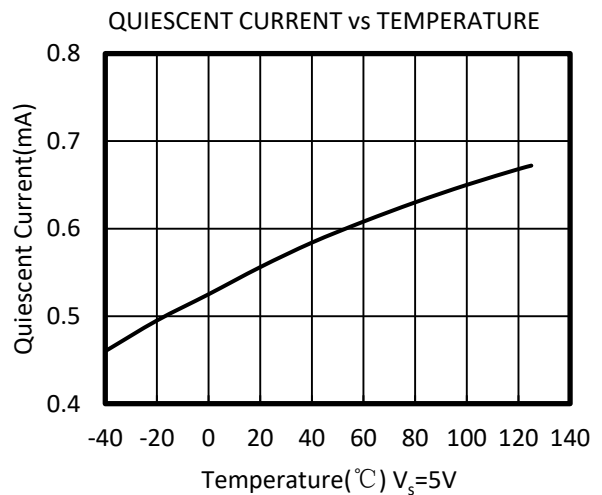
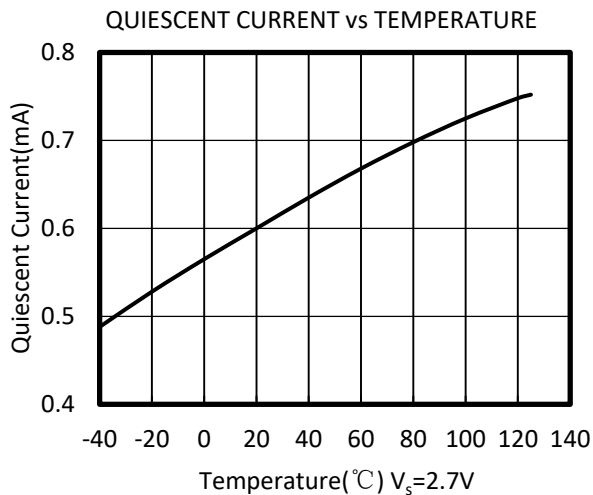
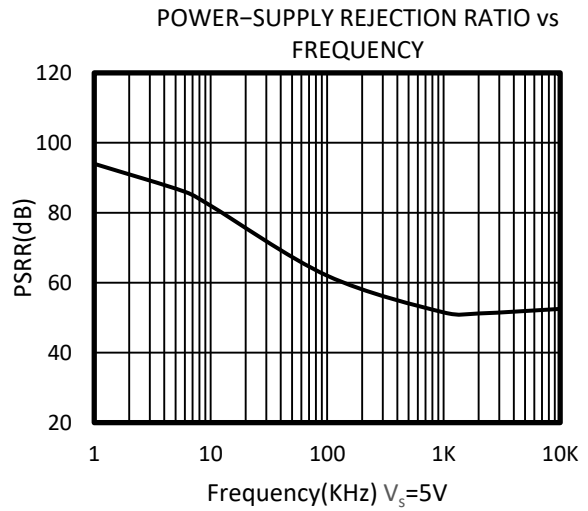
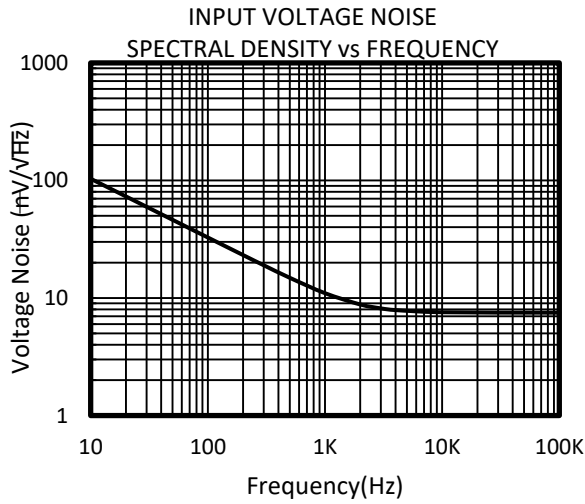
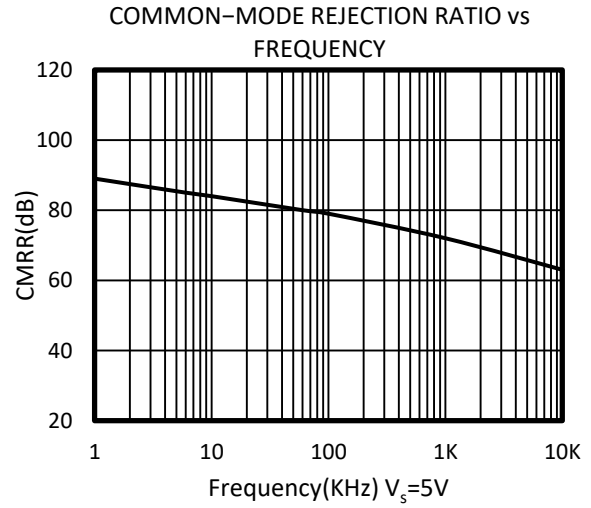
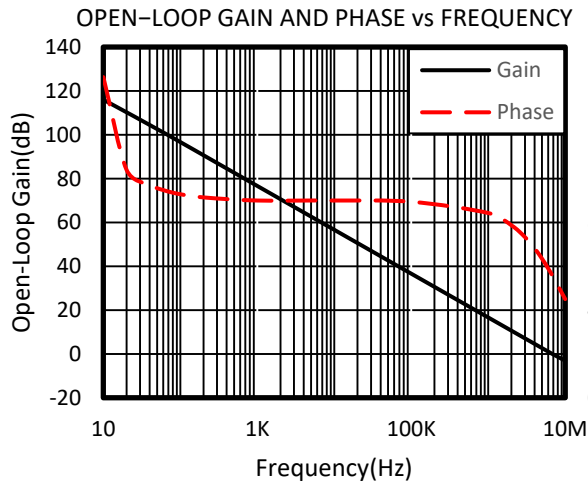
**ELECTRICAL CHARACTERISTICS**

 (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	$T_J$	RS621P, RS622P,RS624P			UNIT
				MIN	TYP	MAX	
<b>POWER SUPPLY</b>							
$V_S$	Operating Voltage Range		25°C	2.5		5.5	V
$I_Q$	Quiescent Current/Amplifier		25°C		600	800	$\mu\text{A}$
PSRR	Power-Supply Rejection Ratio	$V_S = 2.5\text{V to } 5.5\text{V}$ $V_{cm} = (V_-) + 0.5\text{V}$	25°C	78	93		dB
			-40°C to 125°C	72			
<b>INPUT</b>							
$V_{os}$	Input Offset Voltage	$V_{cm} = V_S/2$	25°C		$\pm 0.1$	$\pm 0.5$	mV
$V_{os\ TC}$	Input Offset Voltage Drift	-40°C to 125°C			2		$\mu\text{V}/^\circ\text{C}$
$I_B$	Input Bias Current		25°C		1	10	$\mu\text{A}$
$I_{os}$	Input Offset Current		25°C		1	10	$\mu\text{A}$
$V_{cm}$	Common-Mode Voltage Range	$V_S = 5.5\text{V}$	25°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°C	74	92		dB
			-40°C to 125°C	68			
			25°C	63	83		
			-40°C to 125°C	60			
<b>OUTPUT</b>							
AOL	Open-Loop Voltage Gain	$R_L = 2\text{k}\Omega$ , $V_o = 0.15\text{V to } 4.85\text{V}$	25°C	96	102		dB
			-40°C to 125°C	83			
			25°C	98	106		
			-40°C to 125°C	85			
	Output Swing From Rail	$R_L = 2\text{k}\Omega$	25°C		40		mV
			25°C		7		
$I_{out}$	Output Short-Circuit Current		25°C		50		mA
<b>FREQUENCY RESPONSE</b>							
SR	Slew Rate		25°C		3.7		V/ $\mu\text{s}$
GBP	Gain-Bandwidth Product		25°C		7		MHz
$\Phi_m$	Phase Margin		25°C		64		°
$t_s$	Settling Time, 0.1%				0.5		$\mu\text{s}$
	Overload Recovery Time	$V_{IN} \cdot \text{Gain} \geq V_S$			0.5		$\mu\text{s}$
<b>NOISE</b>							
$e_n$	Input-Referred Voltage Noise	$f = 1\text{ kHz}$	25°C		11		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 10\text{ kHz}$	25°C		7.5		$\text{nV}/\sqrt{\text{Hz}}$

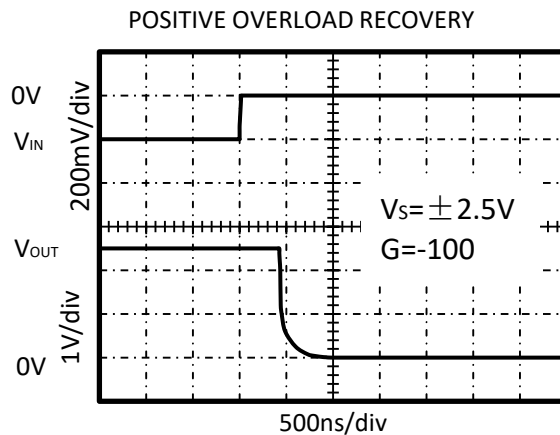
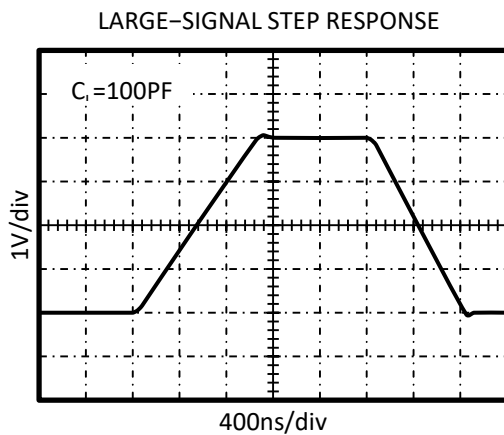
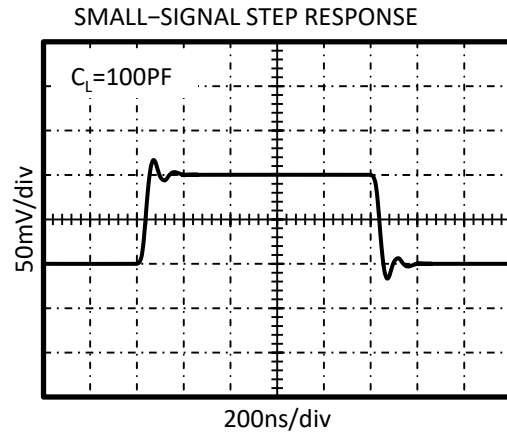
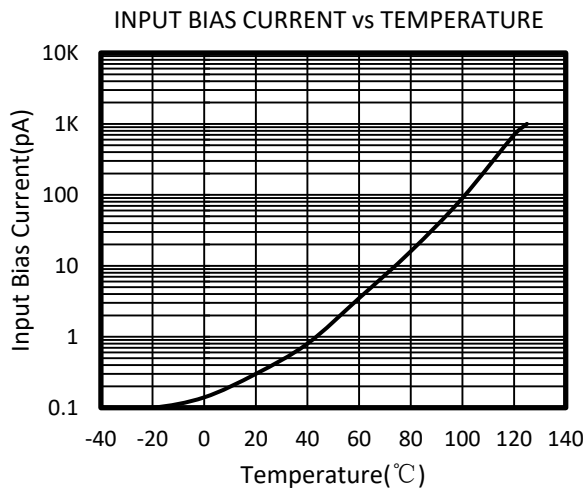
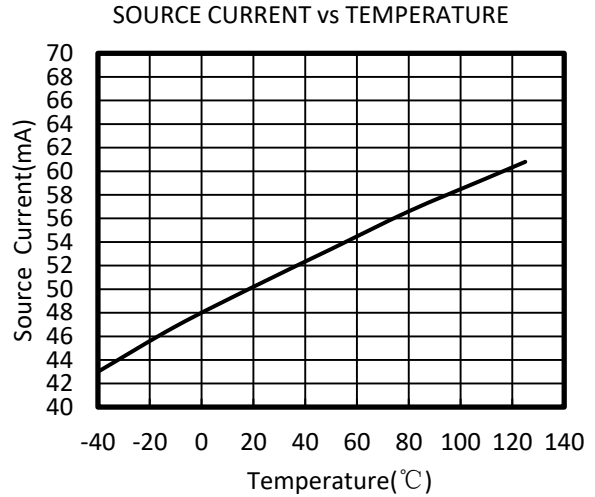
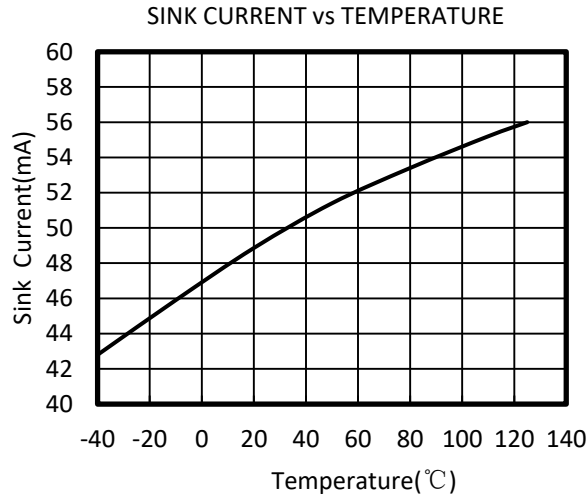
### TYPICAL CHARACTERISTICS

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.



### TYPICAL CHARACTERISTICS

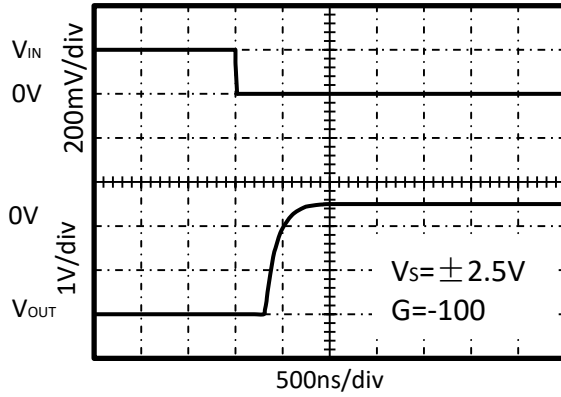
At  $T_A = +25^\circ\text{C}$ ,  $V_S=5\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ ,  $V_{OUT} = V_S/2$ , unless otherwise noted.



### 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.

NEGATIVE OVERLOAD RECOVERY



## APPLICATION NOTES

The RS621P, RS622P, RS624P are 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.

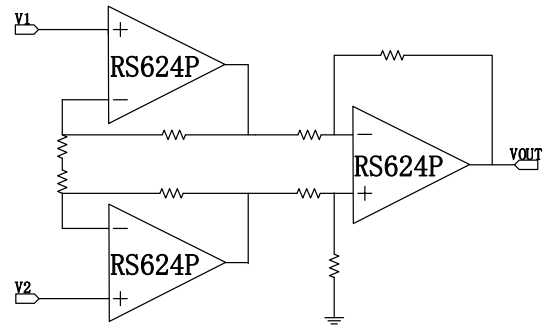


Figure2. Amplifier instrumentation amplifier

## 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.

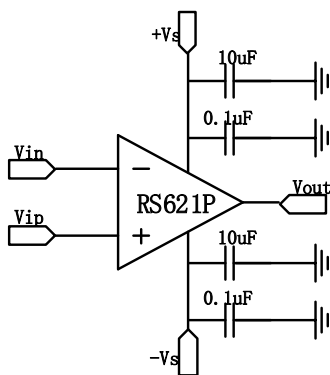


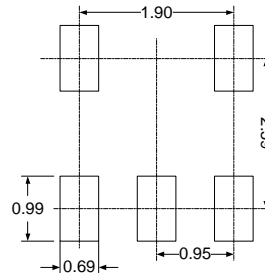
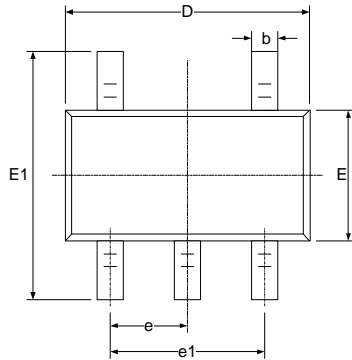
Figure1. Amplifier with Bypass Capacitors

## INSTRUMENTATION AMPLIFIER

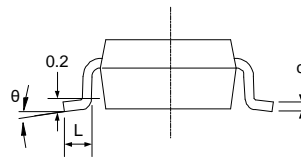
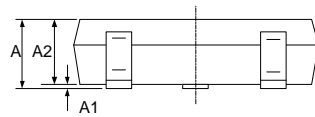
In the three-op amp, instrumentation amplifier configuration shown in Figure2,

# PACKAGE OUTLINE DIMENSIONS

## SOT23-5



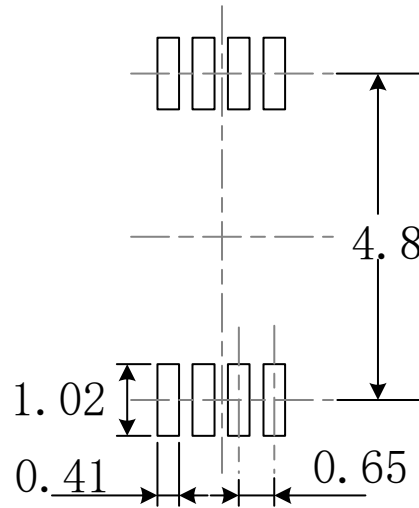
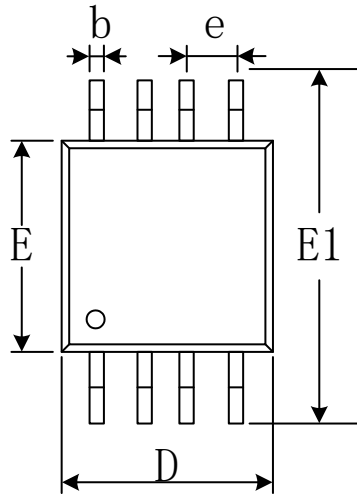
RECOMMENDED LAND PATTERN (Unit: mm)



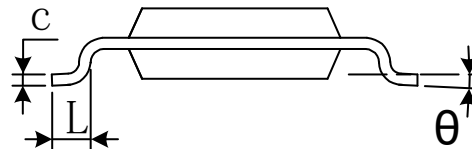
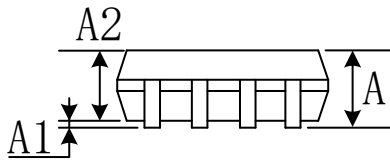
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)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



# MSOP-8

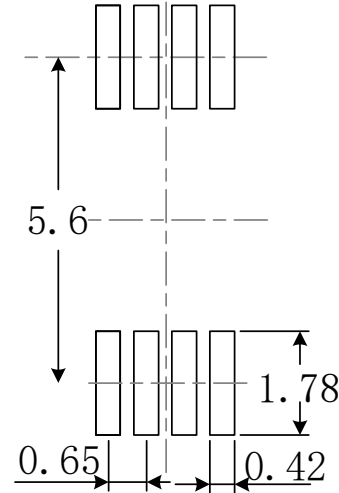
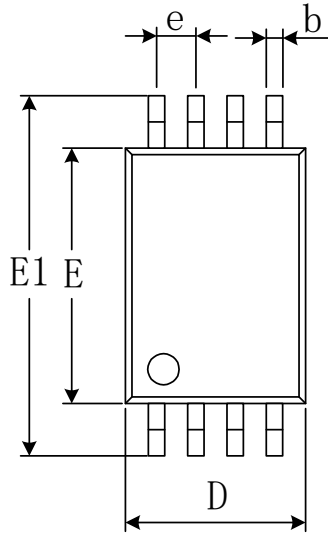


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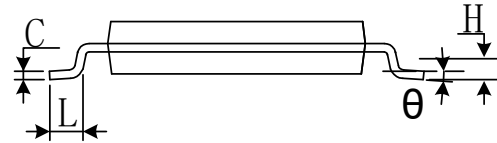
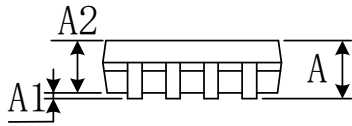


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187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

# TSSOP-8

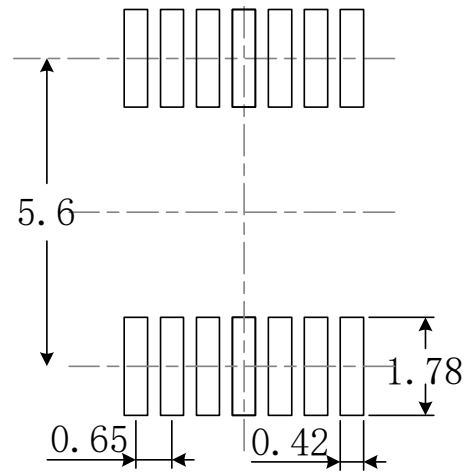
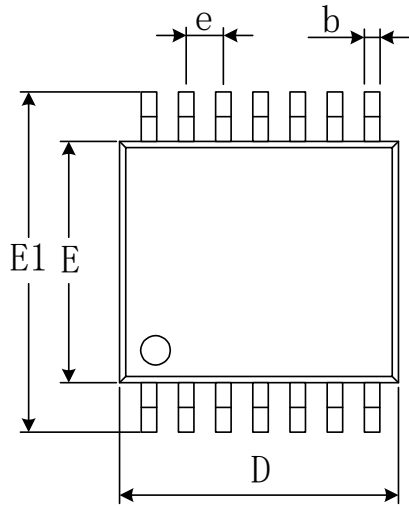


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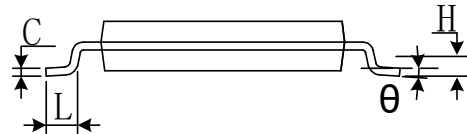
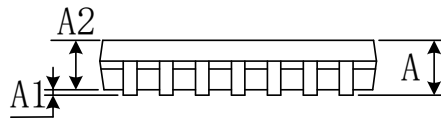


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L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

# TSSOP-14

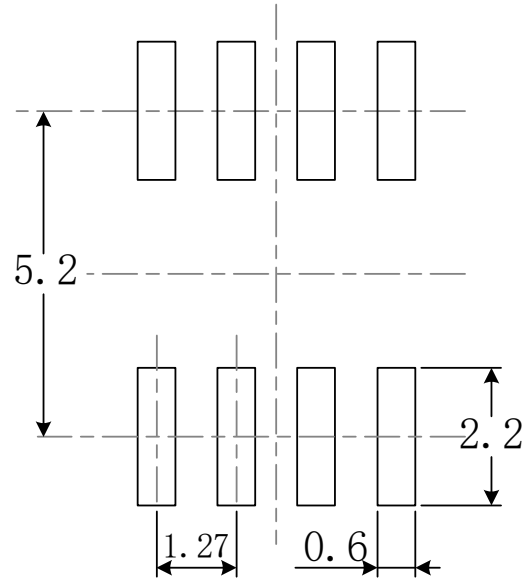
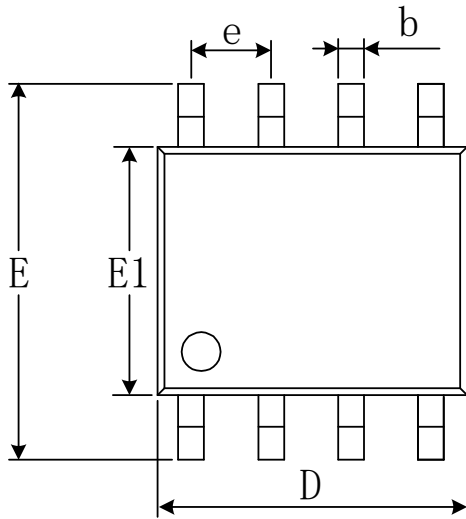


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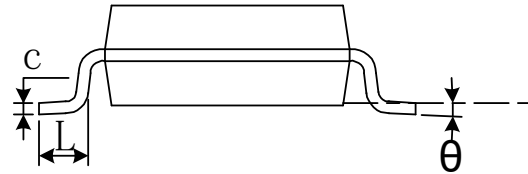
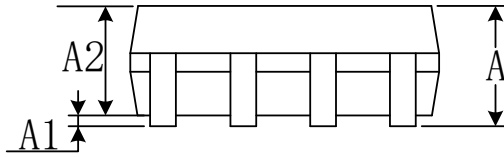


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A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
$\theta$	1°	7°	1°	7°

# SOIC-8

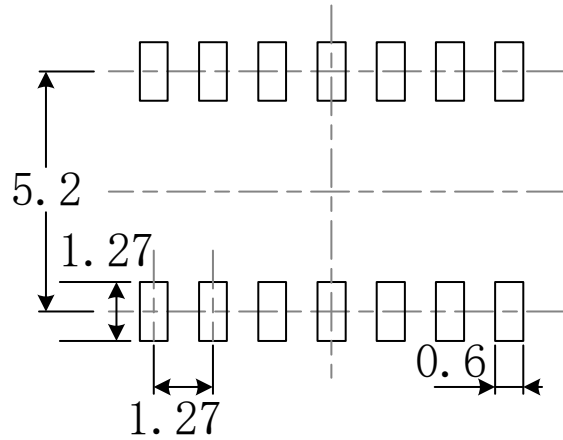
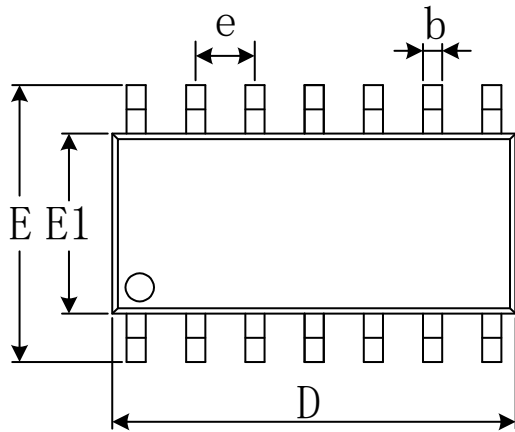


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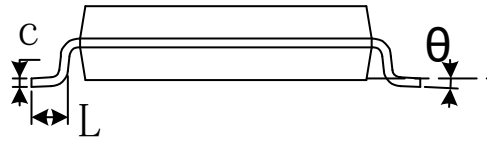
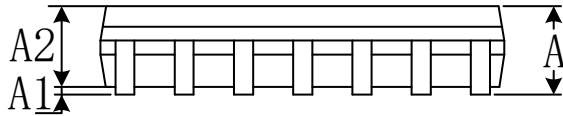


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
$\theta$	0°	8°	0°	8°

# SOIC-14

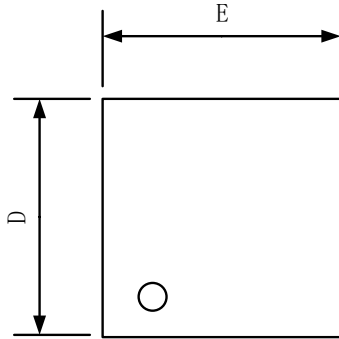


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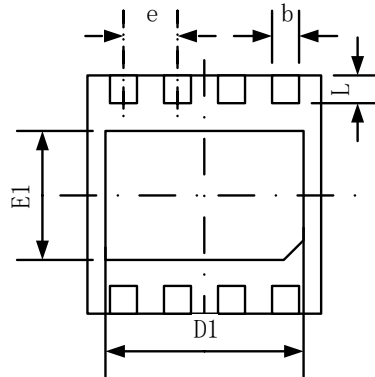


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
$\theta$	0°	8°	0°	8°

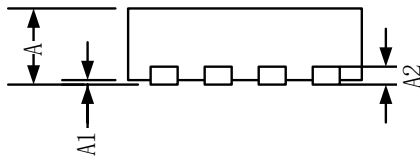
# TDFN-3x3-8L



TOP VIEW



BOTTOM VIEW



SIDE VIEW

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203		0.008	
b	0.300	0.400	0.012	0.016
D	2.900	3.100	0.114	0.122
D1	2.510	2.610	0.099	0.103
E	2.900	3.100	0.114	0.122
E1	1.550	1.650	0.061	0.065
e	0.650 TYP		0.026 TYP	
L	0.350	0.450	0.014	0.018

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