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

FEATURES

- **HIGH GAIN BANDWIDTH:1.1MHz**
- **RAIL-TO-RAIL INPUT AND OUTPUT**
  ±0.5mV Max Vos (RS6331P, RS6332P)
  ±0.8mV Max Vos (RS6334P)
- **INPUT VOLTAGE RANGE: -0.1V to +5.6V with Vs = 5.5V**
- **SUPPLY RANGE: +2.1V to +5.5V**
- **SPECIFIED UP TO +125°C**
- ***Micro* SIZE PACKAGES: SOT23-5, SOT353(SC70-5)**

APPLICATIONS

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

DESCRIPTION

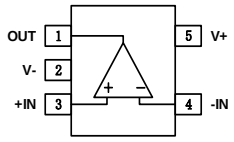
The RS6331P, RS6332P, RS6334P families of products offer low voltage operation and rail-to-rail input and output, as well as excellent speed/power consumption ratio, providing an excellent bandwidth (1.1MHz) and slew rate of 0.5V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.

The RS6331P, RS6332P and RS6334P has lower offset, which is guaranteed not upper than ±0.5mV (RS6331P, RS6332P) / ±0.8mV (RS6334P) at 25°C with Vs = 5V, V_{CM} = Vs/2.

The devices are ideal for sensor interfaces, active filters and portable applications. The RS6331P, RS6332P, RS6334P families of operational amplifiers are specified at the full temperature range of −40°C to +125°C under single supplies of 2.1V to 5.5V or dual power supplies of ±1.05V to ±2.75V.

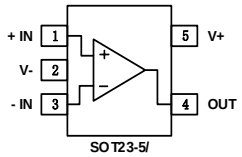
PIN CONFIGURATIONS

RS6331P



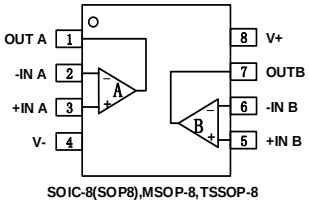
SOT23-5/
SOT353(SC70-5)

RS6331BP



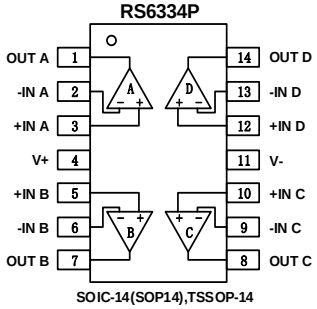
SOT23-5/
SOT353(SC70-5)

RS6332P



SOIC-8(SOP8),MSOP-8,TSSOP-8

RS6334P



SOIC-14(SOP14),TSSOP-14

Note: NC indicates no internal connection

ABSOLUTE MAXIMUM RATINGS (1)

Supply Voltage, V+ to V-.....7.0V
Input Terminals, Voltage (2) ..... – 0.5 to (V+) + 0.5V
Current (2)..... ±10mA
Storage Temperature ..... −65°C to +150°C
Operating Temperature ..... −40°C to +125°C
Junction Temperature.....150°C
Package Thermal Resistance @ T_A = +25°C
SOT23-5, SOT23-6.....200°C/W
SOT353(SC70-5) .....250°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 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
RS6331P	RS6331PXF	-40℃~125℃	SOT23-5	6331P	Tape and Reel,3000
	RS6331BPXF	-40℃~125℃	SOT23-5	6331BP	Tape and Reel,3000
	RS6331PXC5	-40℃~125℃	SOT353(SC70-5)	6331P	Tape and Reel,3000
	RS6331BPXC5	-40℃~125℃	SOT353(SC70-5)	6331BP	Tape and Reel,3000
RS6332P	RS6332PXK	-40℃~125℃	SOIC-8(SOP8)	RS6332P	Tape and Reel,2500
	RS6332PXM	-40℃~125℃	MSOP-8	RS6332P	Tape and Reel,3000
	RS6332PXQ	-40℃~125℃	TSSOP-8	RS6332P	Tape and Reel,3000
RS6334P	RS6334PXP	-40℃~125℃	SOIC-14(SOP14)	RS6334P	Tape and Reel,2500
	RS6334PXQ	-40℃~125℃	TSSOP-14	RS6334P	Tape and Reel,3000

ELECTRICAL CHARACTERISTICS

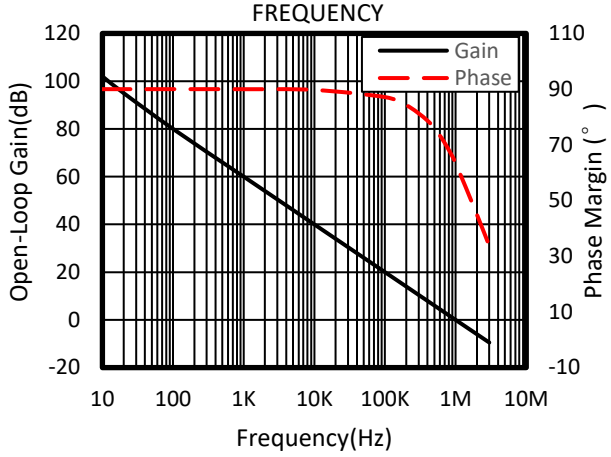
(At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.)

PARAMETER		CONDITIONS	T_J	RS6331P, RS6332P, RS6334P			
				MIN	TYP	MAX	UNITS
POWER SUPPLY							
Vs	Operating Voltage Range		25°C	2.1		5.5	V
IQ	Quiescent Current/Amplifier		25°C		85	145	uA
PSRR	Power-Supply Rejection Ratio	Vs=2.1V to 5.5V, Vcm=(V-)+0.5V	25°C	75	92		dB
			-40°C to 125°C	65			
INPUT							
Vos	Input Offset Voltage	RS6331P	25°C		±0.2	±0.5	mV
		RS6332P	25°C		±0.2	±0.5	
		RS6334P	25°C		±0.3	±0.8	
Vos TC	Input Offset Voltage Average Drift	-40°C to 125°C			2		uV/°C
IB	Input Bias Current		25°C		10	50	pA
Ios	Input Offset Current		25°C		10	50	pA
Vcm	Common-Mode Voltage Range	Vs= 5.5V	25°C	-0.1		5.6	V
CMRR	Common-Mode Rejection Ratio	Vs= 5.5V, Vcm =-0.1V to 4V	25°C	75	95		dB
			-40°C to 125°C	68			
		Vs= 5.5V, Vcm =-0.1V to 5.6V	25°C	63	85		
			-40°C to 125°C	57			
OUTPUT							
AOL	Open-Loop Voltage Gain	R_L=2KΩ, Vo= 0.15V to 4.85V	25°C	95	110		dB
			-40°C to 125°C	85			
		R_L=10KΩ, Vo= 0.05V to 4.95V	25°C	100	120		
			-40°C to 125°C	92			
	Output Swing From Rail	R_L=2KΩ	25°C		25		mV
		R_L=10KΩ			8		
Iout	Output Current Source		25°C		120		mA
FREQUENCY RESPONSE							
SR	Slew Rate		25°C		0.5		V/us
GBP	Gain-Bandwidth Product		25°C		1.1		MHz
PM	Phase Margin		25°C		64		°
ts	Setting Time,0.1%				1.3		us
	Overload Recovery Time	V_{IN}·Gain≥V_S			4.7		us
	Turn-on time	Vs= 5V			20		us
NOISE							
e_n	Input Voltage Noise Density	f = 1KHz	25°C		22		nV/√Hz
		f = 10KHz	25°C		20		nV/√Hz

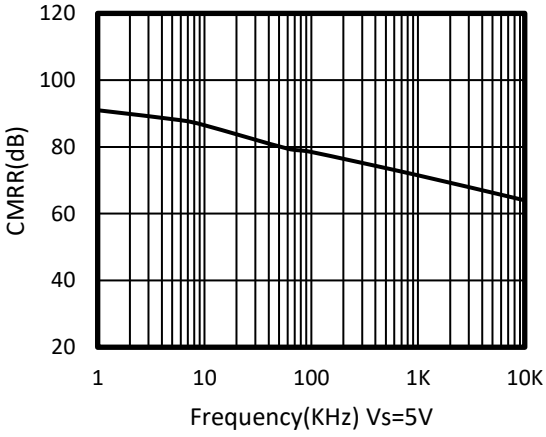
TYPICAL CHARACTERISTICS

At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.

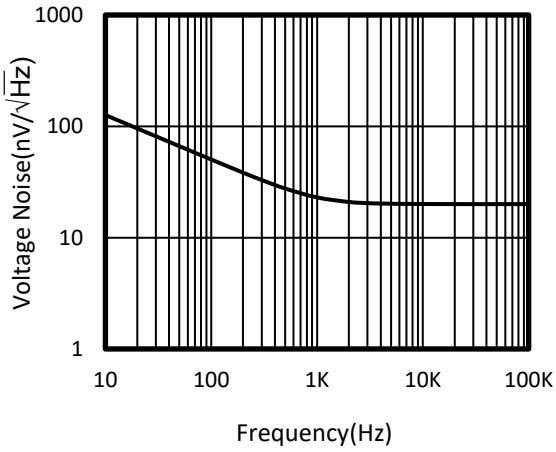
OPEN-LOOP GAIN AND PHASE vs FREQUENCY



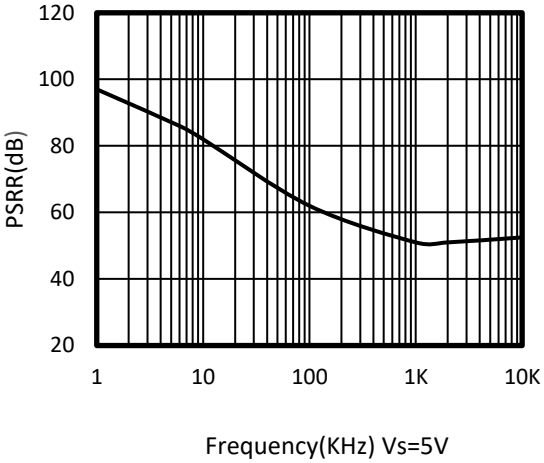
COMMON−MODE REJECTION RATIO vs FREQUENCY



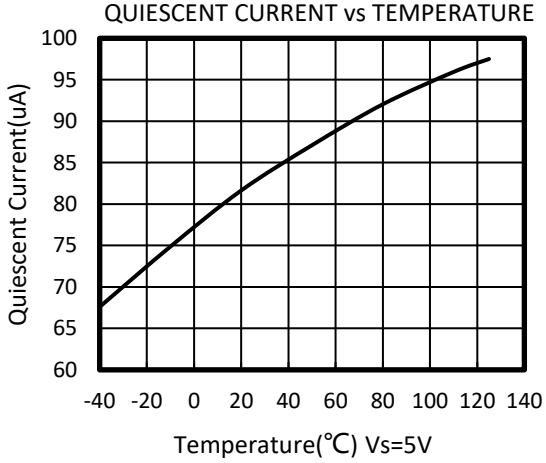
INPUT VOLTAGE NOISE SPECTRAL DENSITY vs FREQUENCY



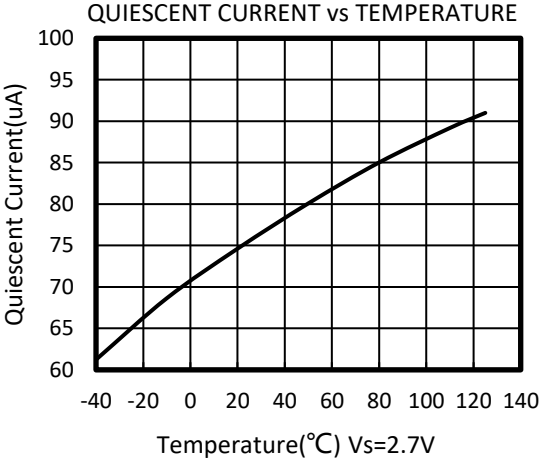
POWER−SUPPLY REJECTION RATIO vs FREQUENCY



QUIESCENT CURRENT vs TEMPERATURE



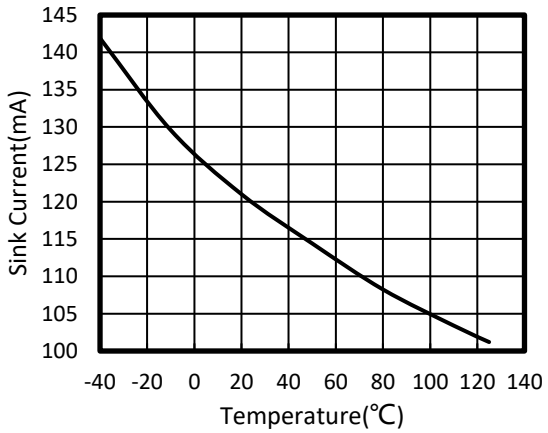
QUIESCENT CURRENT vs TEMPERATURE



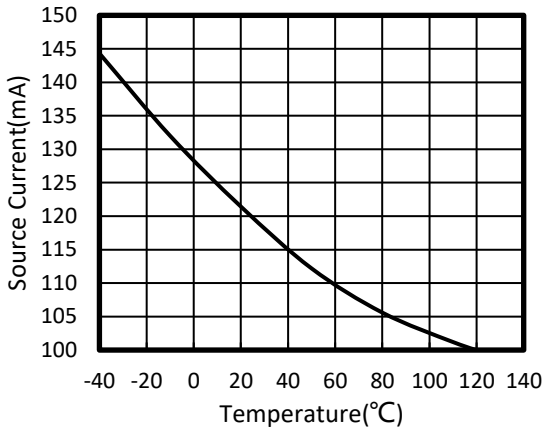
TYPICAL CHARACTERISTICS

At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.

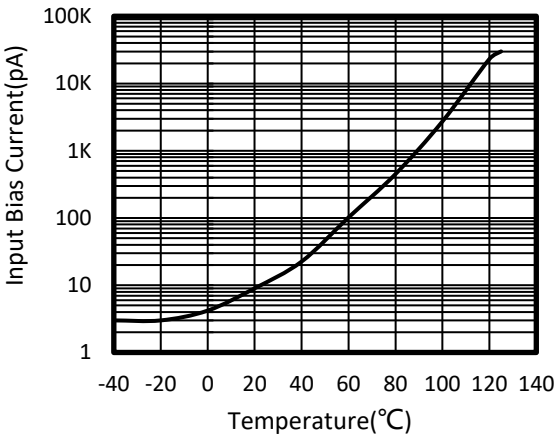
SINK CURRENT vs TEMPERATURE



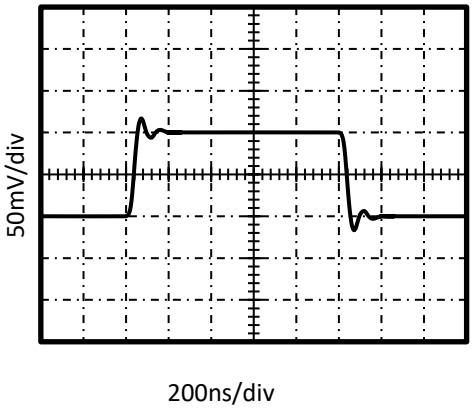
SOURCE CURRENT vs TEMPERATURE



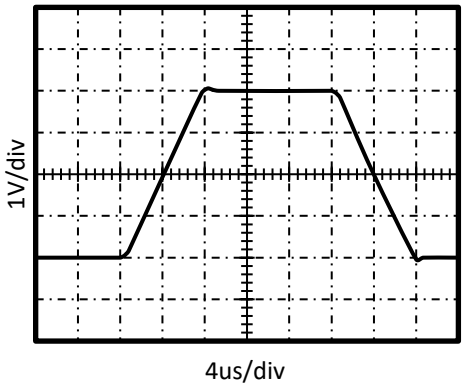
INPUT BIAS CURRENT vs TEMPERATURE



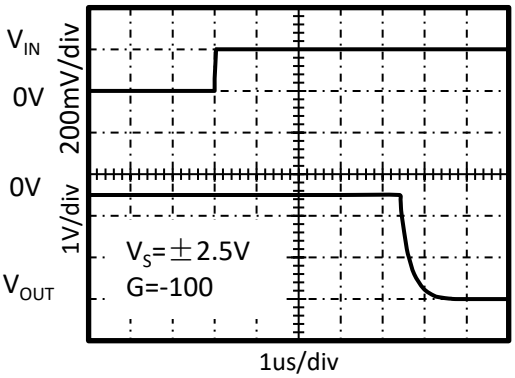
SMALL-SIGNAL STEP RESPONSE



LARGE−SIGNAL STEP RESPONSE



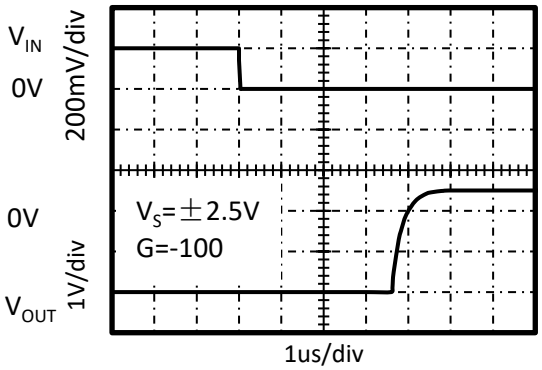
POSITIVE OVERVOLTAGE RECOVERY



TYPICAL CHARACTERISTICS

At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.

NEGATIVE OVERVOLTAGE RECOVERY



APPLICATION NOTES

The RS6331P, RS6332P, RS6334P, are high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.1V to 5.5V (±1.05V to ±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.

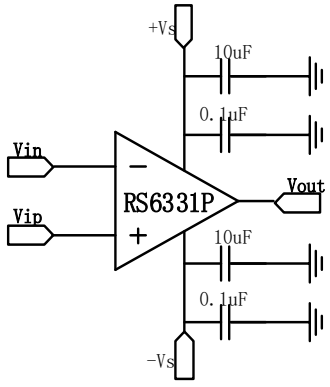


Figure1. Amplifier with Bypass Capacitors

INSTRUMENTATION AMPLIFIER

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

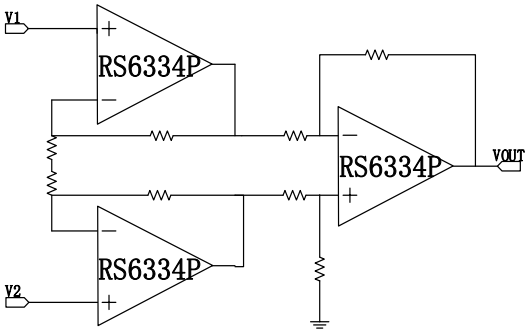
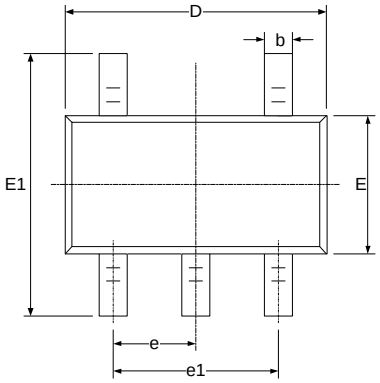
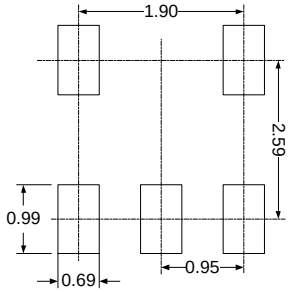


Figure2. Amplifier instrumentation amplifier

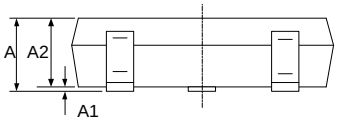
PACKAGE OUTLINE DIMENSIONS

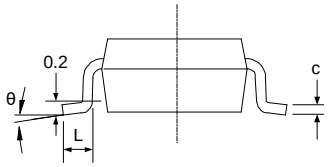
SOT23-5





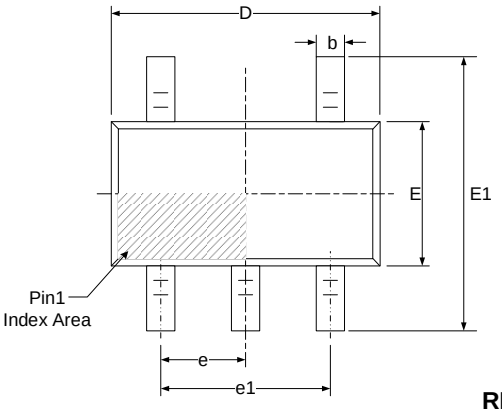
RECOMMENDED LAND PATTERN (Unit: mm)

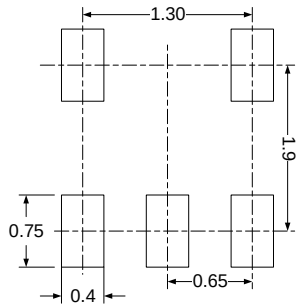




Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)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

SOT353(SC70-5)





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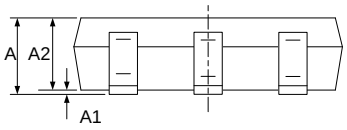
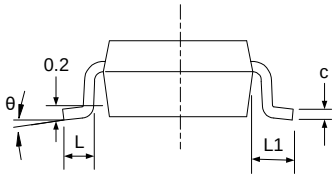
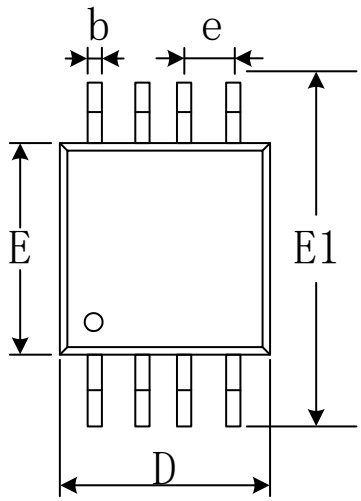
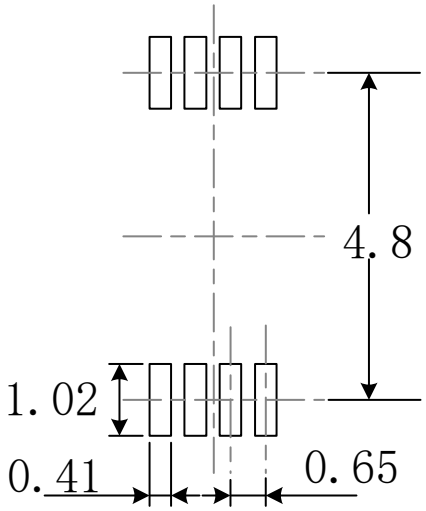




Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650(BSC)		0.026(BSC)	
e1	1.300(BSC)		0.051(BSC)	
L	0.260	0.460	0.010	0.018
L1	0.525		0.021	
θ	0°	8°	0°	8°

MSOP-8





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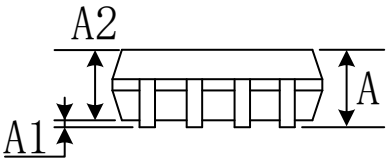
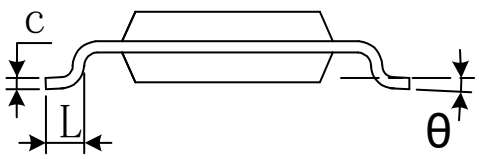
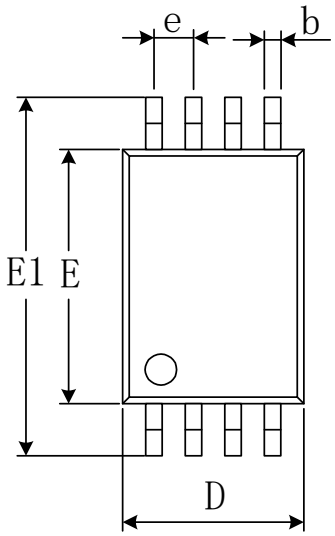
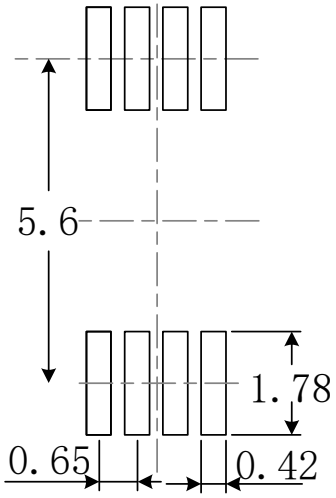




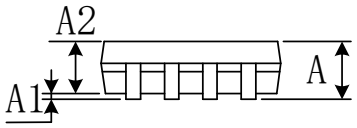
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187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

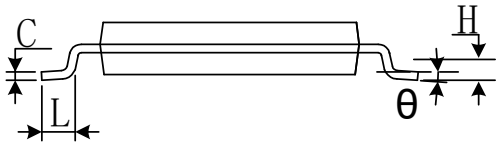
TSSOP-8





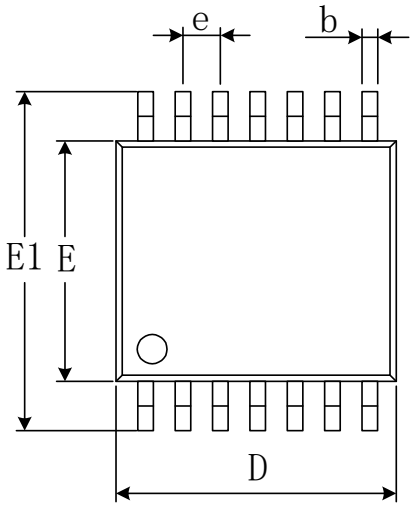
RECOMMENDED LAND PATTERN (Unit: mm)

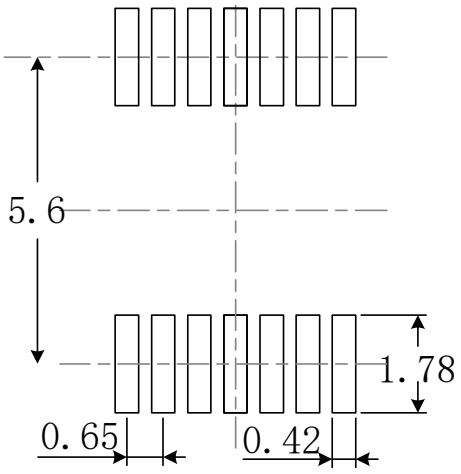




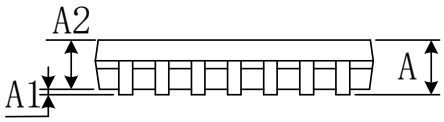
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L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

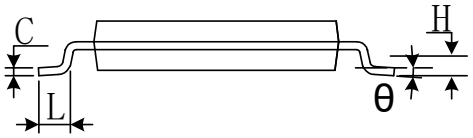
TSSOP-14





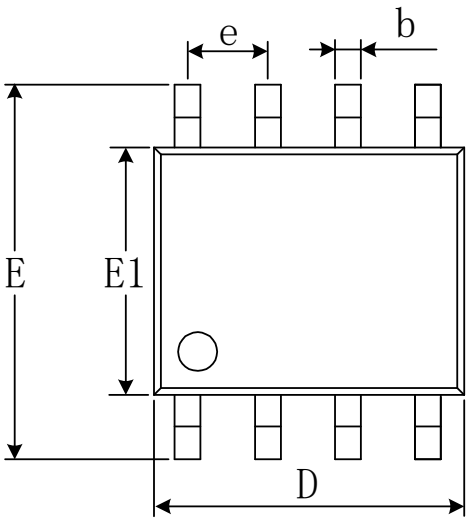
RECOMMENDED LAND PATTERN (Unit: mm)

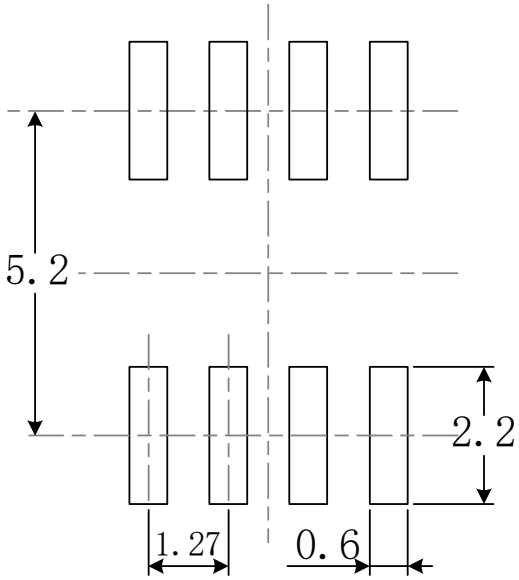




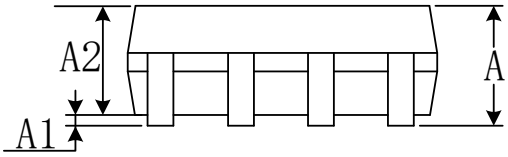
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

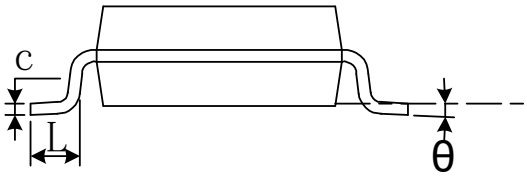
SOIC-8(SOP8)





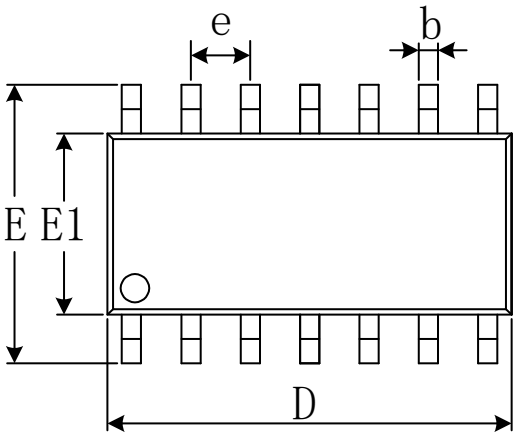
RECOMMENDED LAND PATTERN (Unit: mm)

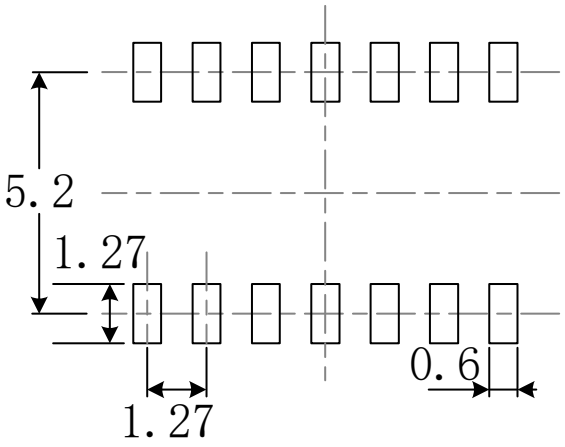




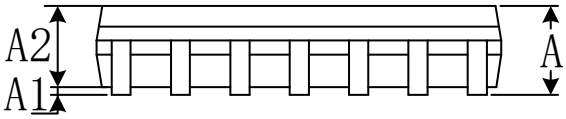
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150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

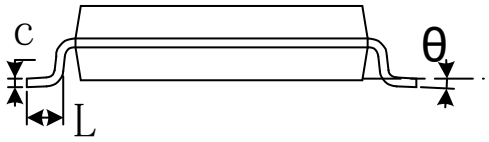
SOIC-14(SOP14)





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	0.310	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
θ	0°	8°	0°	8°

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