10MHz, Rail-to-Rail I/O
CMOS Operational Amplifier

FEATURES

- **HIGH GAIN BANDWIDTH:10MHz**
- **RAIL-TO-RAIL INPUT AND OUTPUT 0.9mV Typical Vos**
- **INPUT VOLTAGE RANGE: -0.1V to +5.6V with Vs = 5.5V**
- **SUPPLY RANGE: +2.5V to +5.5V**
- **SHUTDOWN: RS721S/RS722S**
- **SPECIFIED UP TO +125°C**
- ***Micro*SIZE PACKAGES: SOT23-5, SOT23-6**

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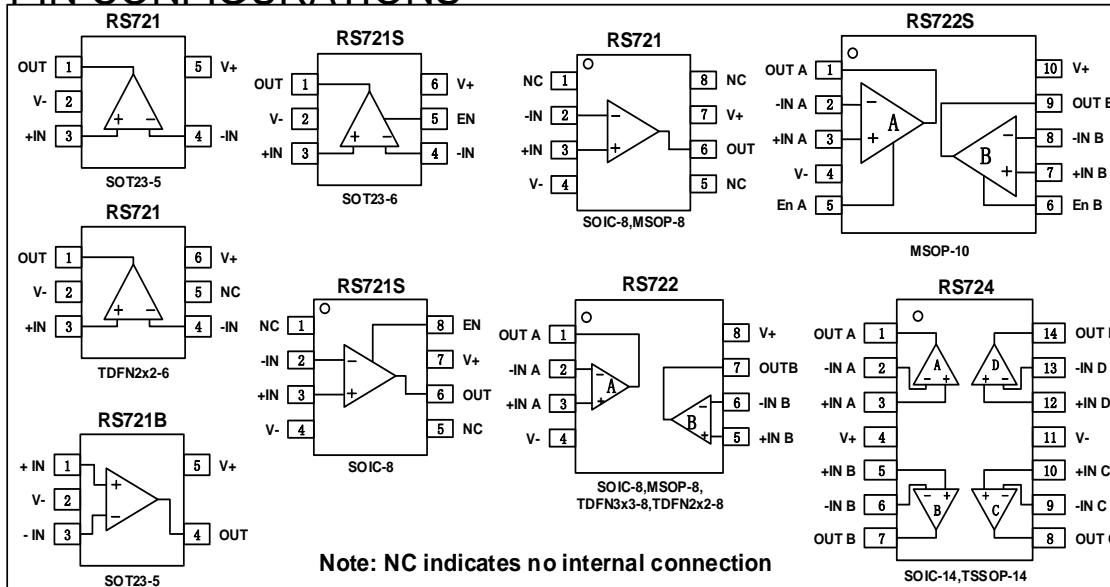
- **SENSORS**
- **PHOTODIODE AMPLIFICATION**
- **ACTIVE FILTERS**
- **TEST EQUIPMENT**
- **DRIVING A/D CONVERTERS**

DESCRIPTION

The RS72X 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 (10MHz) and slew rate of 7V/us. The op-amps are unity gain stable and feature an ultra-low input bias current.

The devices are ideal for sensor interfaces, active filters and portable applications. The RS721S, RS722S include a shutdown mode. Under logic control, the amplifiers can be switched from normal operation to a standby current that is less than 1uA.The RS72X 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

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

(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
RS721	RS721XK	-40°C~125°C	SOIC-8	RS721	Tape and Reel,2500
	RS721XF	-40°C~125°C	SOT23-5	721	Tape and Reel,3000
	RS721BXF	-40°C~125°C	SOT23-5	721B	Tape and Reel,3000
	RS721XM	-40°C~125°C	MSOP-8	RS721	Tape and Reel,3000
	RS721XTDE6	-40°C~125°C	TDFN2x2-6	721	Tape and Reel,3000
RS721S	RS721SXK	-40°C~125°C	SOIC-8	RS721S	Tape and Reel,2500
	RS721SXH	-40°C~125°C	SOT23-6	721S	Tape and Reel,3000
RS722	RS722XK	-40°C~125°C	SOIC-8	RS722	Tape and Reel,2500
	RS722XM	-40°C~125°C	MSOP-8	RS722	Tape and Reel,3000
	RS722XTDC8	-40°C~125°C	TDFN3x3-8	RS722	Tape and Reel,3000
	RS722XTDE8	-40°C~125°C	TDFN2x2-8	RS722	Tape and Reel,3000
RS722S	RS722SXN	-40°C~125°C	MSOP-10	RS722S	Tape and Reel,3000
RS724	RS724XP	-40°C~125°C	SOIC -14	RS724	Tape and Reel,2500
	RS724XQ	-40°C~125°C	TSSOP-14	RS724	Tape and Reel,3000

ELECTRICAL CHARACTERISTICS

(At T_A = +25℃, Vs=5V, R_L = 10kΩ connected to $V_S/2$, and V_{OUT} = $V_S/2$, unless otherwise noted.)
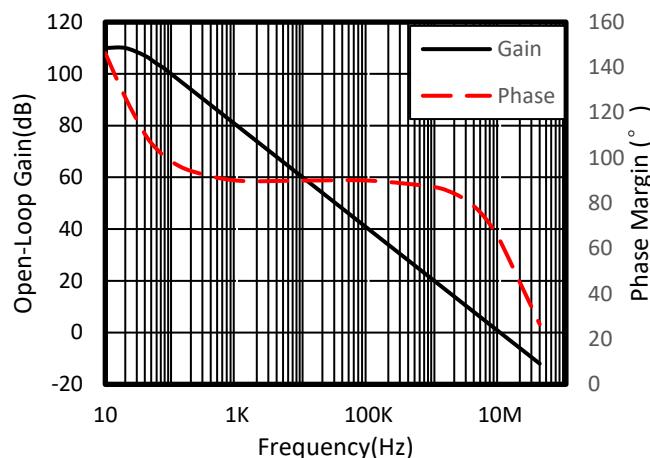
PARAMETER		CONDITIONS	T_J	RS721S,RS722S, RS721,RS722,RS724			UNIT
				MIN	TYP	MAX	
POWER SUPPLY							
Vs	Operating Voltage Range		25°C	2.5		5.5	V
IQ	Quiescent Current/Amplifier		25°C		1.15	1.4	mA
PSRR	Power-Supply Rejection Ratio	Vs= 2.5V to 5.5V	25°C	75	85		dB
		Vcm =(V-)+0.5V	−40°C to 125°C	65			
INPUT							
Vos	Input Offset Voltage		25°C		0.5	2.5	mV
Vos TC	Input Offset Voltage Average Drift	-40°C to 125°C			2.6		uV/°C
IB	Input Bias Current		25°C		1	10	pA
Ios	Input Offset Current		25°C		1	10	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	73	85		dB
			−40°C to 125°C	67			
		Vs = 5.5V, Vcm = -0.1V to 5.6V	25°C	60	75		
			−40°C to 125°C	57			
OUTPUT							
AOL	Open-Loop Voltage Gain	R_L =2KΩ, Vo = 0.15V to 4.85V	25°C	86	95		dB
			−40°C to 125°C	65			
		R_L = 10kΩ, Vo = 0.05V to 4.95V	25°C	90	96		
			−40°C to 125°C	66			
	Output Swing From Rail	R_L = 2KΩ	25°C		52		mV
		R_L = 10kΩ	25°C		7		
Iout	Output Short-Circuit Current		25°C		70		mA
FREQUENCY RESPONSE							
SR	Slew Rate		25°C		7		V/us
GBP	Gain-Bandwidth Product		25°C		10		MHz
Φm	Phase Margin		25°C		62		°
t_s	Settling Time, 0.1%				0.2		us
	Overload Recovery Time	V_{IN} • Gain ⩾ Vs			0.35		us
NOISE							
e_n	Input-Referred Voltage Noise	f = 1 kHz	25°C		9.5		nV/√Hz
		f = 10 kHz	25°C		6.5		nV/√Hz
ENABLE/SHUTTDOWN(RS721S,RS722S)							
$I_{Q(OFF)}$	Supply Current in Shutdown		25°C		<1		uA
t_{OFF}			25°C		3		us
t_{ON}			25°C		20		us
V_L	Shut Down		25°C	V−		(V-)+0.8	V
V_H	Amplifier Is Active		25°C	(V-)+2		V+	V
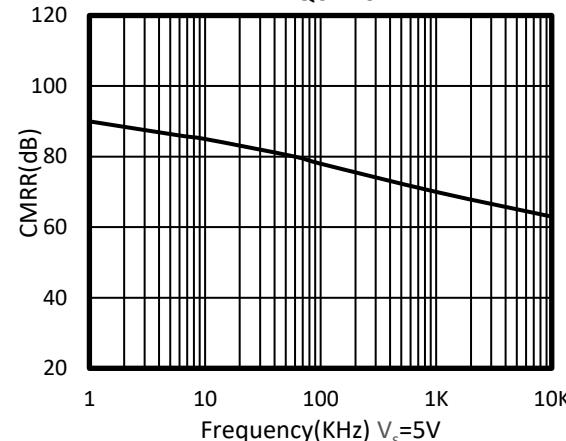
TYPICAL CHARACTERISTICS

At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, unless otherwise noted.
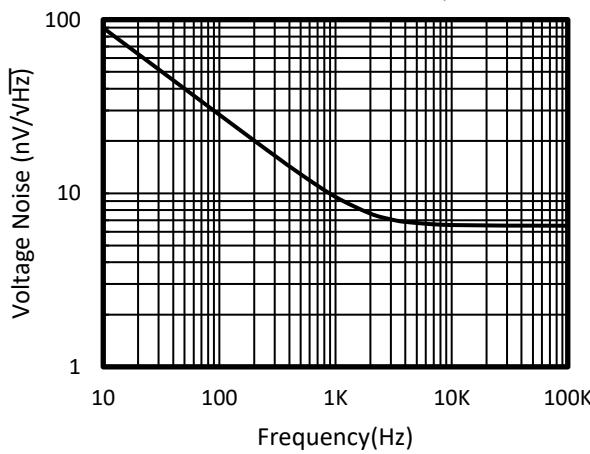
OPEN−LOOP GAIN AND PHASE vs FREQUENCY
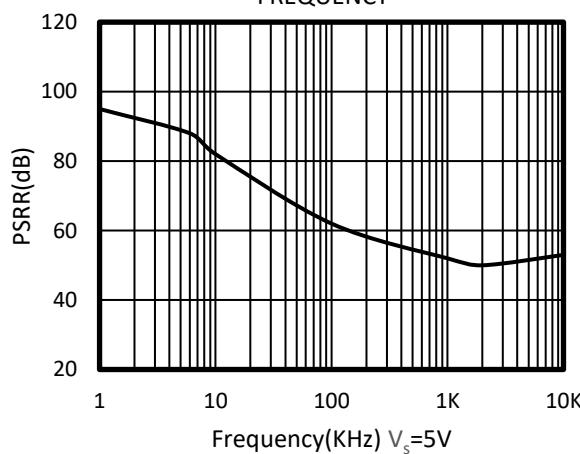
COMMON−MODE REJECTION RATIO vs FREQUENCY
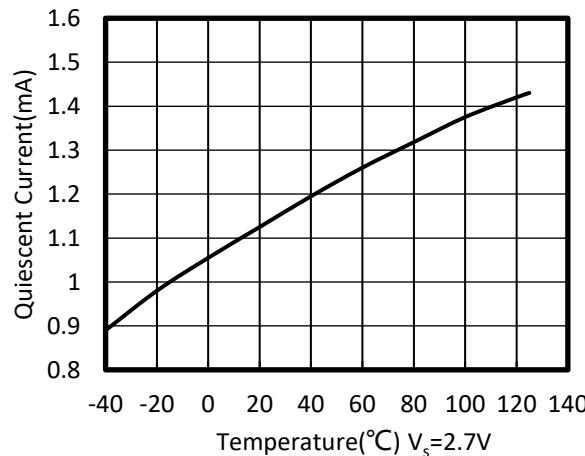
INPUT VOLTAGE NOISE SPECTRAL DENSITY vs FREQUENCY
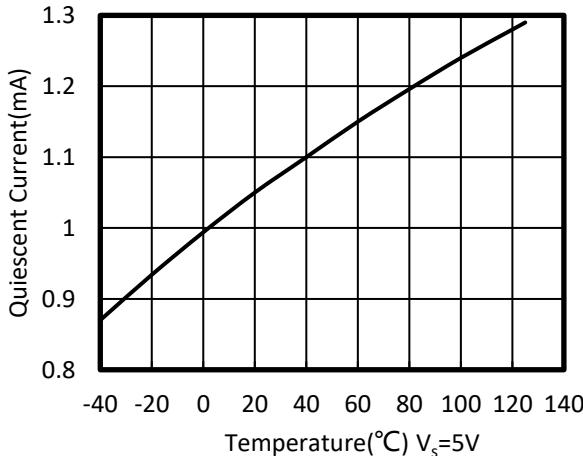
POWER−SUPPLY REJECTION RATIO vs FREQUENCY

QUIESCENT CURRENT vs TEMPERATURE
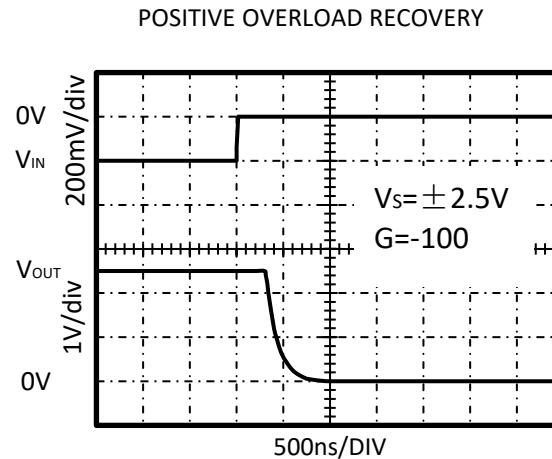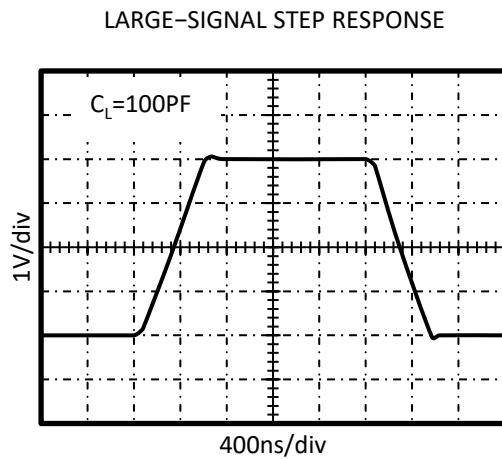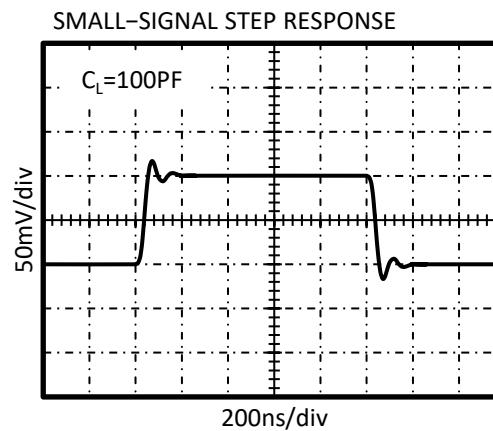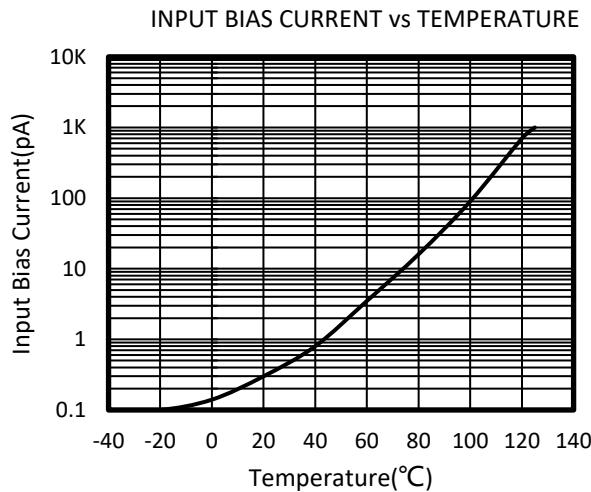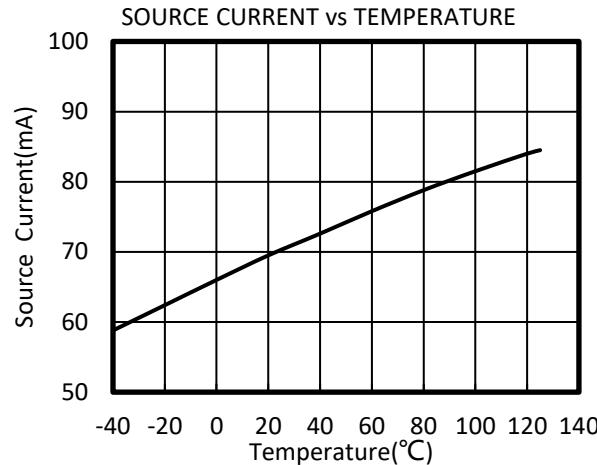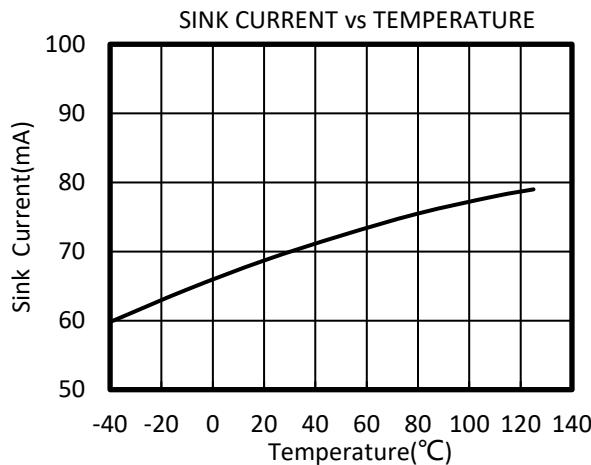
QUIESCENT CURRENT vs TEMPERATURE

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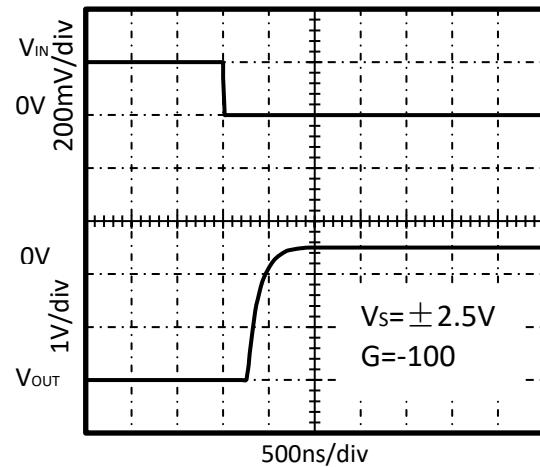
At T_A = +25°C, Vs=5V, R_L = 10kΩ connected to Vs/2, V_{OUT} = Vs/2, unless otherwise noted.

SINK CURRENT vs TEMPERATURE

SOURCE CURRENT vs TEMPERATURE

INPUT BIAS CURRENT vs TEMPERATURE

SMALL−SIGNAL STEP RESPONSE

C_L=100PF

50mV/div

200ns/div

LARGE−SIGNAL STEP RESPONSE

C_L=100PF

1V/div

400ns/div

POSITIVE OVERLOAD RECOVERY

0V

V_{IN}

200mV/div

V_S=±2.5V

G=-100

V_{OUT}

1V/div

0V

500ns/DIV
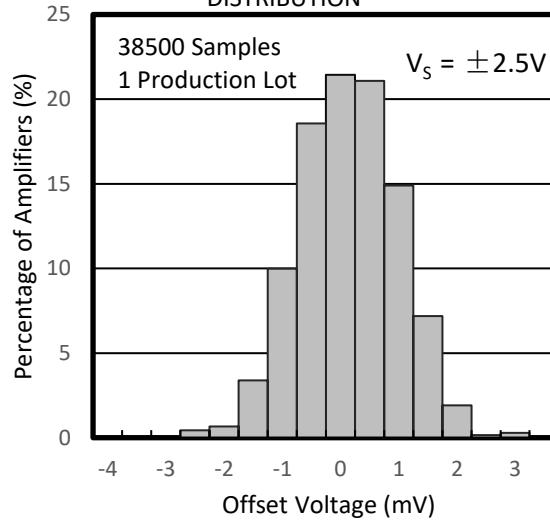
TYPICAL CHARACTERISTICS

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

NEGATIVE OVERLOAD RECOVERY

OFFSET VOLTAGE PRODUCTION DISTRIBUTION

APPLICATION NOTES

The RS721, RS722, RS724, RS721S, RS722S are high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.5V to 5.5V (±1.25V 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.

RS721S/RS722S ENABLE FUNCTION

The RS721S/RS722S includes a shutdown mode. Under logic control, the amplifiers can be switched from normal mode to a standby current of 1uA. When the Enable pin is connected to high, the amplifier is active. Connecting Enable low disables the amplifier, and places the amplifier, and place the output in a high-impedance state.

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.
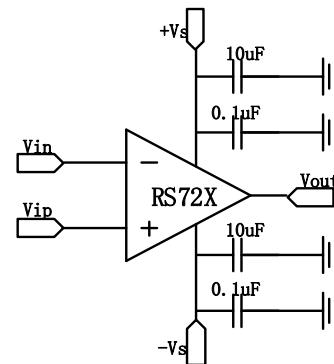
Figure1. Amplifier with Bypass Capacitors

INSTRUMENTATION AMPLIFIER

In the three-op amp, instrumentation amplifier configuration shown in Figure2,
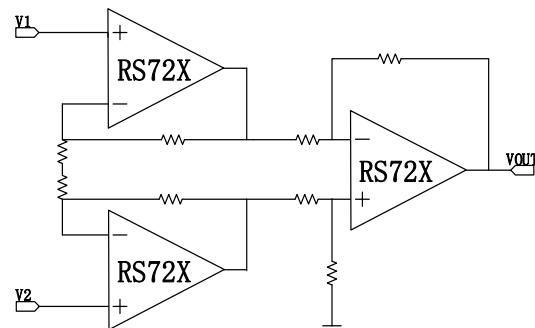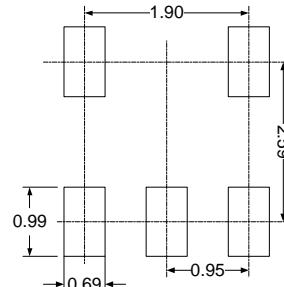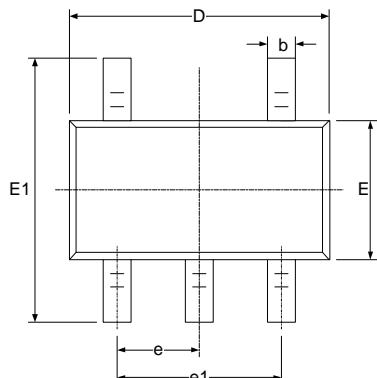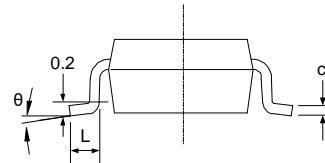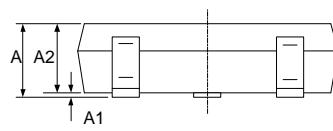
Figure2. Amplifier instrumentation amplifier
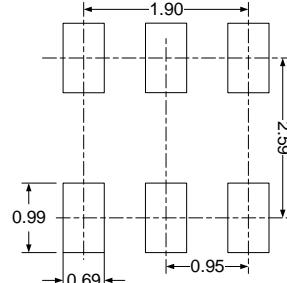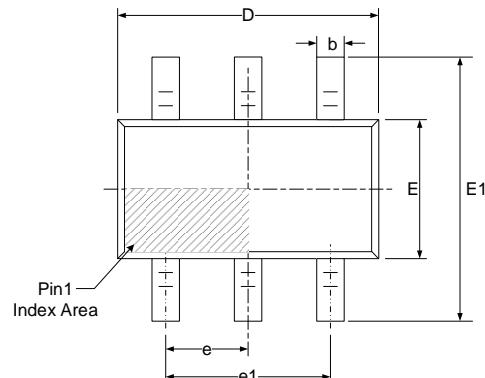
PACKAGE OUTLINE DIMENSIONS
SOT23-5

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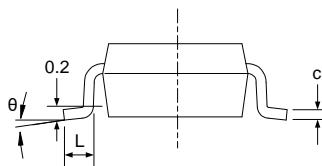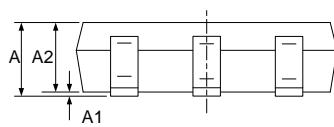
| Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)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

SOT23-6
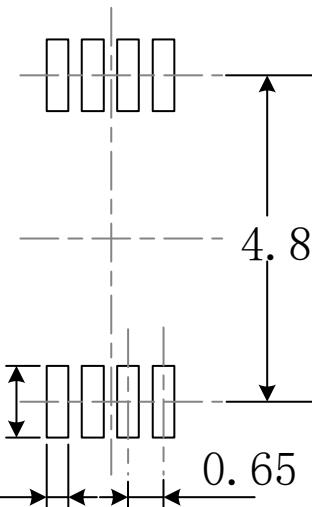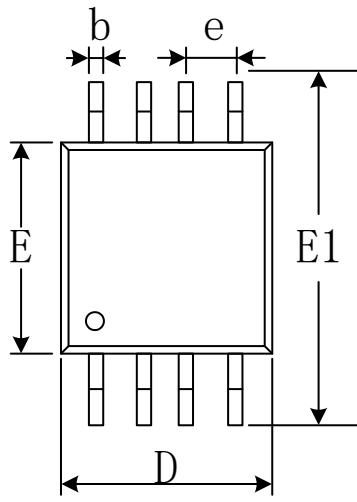
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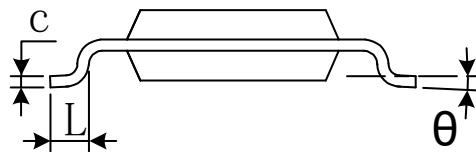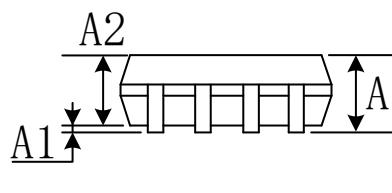
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		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°

# MSOP-8
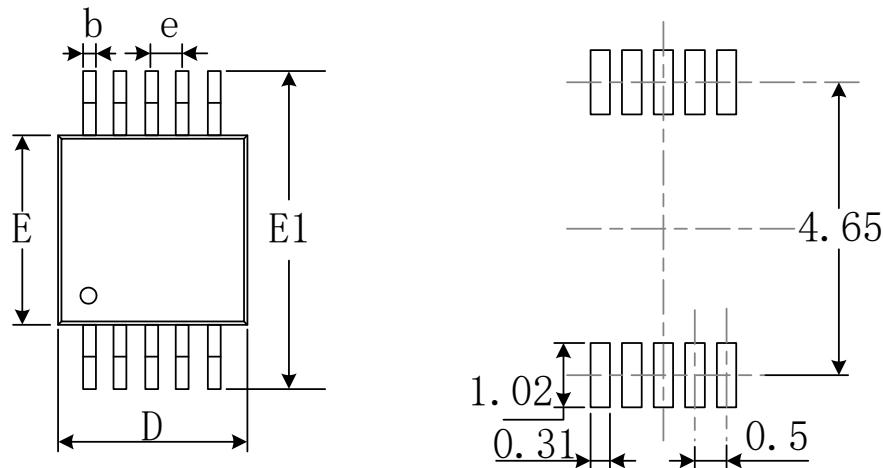
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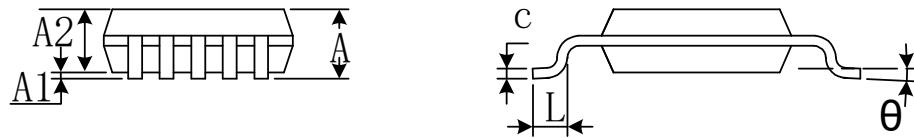
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

MSOP-10
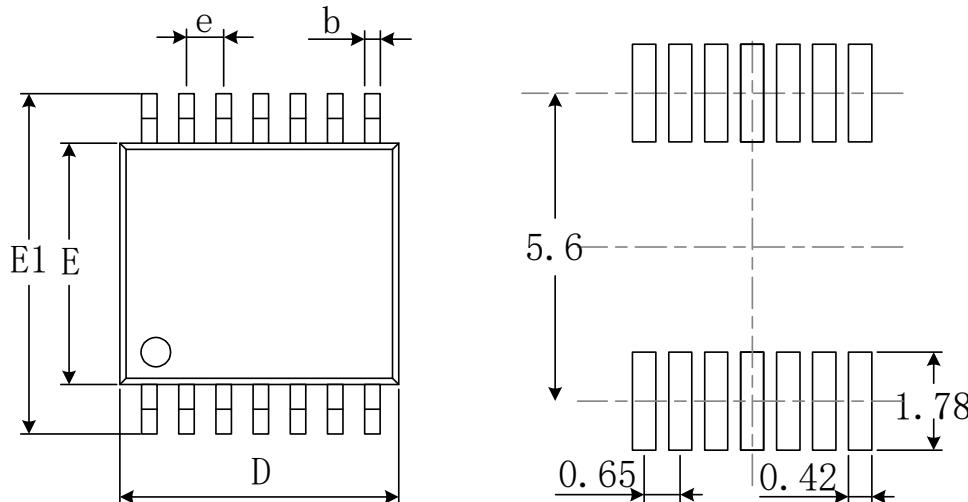
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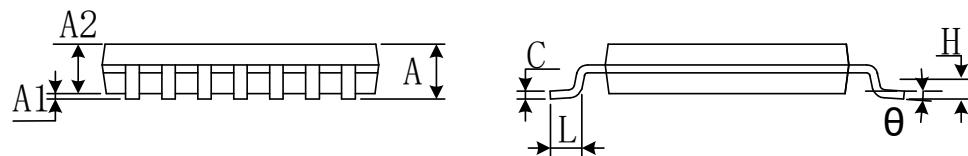
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.180	0.280	0.007	0.011
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.50(BSC)		0.020(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

# TSSOP-14
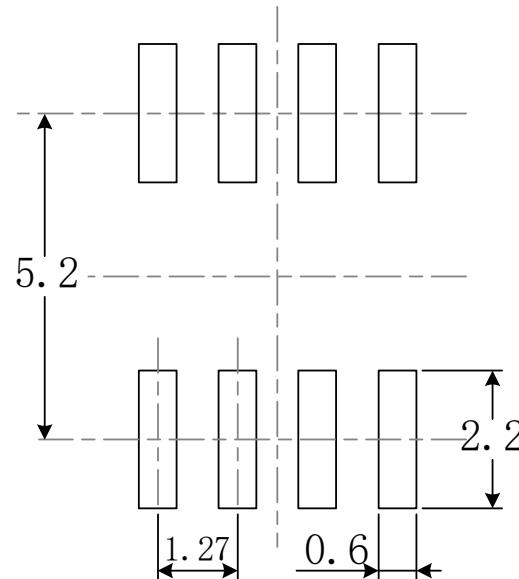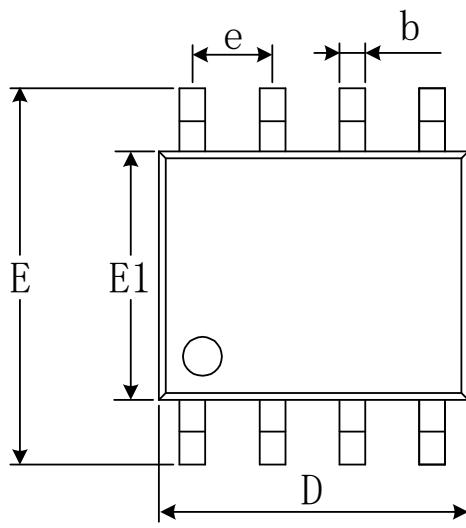
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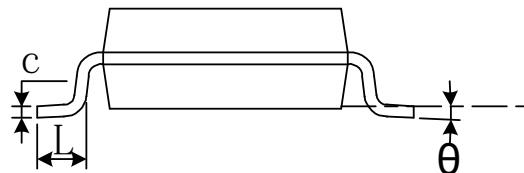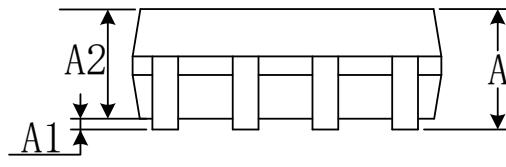
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

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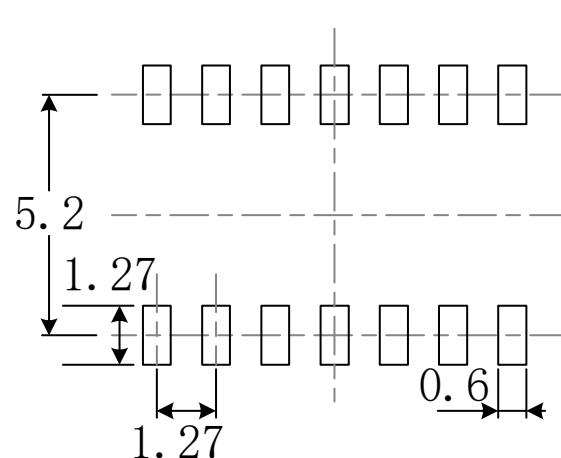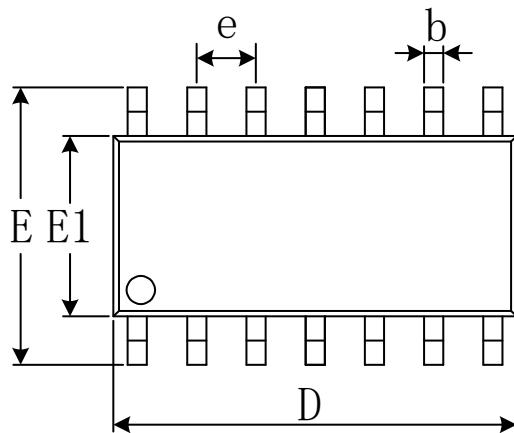
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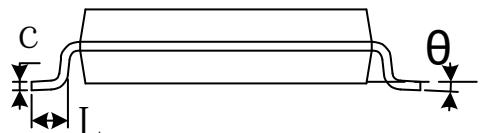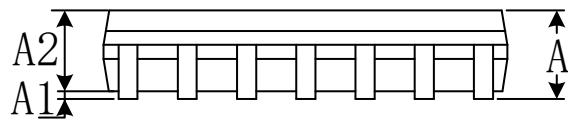
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.800	5.000	0.189	0.197
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150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

SOIC-14
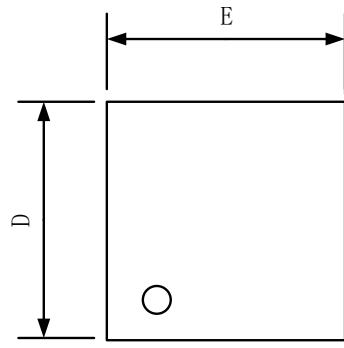
RECOMMENDED LAND PATTERN (Unit: mm)
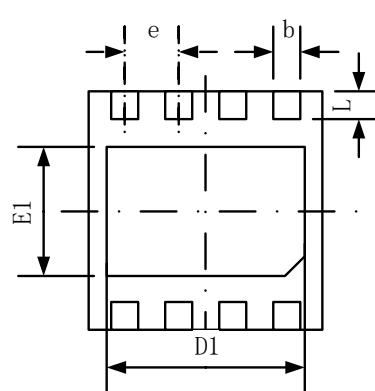
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	8.450	8.850	0.333	0.348
e	1.270(BSC)		0.050(BSC)	
E	5.800	6.200	0.228	0.244
E1	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°
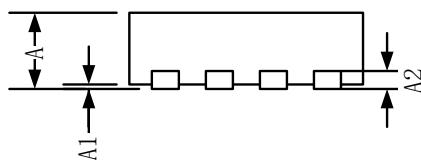
TDFN3x3-8

TOP VIEW
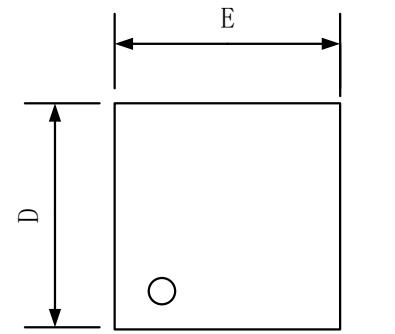
BOTTOM VIEW
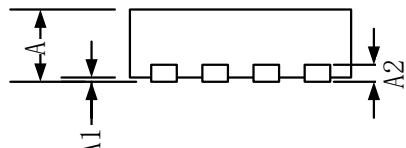
SIDE VIEW

| 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
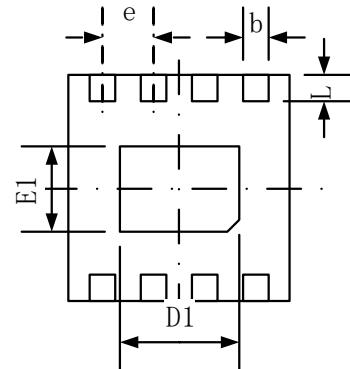
TDFN2x2-8
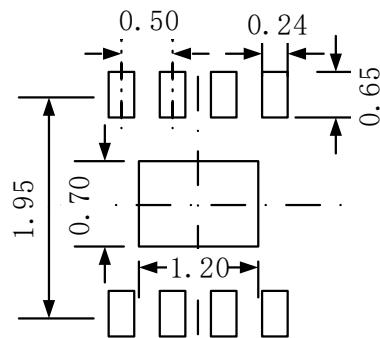
TOP VIEW
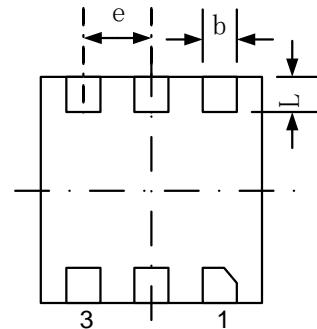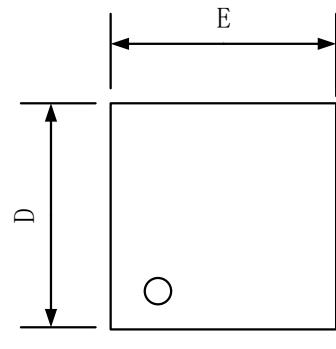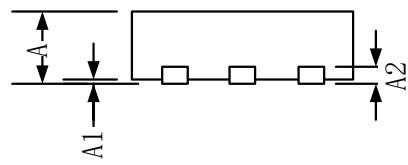
BOTTOM VIEW

SIDE VIEW

RECOMMENDED LAND PATTERN (Unit: mm)

| 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(TYP)		0.008(TYP)	
b	0.180	0.300	0.007	0.012
D	1.900	2.100	0.075	0.083
D1	1.100	1.300	0.043	0.051
E	1.900	2.100	0.075	0.083
E1	0.600	0.800	0.024	0.031
e	0.500(TYP)		0.020(TYP)	
L	0.250	0.450	0.010	0.018

TDFN2x2-6
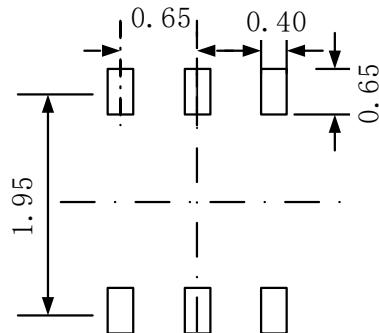

TOP VIEW

BOTTOM VIEW

SIDE VIEW

RECOMMENDED LAND PATTERN (Unit: mm)

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(TYP)		0.008(TYP)	
b	0.250	0.350	0.010	0.012
D	1.900	2.100	0.075	0.083
E	1.900	2.100	0.075	0.083
e	0.650(TYP)		0.026(TYP)	
L	0.250	0.400	0.010	0.018