

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

## FEATURES

- **HIGH GAIN BANDWIDTH:10MHZ**
- **RAIL-TO-RAIL INPUT AND OUTPUT**  
**±0.5mV 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.

### Device Information <sup>(1)</sup>

PART NUMBER	PACKAGE	BODY SIZE(NOM)
RS721	SOT23-5	2.90mm×1.60mm
	SOT23-6	2.90mm×1.60mm
	TDFN2×2-6L	2.00mm×2.00mm
	SOIC-8(SOP8)	4.90mm×3.90mm
	MSOP-8	3.00mm×3.00mm
RS722	SOIC-8(SOP8)	4.90mm×3.90mm
	MSOP-8	3.00mm×3.00mm
	MSOP-10	3.00mm×3.00mm
	TDFN2×2-8L	2.00mm×2.00mm
	TDFN3×3-8L (0303x0.75-0.65)	3.00mm×3.00mm
	TDFN3×3-8L (0303x0.75-0.5)	3.00mm×3.00mm
RS724	SOIC-14(SOP14)	8.65mm×3.90mm
	TSSOP-14	5.00mm×4.40mm

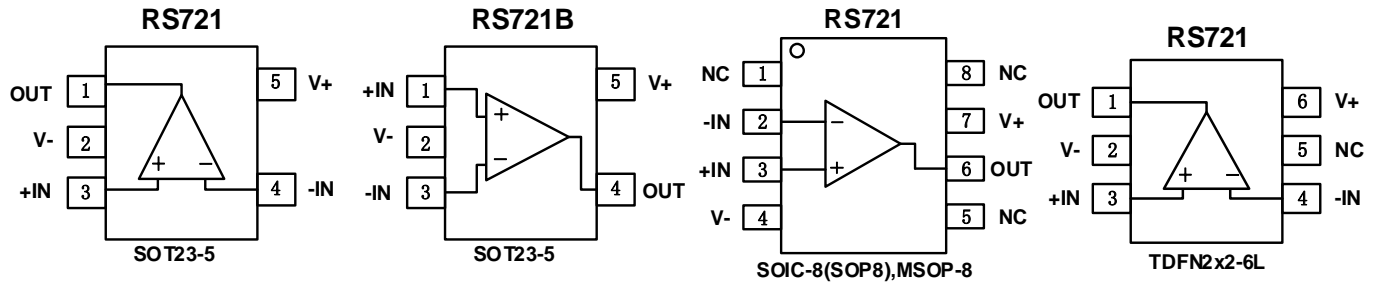
(1) For all available packages, see the orderable addendum at the end of the data sheet.

## Revision History

Note: Page numbers for previous revisions may differ from page numbers in the current version.

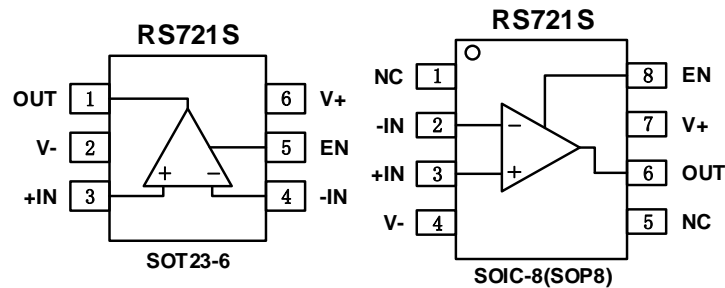
VERSION	Change Date	Change Item
C.1	2021/06/16	Add TDFN3x3-8L(0303x0.75-0.5) package
C.2	2022/06/14	Add TDFN2X2-6L PACKAGE/ORDERING INFORMATION

### Pin Configuration and Functions (Top View)



### Pin Description

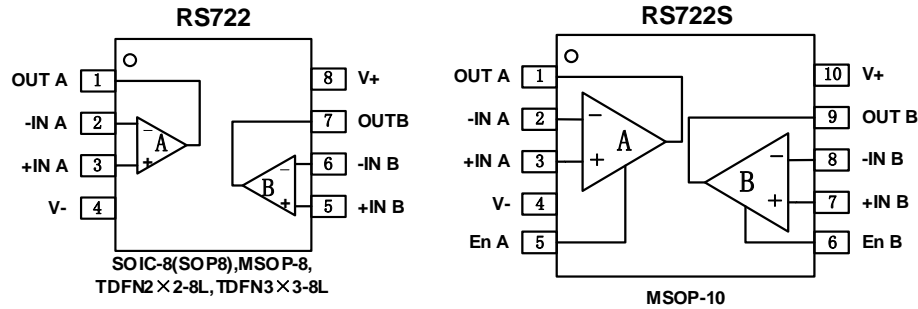
NAME	PIN				I/O	DESCRIPTION
	RS721 SOT23-5	RS721B SOT23-5	RS721 SOIC-8(SOP8)/ MSOP8	RS721 TDFN2x2-6L		
-IN	4	3	2	4	I	Negative (inverting) input
+IN	3	1	3	3	I	Positive (noninverting) input
NC	-	-	1,5,8	5	-	No internal connection (can be left floating)
OUT	1	4	6	1	O	Output
V-	2	2	4	2	-	Negative (lowest) power supply
V+	5	5	7	6	-	Positive (highest) power supply



### Pin Description

NAME	PIN		I/O	DESCRIPTION
	RS721S			
	SOT23-6	SOIC-8(SOP8)		
-IN	4	2	I	Inverting input
+IN	3	3	I	Noninverting input
OUT	1	6	O	Output
EN	5	8	I	Enable pin. This pin turns the regulator on or off. Low = disabled, high = normal operation (pin must be driven)
NC	-	1,5	-	No internal connection (can be left floating)
V-	2	4	-	Negative (lowest) power supply
V+	6	7	-	Positive (highest) power supply

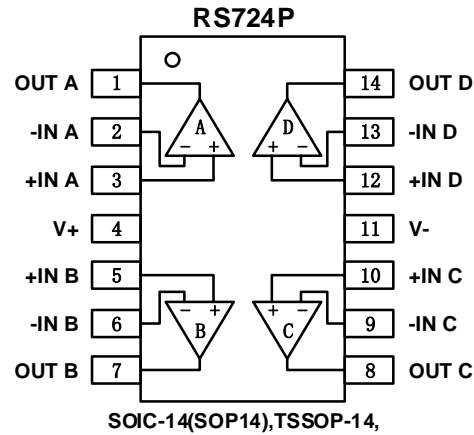
## Pin Configuration and Functions (Top View)



## Pin Description

NAME	PIN		I/O	DESCRIPTION
	RS722	RS722S		
	SOIC-8(SOP8)/MSOP-8/ TDFN2x2-8L/TDFN3x3-8L	MSOP-10		
-INA	2	2	I	Inverting input, channel A
+INA	3	3	I	Noninverting input, channel A
-INB	6	8	I	Inverting input, channel B
+INB	5	7	I	Noninverting input, channel B
OUTA	1	1	O	Output, channel A
OUTB	7	9	O	Output, channel B
EnA	-	5	I	Enable pin, channel A. This pin turns the regulator on or off. Low = disabled, high = normal operation (pin must be driven)
EnB	-	6	I	Enable pin, channel B. This pin turns the regulator on or off. Low = disabled, high = normal operation (pin must be driven)
V-	4	4	-	Negative (lowest) power supply
V+	8	10	-	Positive (highest) power supply

## Pin Configuration and Functions (Top View)



### Pin Description

NAME	PIN	I/O	DESCRIPTION
	SOIC-14(SOP14)/TSSOP-14		
-INA	2	I	Inverting input, channel A
+INA	3	I	Noninverting input, channel A
-INB	6	I	Inverting input, channel B
+INB	5	I	Noninverting input, channel B
-INC	9	I	Inverting input, channel C
+INC	10	I	Noninverting input, channel C
-IND	13	I	Inverting input, channel D
+IND	12	I	Noninverting input, channel D
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
OUTC	8	O	Output, channel C
OUTD	14	O	Output, channel D
V-	11	-	Negative (lowest) power supply
V+	4	-	Positive (highest) power supply

## SPECIFICATIONS

### Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

		MIN	MAX	UNIT
Voltage	Supply, $V_s=(V+) - (V-)$		7	V
	Signal input pin <sup>(2)</sup>	(V-)-0.5	(V+) +0.5	
	Signal output pin <sup>(3)</sup>	(V-)-0.5	(V+) +0.5	
Current	Signal input pin <sup>(2)</sup>	-10	10	mA
	Signal output pin <sup>(3)</sup>	-100	100	mA
	Output short-circuits <sup>(4)</sup>	Continuous		
Temperature	Operating range, $T_A$	-40	125	°C
	Junction, $T_J$		150	
	Storage, $T_{stg}$	-65	150	

(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.

(3) Output terminals are diode-clamped to the power-supply rails. Output signals that can swing more than 0.5V beyond the supply rails should be current-limited to  $\pm 100$ mA or less.

(4) Short-circuit to ground, one amplifier per package.

### ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM)	$\pm 5000$	V
		Machine Model (MM)	$\pm 400$	

### Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
Supply voltage, $V_s=(V+) - (V-)$	Single-supply	2.5		5.5	V
	Dual-supply	$\pm 1.25$		$\pm 2.75$	

### Thermal Information:RS721

THERMAL METRIC <sup>(1)</sup>		RS721				UNIT
		5PINS	6PINS	8PINS		
		SOT23-5	SOT23-6	SOIC-8	MSOP8	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	273.8	187.3	116	165	°C/W
$R_{\theta JC(top)}$	Junction-to-case(top) thermal resistance	126.8	126.5	60	53	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	85.9	32.6	56	87	°C/W
$\Psi_{JT}$	Junction-to-top characterization parameter	10.9	24.1	12.8	4.9	°C/W
$\Psi_{JB}$	Junction-to-board characterization parameter	84.9	32.1	98.3	85	°C/W
$R_{\theta JC(bot)}$	Junction-to-case(bottom) thermal resistance	N/A	N/A	N/A	N/A	°C/W

**Thermal Information:RS722**

THERMAL METRIC <sup>(1)</sup>		RS722					UNIT
		8PINS					
		SOIC-8	MSOP-8	MSOP-10	TDFN2x2-8L	TDFN3x3-8L	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	116	165	169.5	80.1	66.9	°C/W
R <sub>θJC(top)</sub>	Junction-to-case(top) thermal resistance	60	53	84.1	100	54.5	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	56	87	113	45	40.4	°C/W
Ψ <sub>JT</sub>	Junction-to-top characterization parameter	12.8	4.9	15.8	6.8	1.9	°C/W
Ψ <sub>JB</sub>	Junction-to-board characterization parameter	98.3	85	111.6	45.2	40.4	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case(bottom) thermal resistance	N/A	N/A	N/A	22.7	10.8	°C/W

**Thermal Information:RS724**

THERMAL METRIC <sup>(1)</sup>		RS724		UNIT
		14PINS		
		SOIC-14	TSSOP-14	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	83.8	120.8	°C/W
R <sub>θJC(top)</sub>	Junction-to-case(top) thermal resistance	70.7	34.3	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	59.5	62.8	°C/W
Ψ <sub>JT</sub>	Junction-to-top characterization parameter	11.6	1	°C/W
Ψ <sub>JB</sub>	Junction-to-board characterization parameter	37.7	56.5	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case(bottom) thermal resistance	N/A	N/A	°C/W

**PACKAGE/ORDERING INFORMATION**

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking <sup>(1)</sup>	Package Qty
RS721XF	SOT23-5	5	1	-40°C ~125°C	721	Tape and Reel,3000
RS721BXF	SOT23-5	5	1	-40°C ~125°C	721B	Tape and Reel,3000
RS721XK	SOIC-8(SOP8)	8	1	-40°C ~125°C	RS721	Tape and Reel,4000
RS721XM	MSOP-8	8	1	-40°C ~125°C	RS721	Tape and Reel,4000
RS721XTDE6	TDFN2X2-6L	6	1	-40°C ~125°C	721	Tape and Reel,3000
RS721SXK	SOIC-8(SOP8)	8	1	-40°C ~125°C	RS721S	Tape and Reel,4000
RS721SXH	SOT23-6	6	1	-40°C ~125°C	721S	Tape and Reel,3000
RS722XK	SOIC-8(SOP8)	8	2	-40°C ~125°C	RS722	Tape and Reel,4000
RS722XM	MSOP-8	8	2	-40°C ~125°C	RS722	Tape and Reel,4000
RS722XTDE8	TDFN2x2-8L	8	2	-40°C ~125°C	722	Tape and Reel,3000
RS722XTDC8	TDFN3x3-8L (0303X0.75-0.65)	8	2	-40°C ~125°C	RS722	Tape and Reel,5000
RS722XTDC8-B	TDFN3x3-8L (0303X0.75-0.5)	8	2	-40°C ~125°C	RS722B	Tape and Reel,5000
RS722SXN	MSOP-10	10	2	-40°C ~125°C	RS722S	Tape and Reel,4000
RS724XP	SOIC-14(SOP14)	14	4	-40°C ~125°C	RS724	Tape and Reel,4000
RS724XQ	TSSOP-14	14	4	-40°C ~125°C	RS724	Tape and Reel,4000

**NOTE:**

- (1) There may be additional marking, which relates to the lot trace code information(data code and vendor code), the logo or the environmental category on the device.



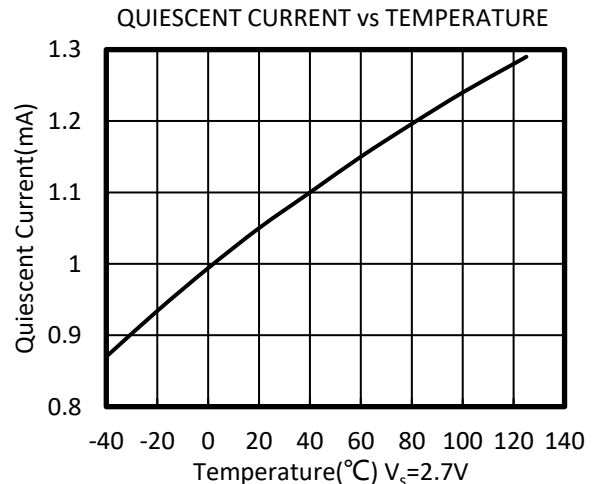
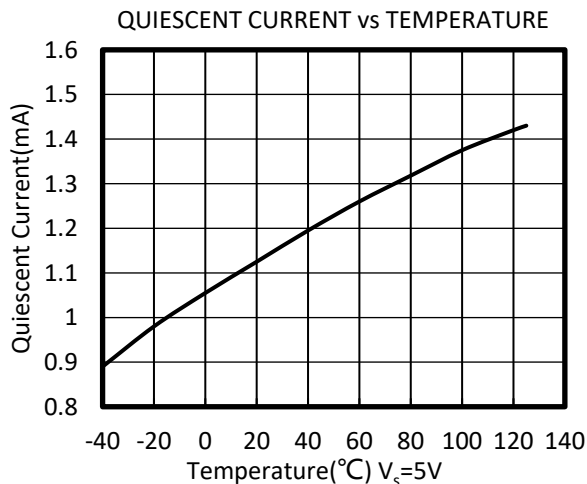
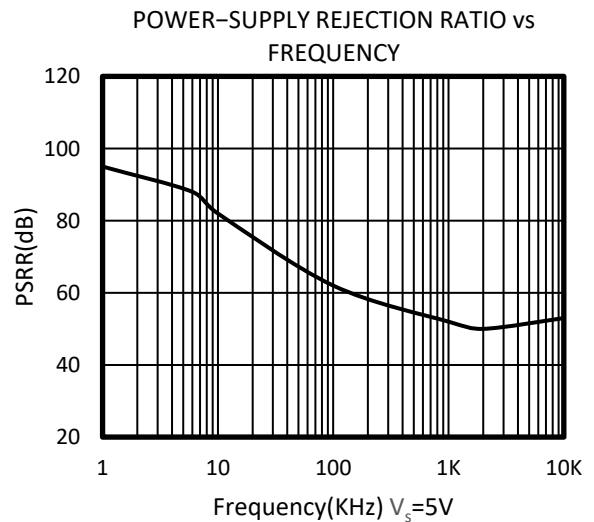
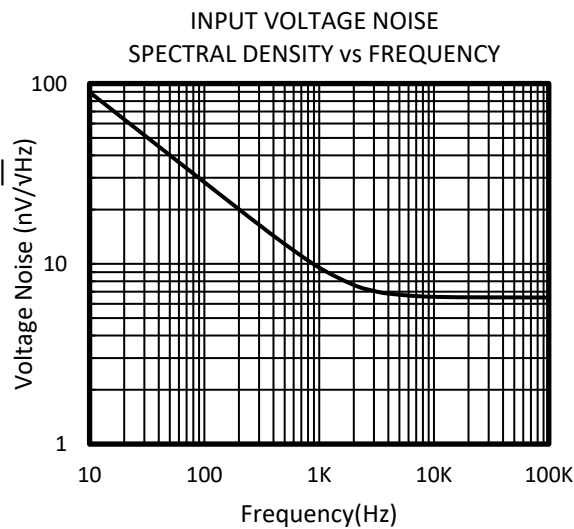
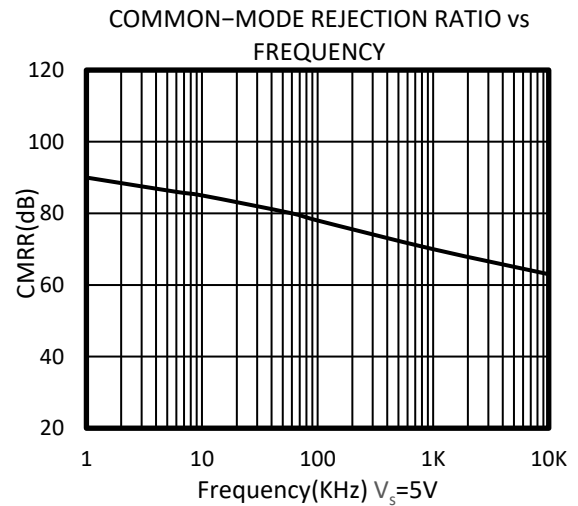
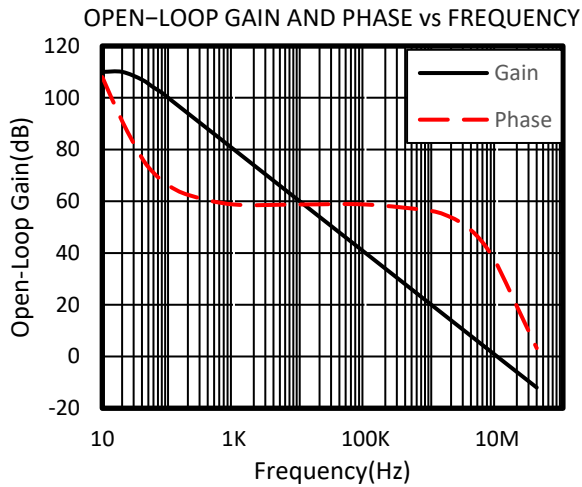
## ELECTRICAL CHARACTERISTICS

(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	$T_J$	RS721S, RS722S, RS721, RS722, RS724			
				MIN	TYP	MAX	UNIT
<b>POWER SUPPLY</b>							
$V_S$	Operating Voltage Range		$25^\circ\text{C}$	2.5		5.5	V
$I_Q$	Quiescent Current/Amplifier		$25^\circ\text{C}$		1.15	1.4	mA
PSRR	Power-Supply Rejection Ratio	$V_S = 2.5\text{V to } 5.5\text{V}$ , $V_{CM} = (V_-) + 0.5\text{V}$	$25^\circ\text{C}$	75	85		dB
			$-40^\circ\text{C to } 125^\circ\text{C}$	65			
<b>INPUT</b>							
$V_{OS}$	Input Offset Voltage		$25^\circ\text{C}$	-2.5	$\pm 0.5$	2.5	mV
$V_{OS\ TC}$	Input Offset Voltage Average Drift	$-40^\circ\text{C to } 125^\circ\text{C}$			$\pm 2.6$		$\mu\text{V}/^\circ\text{C}$
$I_B$	Input Bias Current		$25^\circ\text{C}$		1	10	pA
$I_{OS}$	Input Offset Current		$25^\circ\text{C}$		1	10	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	$V_S = 5.5\text{V}$ , $V_{CM} = -0.1\text{V to } 4\text{V}$	$25^\circ\text{C}$	73	85		dB
			$-40^\circ\text{C to } 125^\circ\text{C}$	67			
			$25^\circ\text{C}$	60	75		
			$-40^\circ\text{C to } 125^\circ\text{C}$	57			
<b>OUTPUT</b>							
AOL	Open-Loop Voltage Gain	$R_L = 2\text{k}\Omega$ , $V_O = 0.15\text{V to } 4.85\text{V}$	$25^\circ\text{C}$	86	95		dB
			$-40^\circ\text{C to } 125^\circ\text{C}$	65			
			$25^\circ\text{C}$	90	96		
			$-40^\circ\text{C to } 125^\circ\text{C}$	66			
	Output Swing from Rail	$R_L = 2\text{k}\Omega$ $R_L = 10\text{k}\Omega$	$25^\circ\text{C}$		52 7		mV
$I_{OUT}$	Output Short-Circuit Current		$25^\circ\text{C}$		70		mA
<b>FREQUENCY RESPONSE</b>							
SR	Slew Rate		$25^\circ\text{C}$		7		V/ $\mu\text{s}$
GBP	Gain-Bandwidth Product		$25^\circ\text{C}$		10		MHz
PM	Phase Margin		$25^\circ\text{C}$		62		$^\circ$
$t_S$	Setting Time, 0.1%				0.2		$\mu\text{s}$
	Overload Recovery Time	$V_{IN} \cdot \text{Gain} \geq V_S$			0.35		$\mu\text{s}$
<b>NOISE</b>							
$e_n$	Input Voltage Noise Density	$f = 1\text{KHz}$ $f = 10\text{KHz}$	$25^\circ\text{C}$		9.5		$\text{nV}/\sqrt{\text{Hz}}$
			$25^\circ\text{C}$		6.5		$\text{nV}/\sqrt{\text{Hz}}$
<b>ENABLE/SHUTDOWN (RS721S, RS722S)</b>							
$I_{Q(OFF)}$	Supply Current in Shutdown		$25^\circ\text{C}$		<1		$\mu\text{A}$
$t_{OFF}$			$25^\circ\text{C}$		3		$\mu\text{s}$
$t_{ON}$			$25^\circ\text{C}$		20		$\mu\text{s}$
$V_L$	Shut Down		$25^\circ\text{C}$	$V_-$		$(V_-) + 0.8$	V
$V_H$	Amplifier Is Active		$25^\circ\text{C}$	$(V_-) + 2$		$V_+$	V

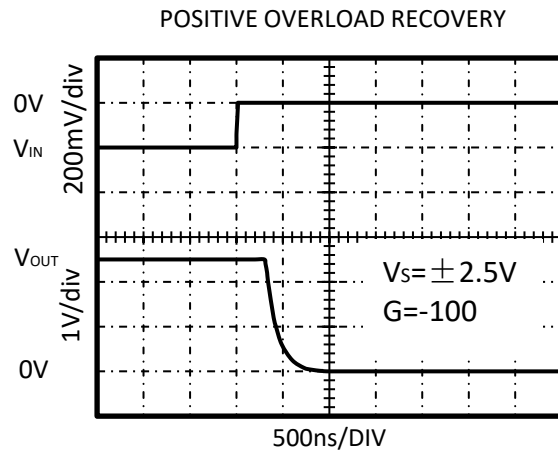
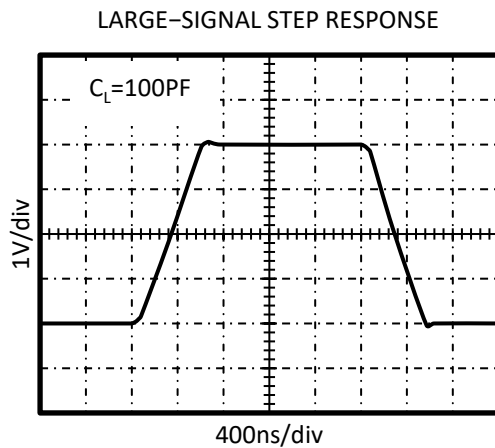
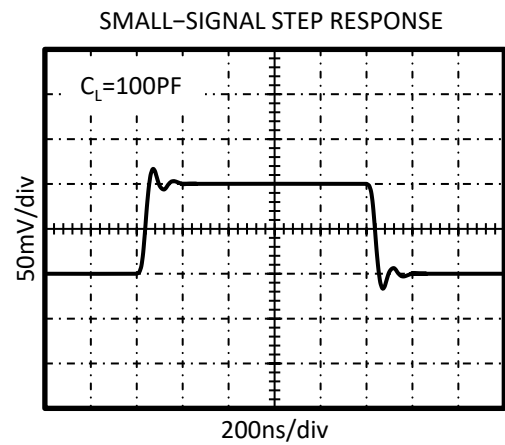
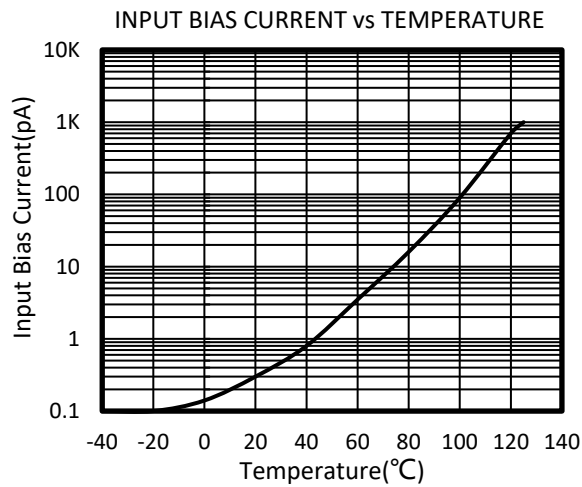
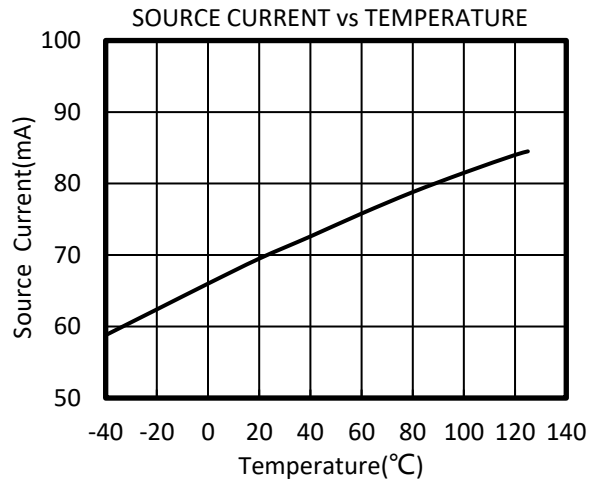
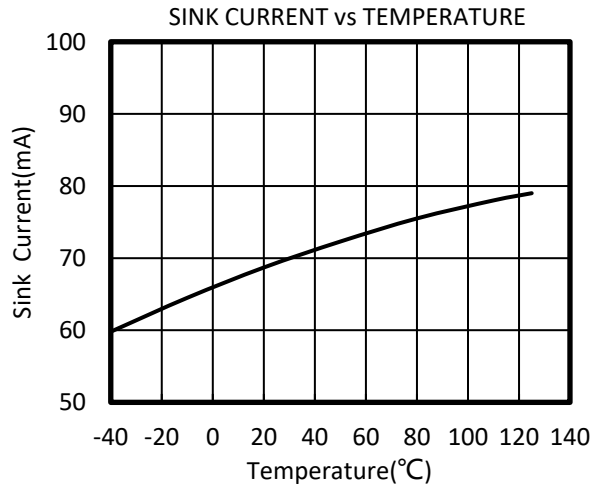
## TYPICAL CHARACTERISTICS

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.



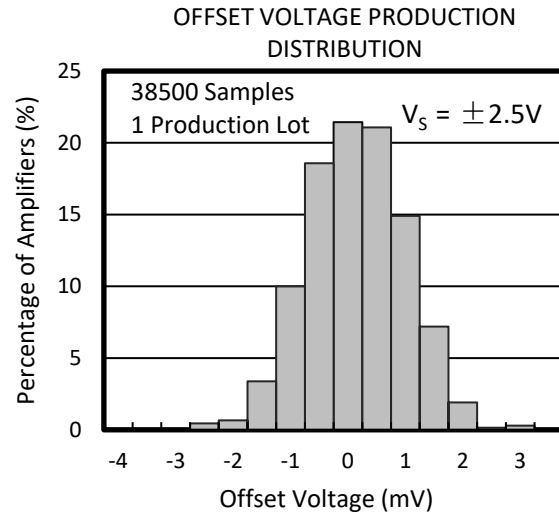
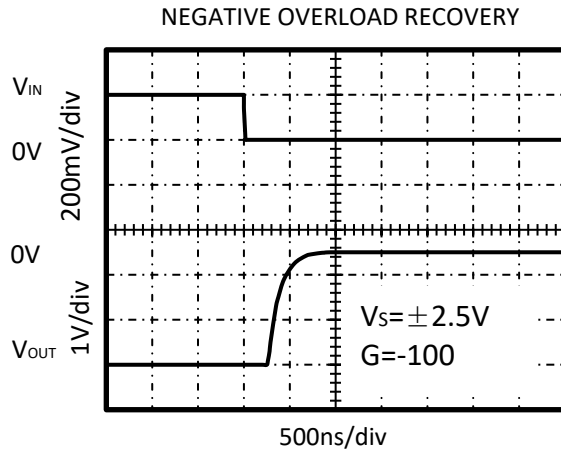
## TYPICAL CHARACTERISTICS

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.



## Detailed Description

### Overview

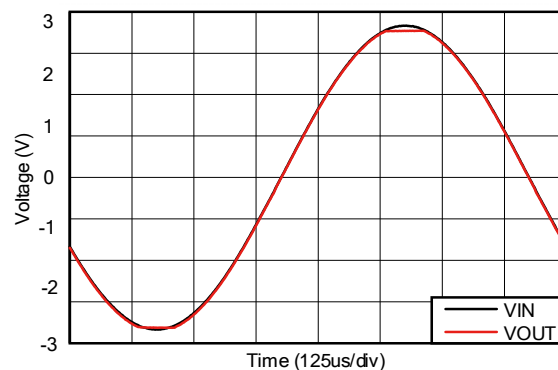
The RS721, RS722, RS724, RS721S, RS722S are high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.5V to 5.5V( $\pm 1.25V$  to  $\pm 2.75V$ ). Supply voltages higher than 7V(absolute maximum) can permanently damage the amplifier. Rail-to-rail input and output swing significantly increases dynamic range, especially in low-supply applications. Good layout practice mandates use of a 0.1 $\mu$ F 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 1 $\mu$ A. 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.

### Phase Reversal Protection

The RS72X family has internal phase-reversal protection. Many op amps exhibit phase reversal when the input is driven beyond the linear common-mode range. This condition is most often encountered in noninverting circuits when the input is driven beyond the specified common-mode voltage range, causing the output to reverse into the opposite rail. The input of the RS72X prevents phase reversal with excessive common-mode voltage. Instead, the appropriate rail limits the output voltage. This performance is shown in figure 1.



**Figure 1. Output Waveform Devoid of Phase Reversal During an Input Overdrive Condition**

### EMI Rejection Ratio (EMIRR)

The electromagnetic interference (EMI) rejection ratio, or EMIRR, describes the EMI immunity of operational amplifiers. An adverse effect that is common to many operational amplifiers is a change in the offset voltage as a result of RF signal rectification. An operational amplifier that is more efficient at rejecting this change in offset as a result of EMI has a higher EMIRR and is quantified by a decibel value. Measuring EMIRR can be performed in many ways, but this document provides the EMIRR IN+, which specifically describes the EMIRR performance when the RF signal is applied to the noninverting input pin of the operational amplifier. In general, only the noninverting input is tested for EMIRR for the following three reasons:

- Operational amplifier input pins are known to be the most sensitive to EMI, and typically rectify RF signals better than the supply or output pins.
- The noninverting and inverting operational amplifier inputs have symmetrical physical layouts and exhibit nearly matching EMIRR performance.
- EMIRR is easier to measure on noninverting pins than on other pins because the noninverting input pin can be isolated on a printed-circuit-board (PCB). This isolation allows the RF signal to be applied directly to the noninverting input pin with no complex interactions from other components or connecting PCB traces.

### Detailed Description (continued)

The EMIRR IN+ of the RS72X is plotted versus frequency in Figure 2. If available, any dual and quad operational amplifier device versions have approximately identical EMIRR IN+ performance. The RS72X unity-gain bandwidth is 10MHz. EMIRR performance below this frequency denotes interfering signals that fall within the operational amplifier bandwidth.

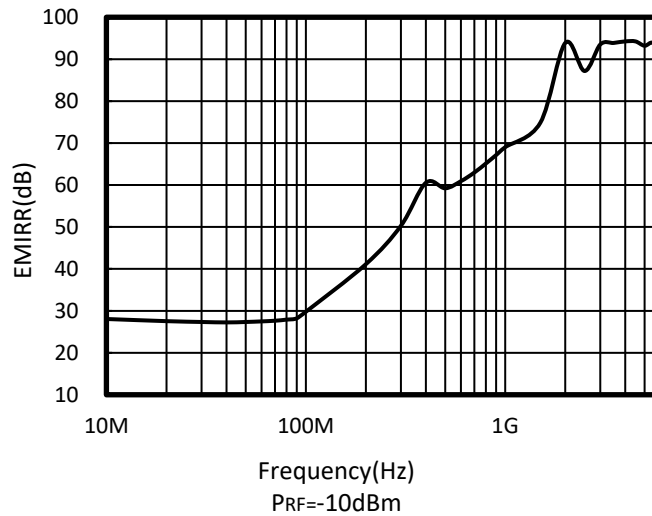


Figure 2.RS72X EMIRR vs Frequency

### EMIRR IN+ Test Configuration

Figure 3 shows the circuit configuration for testing the EMIRR IN+. An RF source is connected to the operational amplifier noninverting input pin using a transmission line. The operational amplifier is configured in a unity-gain buffer topology with the output connected to a low-pass filter (LPF) and a digital multimeter (DMM). A large impedance mismatch at the operational amplifier input causes a voltage reflection; however, this effect is characterized and accounted for when determining the EMIRR IN+. The resulting dc offset voltage is sampled and measured by the multimeter. The LPF isolates the multimeter from residual RF signals that can interfere with multimeter accuracy.

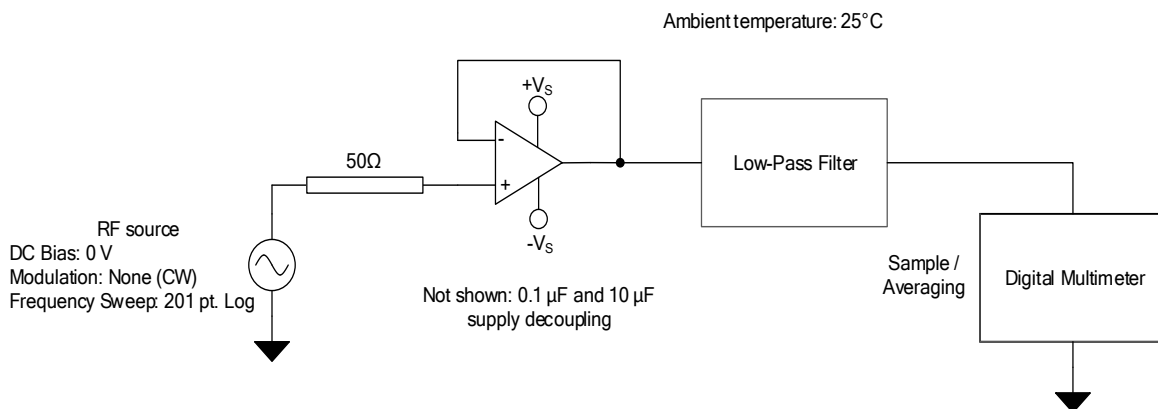


Figure 3. EMIRR IN+ Test Configuration Schematic

## APPLICATION NOTE

The RS72X 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 0.1  $\mu F$  capacitor placed closely across the supply pins.

### Typical Applications

#### 25-kHz Low-pass Filter

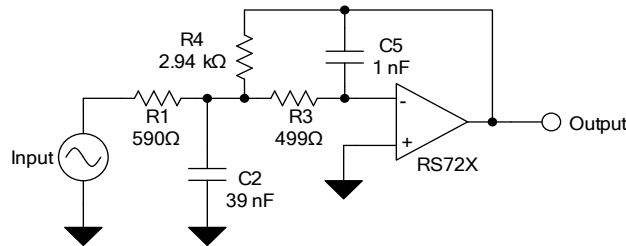


Figure 4. 25-kHz Low-Pass Filter

#### Design Requirements

Low-pass filters are commonly employed in signal processing applications to reduce noise and prevent aliasing. The RS72X devices are ideally suited to construct high-speed, high-precision active filters. Figure 4 shows a second-order, low-pass filter commonly encountered in signal processing applications.

Use the following parameters for this design example:

- Gain = 5 V/V (inverting gain)
- Low-pass cutoff frequency = 25 kHz
- Second-order Chebyshev filter response with 3-dB gain peaking in the passband

#### Detailed Design Procedure

The infinite-gain multiple-feedback circuit for a low-pass network function is shown in Figure 4. Use Equation 1 to calculate the voltage transfer function.

$$\frac{\text{Output}}{\text{Input}}(s) = \frac{-1/R_1 R_3 C_2 C_5}{s^2 + (s/C_2) (1/R_1 + 1/R_3 + 1/R_4) + 1/R_3 R_4 C_2 C_5} \quad (1)$$

This circuit produces a signal inversion. For this circuit, the gain at dc and the low-pass cutoff frequency are calculated by Equation 2:

$$\text{Gain} = \frac{R_4}{R_1}$$

$$f_c = \frac{1}{2\pi} \sqrt{1/R_3 R_4 C_2 C_5} \quad (2)$$

#### Application Curve

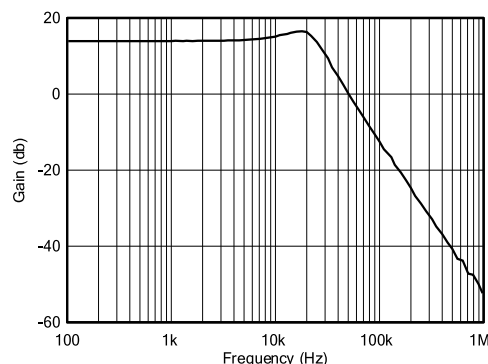


Figure 5. Low-pass filter transfer function

## LAYOUT

### Layout Guidelines

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 0.1 $\mu$ F 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.

### Layout Example

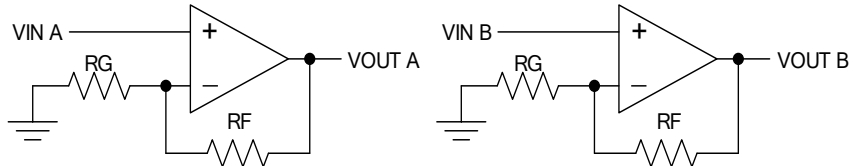


Figure 6. Schematic Representation

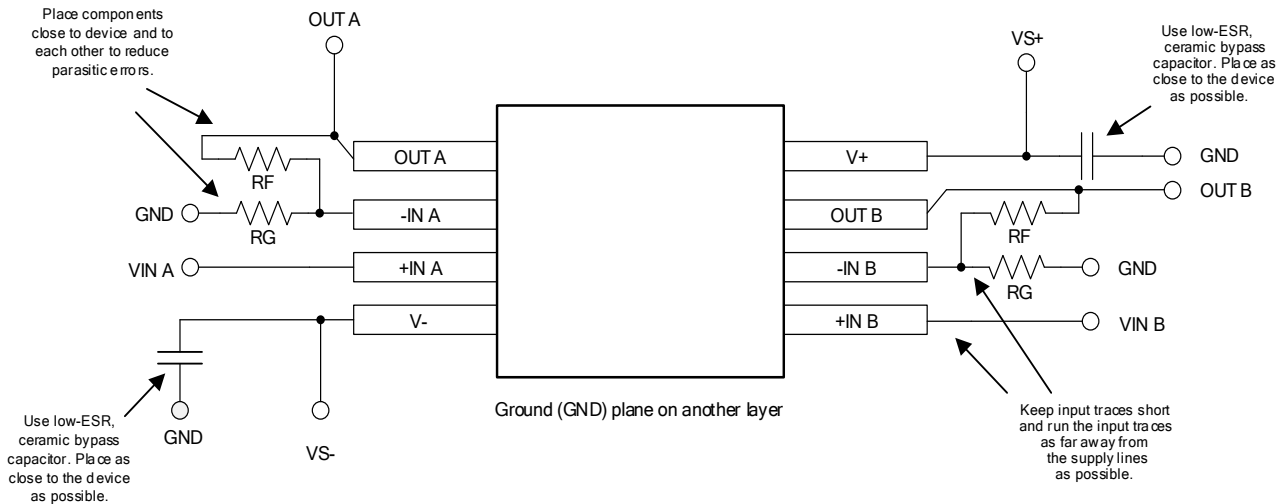
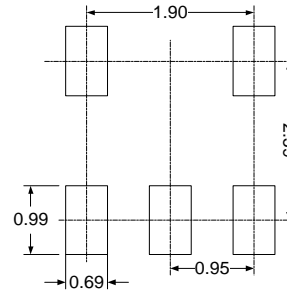
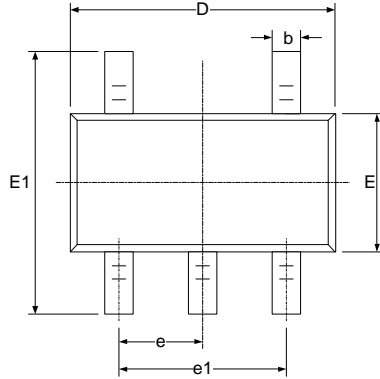
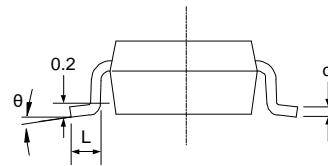
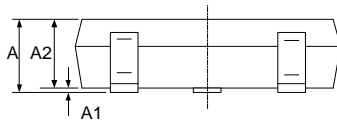
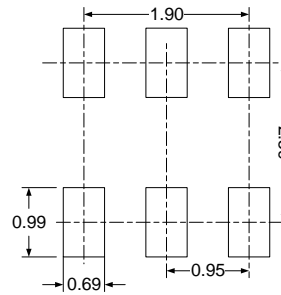
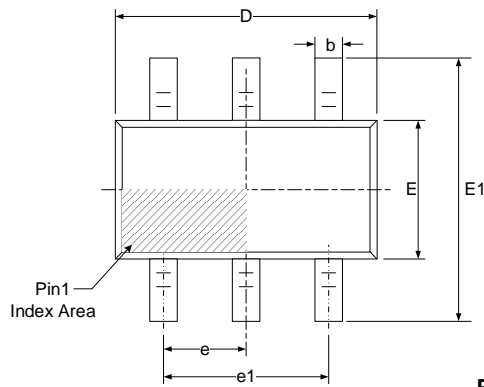
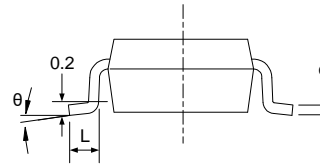
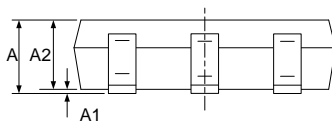


Figure 7. Layout Example

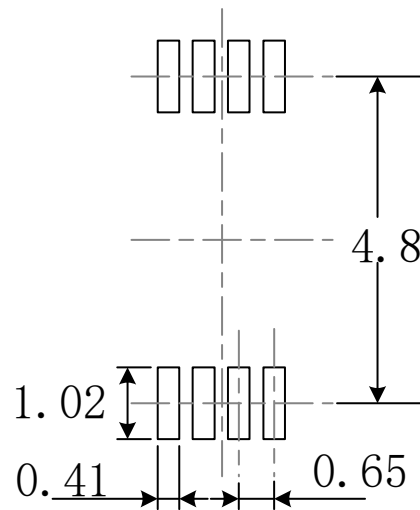
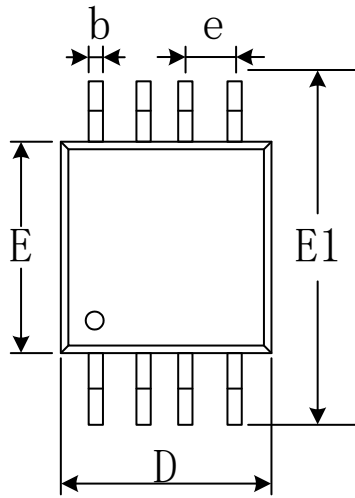
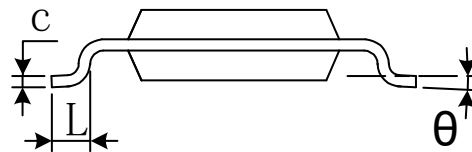
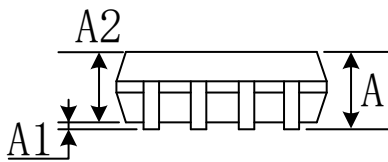


**PACKAGE OUTLINE DIMENSIONS**  
**SOT23-5**

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


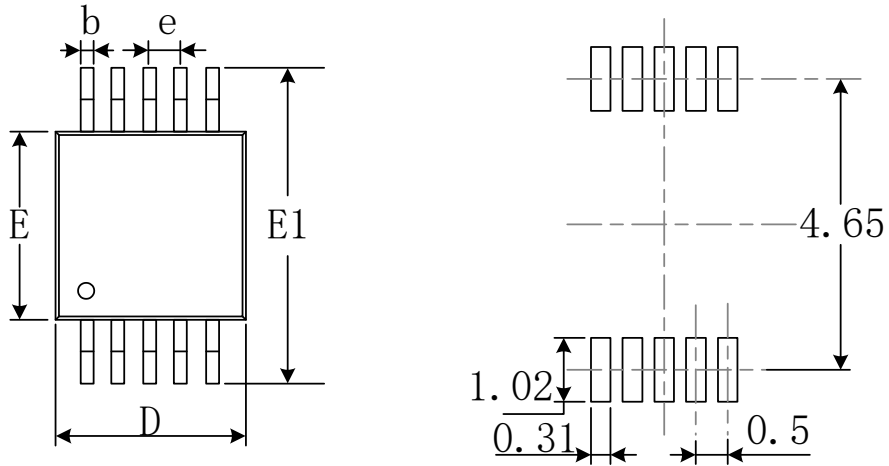
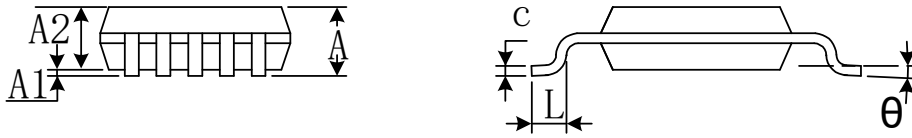
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
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**

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


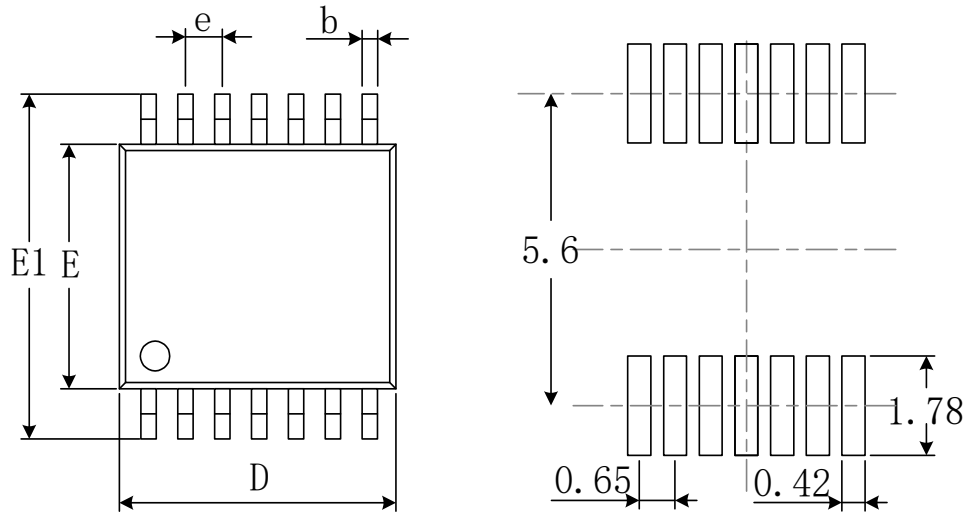
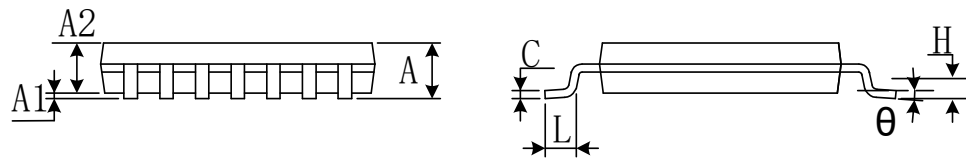
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
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**

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


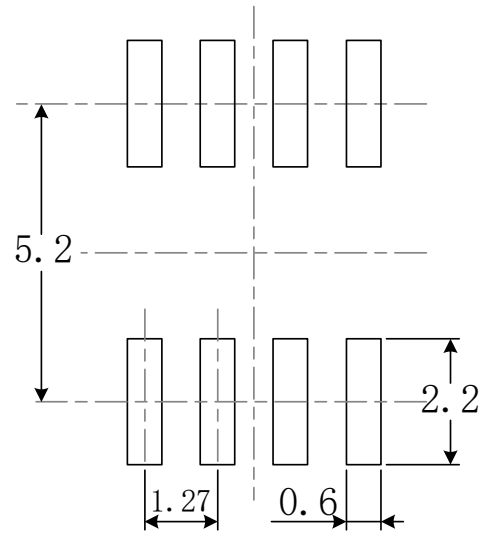
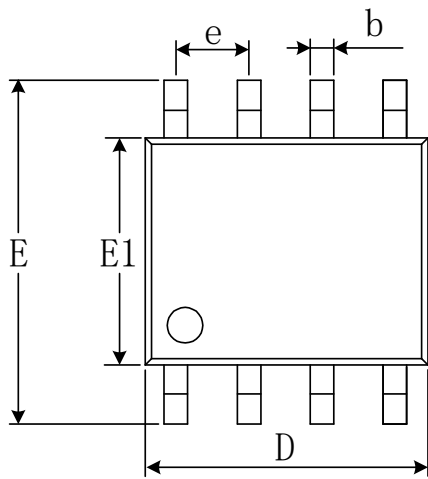
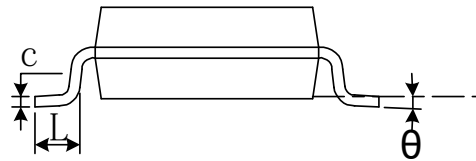
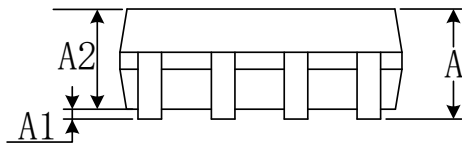
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.650(BSC)		0.026(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187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

**MSOP-10**

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


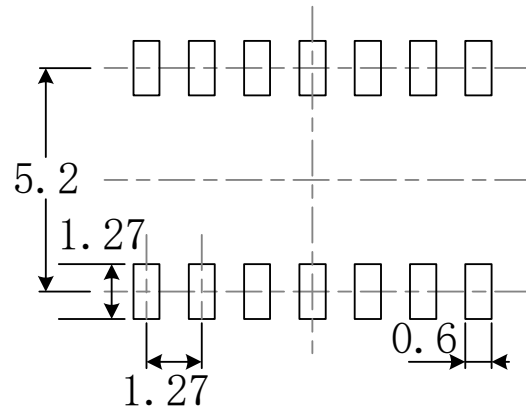
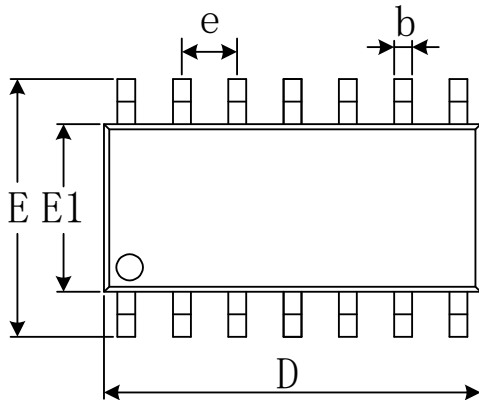
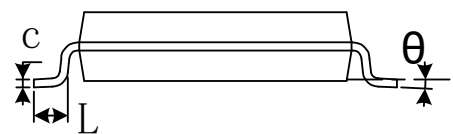
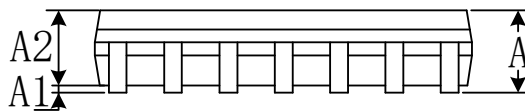
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.180	0.280	0.007	0.011
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
e	0.50(BSC)		0.020(BSC)	
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187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

**TSSOP-14**

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


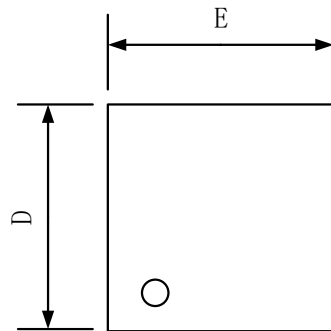
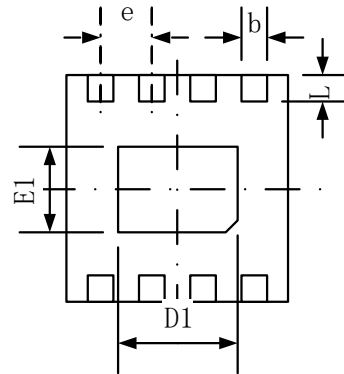
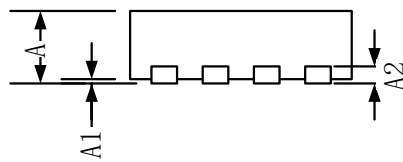
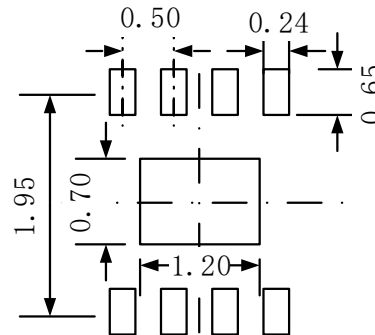
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC)		0.026(BSC)	
L	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
$\theta$	0°	8°	0°	8°

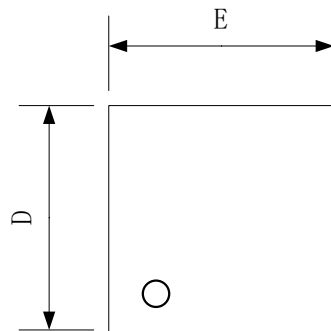
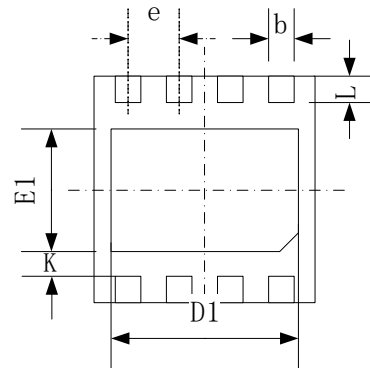
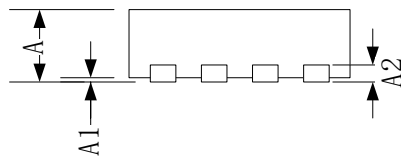
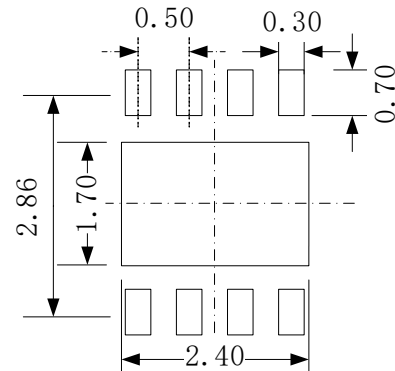
**SOIC-14(SOP14)**

**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
$\theta$	0°	8°	0°	8°

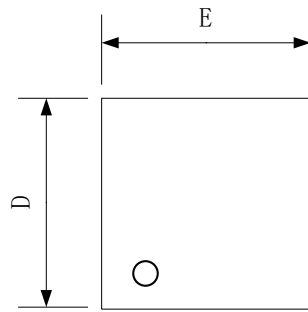
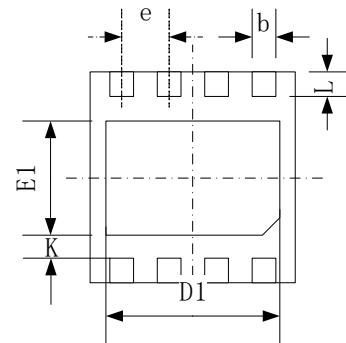
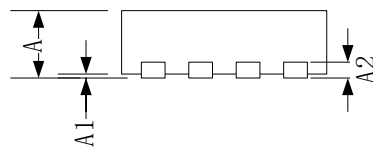
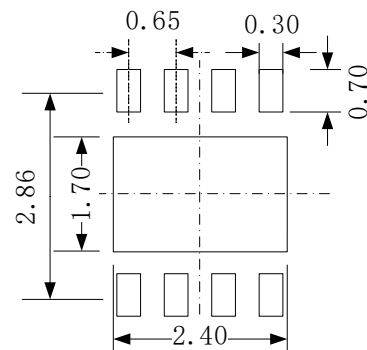
**TDFN-2x2-8**

**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

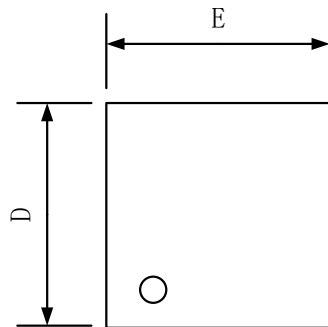
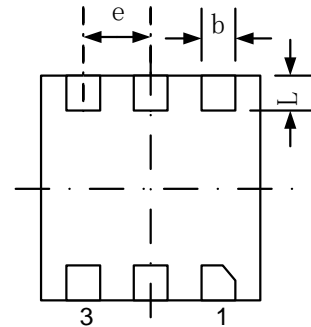
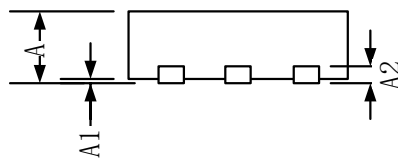
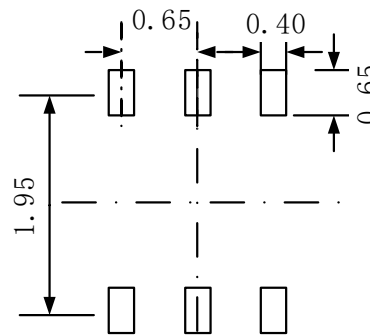


**TDFN-3x3-8L (0303x0.75-0.5)**

**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 REF		0.008 REF	
b	0.200	0.300	0.008	0.012
D	2.900	3.100	0.114	0.122
D1	2.350	2.550	0.093	0.100
E	2.900	3.100	0.114	0.122
E1	1.500	1.700	0.059	0.067
e	0.500 TYP		0.020 TYP	
L	0.350	0.450	0.014	0.018
K	0.300 REF		0.012 REF	

**TDFN-3x3-8L (0303x0.75-0.65)**

**TOP VIEW**

**BOTTOM VIEW**

**SIDE VIEW**

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

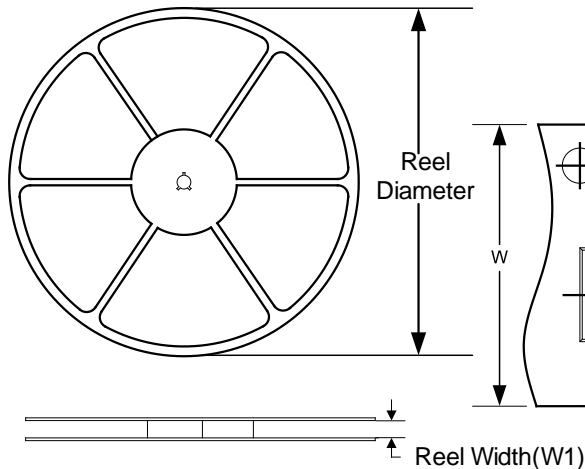
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203 REF		0.008 REF	
b	0.200	0.300	0.008	0.012
D	2.900	3.100	0.114	0.122
D1	2.250	2.350	0.089	0.093
E	2.900	3.100	0.114	0.122
E1	1.450	1.550	0.057	0.061
e	0.650 TYP		0.026 TYP	
L	0.425	0.525	0.017	0.021
K	0.200 REF		0.008 REF	

**TDFN2x2-6L**

**TOP VIEW**

**BOTTOM VIEW**

**SIDE VIEW**

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

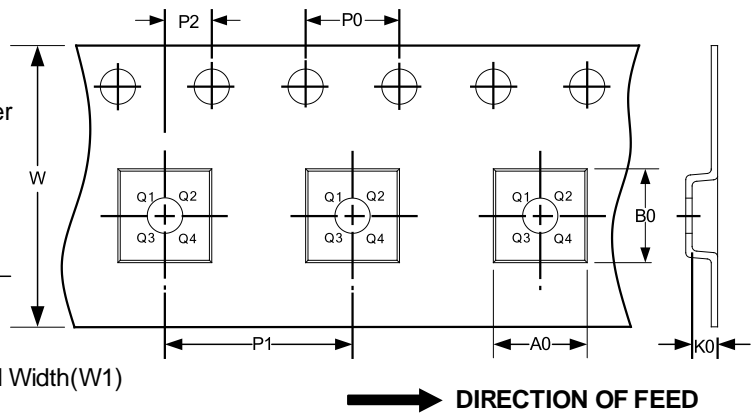
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.700	0.800	0.028	0.031
A1	0.000	0.050	0.000	0.002
A2	0.203(TYP)		0.008(TYP)	
b	0.250	0.350	0.010	0.012
D	1.900	2.100	0.075	0.083
E	1.900	2.100	0.075	0.083
e	0.650(TYP)		0.026(TYP)	
L	0.250	0.400	0.010	0.018

## TAPE AND REEL INFORMATION

### REEL DIMENSIONS



### TAPE DIMENSION



NOTE: The picture is only for reference. Please make the object as the standard.

### KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOT23-6	7"	9.5	3.17	3.23	1.37	4.0	4.0	2.0	8.0	Q3
SOIC-8(SOP8)	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1
MSOP-8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
MSOP-10	13"	12.4	5.20	3.30	1.20	4.0	8.0	2.0	12.0	Q1
SOIC-14(SOP14)	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP-14	13"	12.4	6.95	5.60	1.20	4.0	8.0	2.0	14.0	Q1
TDFN2x2-6L	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q1
TDFN2x2-8	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q2
TDFN-3x3-8L (0303x0.75-0.5)	13"	12.4	3.35	3.35	1.13	4.0	8.0	2.0	12.0	Q1
TDFN-3x3-8L (0303x0.75-0.65)	13"	12.4	3.35	3.35	1.13	4.0	8.0	2.0	12.0	Q1