13MHz, Rail-to-Rail I/O CMOS Operational Amplifier

1 FEATURES

- **HIGH GAIN BANDWIDTH: 13MHz**
- **RAIL-TO-RAIL INPUT AND OUTPUT ±0.2mV Typical Vos**
- **INPUT VOLTAGE RANGE: -0.1V to +5.6V with Vs = 5.5V**
- **SUPPLY RANGE: +2.7V to +5.5V**
- **SPECIFIED UP TO +125°C**
- **Micro SIZE PACKAGES: SOT23-5, SOT23-6**

2 APPLICATIONS

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

3 DESCRIPTIONS

The RS72XP 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 (13MHz) and slew rate of 8V/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 RS72XP families of operational amplifiers are specified at the full temperature range of -40°C to +125°C under single or dual power supplies of 2.7V to 5.5V.

Device Information [1]

PART NUMBER	PACKAGE	BODY SIZE(NOM)
RS721P	SOT23-5	2.90mm×1.60mm
	SOIC-8(SOP8)	4.90mm×3.90mm
	MSOP-8	3.00mm×3.00mm
	SOT353 (SC70-5)	2.10mm×1.25mm
RS722P	SOIC-8(SOP8)	4.90mm×3.90mm
	MSOP-8	3.00mm×3.00mm
	TSSOP-8	3.00mm×4.40mm
	TDFN2×2-8L	2.00mm×2.00mm
RS724P	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.

Table of Contents

4 Revision History

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

VERSION	Change Date	Change Item
D.1	2022/07/19	Version Updated
D.2	2023/09/22	Added Thermal Pad Pin Description

5 PACKAGE/ORDERING INFORMATION [1]

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking [2]	Package Qty
RS721PXF	SOT23-5	5	1	-40°C ~125°C	721P	Tape and Reel,3000
RS721PXC5	SOT353(SC70-5)	5	1	-40°C ~125°C	721P	Tape and Reel,3000
RS721BPXF	SOT23-5	5	1	-40°C ~125°C	721BP	Tape and Reel,3000
RS721BPXC5	SOT353(SC70-5)	5	1	-40°C ~125°C	721BP	Tape and Reel,3000
RS721PXK	SOIC-8(SOP8)	8	1	-40°C ~125°C	RS721P	Tape and Reel,4000
RS721PXM	MSOP-8	8	1	-40°C ~125°C	RS721P	Tape and Reel,4000
RS722PXK	SOIC-8(SOP8)	8	2	-40°C ~125°C	RS722P	Tape and Reel,4000
RS722PXM	MSOP-8	8	2	-40°C ~125°C	RS722P	Tape and Reel,4000
RS722PXQ	TSSOP-8	8	2	-40°C ~125°C	RS722P	Tape and Reel,4000
RS722PXTDE8	TDFN2x2-8L	8	2	-40°C ~125°C	722P	Tape and Reel,3000
RS724PXP	SOIC-14(SOP14)	14	4	-40°C ~125°C	RS724P	Tape and Reel,4000
RS724PXQ	TSSOP-14	14	4	-40°C ~125°C	RS724P	Tape and Reel,4000

NOTE:
(1)   This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the right-hand navigation.
(2)   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.

## 6 Pin Configuration and Functions (Top View)

RS721P

RS721BP

RS721P

SOT23-5/SOT353(SC70-5)

SOT23-5/SOT353(SC70-5)
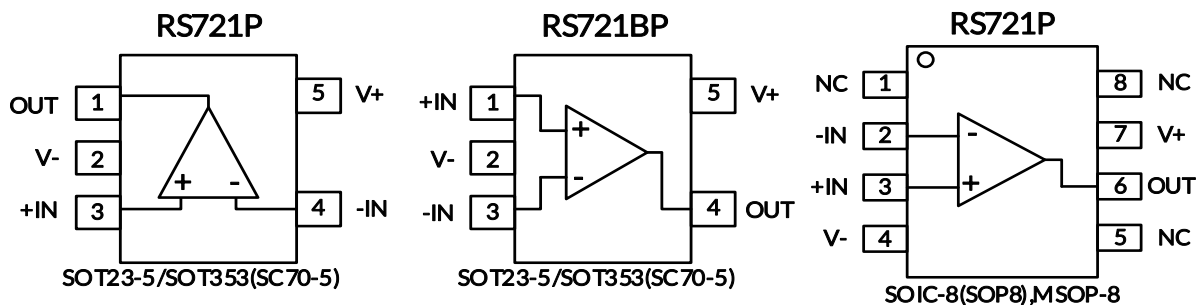
SOIC-8(SOP8),MSOP-8

Pin Description

NAME	PIN			I/O (1)	DESCRIPTION
	RS721P	RS721BP	RS721P		
	SOT23-5/ SOT353(SC70-5)	SOT23-5/ SOT353(SC70-5)	SOIC-8(SOP8)/ MSOP8		
-IN	4	3	2	I	Negative (inverting) input
+IN	3	1	3	I	Positive (noninverting) input
NC (2)	-	-	1,5,8	-	No internal connection (can be left floating)
OUT	1	4	6	O	Output
V-	2	2	4	-	Negative (lowest) power supply
V+	5	5	7	-	Positive (highest) power supply

(1)   I = Input, O = Output.
(2)   There is no internal connection. Typically, GND is the recommended connection to a heat spreading plane.

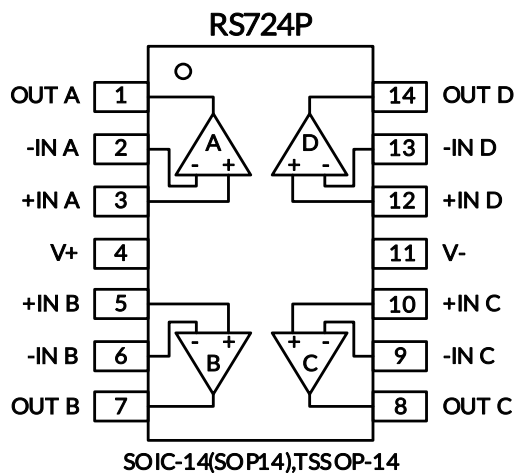## Pin Configuration and Functions (Top View)

RS722P

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

RS722P

TDFN2x2-8L

Thermal Pad
on Bottom
(can be left floating)
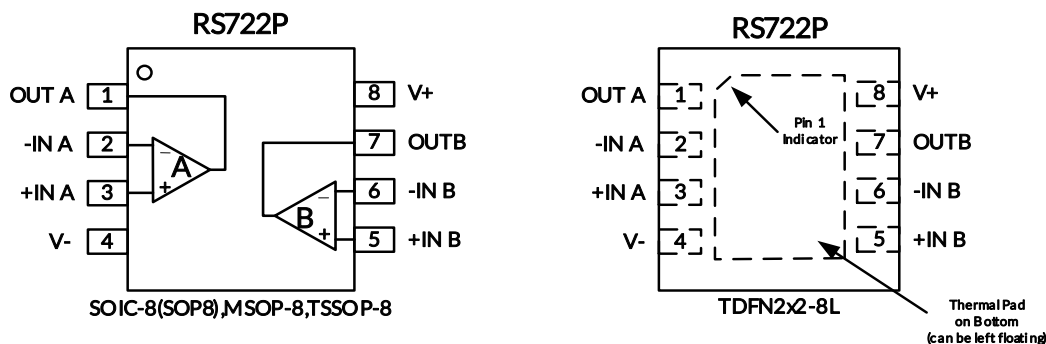
Pin Description

| NAME | PIN | I/O (1) | DESCRIPTION |
	SOIC-8(SOP8)/MSOP8/TSSOP-8/TDFN2×2-8L		
-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
OUTA	1	O	Output, channel A
OUTB	7	O	Output, channel B
V-	4	-	Negative (lowest) power supply
V+	8	-	Positive (highest) power supply
-	Thermal Pad	-	Connect thermal pad to V-

(1) I = Input, O = Output.

Pin Configuration and Functions (Top View)

RS724P

SOIC-14(SOP14),TSSOP-14

Pin Description

NAME	PIN SOIC-14(SOP14)/TSSOP-14	I/O [1]	DESCRIPTION
-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

(1) I = Input, O = Output.

7 SPECIFICATIONS

7.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) [1]

			MIN	MAX	UNIT
Voltage	Supply, V_S=(V+) - (V-)			7	V
	Signal input pin [2]		(V-)-0.5	(V+) +0.5	
	Signal output pin [3]		(V-)-0.5	(V+) +0.5	
Current	Signal input pin [2]		-10	10	mA
	Signal output pin [3]		-200	200	mA
	Output short-circuits [4]		Continuous		
$θ_{JA}$	Package thermal impedance [5]	SOT23-5		230	°C/W
		SOIC-8(SOP8)		110.88	
		MSOP-8		165.7	
		TSSOP-8		240	
		SOIC-14(SOP14)		104.5	
		TSSOP14		89.21	
		SOT353(SC70-5)		376	
		TDFN2×2-8L		80	
Temperature	Operating range, T_A		-40	125	°C
	Junction, T_J [6]		-40	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 ±200mA or less.

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

(5) The package thermal impedance is calculated in accordance with JESD-51.

(6) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{θJA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A) / R_{θJA}$. All numbers apply for packages soldered directly onto a PCB.

7.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001[1]	±5000	V
		Charged-device model (CDM), per ANSI/ESDA/JEDEC JS-002[2]	±1000	
		Machine Model (MM)	±400	

(1) JEDEC document JEP155 states that 500 V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250 V CDM allows safe manufacturing with a standard ESD control process.

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.

7.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
Supply voltage，V_S= (V+) - (V-)	Single-supply	2.7		5.5	V
	Dual-supply	±1.35		±2.75	

7.4 ELECTRICAL CHARACTERISTICS

(At T_A = +25°C, V_S=2.7V to 5.5V, R_L = 10kΩ connected to V_S/2, and V_{OUT} = V_S/2, V_{CM} = V_S/2, Full [9] = -40°C to +125°C, unless otherwise noted.) [1]

| PARAMETER		CONDITIONS	T_J	RS721P, RS722P, RS724P			UNIT
				MIN [2]	TYP [3]	MAX [2]	
POWER SUPPLY							
V_S	Operating Voltage Range		25°C	2.7		5.5	V
I_Q	Quiescent Current Per Amplifier	V_S=±2.5V, Io=0mA	25°C		1.15	1.35	mA
			Full			1.85	
PSRR	Power-Supply Rejection Ratio	V_S=2.7V to 5.5V	25°C	74	93		dB
			Full	70			
INPUT							
V_{OS}	Input Offset Voltage	V_{CM}=V_S/2	25°C	-0.8	±0.2	0.8	mV
$V_{OS} T_C$	Input Offset Voltage Average Drift	V_{CM}=V_S/2	Full		±2.6		uV/°C
IB	Input Bias Current [4] [5]	V_{CM}=0V	25°C		±1	±10	pA
I_{OS} [5]	Input Offset Current	V_{CM}=0V	25°C		±1	±10	pA
V_{CM}	Common-Mode Voltage Range	V_S= 5.5V	25°C	-0.1		5.6	V
CMRR	Common-Mode Rejection Ratio	V_S= 5.5V V_{CM}=-0.1V to 3.5V	25°C	73	90		dB
			Full	70			
		V_S= 5.5V V_{CM}=-0.1V to 5.6V	25°C	60	77		
			Full	59			
OUTPUT							
A_{OL}	Open-Loop Voltage Gain	R_L=10KΩ, Vo=(V-) +0.1V to (V+)-0.1V	25°C	110	127		dB
			Full	94			
	Output Swing from Rail	V_S=±2.5V, R_L=10KΩ	25°C		10	20	mV
I_{OUT}	Output Short-Circuit Current [6] [7]		25°C	±80	±150		mA
C_{LOAD}	Capacitive Load Drive		25°C		100		pF
FREQUENCY RESPONSE							
SR	Slew Rate [8]	G=+1, C_L=100pF	25°C		8		V/us
GBP	Gain-Bandwidth Product		25°C		13		MHz
PM	Phase Margin [5]		25°C		62		°
t_S	Settling Time,0.1%	V_S=±2.5V, G=+1, C_L=100pF, Step=2V	25°C		0.8		us
t_{OR}	Overload Recovery Time	V_{IN}·Gain≥V_S,G=-10	25°C		0.4		us
NOISE							
En	Input Voltage Noise	f = 0.1Hz to 10Hz, V_S=±2.5V	25°C		3.6		uV_{PP}
e_n	Input Voltage Noise Density	f = 1KHz	25°C		TBD		nV/$\sqrt{Hz}$

NOTE:
(1) Electrical table values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device.
(2) Limits are 100% production tested at 25℃. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.
(3) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.
(4) Positive current corresponds to current flowing into the device.
(5) This parameter is ensured by design and/or characterization and is not tested in production.
(6) The maximum power dissipation is a function of $T_{J(MAX)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any ambient temperature is PD = ($T_{J(MAX)}$ - T_A) / $R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.
(7) Short circuit test is a momentary test.
(8) Number specified is the slower of positive and negative slew rates.
(9) Specified by characterization only.

7.5 TYPICAL CHARACTERISTICS

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, V_S=5V, R_L = 10kΩ connected to V_S/2, V_{OUT} = V_S/2, unless otherwise noted.
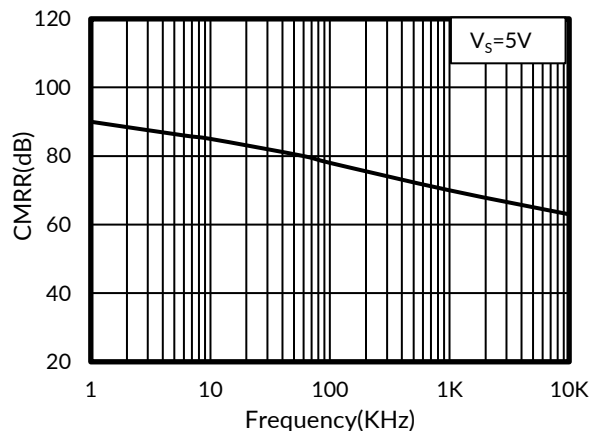
Figure 1. Common−mode Rejection Ratio vs Frequency
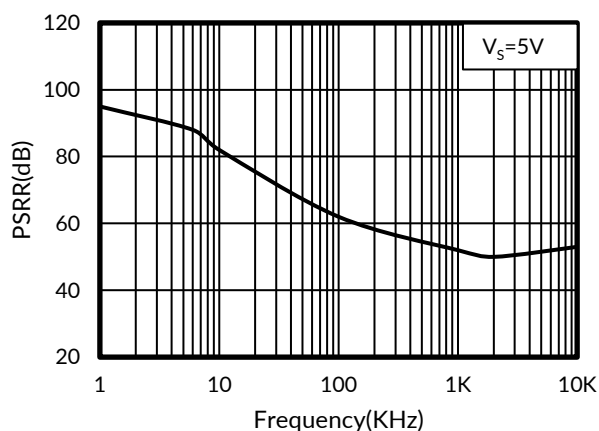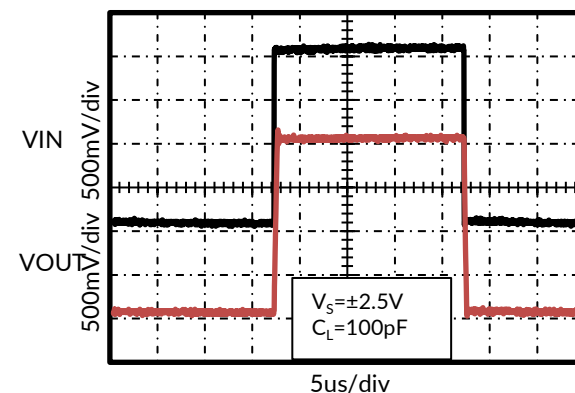
Figure 2. Power-Supply Rejection Ratio vs Frequency
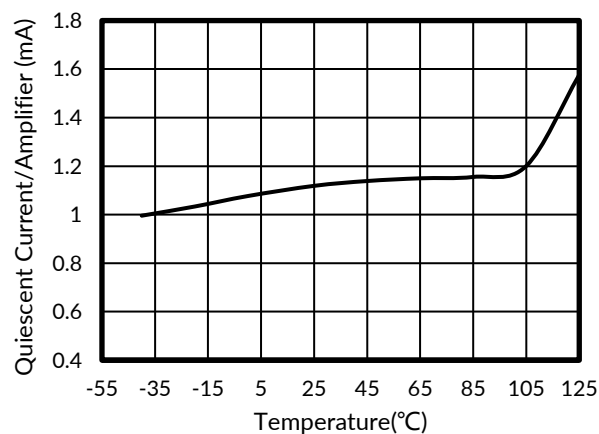
Figure 3. Quiescent Current vs Temperature
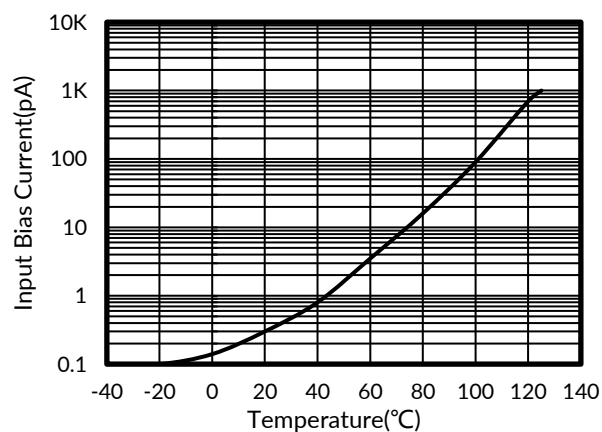
Figure 4. Input Bias Current vs Temperature
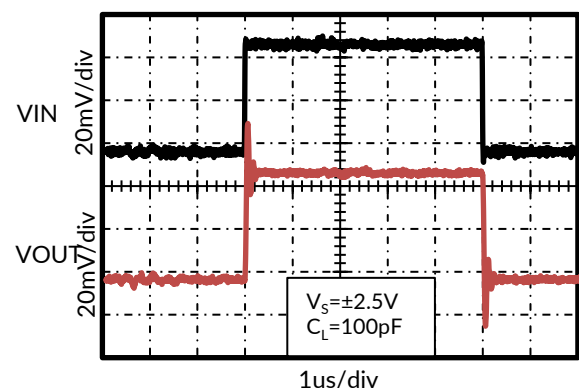
Figure 5. Small-Signal Step Response

Figure 6. Large-Signal Step Response

TYPICAL CHARACTERISTICS

NOTE: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only.

At T_A = +25°C, V_S=5V, R_L = 10kΩ connected to V_S/2, V_{OUT} = V_S/2, unless otherwise noted.
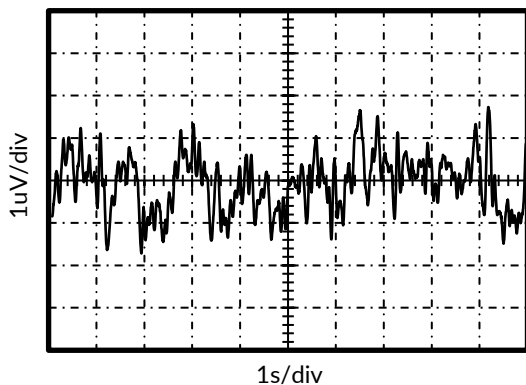
Figure 7. 0.1Hz to 10Hz Input Voltage Noise

8 Detailed Description

8.1 Overview

The RS721P, RS722P, RS724P are high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.7V to 5.5V (±1.35V 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.

8.2 Phase Reversal Protection

The RS72XP 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 RS72XP prevents phase reversal with excessive common-mode voltage. Instead, the appropriate rail limits the output voltage. This performance is shown in figure 8.
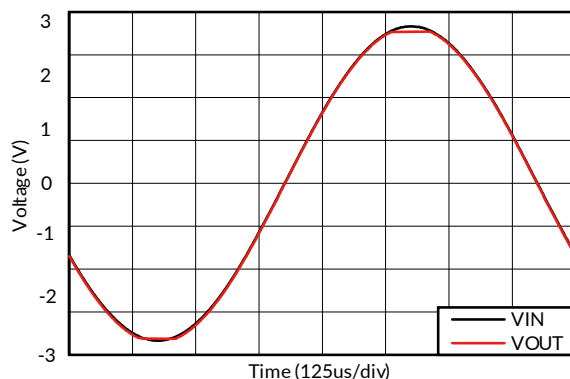
Figure 8. Output Waveform Devoid of Phase Reversal During an Input Overdrive Condition

8.3 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.

The EMIRR IN+ of the RS72XP is plotted versus frequency in Figure 9. If available, any dual and quad operational amplifier device versions have approximately identical EMIRR IN+ performance. The RS72XP unity-gain bandwidth is 13MHz. EMIRR performance below this frequency denotes interfering signals that fall within the operational amplifier bandwidth.

Detailed Description (continued)
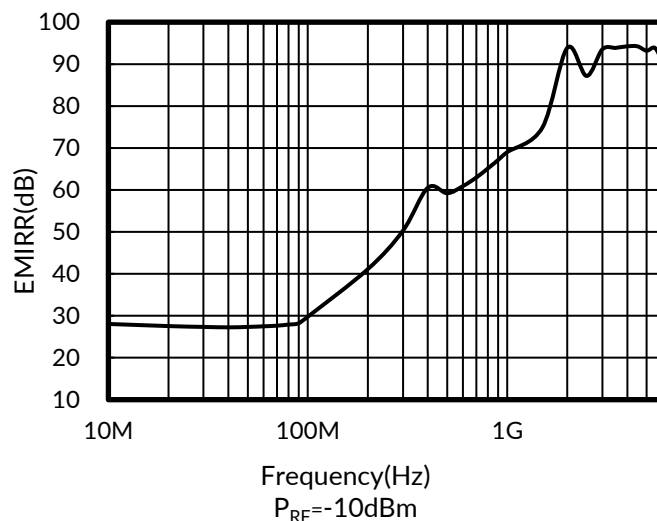
Figure 9. RS72XP EMIRR vs Frequency

8.4 EMIRR IN+ Test Configuration

Figure 10 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.
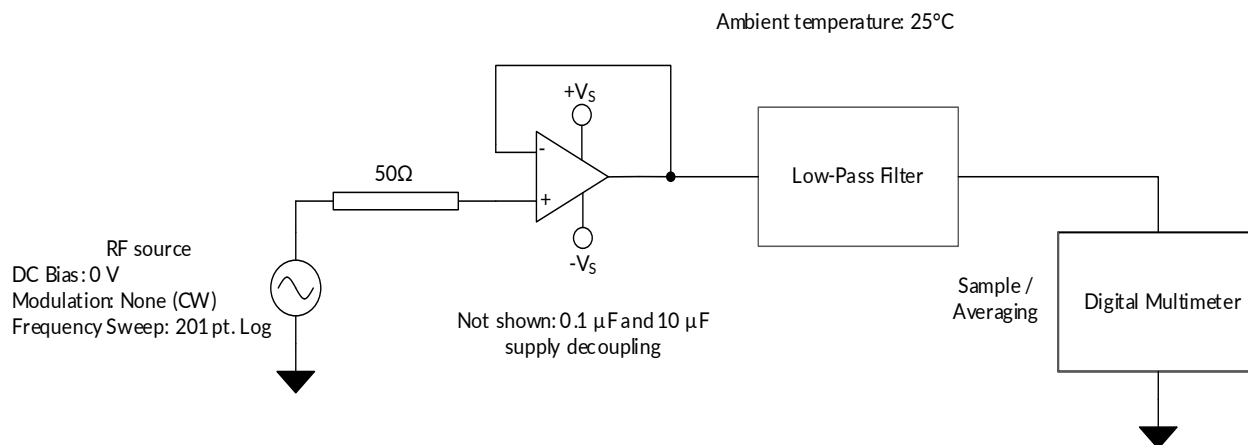
Figure 10. EMIRR IN+ Test Configuration Schematic

9 Application and Implementation

Information in the following applications sections is not part of the RUNIC component specification, and RUNIC does not warrant its accuracy or completeness. RUNIC's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 APPLICATION NOTE

The RS72XP are high precision, rail-to-rail operational amplifiers that can be run from a single-supply voltage 2.7V to 5.5V (±1.35V 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.

Typical Applications
9.2 25-kHz Low-pass Filter
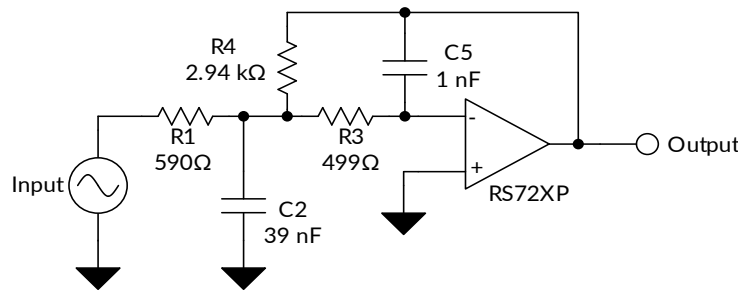
Figure 11. 25-kHz Low-Pass Filter

9.3 Design Requirements

Low-pass filters are commonly employed in signal processing applications to reduce noise and prevent aliasing. The RS72XP devices are ideally suited to construct high-speed, high-precision active filters. Figure 11 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

9.4 Detailed Design Procedure

The infinite-gain multiple-feedback circuit for a low-pass network function is shown in Figure 11. Use Equation 1 to calculate the voltage transfer function.

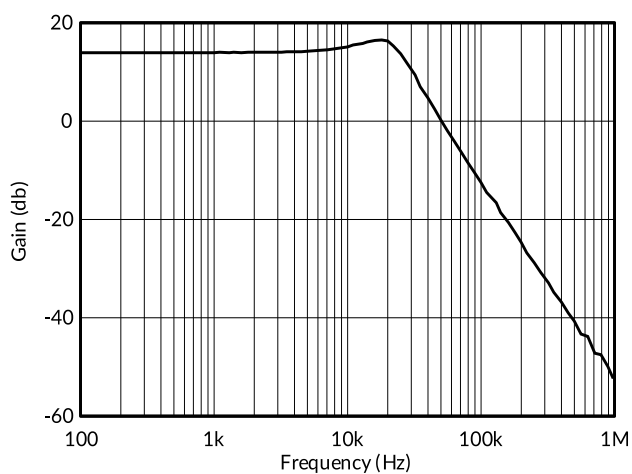$$\frac{Output}{Input}(s) = \frac{-1/R_1 R_3 C_2 C_5}{s^2 + (s/C_2)(1/R_1 + 1/R_3 + 1/R_4) + 1/R_3 R_4 C_2 C_5}$$

(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:

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

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

(2)

9.5 Application Curve


Figure 12. Low-pass filter transfer function

10 LAYOUTS

10.1 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 0.1uF 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.

10.2 Layout Example
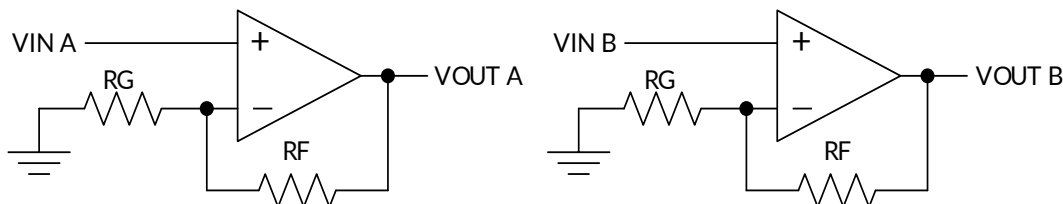
Figure 13. Schematic Representation
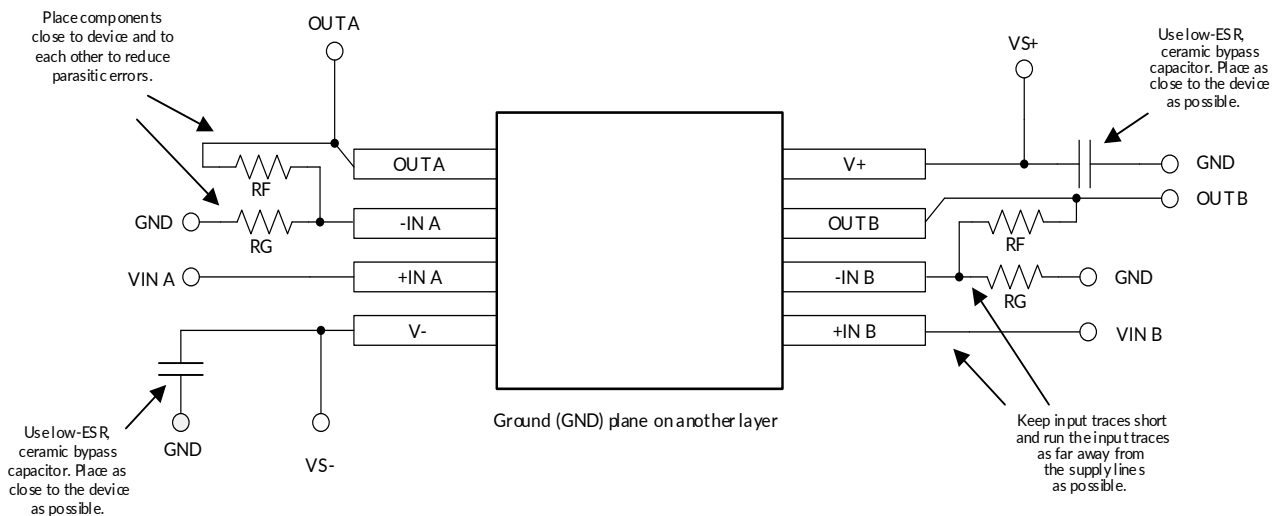
Figure 14. Layout Example

NOTE: Layout Recommendations have been shown for dual op-amp only, follow similar precautions for Single and four.

11 PACKAGE OUTLINE DIMENSIONS
SOT23-5 [3]
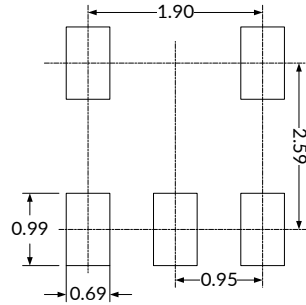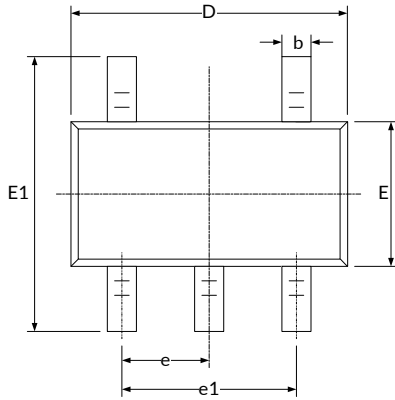
RECOMMENDED LAND PATTERN (Unit: mm)
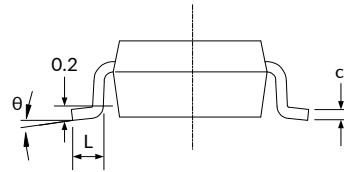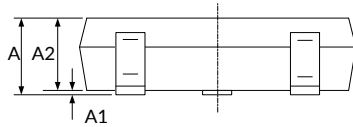
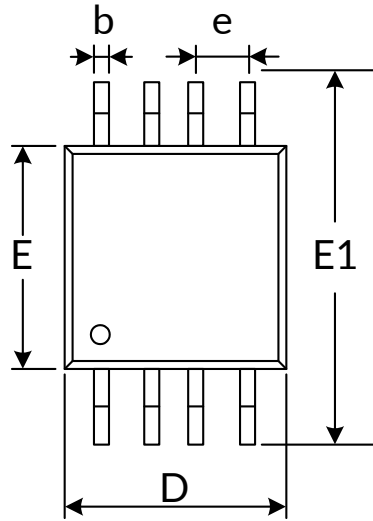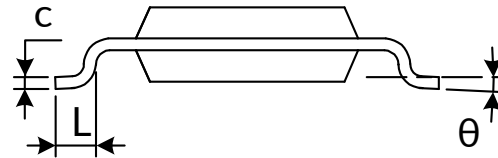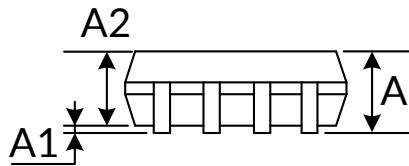| Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D [1]	2.820	3.020	0.111	0.119
E [1]	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC) [2]		0.037(BSC) [2]	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

SOT353(SC70-5) [3]
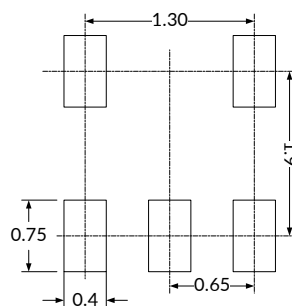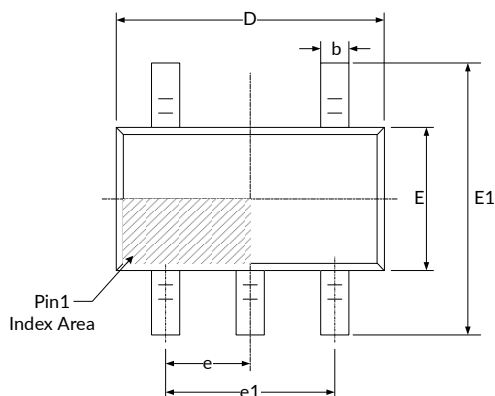
RECOMMENDED LAND PATTERN (Unit: mm)
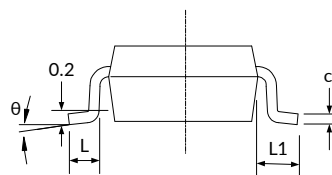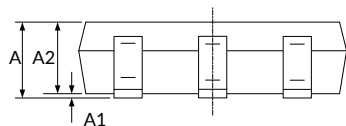
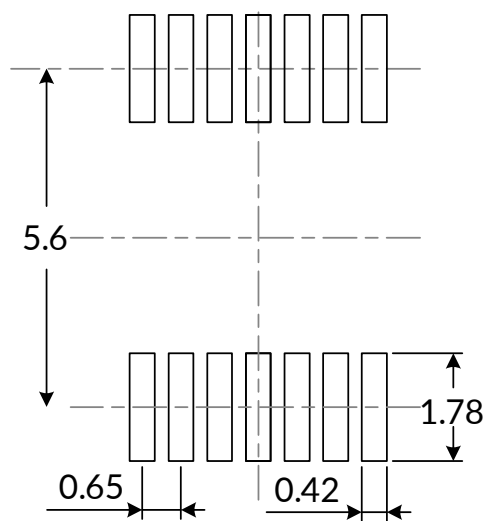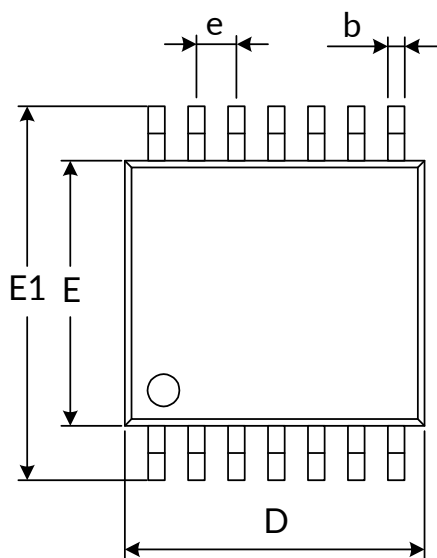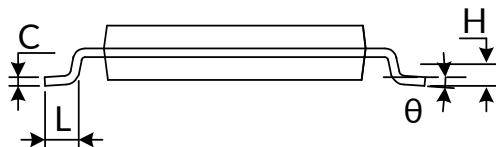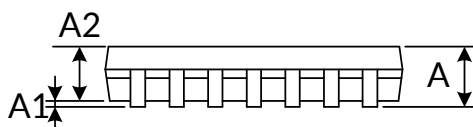| Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D [1]	2.000	2.200	0.079	0.087
E [1]	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.650(BSC) [2]		0.026(BSC) [2]	
e1	1.300(BSC) [2]		0.051(BSC) [2]	
L	0.260	0.460	0.010	0.018
L1	0.525		0.021	
θ	0°	8°	0°	8°

NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

MSOP-8 [3]
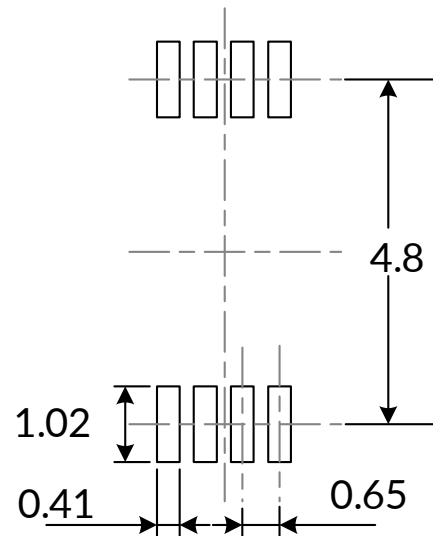
RECOMMENDED LAND PATTERN (Unit: mm)

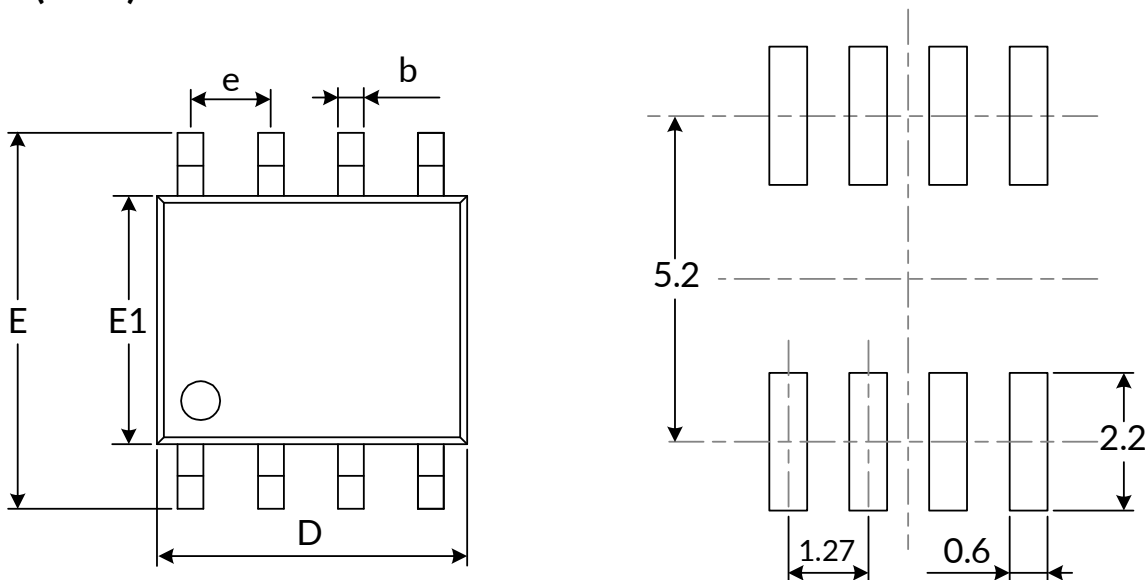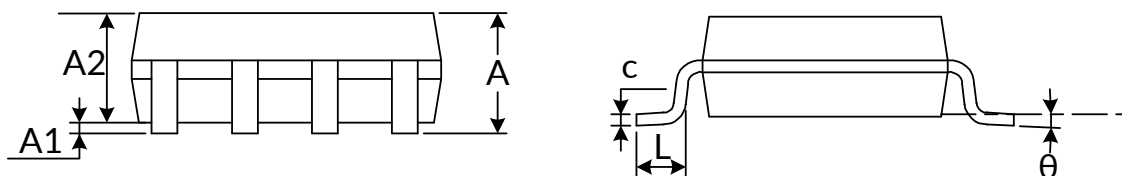| Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D [1]	2.900	3.100	0.114	0.122
e	0.650(BSC) [2]		0.026(BSC) [2]	
E [1]	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

NOTE:
    1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
    2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
    3. This drawing is subject to change without notice.

TSSOP-14 [3]

RECOMMENDED LAND PATTERN (Unit: mm)

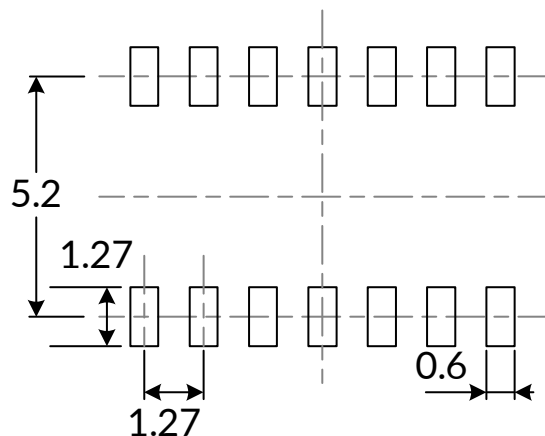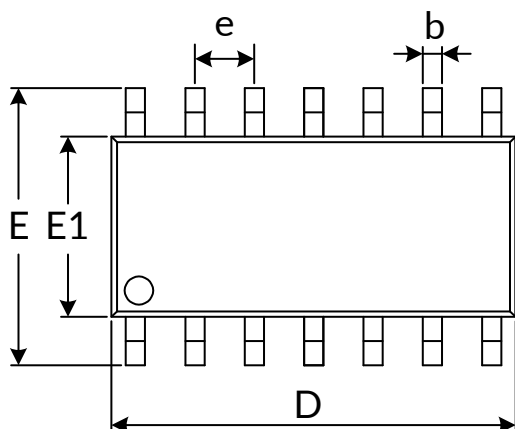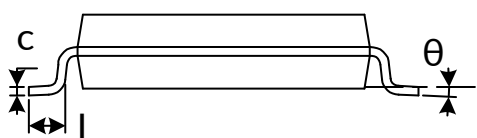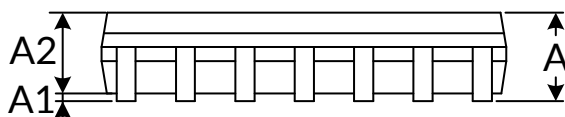| Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D [1]	4.860	5.100	0.191	0.201
E [1]	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC) [2]		0.026(BSC) [2]	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

NOTE:
  1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
  2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
  3. This drawing is subject to change without notice.

SOIC-8(SOP8) [3]

RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	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 [1]	4.800	5.000	0.189	0.197
e	1.270(BSC) [2]		0.050(BSC) [2]	
E	5.800	6.200	0.228	0.244
E1 [1]	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

NOTE:
    1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
    2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
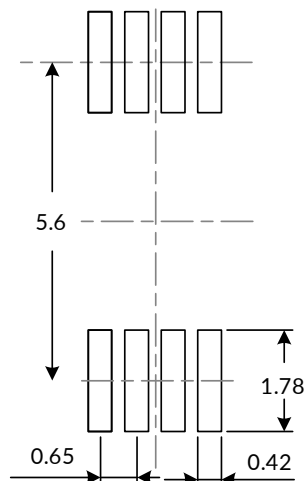   3. This drawing is subject to change without notice.

SOIC-14(SOP14) [3]

RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	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 [1]	8.450	8.850	0.333	0.348
e	1.270(BSC) [2]		0.050(BSC) [2]	
E	5.800	6.200	0.228	0.244
E1 [1]	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
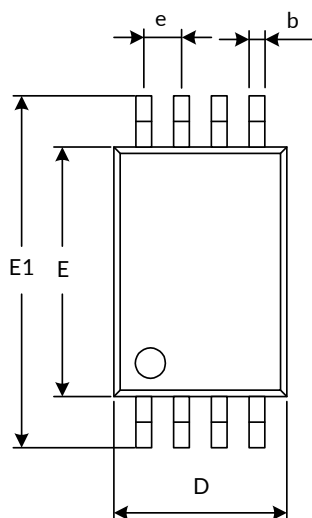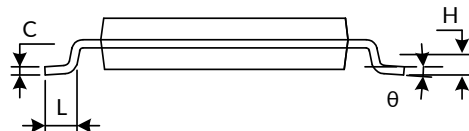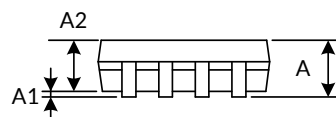3. This drawing is subject to change without notice.

TSSOP-8 [3]

RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]		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 [1]	2.900	3.100	0.114	0.122
E [1]	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC) [2]		0.026(BSC) [2]	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°	7°	1°	7°

NOTE:
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
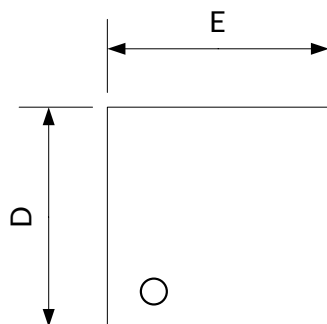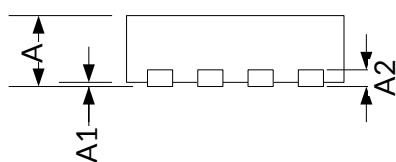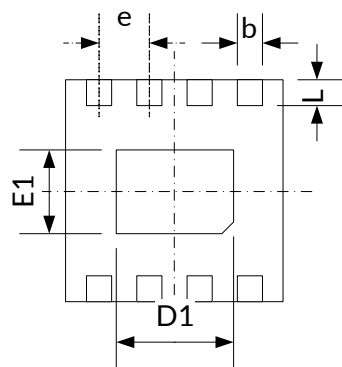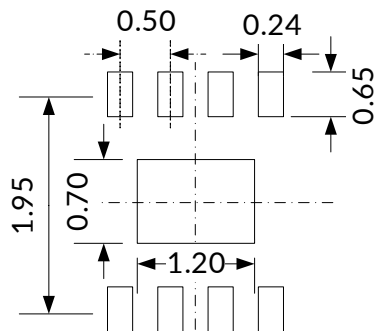3. This drawing is subject to change without notice.

TDFN-2x2-8 [2]

TOP VIEW

BOTTOM VIEW

SIDE VIEW

RECOMMENDED LAND
PATTERN (Unit: mm)

| Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A [1]	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]	1.900	2.100	0.075	0.083
D1	1.100	1.300	0.043	0.051
E [1]	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

NOTE:
   1. Plastic or metal protrusions of 0.075mm maximum per side are not included.
   2. This drawing is subject to change without notice.

12 TAPE AND REEL INFORMATION

REEL DIMENSIONS

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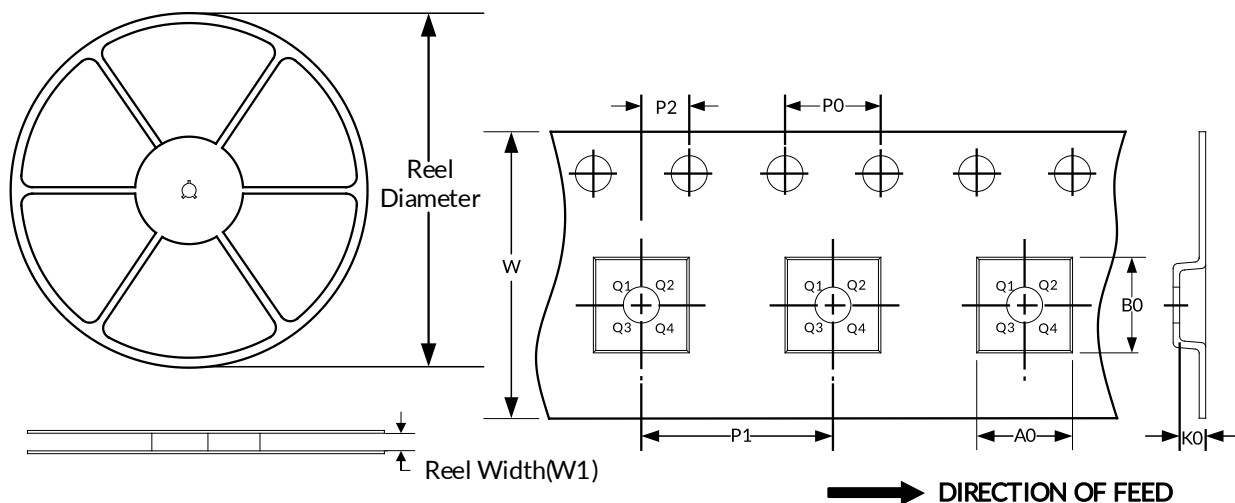
NOTE: The picture is only for reference. Please make the object as the standard.

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
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
SOIC-14(SOP14)	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP-8	13"	12.4	6.90	3.45	1.65	4.0	8.0	2.0	12.0	Q1
TSSOP-14	13"	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1
SOT353(SC70-5)	7"	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3
TDFN2X2-8L	7"	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q2

NOTE:
1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.

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