

# Zero-Drift, Rail-to-Rail I/O CMOS Operational Amplifiers

## 1 FEATURES

- **Low Offset Voltage:  $\pm 40\mu\text{V}$  (Max)**
- **Input Offset Drift:  $\pm 0.05\mu\text{V}/^\circ\text{C}$**
- **High Gain Bandwidth Product: 350KHz**
- **Rail-to-Rail Input and Output**
- **High Gain, CMRR, PSRR: 130dB**
- **High Slew Rate: 0.17V/us**
- **Low Noise: 1.6uVp-p (0.01~10Hz)**
- **Low Power Consumption: 60uA /op amp**
- **Overload Recovery Time: 6us**
- **Low Supply Voltage: +2.3 V to +5.5 V**
- **No External Capacitors Required**
- **Extended Temperature: -40°C to +125°C**

## 2 APPLICATIONS

- **Temperature Sensors**
- **Medical/Industrial Instrumentation**
- **Pressure Sensors**
- **Battery-Powered Instrumentation**
- **Active Filtering**
- **Weight Scale Sensor**
- **Strain Gage Amplifiers**
- **Power Converter/Inverter**

## 3 DESCRIPTIONS

The RS8511, RS8512, RS8514 series of CMOS operational amplifiers use auto-zero techniques to simultaneously provide very low offset voltage (40uV max) and near-zero drift over time and temperature. This family of amplifiers has ultralow noise, offset and power.

This miniature, high-precision operational amplifiers offset high input impedance and rail-to-rail input and rail-to-rail output swing. With high gain-bandwidth product of 350KHz and slew rate of 0.17V/us.

Single or dual supplies as low as +2.3V ( $\pm 1.15\text{V}$ ) and up to +5.5V ( $\pm 2.75\text{V}$ ) may be used.

The RS8511/ RS8512/ RS8514 are specified for the extended industrial and automotive temperature range (-40°C to 125°C). The RS8511 single amplifier is available in 5-lead SOT23, 8-lead MSOP8 and 8-lead SOIC packages, The RS8512 dual amplifier is available in 8-lead SOIC, 8-lead DFN2x2 and 8-lead TSSOP narrow surface mount packages. The RS8514 quad is available in 14-lead SOIC and 14-lead narrow TSSOP packages.

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

PART NUMBER	PACKAGE	BODY SIZE(NOM)
RS8511	SOT23-5	2.90mm×1.60mm
	SOIC-8(SOP8)	4.90mm×3.90mm
	MSOP-8	3.00mm×3.00mm
RS8512	SOIC-8(SOP8)	4.90mm×3.90mm
	MSOP-8	3.00mm×3.00mm
	DFN2×2-8L	2.00mm×2.00mm
RS8514	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.

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## 4 Revision History

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

Version	Change Date	Change Item
C.1	2022/06/02	1. Update Package Qty on Page 3@RevB.7 2. Added TAPE AND REEL INFORMATION 3. Change Input Bias Current vs Temperature charts on Page 5@RevB.7
C.2	2023/09/15	1. Added Pin Description 2. Delete RS8513 related content

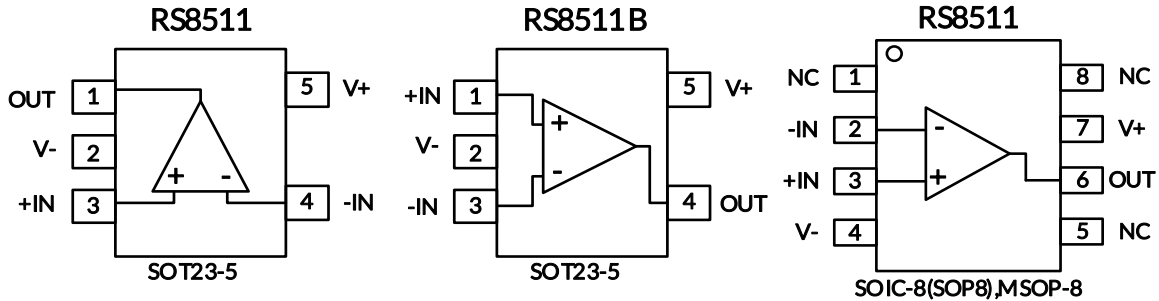
**5 PACKAGE/ORDERING INFORMATION (1)**

Orderable Device	Package Type	Pin	Channel	Op Temp(°C)	Device Marking (2)	Package Qty
RS8511XF	SOT23-5	5	1	-40°C ~125°C	8511	Tape and Reel,3000
RS8511BXF	SOT23-5	5	1	-40°C ~125°C	8511B	Tape and Reel,3000
RS8511XK	SOIC-8 (SOP8)	8	1	-40°C ~125°C	RS8511	Tape and Reel,4000
RS8511XM	MSOP-8	8	1	-40°C ~125°C	RS8511	Tape and Reel,4000
RS8512XK	SOIC-8 (SOP8)	8	2	-40°C ~125°C	RS8512	Tape and Reel,4000
RS8512XM	MSOP-8	8	2	-40°C ~125°C	RS8512	Tape and Reel,4000
RS8512XTDE8	DFN2x2-8L	8	2	-40°C ~125°C	8512	Tape and Reel,3000
RS8514XP	SOIC-14 (SOP14)	14	4	-40°C ~125°C	RS8514	Tape and Reel,4000
RS8514XQ	TSSOP-14	14	4	-40°C ~125°C	RS8514	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)

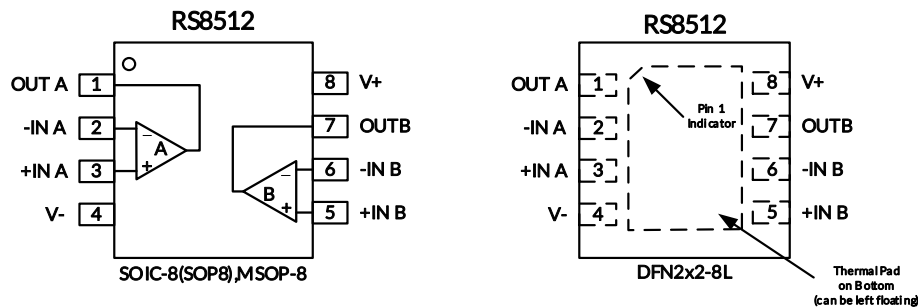


### Pin Description

NAME	PIN			I/O <sup>(1)</sup>	DESCRIPTION
	RS8511	RS8511B	RS8511		
	SOT23-5	SOT23-5	SOIC-8 (SOP8)/ MSOP8		
-IN	4	3	2	I	Negative (inverting) input
+IN	3	1	3	I	Positive (noninverting) input
NC <sup>(2)</sup>	-	-	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.

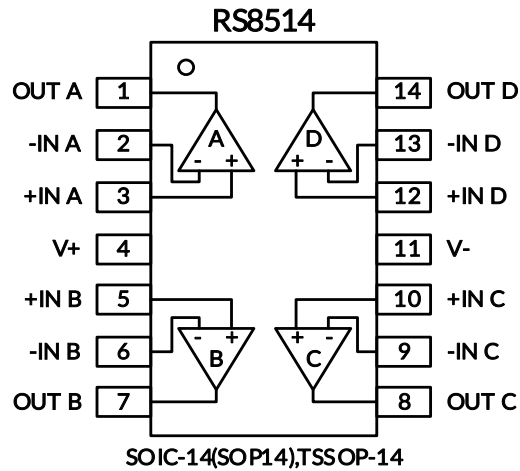


### Pin Description

NAME	PIN	I/O <sup>(1)</sup>	DESCRIPTION
	SOIC-8 (SOP8)/ MSOP8/DFN2x2-8L		
-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)



### Pin Description

NAME	PIN	I/O <sup>(1)</sup>	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

(1) I = Input, O = Output.

## 7 SPECIFICATIONS

### 7.1 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>	-55	55	mA
	Output short-circuit <sup>(4)</sup>	Continuous		
$\theta_{JA}$	Package thermal impedance <sup>(5)</sup>	SOT23-5	230	°C/W
		SOIC-8(SOP8)	110	
		MSOP-8	170	
		SOIC-14(SOP14)	105	
		TSSOP-14	90	
		DFN2x2-8L	80	
Temperature	Operating range, $T_A$	-40	125	°C
	Junction, $T_J$ <sup>(6)</sup>	-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  $\pm 55$ mA 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  $T_{J(MAX)}$ ,  $R_{\theta JA}$ , and  $T_A$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{J(MAX)} - T_A) / R_{\theta JA}$ . 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)	$\pm 5000$	V
		Machine Model (MM)	$\pm 400$	



#### 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	2.3		5.5	V
	Dual-supply	$\pm 1.15$		$\pm 2.75$	

## 7.4 ELECTRICAL CHARACTERISTICS

Boldface limits apply over the specified temperature range,  $T_A^{(9)} = -40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

(At  $T_A = +25^{\circ}\text{C}$ ,  $V_S=5\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , and  $V_{OUT} = V_S/2$ ,  $V_{CM} = V_S/2$ , unless otherwise noted.)<sup>(1)</sup>

PARAMETER	SYMBOL	CONDITION	$T_J$	RS8511, RS8512, RS8514			
				MIN <sup>(2)</sup>	TYP <sup>(3)</sup>	MAX <sup>(2)</sup>	UNIT
<b>OFFSET VOLTAGE</b>							
Input Offset Voltage	$V_{OS}$	$V_{CM} = V_S/2$	$25^{\circ}\text{C}$	-40	$\pm 7$	40	$\mu\text{V}$
Input Offset Voltage Average Drift	$V_{OS} T_C$	$V_{CM} = V_S/2$	$25^{\circ}\text{C}$		$\pm 0.05$	$\pm 0.2$	$\mu\text{V}/^{\circ}\text{C}$
Power-Supply Rejection Ratio	PSRR	$V_S = +2.3\text{V}$ to $+5.5\text{V}$ , $V_{CM} = 0$	$25^{\circ}\text{C}$	110	130		dB
Channel Separation, dc			$25^{\circ}\text{C}$		0.1		$\mu\text{V}/\text{V}$
<b>INPUT BIAS CURRENT</b>							
Input Bias Current <sup>(4)(5)</sup>	$I_B$	$V_{CM} = V_S/2$	$25^{\circ}\text{C}$		$\pm 50$		pA
Input Offset Current <sup>(4)</sup>	$I_{OS}$		$25^{\circ}\text{C}$		$\pm 10$		pA
<b>NOISE PERFORMANCE</b>							
Input Voltage Noise	$e_{n\text{p-p}}$	$f = 0.01\text{Hz}$ to $10\text{Hz}$	$25^{\circ}\text{C}$		1.6		$\mu\text{V}_{pp}$
Input Voltage Noise	$e_{n\text{p-p}}$	$f = 0.01\text{Hz}$ to $1\text{Hz}$	$25^{\circ}\text{C}$		0.48		$\mu\text{V}_{pp}$
Input Voltage Noise Density	$e_n$	$f = 1\text{KHz}$	$25^{\circ}\text{C}$		70		$\text{nV}/\sqrt{\text{Hz}}$
Input Current Noise Density	$i_n$	$f = 10\text{Hz}$	$25^{\circ}\text{C}$		8		$\text{fA}/\sqrt{\text{Hz}}$
<b>INPUT VOLTAGE RANGE</b>							
Common-Mode Voltage Range	$V_{CM}$		$25^{\circ}\text{C}$	(V-)-0.1		(V+)+0.1	V
Common-Mode Rejection Ratio	CMRR	$(V-)-0.1\text{V} < V_{CM} < (V+)+0.1\text{V}$	$25^{\circ}\text{C}$	110	130		dB
<b>INPUT CAPACITANCE</b>							
Differential			$25^{\circ}\text{C}$		1		pF
Common-Mode			$25^{\circ}\text{C}$		5		pF
<b>Open-Loop Gain</b>							
Open-Loop Voltage Gain	$A_{OL}$	$R_L = 10\text{k}\Omega$ , $V_O = 0.3\text{V}$ to $4.7\text{V}$	Full	110	130		dB
<b>DYNAMIC PERFORMANCE</b>							
Slew Rate <sup>(8)</sup>	SR	$G = +1$	$25^{\circ}\text{C}$		0.17		$\text{V}/\mu\text{s}$
Gain-Bandwidth Product	GBW		$25^{\circ}\text{C}$		350		KHz
Overload Recovery Time	$t_{OR}$		$25^{\circ}\text{C}$		6		$\mu\text{s}$
<b>OUTPUT CHARACTERISTICS</b>							
Output Voltage High	$V_{OH}$	$R_L = 100\text{K}\Omega$ to GND	$25^{\circ}\text{C}$	4.99	4.998		V
		$R_L = 10\text{K}\Omega$ to GND	$25^{\circ}\text{C}$	4.95	4.98		
Output Voltage Low	$V_{OL}$	$R_L = 100\text{K}\Omega$ to V+	$25^{\circ}\text{C}$		1	10	mV
		$R_L = 10\text{K}\Omega$ to V+	$25^{\circ}\text{C}$		10	30	
Short-Circuit Current <sup>(6)(7)</sup>	$I_{SC}$		$25^{\circ}\text{C}$		$\pm 25$		mA
<b>POWER SUPPLY</b>							
Operating Voltage Range	$V_S$		$25^{\circ}\text{C}$	2.3		5.5	V
Quiescent Current Per Amplifier	$I_Q$		$25^{\circ}\text{C}$		60	87	$\mu\text{A}$



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°C. 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) This parameter is ensured by design and/or characterization and is not tested in production.
- (5) Positive current corresponds to current flowing into the device.
- (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  $T_A = +25^{\circ}\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ ,  $V_{OUT} = V_S/2$ , unless otherwise noted.

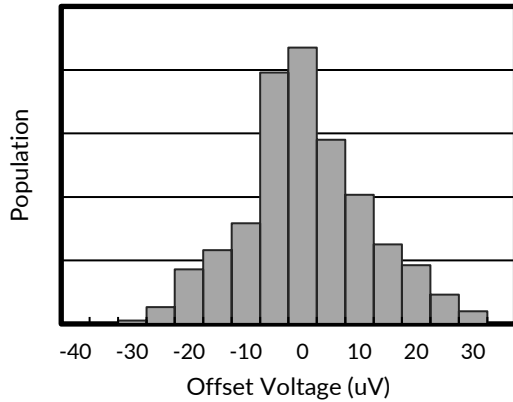


Figure 1. Offset Voltage Production Distribution

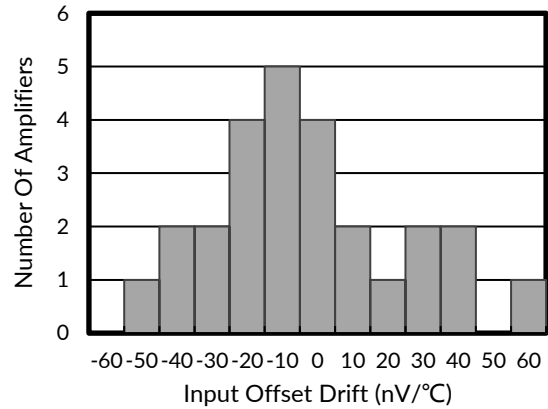


Figure 2. Offset Voltage Drift Production Distribution

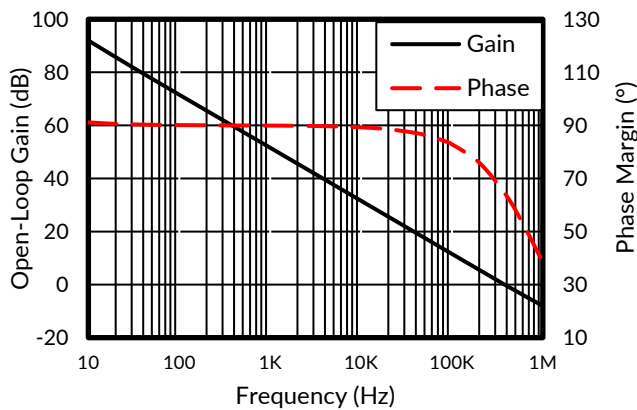


Figure 3. Open-Loop Gain and Phase vs Frequency

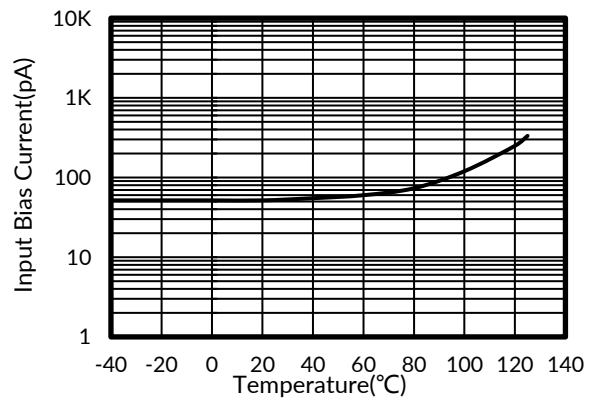


Figure 4. Input Bias Current vs Temperature

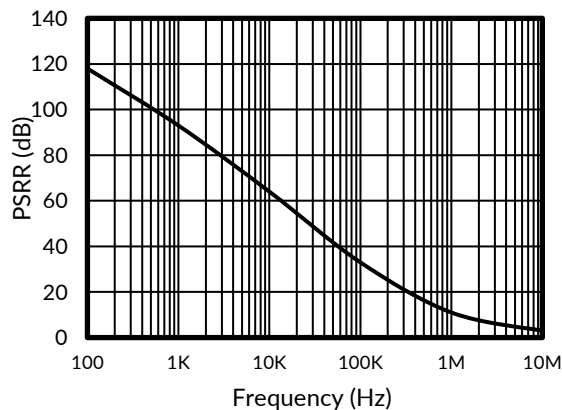


Figure 5. Power-Supply Rejection Ratio vs Frequency

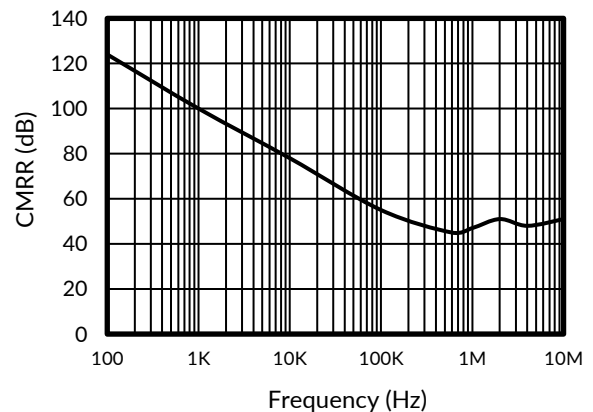


Figure 6. Common-Mode Rejection Ratio vs Frequency

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

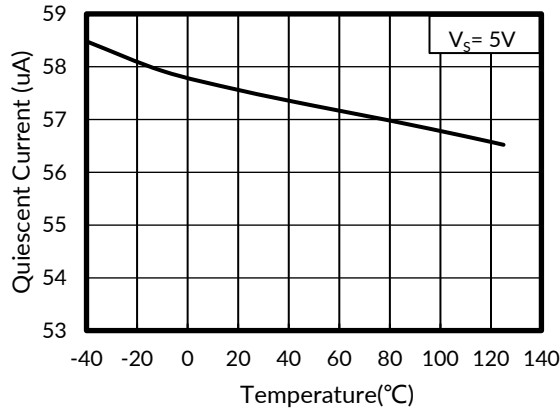


Figure 7. Quiescent Current vs Temperature

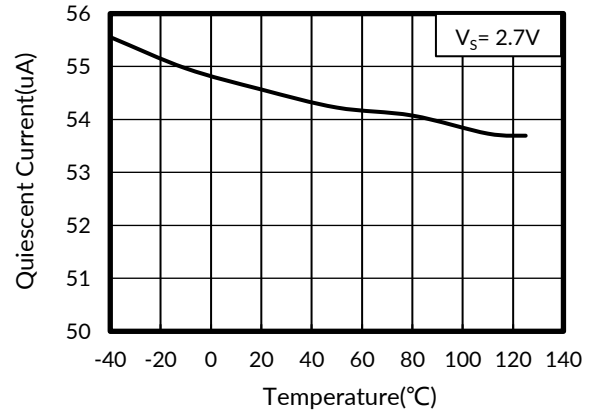


Figure 8. Quiescent Current vs Temperature

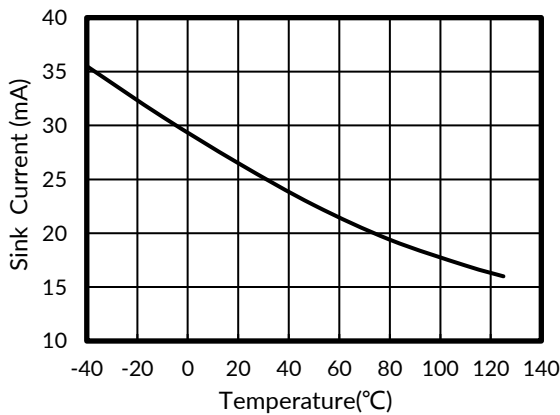


Figure 9. Sink Current vs Temperature

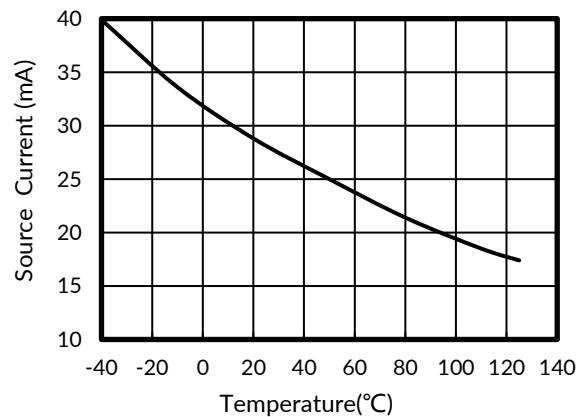


Figure 10. Source Current vs Temperature

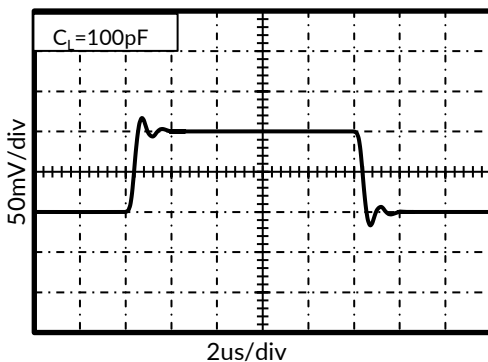


Figure 11. Small-Signal Step Response

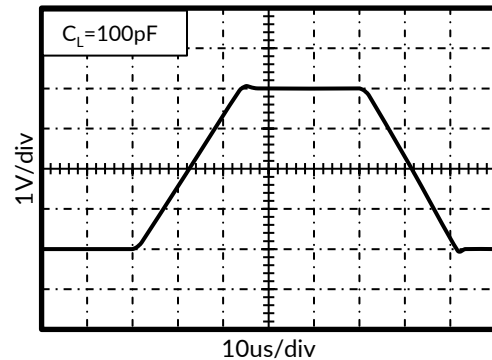
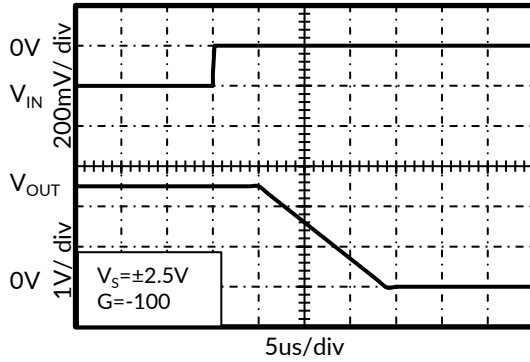


Figure 12. Large-Signal Step Response

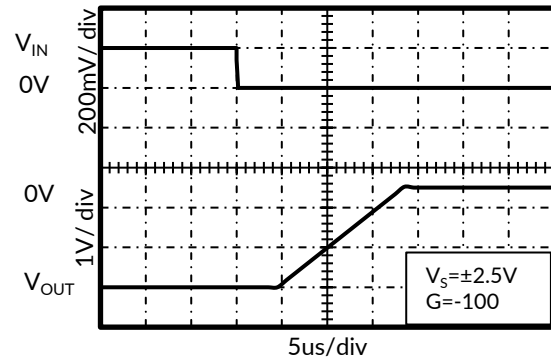
## TYPICAL CHARACTERISTICS

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.

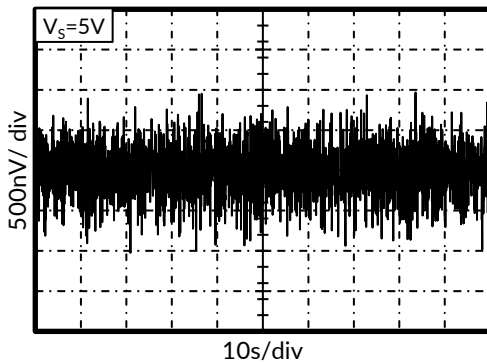
At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ ,  $V_{OUT} = V_S/2$ , unless otherwise noted.



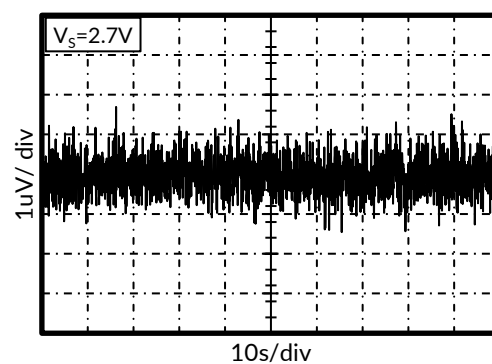
**Figure 13. Positive Overtolerance Recovery**



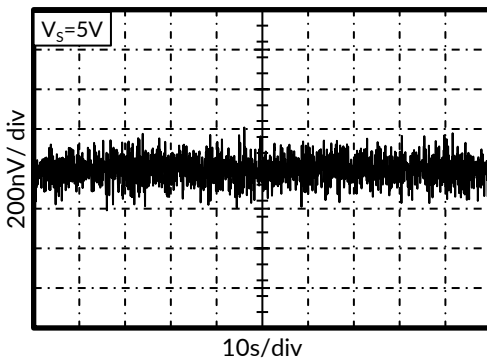
**Figure 14. Negative Overtolerance Recovery**



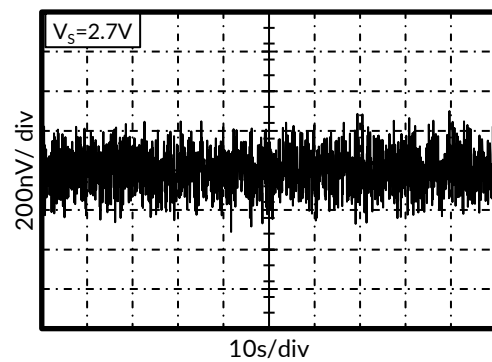
**Figure 15. 0.01Hz to 10Hz Noise**



**Figure 16. 0.01Hz to 10Hz Noise**



**Figure 17. 0.01Hz to 1Hz Noise**



**Figure 18. 0.01Hz to 1Hz Noise**

## 8 Detailed Description

### 8.1 Overview

The RS8511, RS8512, RS8514 series op amps are unity-gain stable and free from unexpected output phase reversal. They use auto-zeroing techniques to provide low offset voltage and very low drift over time and temperature.

Good layout practice mandates use of a 0.1uF capacitor placed closely across the supply pins. For lowest offset voltage and precision performance, circuit layout and mechanical conditions should be optimized. Avoid temperature gradients that create thermoelectric (Seebeck) effects in thermocouple junctions formed from connecting dissimilar conductors. These thermally-generated potentials can be made to cancel by assuring that they are equal on both input terminals.

- Use low thermoelectric-coefficient connections (avoid dissimilar metals).
- Thermally isolate components from power supplies or other heat-sources.
- Shield op amp and input circuitry from air currents, such as cooling fans.

Following these guidelines will reduce the likelihood of junctions being at different temperatures, which can cause thermoelectric voltages of 0.1uV/°C or higher, depending on materials used.

### 8.2 OPERATING VOLTAGE

The RS8511, RS8512, RS8514 series op amps operate over a power-supply range of +2.3V to +5.5V ( $\pm 1.15V$  to  $\pm 2.75V$ ). Supply voltages higher than 7V (absolute maximum) can permanently damage the amplifier. Parameters that vary over supply voltage or temperature are shown in the Typical Characteristics section of this data sheet.

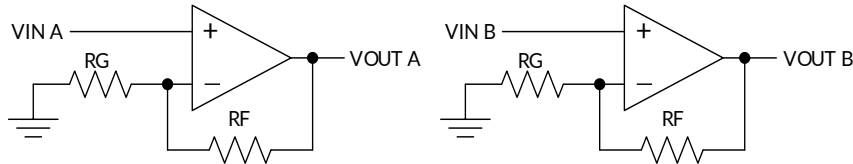
## 9 Layout

### 9.1 Layout Guidelines

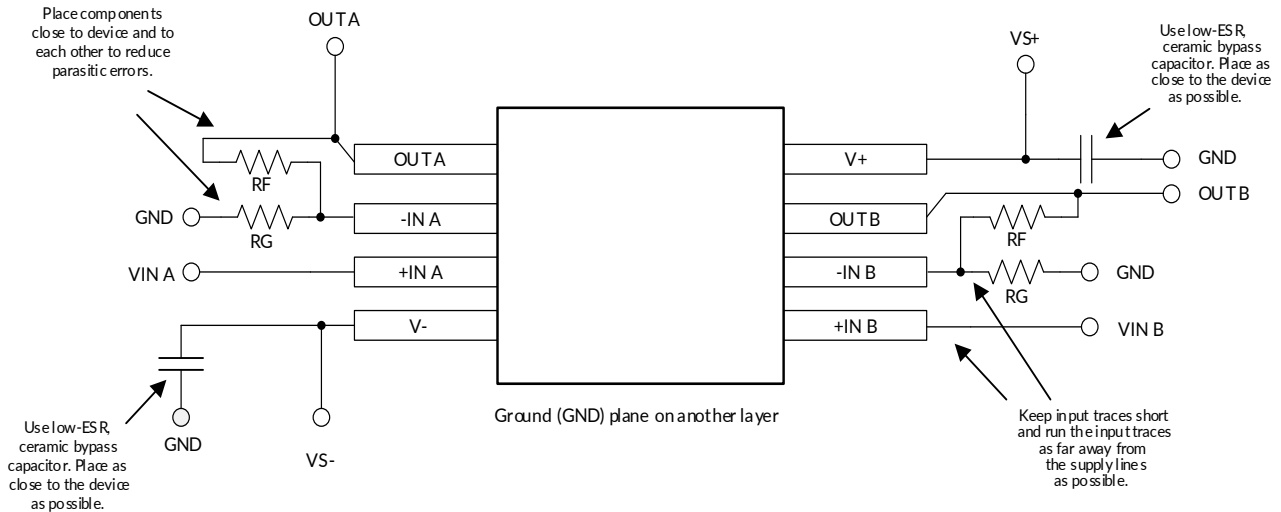
Attention to good layout practices is always recommended. Keep traces short. When possible, use a PCB ground plane with surface-mount components placed as close to the device pins as possible. Place a 0.1 $\mu$ F capacitor closely across the supply pins.

These guidelines should be applied throughout the analog circuit to improve and provide benefits such as reducing the EMI susceptibility.

### 9.2 Layout Example



**Figure 19. Schematic Representation**

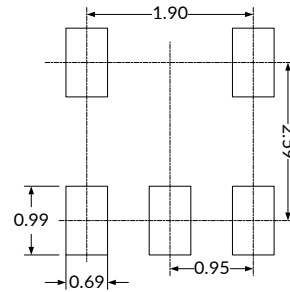
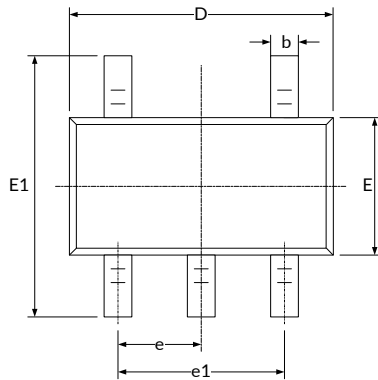


**Figure 20. Layout Example**

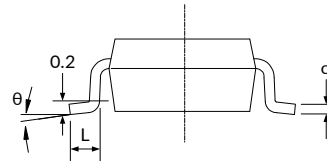
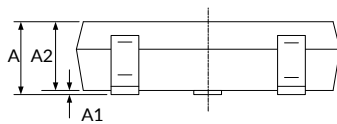
NOTE: Layout Recommendations have been shown for dual op-amp only, follow similar precautions for Single and four.

# 10 PACKAGE OUTLINE DIMENSIONS

## SOT23-5<sup>(3)</sup>



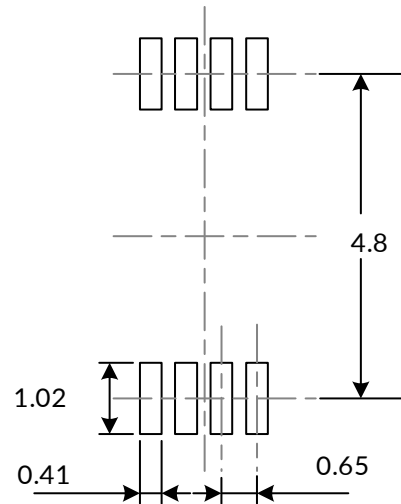
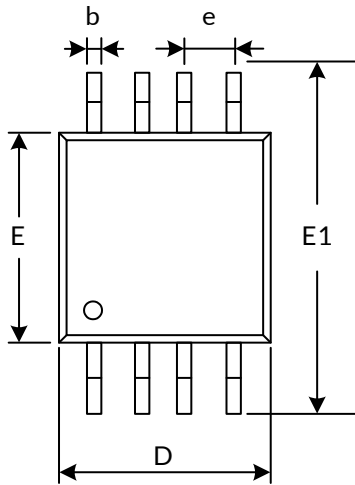
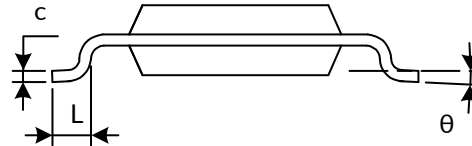
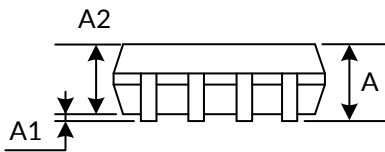
RECOMMENDED LAND PATTERN (Unit: mm)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A <sup>(1)</sup>	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 <sup>(1)</sup>	2.820	3.020	0.111	0.119
E <sup>(1)</sup>	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC) <sup>(2)</sup>		0.037(BSC) <sup>(2)</sup>	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
$\theta$	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.

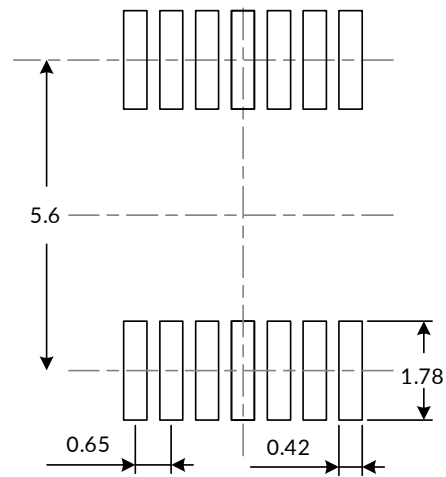
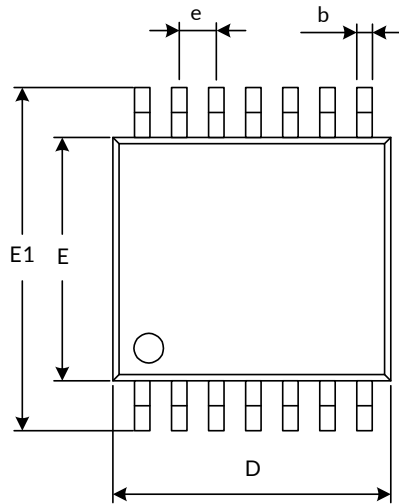
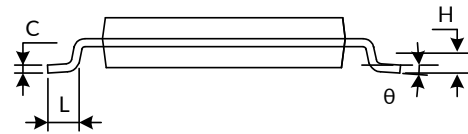
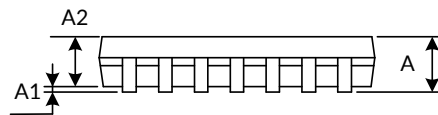
**MSOP-8<sup>(3)</sup>**

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


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A <sup>(1)</sup>	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 <sup>(1)</sup>	2.900	3.100	0.114	0.122
e	0.650(BSC) <sup>(2)</sup>		0.026(BSC) <sup>(2)</sup>	
E <sup>(1)</sup>	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°

**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.

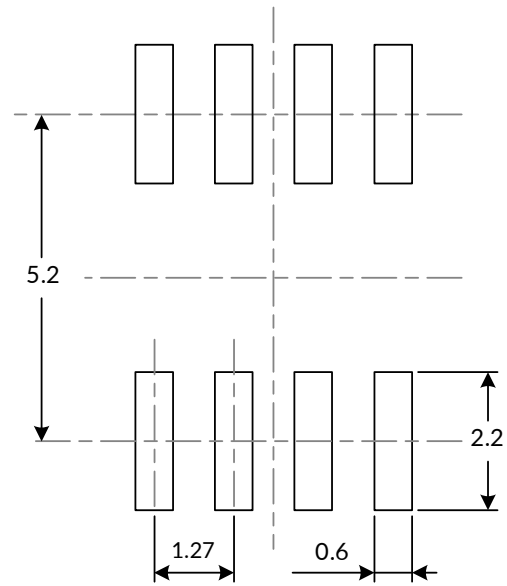
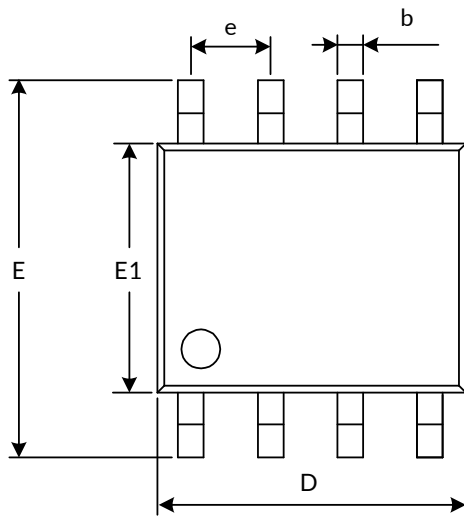
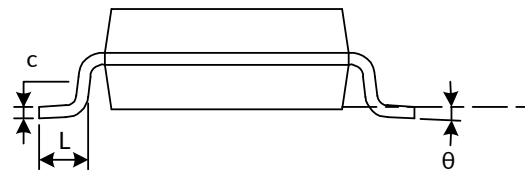
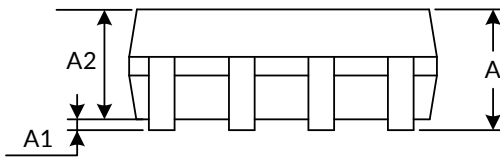


**TSSOP-14 (3)**

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


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A <sup>(1)</sup>		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 <sup>(1)</sup>	4.860	5.100	0.191	0.201
E <sup>(1)</sup>	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650(BSC) <sup>(2)</sup>		0.026(BSC) <sup>(2)</sup>	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
$\theta$	1°	7°	1°	7°

**NOTE:**

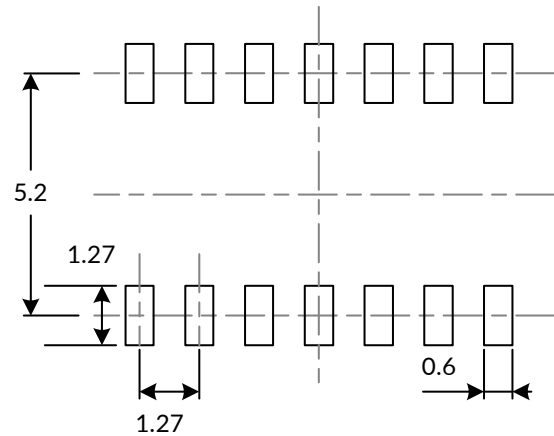
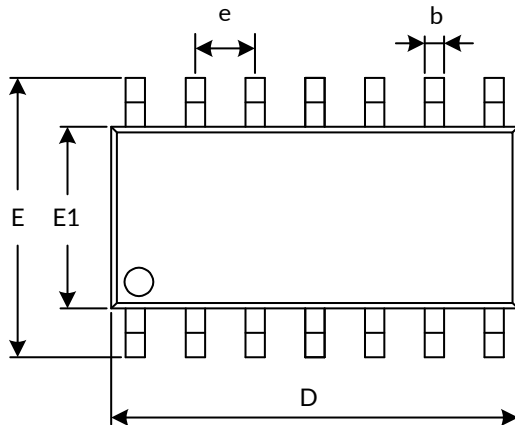
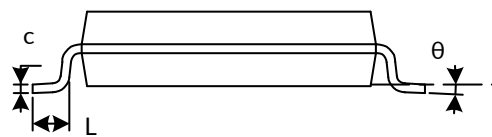
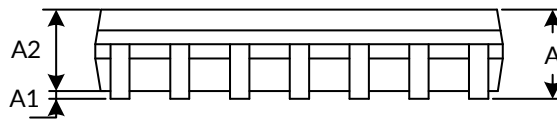
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

**SOIC-8 (SOP8) <sup>(3)</sup>**

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


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A <sup>(1)</sup>	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 <sup>(1)</sup>	4.800	5.000	0.189	0.197
e	1.270(BSC) <sup>(2)</sup>		0.050(BSC) <sup>(2)</sup>	
E	5.800	6.200	0.228	0.244
E1 <sup>(1)</sup>	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
$\theta$	0°	8°	0°	8°

**NOTE:**

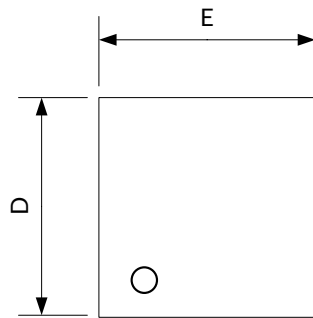
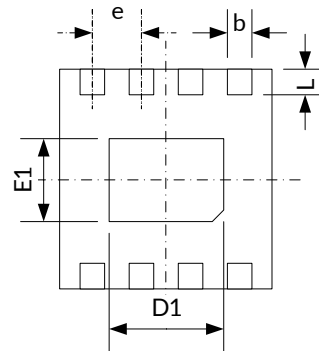
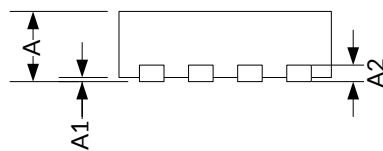
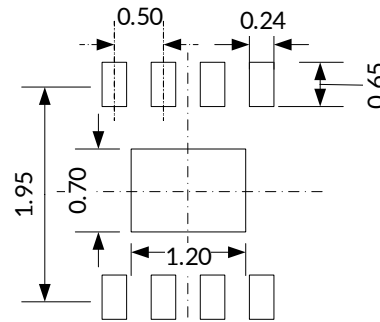
1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

**SOIC-14 (SOP14)<sup>(3)</sup>**

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


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A <sup>(1)</sup>	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 <sup>(1)</sup>	8.450	8.850	0.333	0.348
e	1.270(BSC) <sup>(2)</sup>		0.050(BSC) <sup>(2)</sup>	
E	5.800	6.200	0.228	0.244
E1 <sup>(1)</sup>	3.800	4.000	0.150	0.157
L	0.400	1.270	0.016	0.050
$\theta$	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.

**DFN2x2-8L (2)**

**TOP VIEW**

**BOTTOM VIEW**

**SIDE VIEW**

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

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A <sup>(1)</sup>	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 <sup>(1)</sup>	1.900	2.100	0.075	0.083
D1	1.100	1.300	0.043	0.051
E <sup>(1)</sup>	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

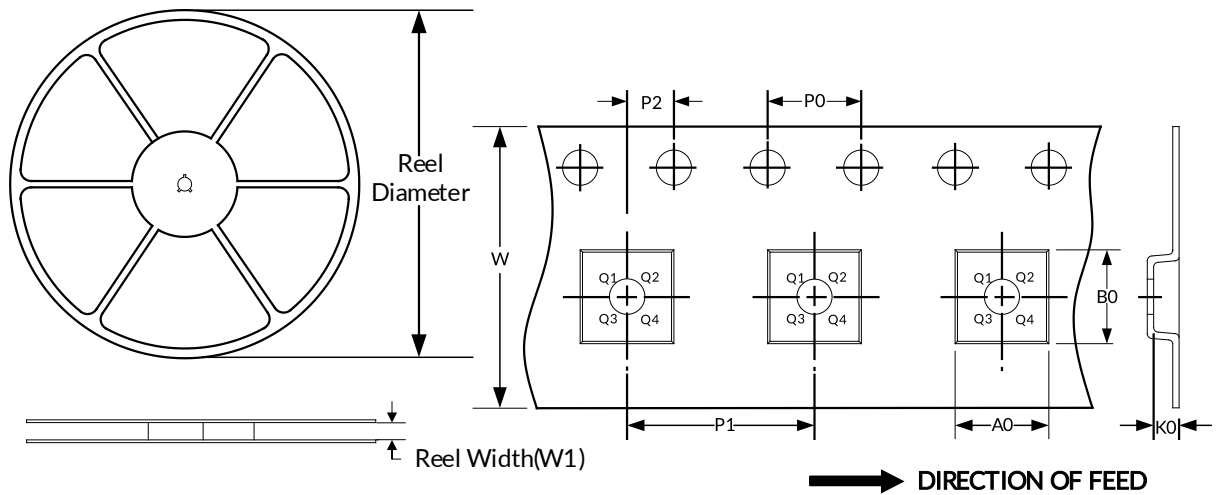
**NOTE:**

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

# 11 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
MSOP8	13"	12.4	5.20	3.30	1.50	4.0	8.0	2.0	12.0	Q1
TSSOP14	13"	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1
SOIC-8 (SOP8)	13"	12.4	6.40	5.40	2.10	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
DFN2x2-8L	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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