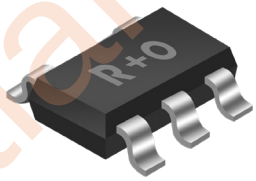
Zero-Drift, Rail-to-Rail I/O CMOS Operational Amplifiers

Features

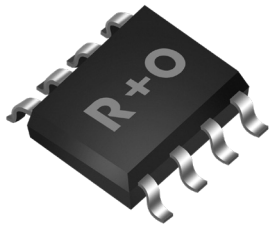
- Input Offset Drift: ±0.005μV/° C
- Bandwidth: 10MHz
- Input Voltage Range: (V-) - 0.5V to (V+) + 0.5V
- Low Input Bias Current: ±50pA(Typ.)
- Supply Voltage Range: +2.7V to +5.5V
- Open-Loop Voltage Gain: 130dB(Typ.)
- Slew Rate: 5V/μs
- Input Offset Voltage: ±1μV(Typ.)

Supply Voltage
+2.7V ~ +5.5V
Offset Voltage
±1μV(Typ.)

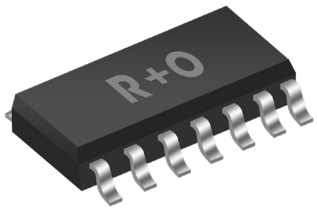
SOT-23-5



SOP-8



SOP-14



Applications

- Temperature/Pressure Sensors
- Battery-Powered Instrumentation
- Active Filtering
- Power Converter/Inverter

General Description

The HA8551, HA8552 and HA8554 series of CMOS operational amplifiers use auto-zero techniques to simultaneously provide very low offset voltage (5μV 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 10MHz and slew rate of 5V/μs.Single or dual supplies as low as +2.7V(±1.35V) and up to +5.5V (±2.75V) may be used.

The HA8551, HA8552 and HA8554 are specified for the extended industrial and automotive temperature range (-40 to 125 °C). The HA8551 single amplifier is available in 5-lead SOT-23, 8-lead MSOP-8 and 8-lead SOP-8 packages, The HA8552 dual amplifier is available in 8-lead SOP-8 and 8-lead TSSOP narrow surface mount packages. The HA8554 quad is available in 14-lead SOP-8 and 14-lead narrow TSSOP packages.

Reference News

Marking:
HA8551S5: 8551
HA8552P8: R+O+HA8552+Date code
HA8554X4: R+O+HA8554+Date code

Part Numbering

HA8552□□

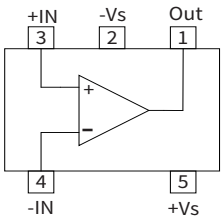
- Package Type: P8:SOP-8 S5: SOT-23-5 X4: SOP-14
- Version: 1: Single OPA 2: Dual OPA 4: Quad OPA
- Serial Number
- Amplifier
- R+O Co.,Ltd.

Ordering Information

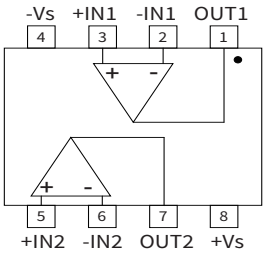
Order Number	Package	Package Code	Unit Weight(g)	Reel(pcs)	Box(pcs)	Carton(pcs)	Delivery Mode	MSL
HA8551S5	SOT-23-5	R1	0.0146	3000	30000	120000	7"	3
HA8552P8	SOP-8	R3	0.077	4000	8000	80000	13"	3
HA8554X4	SOP-14	R3	0.134	4000	8000	80000	13"	3

Pin Configuration

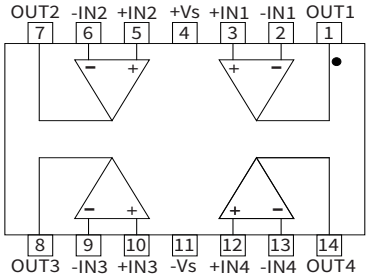
SOT-23-5



SOP-8



SOP-14



Pin Description

Pin Name	Functional Description
OUT, OUT 1 to 4	Output of operational amplifier
IN-, IN 1- to IN 4-	Negative input of of operational amplifier
IN+, IN 1+ to IN 4+	Positive input of of operational amplifier
$-V_S$	Negative power supply
$+V_S$	Positive power supply

Absolute Maximum Ratings (T_A = 25°C Unless otherwise specified)

Parameter		Symbol	Value	Unit
Supply Voltage, ($+V_S$) to ($-V_S$)		$+V_S$	6.0	V
Signal Input Voltage		V_{IN}	($-V_S$) – 0.5 to ($+V_S$) + 0.5	V
Signal Output Voltage		V_{OUT}	($-V_S$) – 0.5 to ($+V_S$) + 0.5	V
Signal Input Current		I_{iN}	-10 to +10	mA
Signal Output Current		I_o	-35 to +35	mA
Maximum Junction Temperature(2)		T_J	150	°C
Operating Temperature Range		T_{OPR}	–40 to 125	°C
Storage Temperature Range		T_{STG}	–65 to 150	°C
Lead Temperature (Soldering, 10 sec)		T_L	260	°C
Human Body Model ESD Protection		ESD HBM	±2	KV
Machine Model ESD Protection		ESD MM	400	V
Thermal Resistance@TA=+25°C (3)	SOT23-5	θ_{JA}	230	°C /W
	SOP-8	θ_{JA}	110	°C /W
	SOP-14	θ_{JA}	105	°C /W

Note1. Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.Electrostatic discharge can also cause damage to chips, so it is suggested to take some preventive measures for integrated circuits. Failure to follow proper handling and installation can also cause damage.

Note2. 5.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.

Note3. The package thermal impedance is calculated in accordance with JESD-51.

Electrical Characteristics (V_S = 5.5V, R_L = 10kΩ, V_{ICR} = V_S/2, V_{OUT} = V_S/2, T_A = 25℃ , unless otherwise)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
AC Specifications						
Gain-Bandwidth Product	GBW	T_A = 25°C	--	10	--	MHz
Slew Rate	SR	G = +1	--	5	--	V/μs
Input Voltage Noise Density	e_N	f = 1kHz	--	35	--	nV/ √ Hz
Input Voltage Noise	e_NP-P	f = 0.01Hz to 10Hz	--	0.75	--	μV_{P-P}
		f = 0.01Hz to 1Hz	--	0.22	--	μV_{P-P}
Channel Separation	V_{o1} / V_{o2}	V_S=2.7V to 5.5V	--	0.1	--	μV/V
DC Characteristics						
Operating Voltage Range	V_s	--	2.7	--	5.5	V
Input Offset Voltage	V_{OS}	V_{CM} = Vs/2	-5	±1.0	5	μV
Input Bias Current	I_B	V_{CM} = Vs/2	--	±50	--	pA
Input Offset Current	I_{OS}	V_{CM} = Vs/2	--	±10	--	pA
Open-Loop Voltage Gain	A_{OL}	R_L = 10KΩ, V_{OUT} = +0.3V to 4.7V	110	130	--	dB
Power Supply Rejection Ratio	PSRR	V_S=2.7V to 5.5V, V_{CM} = (-VS) + 0.5V	110	130	--	dB
Input Offset Voltage Average Drift	$\Delta V_{OS}/\Delta T$	--	--	0.005	0.05	μV/°C
Quiescent Current	I_Q	I_{OUT} = 0mA	--	700	--	μA
Input Characteristics						
Common-mode Input Voltage Range	V_{CMR}	V_S = 5.5V	(-V_S) – 0.1	--	(+V_S) + 0.1	V
Common Mode Rejection Ratio	CMRR	V_S = 5.5V, V_{CM} = -0.1 to 5.6V	110	130	--	dB
Input Differential Capacitance	--	--	--	1	-	pF
Input Common Capacitance	--	--	--	5	--	pF
Output Characteristics						
Short-Circuit Current	I_{SC}	--	--	±50	--	mA
Output Voltage Swing from Rail	V_{OH}	R_L = 100KΩ to GND	4.99	4.998	--	V
		R_L = 10KΩ to GND	4.95	4.98	--	V
	V_{OL}	R_L = 100KΩ to +V_S	--	1	10	mV
		R_L = 10KΩ to +V_S	--	10	30	mV
Overload Recovery Time	t_{OR}	--	--	1	--	μs

Typical Performance Characteristics(V_S = 5V, R_L = 10kΩ connected to V_S/2, V_{OUT} = V_S/2, T_A = 25℃)

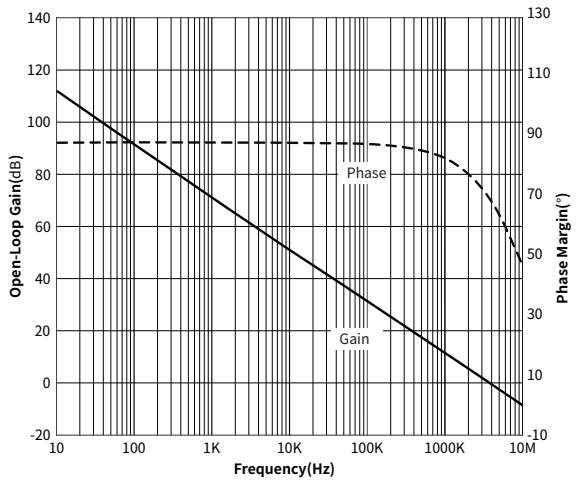


Fig.1 Open-Loop Gain and Phase vs. Frequency

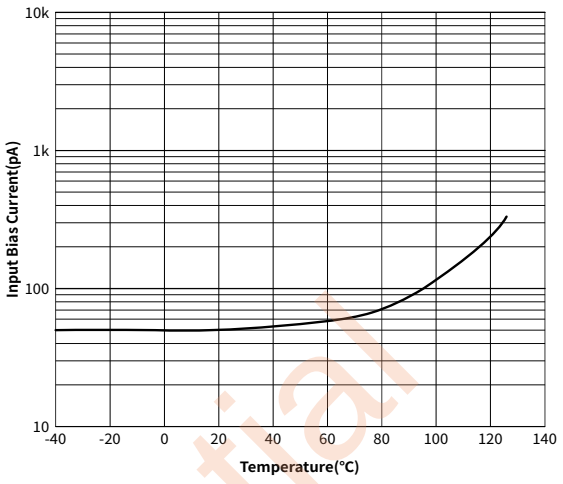


Fig.2 Input Bias Current vs. Temperature

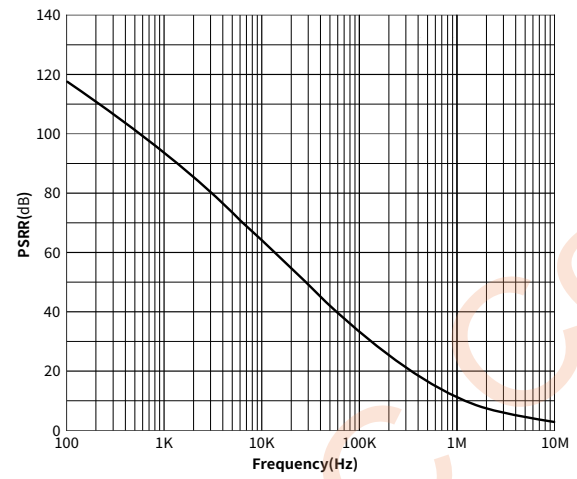


Fig.3 Power-Supply Rejection Ratio vs. Frequency

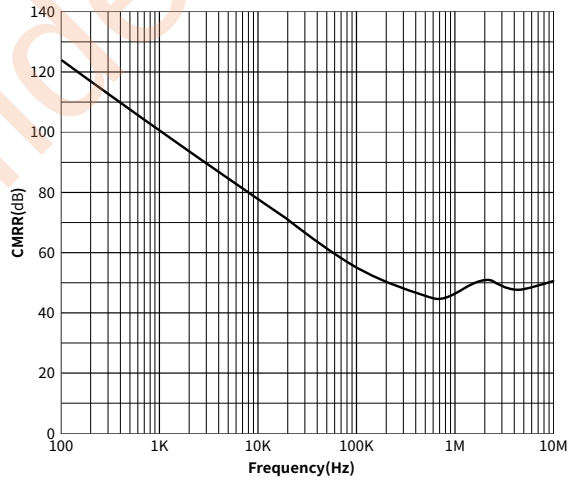


Fig.4 Common-Mode Rejection Ration vs. Frequency

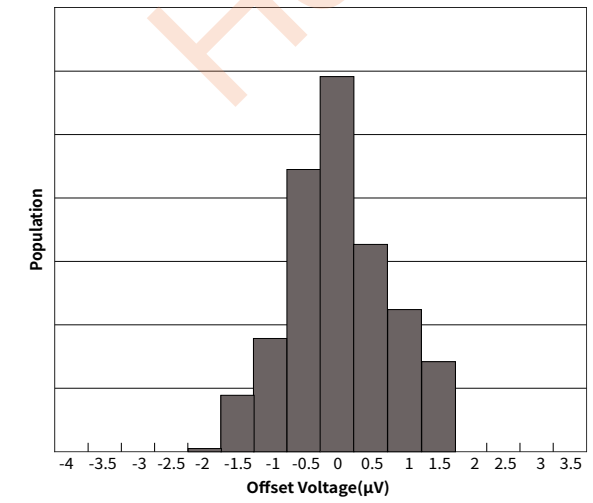


Fig.5 Offset Voltage Production Distribution

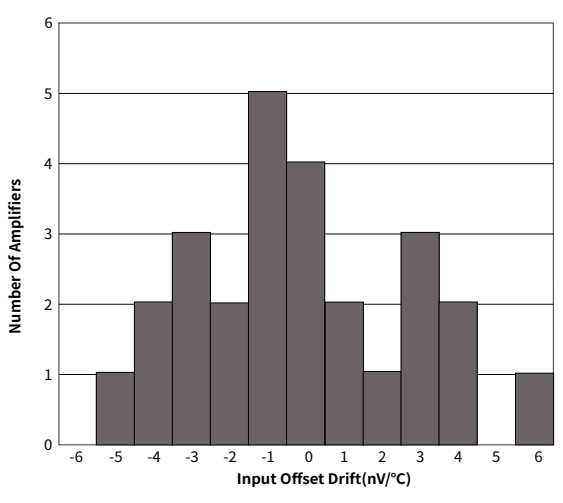


Fig.6 Offset Voltage Drift Production Distribution

Typical Performance Characteristics(V_S = 5V, R_L = 10kΩ connected to V_S/2, V_{OUT} = V_S/2, T_A = 25℃)

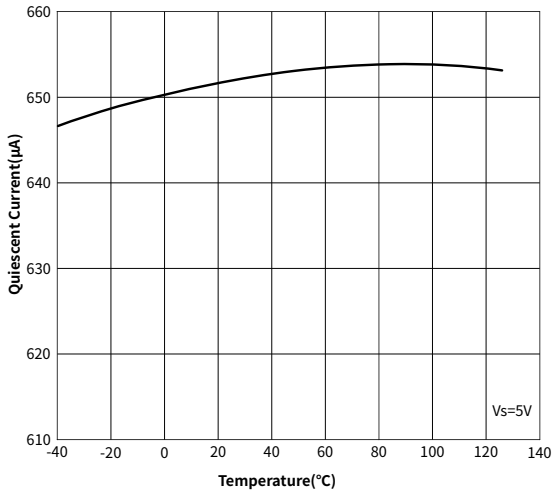


Fig.7 Quiescent Current vs. Temperature

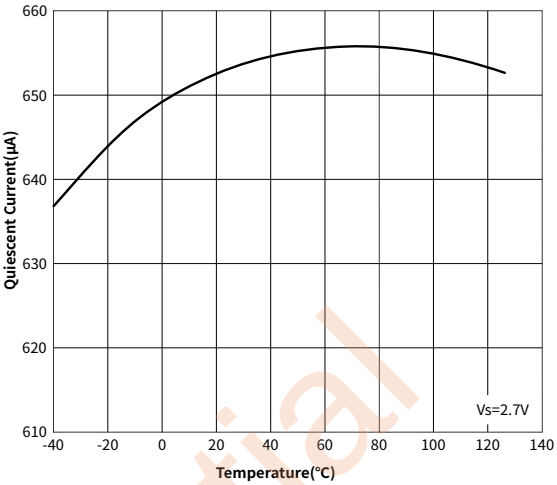


Fig.8 Quiescent Current vs. Temperature

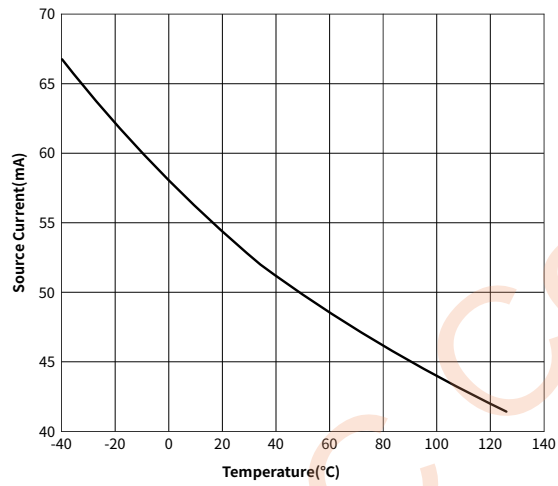


Fig.9 Source Current vs. Temperature

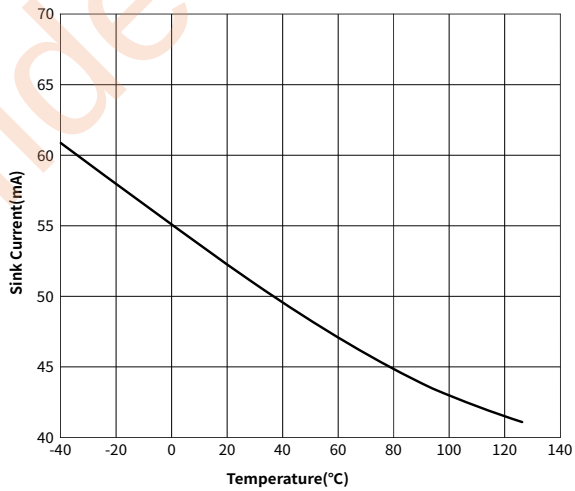


Fig.10 Sink Current vs. Temperature

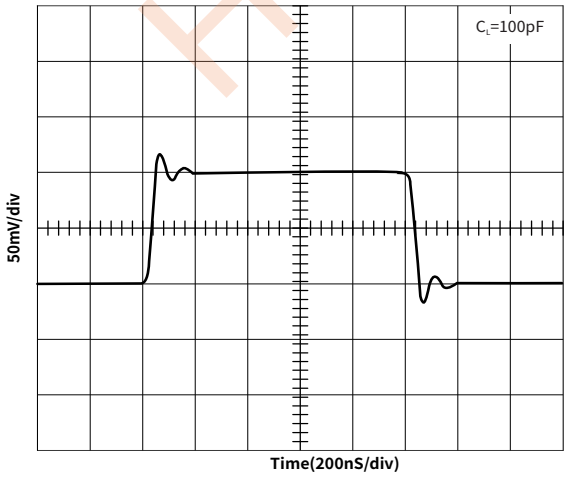


Fig.11 Small-Signal Step Response

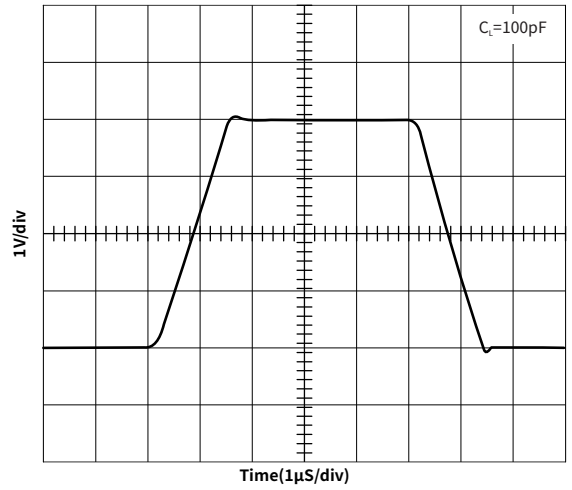


Fig.12 Large-Signal Step Response

Typical Performance Characteristics(V_S = 5V, R_L = 10kΩ connected to $V_S/2$, V_{OUT} = $V_S/2$, T_A = 25℃)

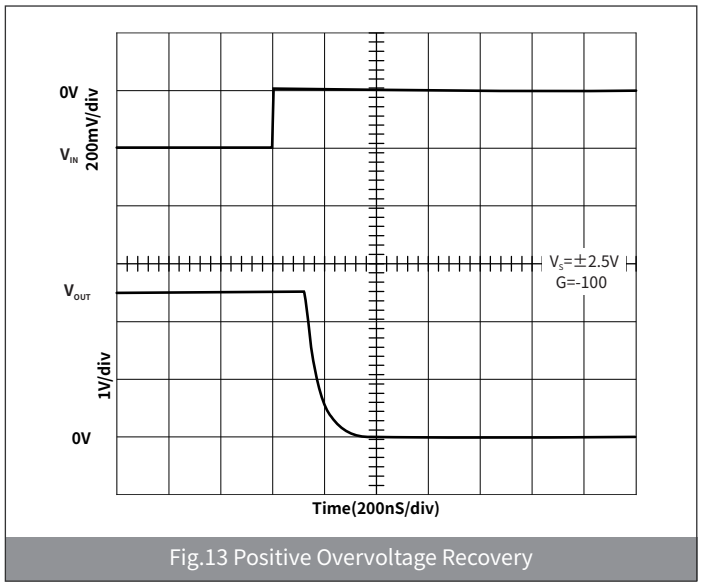


Fig.13 Positive Overvoltage Recovery

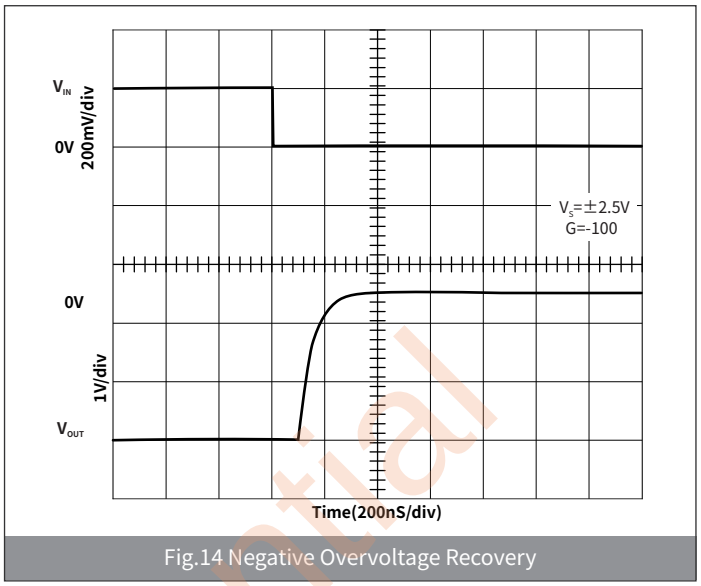


Fig.14 Negative Overvoltage Recovery

Application Summary

The HA8551, HA8552, HA8554 series opamps 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 0.1μF 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 0.1μV/° C or higher, depending on materials used.

Operating Voltage

The HA8551, HA8552, HA8554 series opamps operate over a power-supply range of +2.7V to +5.5V (±1.35V to ±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.

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 0.1μF 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 (electromagnetic-interference) susceptibility.

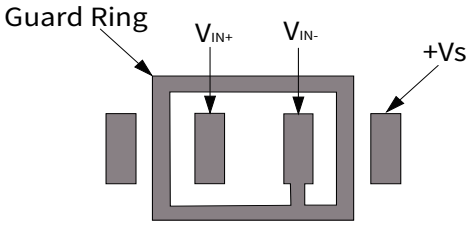
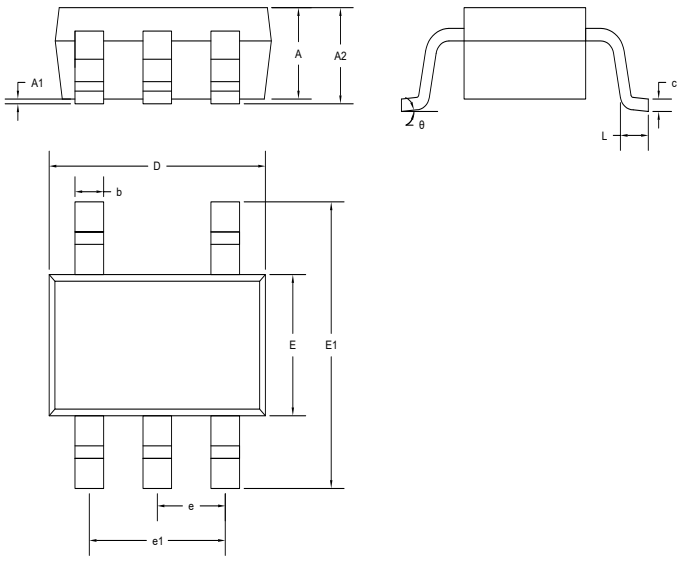


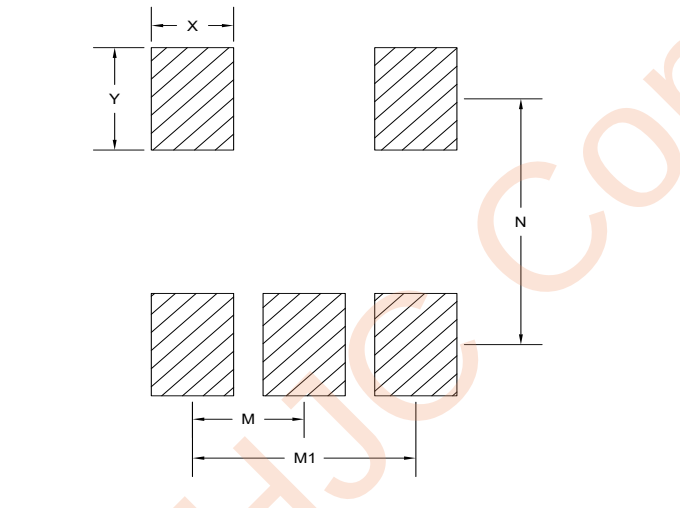
Figure 1.The Layout of Guard Ring

Package Outline Dimensions (SOT-23-5)



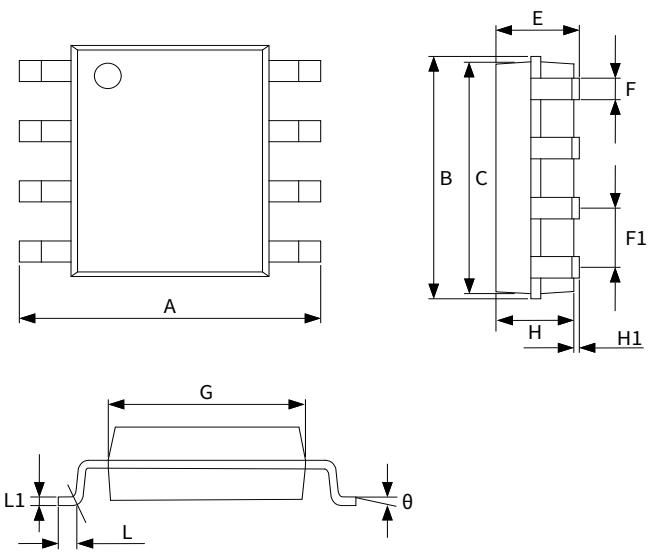
Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.05	1.25	0.041	0.049
A1	0	0.13	0.000	0.005
A2	1.05	1.15	0.041	0.045
b	0.3	0.5	0.012	0.020
c	0.10	0.2	0.004	0.008
D	2.82	3.02	0.111	0.119
E	1.50	1.70	0.059	0.067
E1	2.65	2.95	0.104	0.116
e	0.95 BSC		0.037BSC	
e1	1.90 BSC		0.075 BSC	
L	0.3	0.60	0.012	0.024
θ	0	8°	0	8°

Suggested Pad Layout



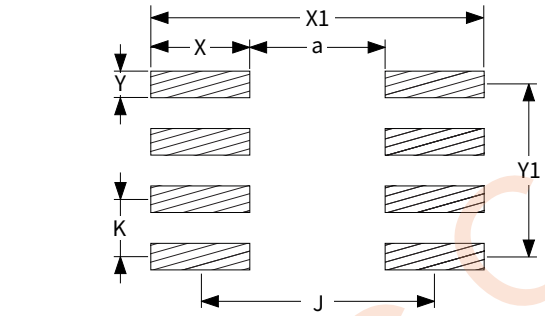
Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
X	0.85	0.85	0.033	0.033
Y	0.90	1.10	0.035	0.043
M	0.85	1.05	0.033	0.041
M1	1.80	2.0	0.071	0.079
N	2.3	2.5	0.091	0.098

Package Outline Dimensions (SOP-8)



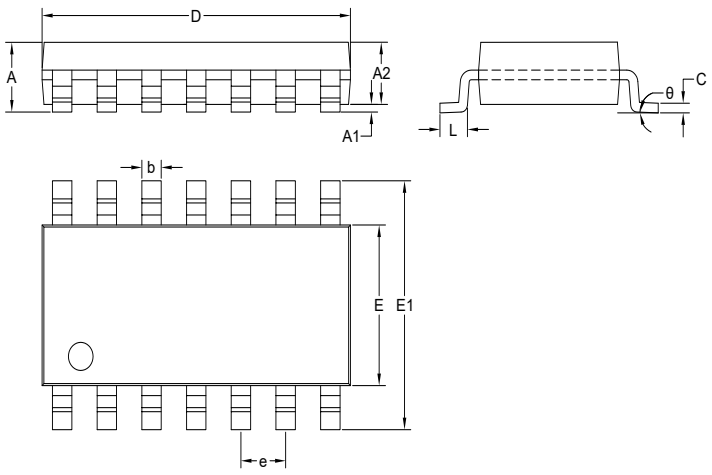
Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	5.70	6.30	0.224	0.248
B	5.13MAX.		0.202MAX.	
C	4.72	5.12	0.186	0.201
E	1.80MAX.		0.071MAX.	
F	0.31	0.51	0.0122	0.020
F1	1.27TYP.		0.050TYP.	
G	3.75	4.15	0.148	0.163
H	1.35	1.65	0.053	0.065
H1	0.1	0.25	0.004	0.010
L	0.3	0.7	0.012	0.028
L1	0.21TYP.		0.008TYP.	
θ	-	8°	-	8°

Suggested Pad Layout



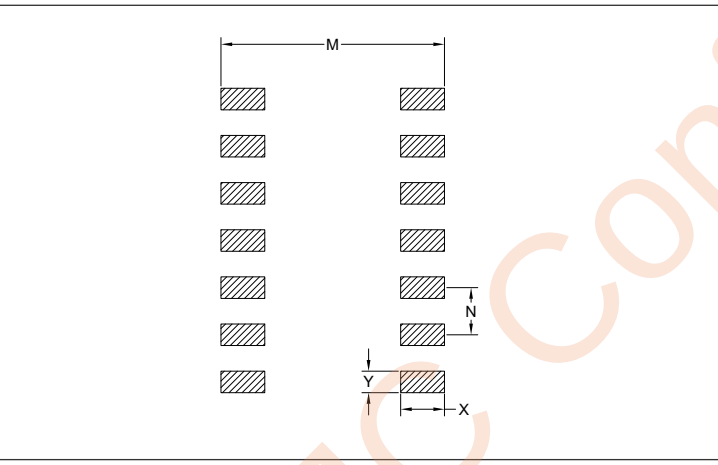
Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
a	2.90	3.10	0.114	0.122
J	5.10	5.30	0.201	0.209
K	1.17	1.37	0.046	0.054
X	2.10	2.30	0.083	0.091
X1	7.30	7.50	0.287	0.295
Y	0.50	0.70	0.020	0.028
Y1	3.71	3.91	0.146	0.154

Package Outline Dimensions (SOP-14)



Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.35	1.55	0.053	0.061
b	0.33	0.51	0.013	0.020
c	0.17	0.25	0.007	0.010
D	8.36	8.76	0.329	0.345
E	3.80	4.00	0.150	0.157
E1	5.80	6.20	0.228	0.244
e	1.27BSC		0.050BSC	
L	0.40	1.27	0.016	0.050
θ	0°	8°	0°	8°

Suggested Pad Layout



Symbol	Dimensions			
	Millimeters		Inches	
	Min.	Max.	Min.	Max.
X	-	1.18	-	0.046
Y	-	0.58	-	0.023
N	-	1.27	-	0.050
M	-	6.5	-	0.256