

Zero-Drift, Rail-to-Rail I/O CMOS Operational Amplifiers**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: $0.17\text{V}/\mu\text{s}$
- * Low Noise: $1.6\mu\text{Vp-p}$ (0.01~10Hz)
- * Low Power Consumption: 60uA/op amp
- * Overload Recovery Time: 6 μs
- * Low Supply Voltage: +2.3 V to +5.5 V
- * No External Capacitors Required
- * Operating Temperature: -40°C to $+125^\circ\text{C}$

Applications

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

General Description

The HCR8511/HCR8512/HCR8514 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 $0.17\text{V}/\mu\text{s}$.

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 HCR8511/HCR8512/HCR8514 are specified for the extended industrial and automotive temperature range (-40°C to 125°C). The HCR8511(single) amplifier is available in SOT23-5 packages, The HCR8512(dual) amplifier is available in SOIC-8 and MSOP8 packages. The HCR8514(quad) amplifier is available in SOIC-14 packages.



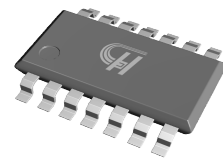
SOT23-5



MSOP-8



SOIC-8(SOP-8)



SOIC-14(SOP-14)

Figure 1. Package Type of HCR8511/HCR8512/HCR8514

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

Pin Configuration

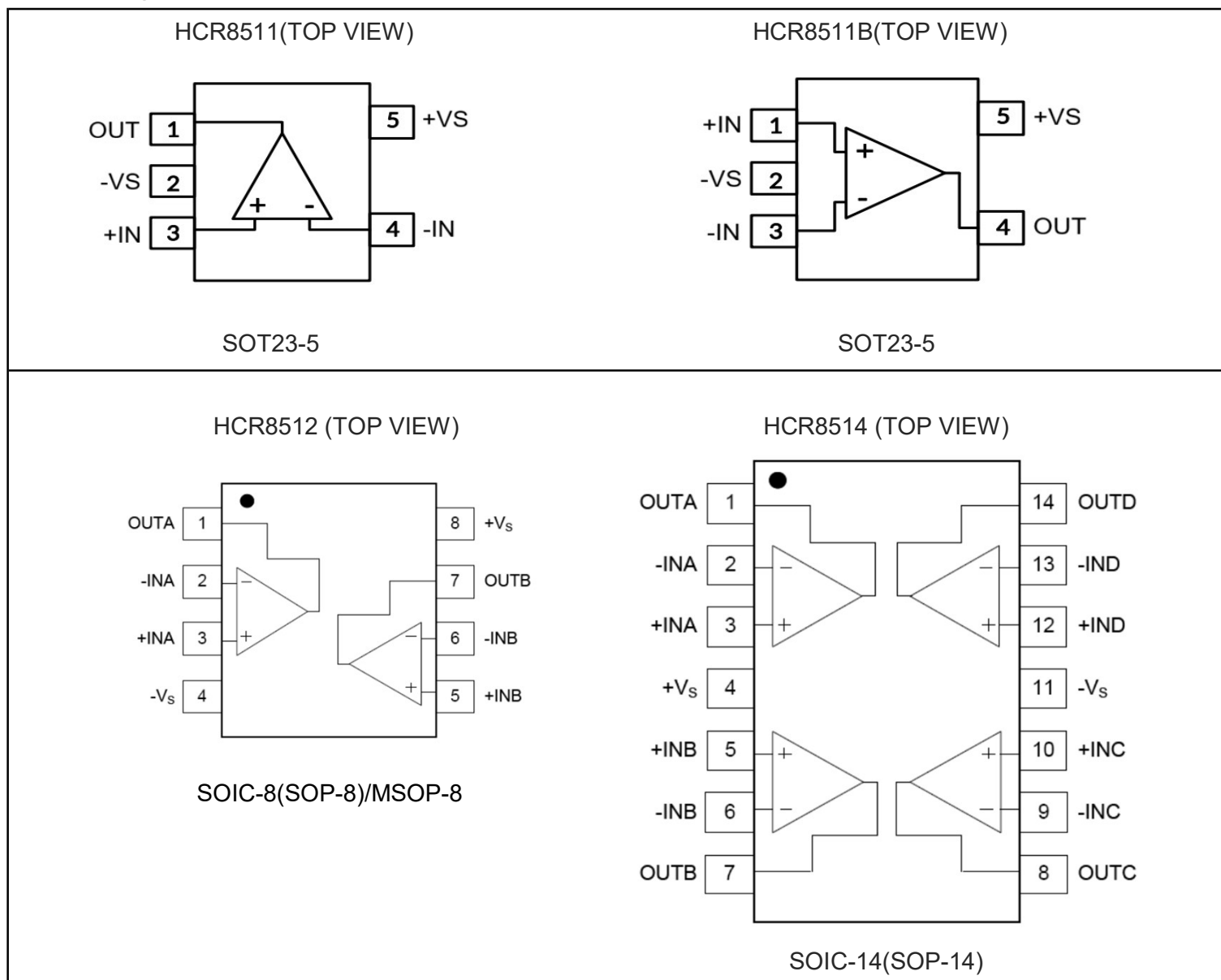
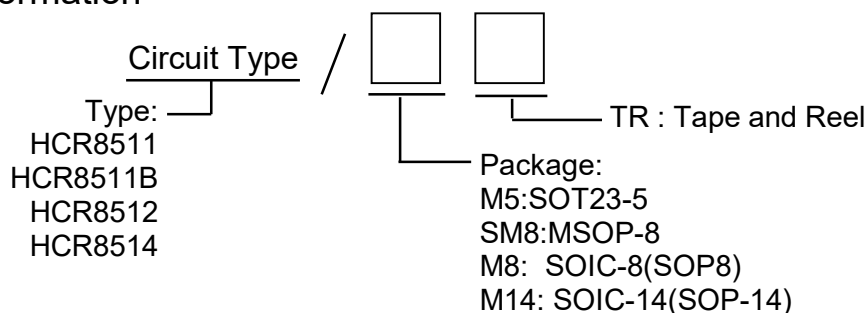


Figure 2. Pin Configuration of HCR8511/HCR8512/HCR8514(Top View)

Pin Function Table

Name	Function
+IN, +INA, +INB, +INC, +IND	Non-inverting Inputs
-IN, -INA, -INB, -INC, -IND	Inverting Inputs
+Vs	Positive(highest) Power Supply
-Vs	Negative(lowest) Power Supply
OUT, OUTA, OUTB, OUTC, OUTD	Outputs

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

Ordering Code

Part Number	Channel	Marking ⁽¹⁾	Op Temp('C)	MSL ⁽²⁾	Package	Package Qty
HCR8511/M5TR	1	8511	-40'C to +125'C	MSL3	SOT23-5	3000pcs/TR
HCR8511B/M5TR	1	8511B	-40'C to +125'C	MSL3	SOT23-5	3000pcs/TR
HCR8512/SM8TR	2	HCR8512xx	-40'C to +125'C	MSL3	MSOP-8	3000pcs/TR
HCR8512/M8TR	2	HCR8512xx	-40'C to +125'C	MSL3	SOIC-8 (SOP-8)	4000pcs/TR
HCR8514/M14TR	4	HCR8514xx	-40'C to +125'C	MSL3	SOIC-14 (SOP-14)	2500pcs/TR

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.

2: HCRSEMI classify the MSL level with using the common preconditioning setting in our assembly factory conforming to the JEDEC industrial standard J-STD-20F. Please align with HCRSEMI if your end application is quite critical to the preconditioning setting or if you have special requirement.

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

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

Parameter		Symbol	Min.	Max.	Unit
Supply Voltage, +Vs to -Vs		V+	-	7	V
Signal Input Voltage		V _{IN}	(V ₋)-0.5	(V ₊)+0.5	V
Signal Output Voltage		V _{out}	(V ₋)-0.5	(V ₊)+0.5	V
Signal Input Current		I _{IN}	-10	+10	mA
Signal Output Current		I _O	-55	+55	mA
Output Short-circuit ⁽³⁾		-	Continuous		
Thermal Resistance ⁽⁴⁾ @T _A =+25°C	SOT23-5	θ _{JA}	-	230	'C/W
	SOIC-8	θ _{JA}	-	110	'C/W
	MSOP-8	θ _{JA}	-	170	'C/W
	SOIC-14	θ _{JA}	-	105	'C/W
Storage Temperature Range		T _{STG}	-65 to +150		'C
Operating Temperature Range ^{note 2}		T _A	-40 to +125		'C
Junction Temperature ⁽⁵⁾		T _J	+150		'C
Lead Temperature (Soldering, 10s)		T _{LEAD}	260		'C
Human Body Model ESD Protection		ESD HBM	±5		KV
Machine Model ESD Protection		ESD MM	±400		V

Note 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. Short-circuit to ground, one amplifier per package.

4. The package thermal impedance is calculated in accordance with JEDEC-51.

5. 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 $PD = (T_{J(MAX)} - T_A) / R_{\theta JA}$. All numbers apply for packages soldered directly onto a PCB.

Recommended Operating Conditions

Parameter		Symbol	Min.	Max.	Unit
Supply Voltage, +Vs to -Vs	Signal-supply	V _{IN}	2.3	5.5	V
	Dual-supply		±1.15	±2.75	V
Operating Temperature Range		T _a	-40	+125	'C

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

(TA=25 °C, VS=+5.5V, RL=10KΩ connected to VS/2V, and VOUT=VS/2. VCM=VS/2, Unless Otherwise Specified.)

Parameter	Symbol	Conditions	Min	Type	Max	Unit
Offset Voltage						
Input Offset Voltage	Vos	VCM=VS/2	-40	±7	40	uV
Input Offset Voltage Average Drift	ΔVos/ΔT	-	-	0.05	0.2	uV/°C
Power Supply Rejection Ratio	PSRR	VS=2.3V to 5.5V, VCM=0	110	130	-	dB
Channel Separation, dc		VS=2.3V to 5.5V	-	0.1	-	uV/V
Input Bias Current:						
Input Bias Current:	IB	VCM=VS/2	-	±50	-	pA
Input Offset Current:	Ios	VCM=VS/2	-	±10	-	pA
Input Voltage Range						
Common-Mode Voltage Range	VCM	-	(V-)-0.1	-	(V+)+0.1	V
Common Mode Rejection Ratio	CMRR	(V-)-0.1V<VCM<(V+)+0.1V	110	130	-	dB
Input Capacitance						
Input differential capacitance			-	1	-	pF
Input common capacitance			-	5	-	pF
Output Characteristics						
Open-Loop Voltage Gain	AOL	RL=10KΩ, Vo=0.3V to 4.7V	110	130	-	dB
Output Voltage High	VOH	RL=100KΩ to GND	4.99	4.998	-	V
		RL=10KΩ to GND	4.95	4.98	-	V
Output Voltage Low	VOL	RL=100KΩ to V+	-	1	10	mV
		RL=10KΩ to V+	-	10	30	mV
Short-Circuit Current	ISHRT	-	-	±25	-	mA
Power Supply						
Operating Voltage Range	VS		2.3	-	5.5	V
Quiescent Current per Amplifier	IQ	IOUT=0mA	-	60	87	uA
Dynamic Performance						
Gain Bandwidth Product	GBW	-	-	350	-	KHz
Slew Rate	SR	G=+1	-	0.17	-	V/uS
Overload Recovery Time	tor	-	-	6	-	us
Noise Performance						
Input Voltage Noise	enp-p	f=0.01Hz to 10Hz	-	1.6	-	uVpp
		f=0.01Hz to 1Hz	-	0.48	-	uVpp
Input Voltage Noise Density	en	f=1KHz	-	70	-	nV/√Hz

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

Typical Performance Characteristics.

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

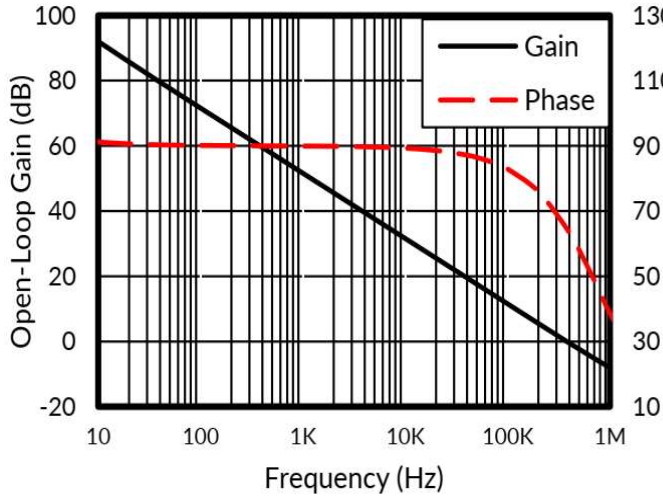


Figure 3. Open-Loop Gain and Phase vs Frequency

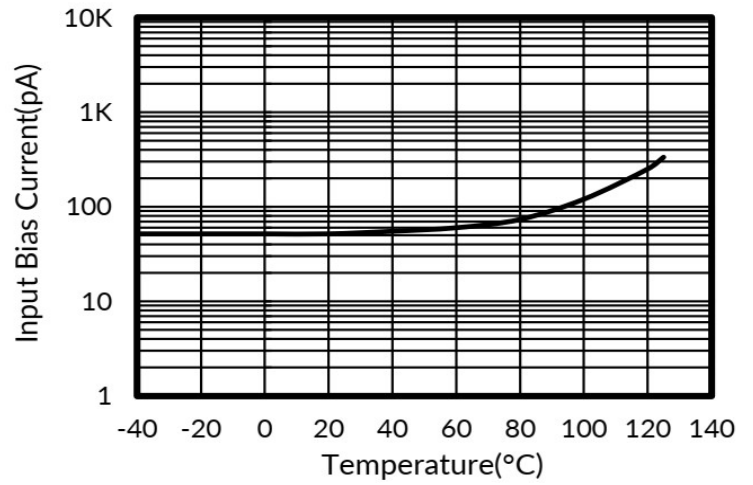


Figure 4. Input Bias Current vs Temperature

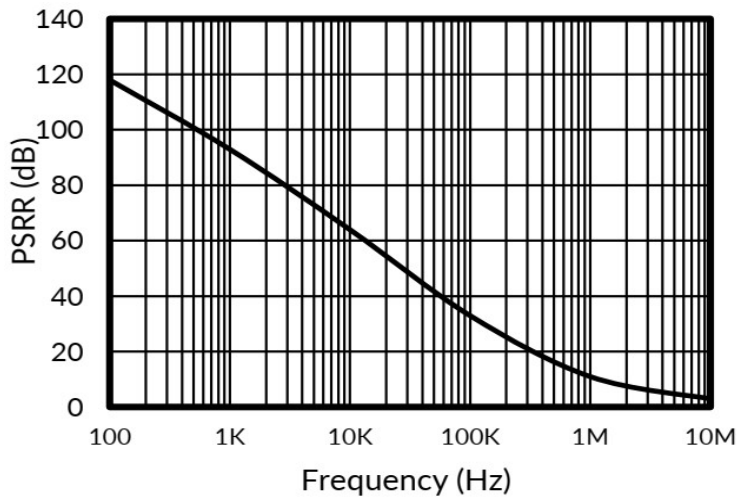


Figure 5. Power-Supply Rejection Ratio vs Frequency

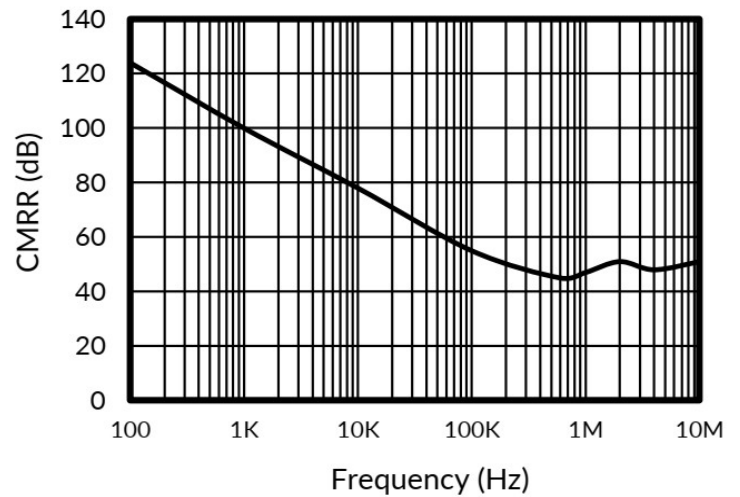


Figure 6. Common-Mode Rejection Ratio vs Frequency

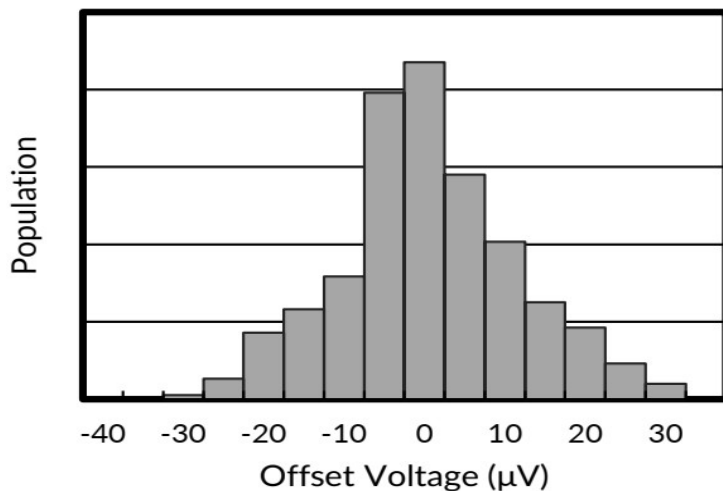


Figure 7. Offset Voltage Production Distribution

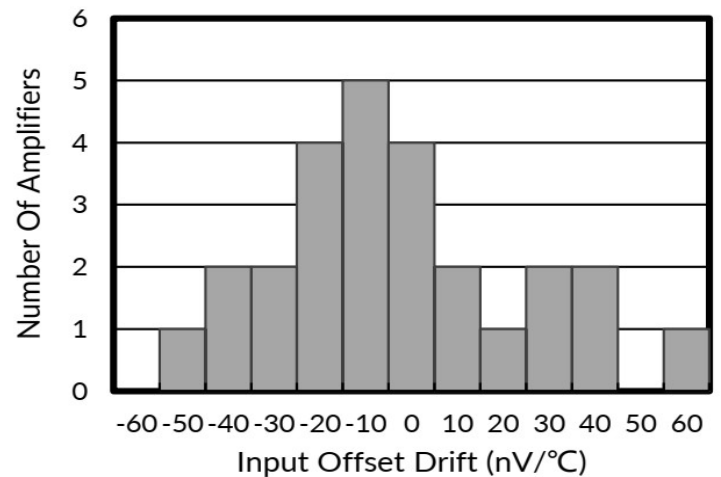


Figure 8. Offset Voltage Drift Production Distribution

Zero-Drift, Rail-to-Rail I/O CMOS Operational Amplifiers
Typical Performance Characteristics(Con.)

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

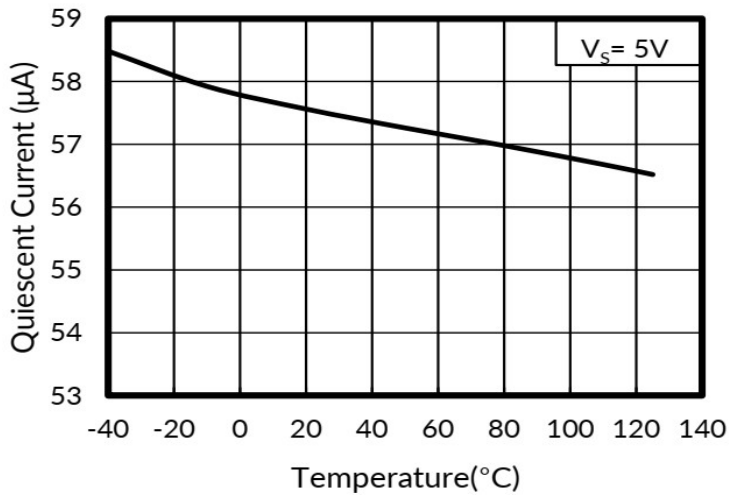


Figure 9. Quiescent Current vs Temperature

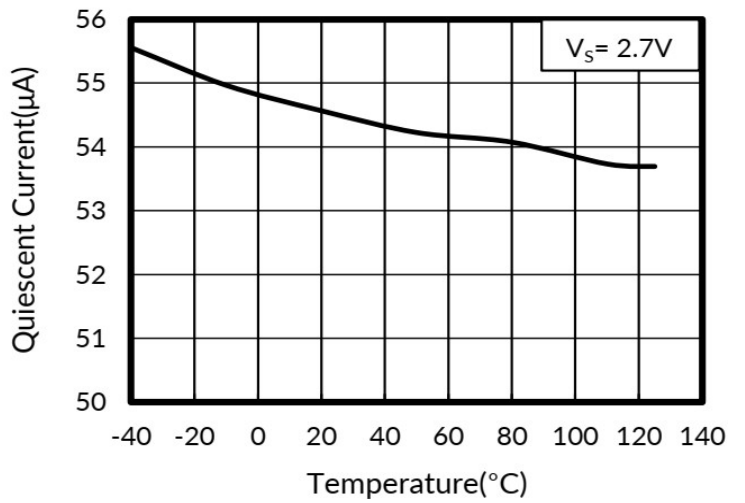


Figure 10. Quiescent Current vs Temperature

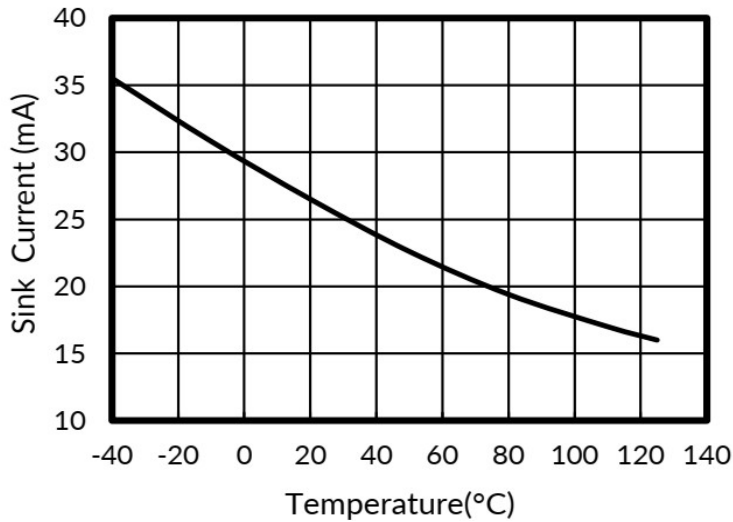


Figure 11. Source Current vs Temperature

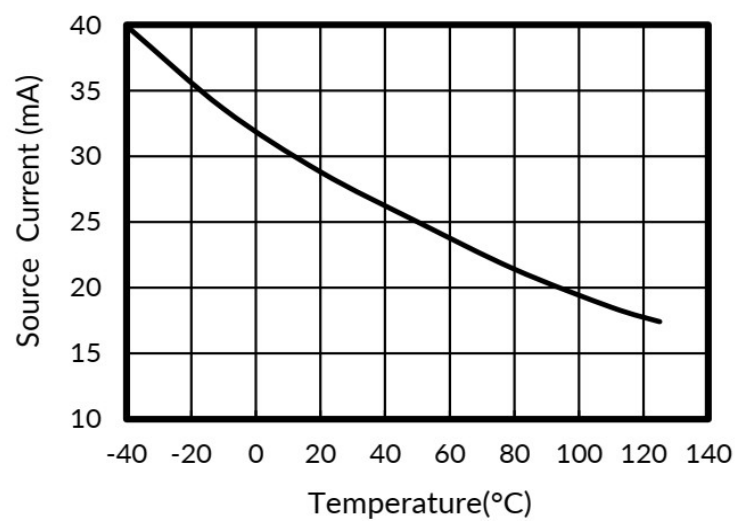


Figure 12. Sink Current vs Temperature

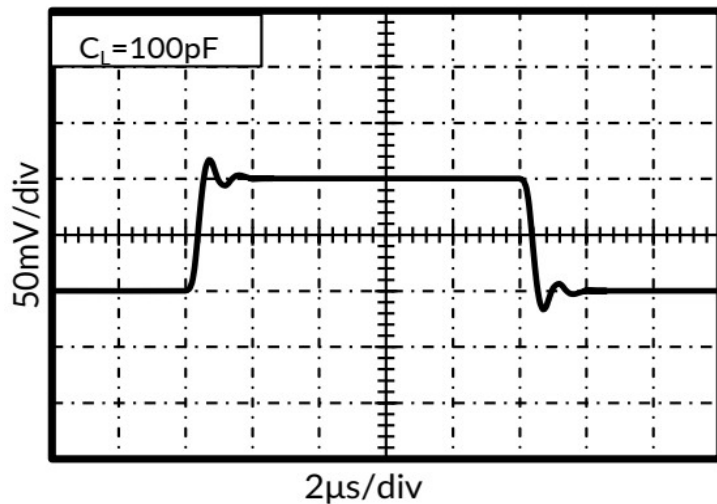


Figure 13. Small-Signal Step Response

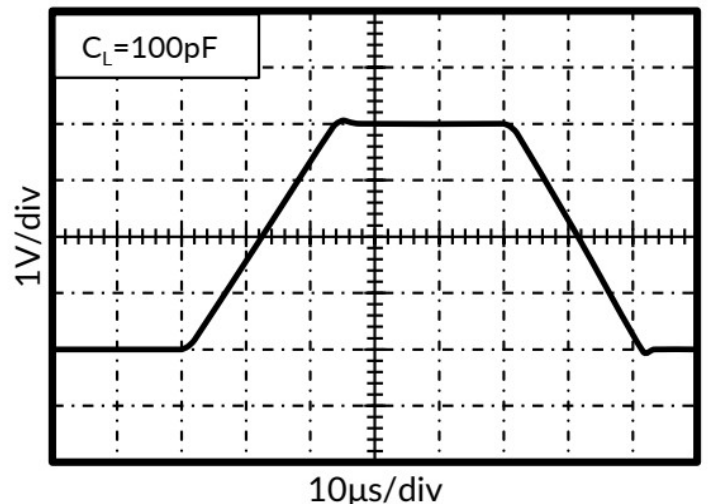


Figure 14. Large-Signal Step Response

Zero-Drift, Rail-to-Rail I/O CMOS Operational Amplifiers
Typical Performance Characteristics(Con.)

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

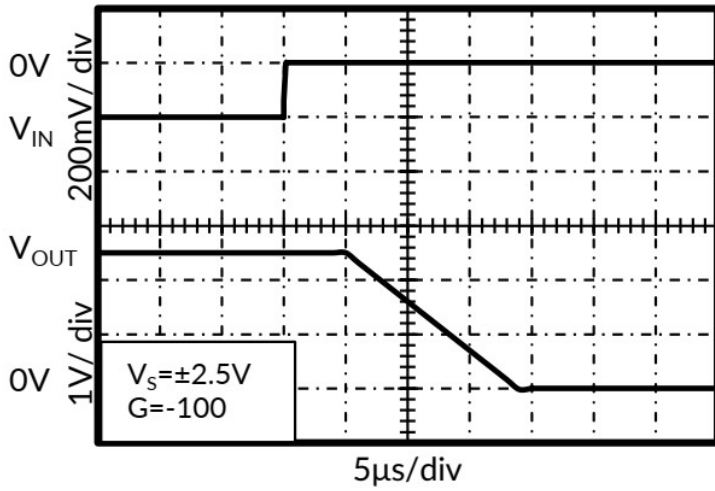


Figure 15. Positive Overvoltage Recovery

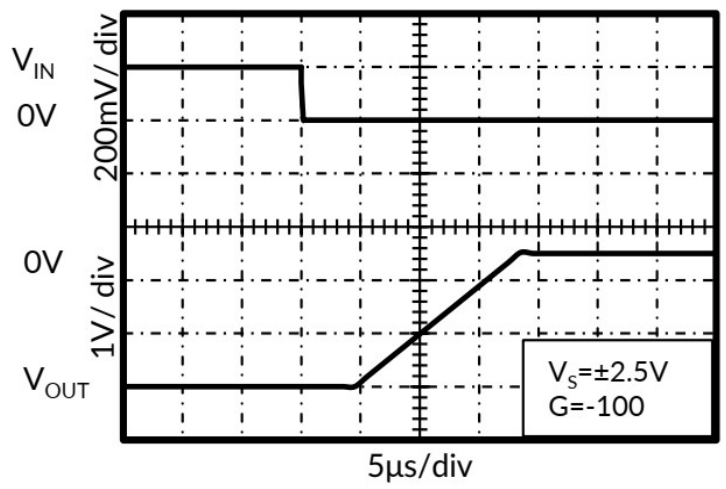


Figure 16. Negative Overvoltage Recovery

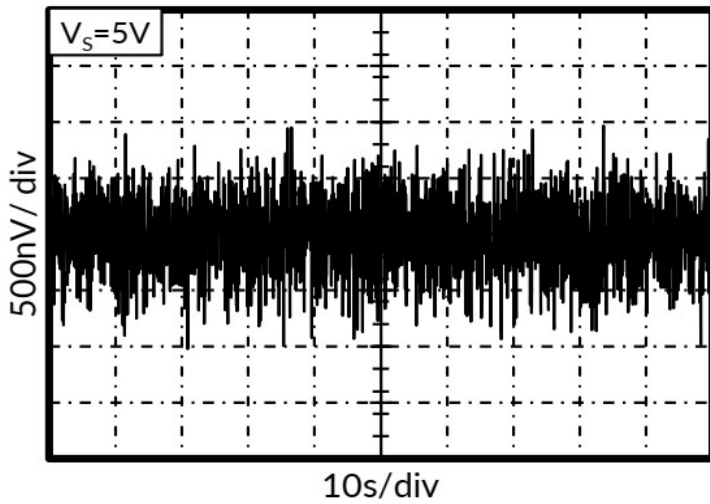


Figure 17. 0.01Hz to 10Hz Noise

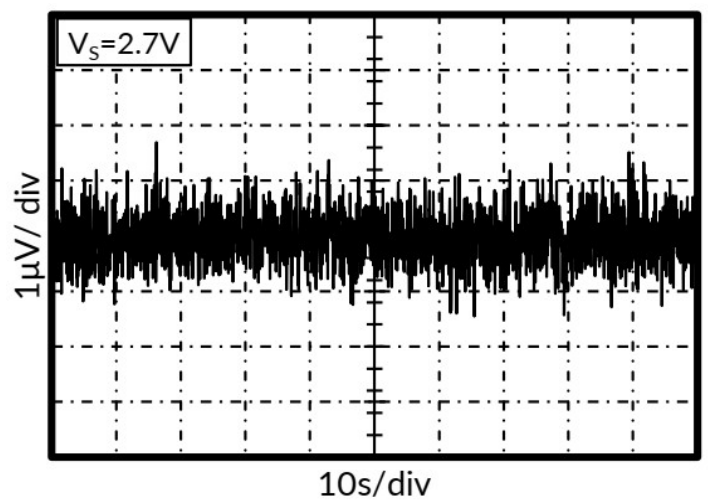


Figure 18. 0.01Hz to 10Hz Noise

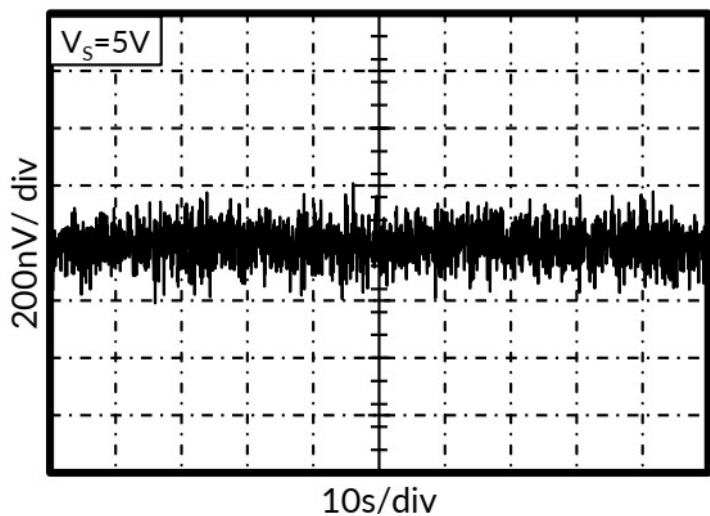


Figure 19. 0.01Hz to 1Hz Noise

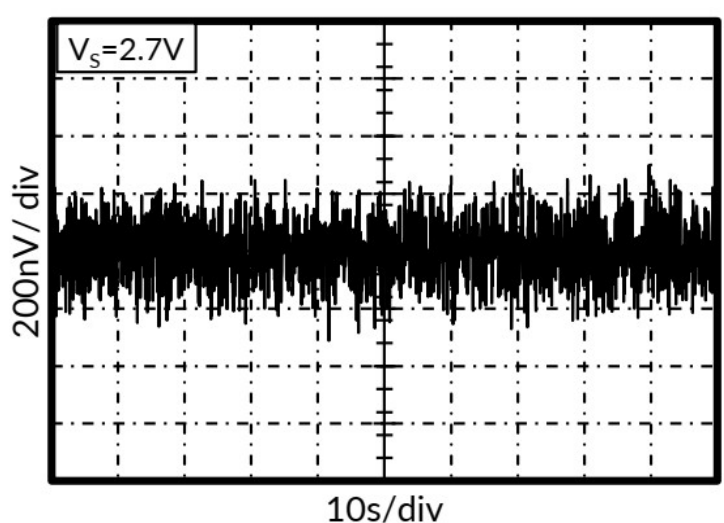


Figure 20. 0.01Hz to 1Hz Noise

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

Detailed Description

The HCR8511/HCR8512/HCR8514 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 0.1 μ F 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 0.1 μ V/ $^{\circ}$ C or higher, depending on materials used.

Operating Voltage

The HCR8511/HCR8512/HCR8514 series op amps operate over a power-supply range of +2.3V to +5.5V (± 1.15 V to ± 2.75 V). 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 Information

Layout Guidelines

Attention to good layout practices is always recommend. 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 μ 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

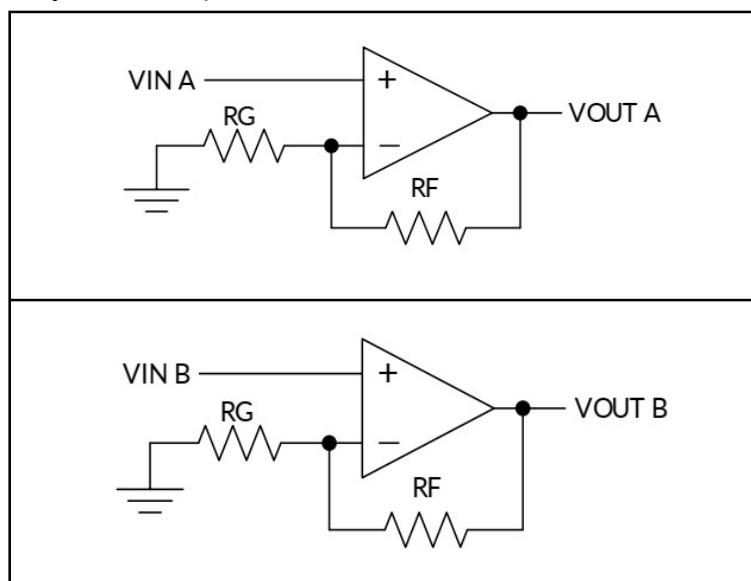
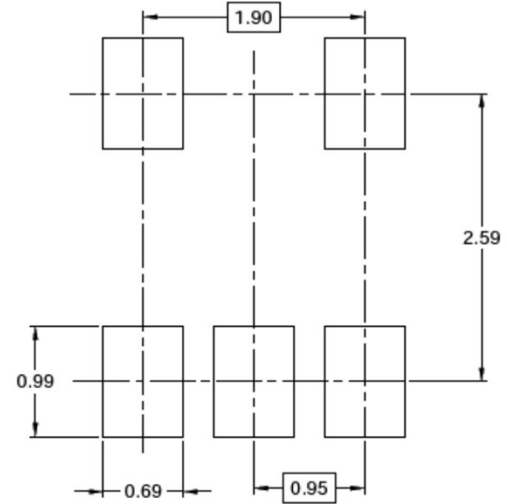
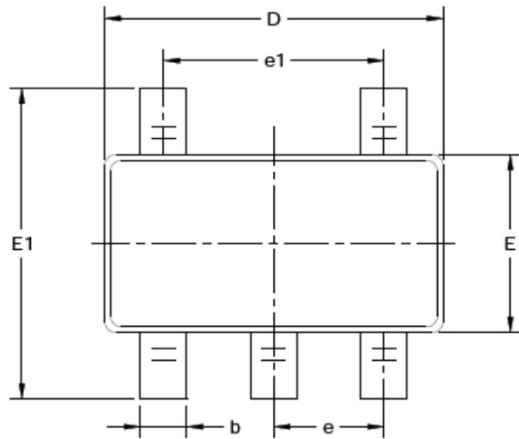
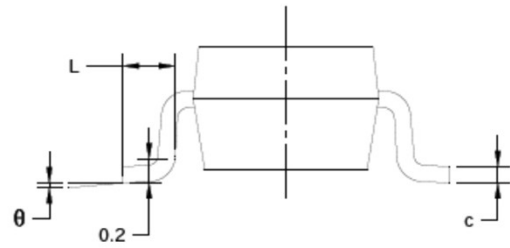
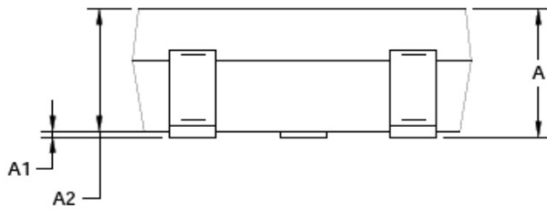


Figure 21. Schematic Representation

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

M5: SOT23-5 package


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	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

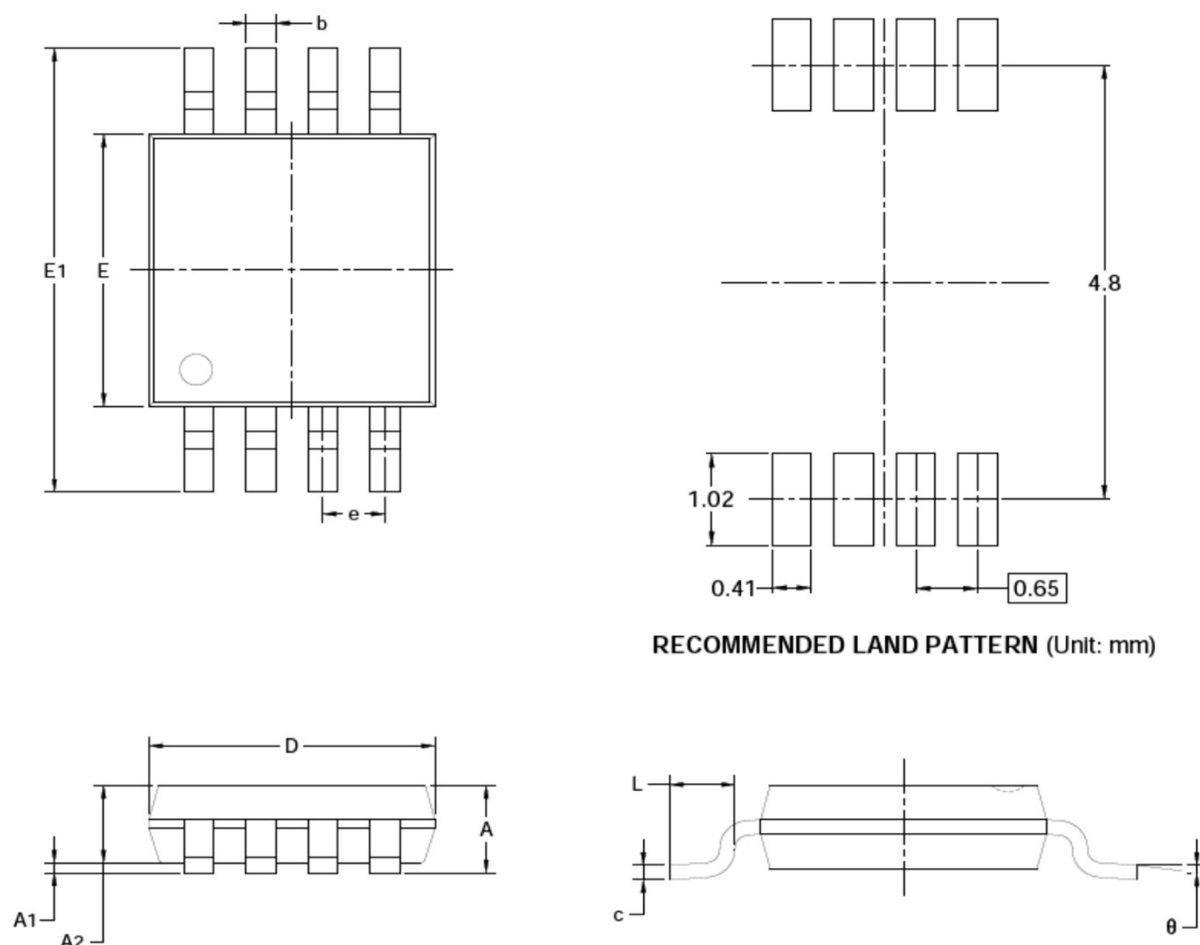
NOTES:

1. Body dimensions do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

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

Mechanical Dimensions(Con.)

SM8: MSOP-8 Package



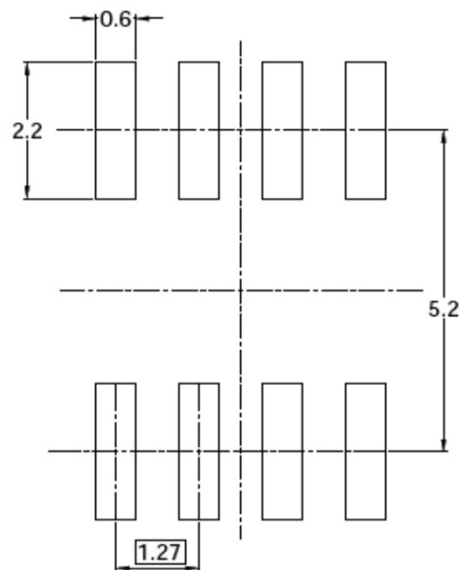
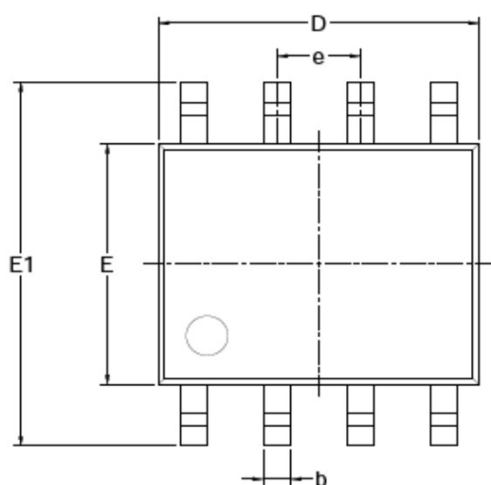
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

NOTES:

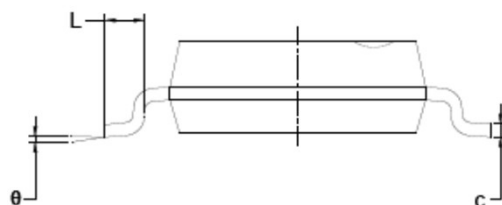
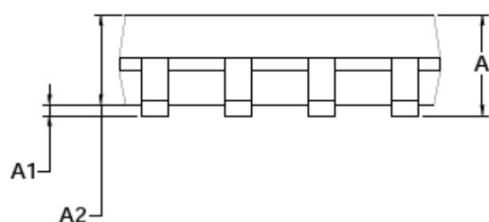
1. Body dimensions do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

Zero-Drift, Rail-to-Rail I/O CMOS Operational Amplifiers
Mechanical Dimensions(Con.)

M8: SOIC-8(SOP-8) Package



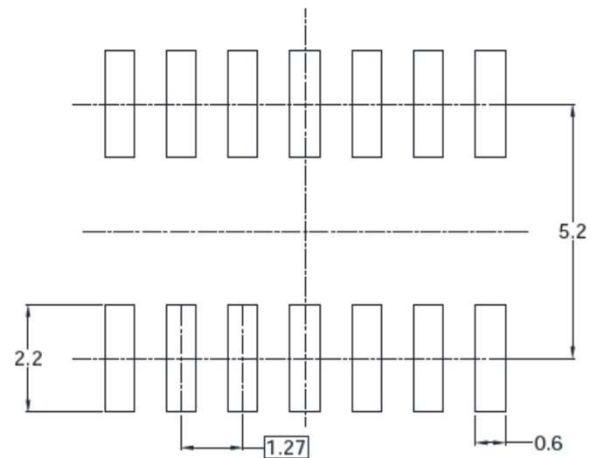
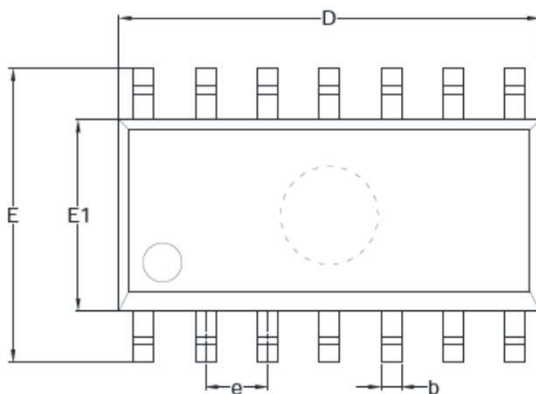
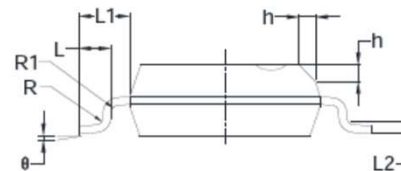
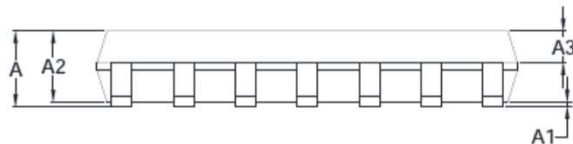
RECOMMENDED LAND PATTERN (Unit: mm)



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	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

NOTES:

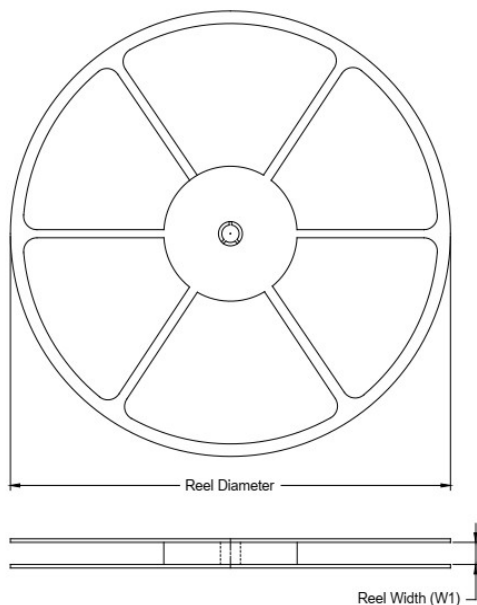
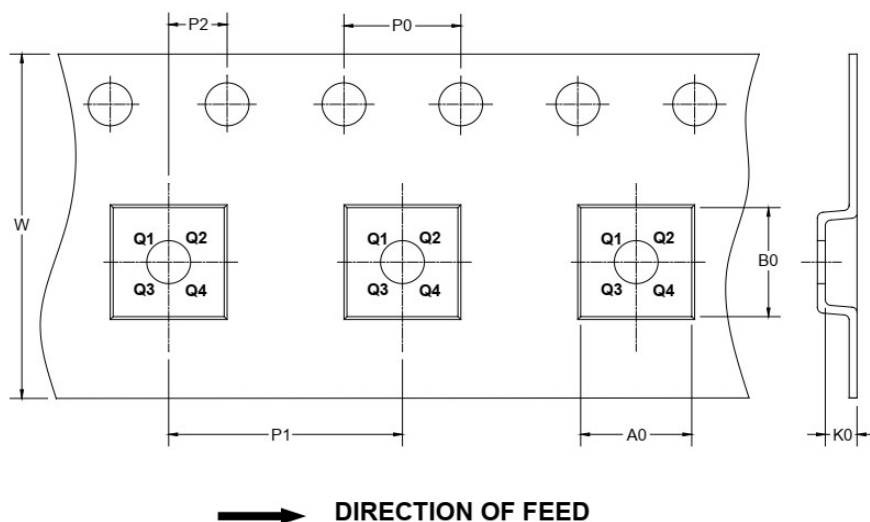
1. Body dimensions do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

Zero-Drift, Rail-to-Rail I/O CMOS Operational Amplifiers
Mechanical Dimensions(Con.)
M14: SOIC-14 Package

RECOMMENDED LAND PATTERN (Unit: mm)


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80	0.018	0.032
L1	1.04 REF		0.040 REF	
L2	0.25 BSC		0.01 BSC	
R	0.07		0.003	
R1	0.07		0.003	
h	0.30	0.50	0.012	0.020
θ	0°	8°	0°	8°

NOTES:

1. Body dimensions do not include mold flash or protrusion.
2. This drawing is subject to change without notice.

Zero-Drift, Rail-to-Rail I/O CMOS Operational Amplifiers
Tape and Reel Information
REEL DIMENSIONS

TAPE DIMENSIONS


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

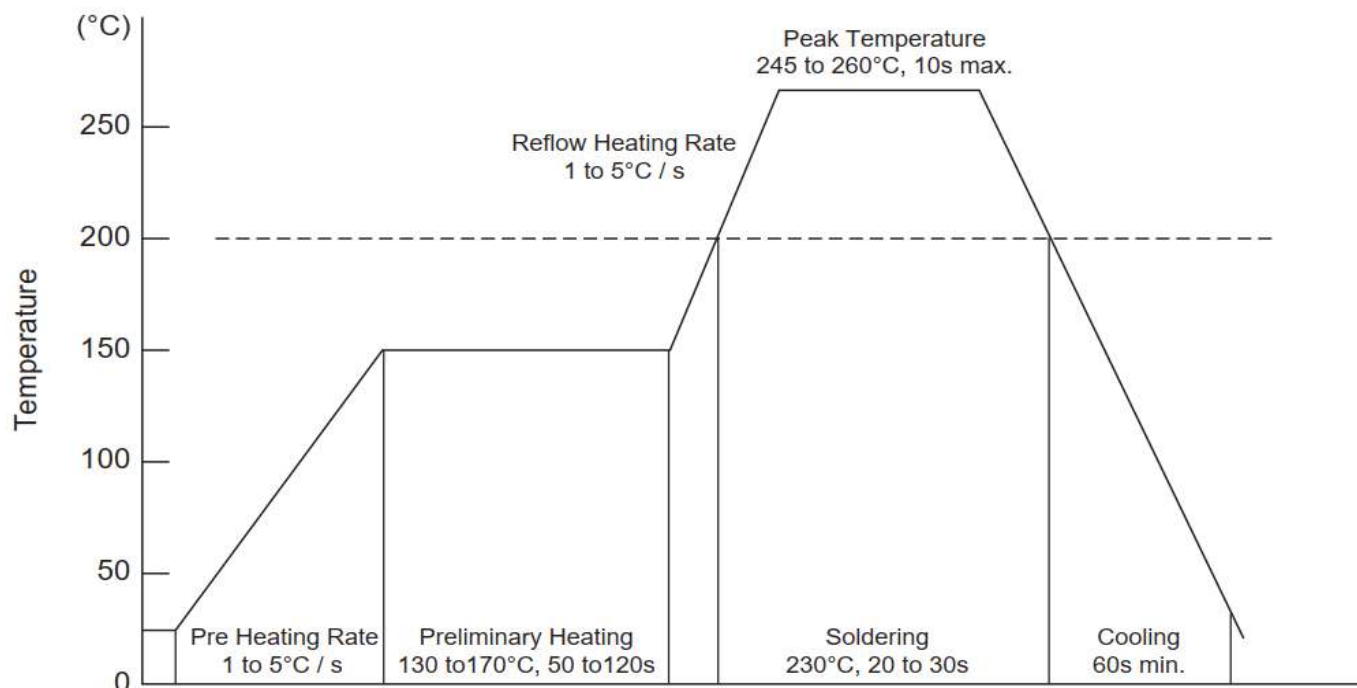
KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOT-23-5	7"	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
SOIC-8	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	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1

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

Conditions of Soldering and Storage

- * Recommended condition of reflow soldering



Recommended peak temperature is over 245°C, if peak temperature is below 245°C, you may adjust the following parameters:

- * Time length of peak temperature (longer)
 - * Time length of soldering (longer)
 - * Thickness of solder paste (thicker)
- * Conditions of hand soldering
 - * Temperature : 300°C
 - * Time : 3s max
 - * Times : one time
 - * Storage conditions
 - * Temperature
5 to 40°C
 - * Humidity
30 to 80% RH
 - * Recommended period
One year after manufacturing