

# SGM8249-4

## 8MHz, High Voltage, High Precision, Low Noise, Rail-to-Rail Output Operational Amplifier

---

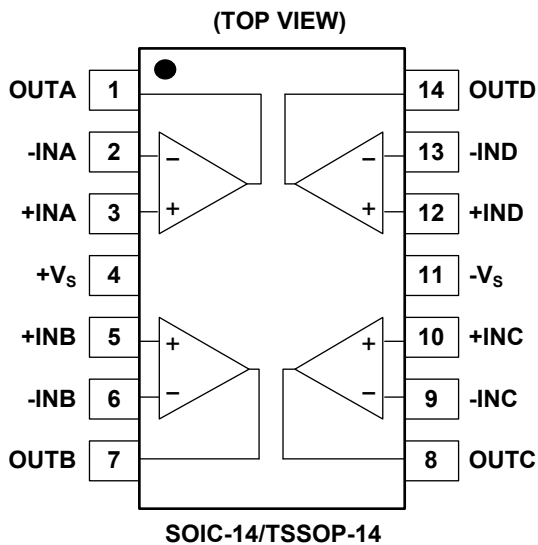
### GENERAL DESCRIPTION

The SGM8249-4 is a rail-to-rail output, low noise and high precision operational amplifier which has low input offset voltage and bias current. This device can operate from  $\pm 2.25V$  to  $\pm 18V$  dual power supplies or from 4.5V to 36V single supply.

The rail-to-rail output swing provided by the SGM8249-4 makes both high-side and low-side sensing easy. The combination of these characteristics makes the SGM8249-4 a good choice for temperature, position and pressure sensors, medical equipment and strain gauge amplifiers, or any other 4.5V to 36V application requiring precision and long term stability.

The SGM8249-4 is available in Green SOIC-14 and TSSOP-14 packages. It is specified over the extended  $-40^{\circ}C$  to  $+125^{\circ}C$  temperature range.

### PIN CONFIGURATIONS



### FEATURES

- **Low Offset Voltage:** 2 $\mu$ V (TYP), 12 $\mu$ V (MAX)
- **Rail-to-Rail Output Swing**
- **Support Single or Dual Power Supplies:** 4.5V to 36V or  $\pm 2.25V$  to  $\pm 18V$
- **Open-Loop Voltage Gain:** 150dB (TYP)
- **PSRR:** 150dB (TYP)
- **CMRR:** 140dB (TYP)
- **Input Voltage Noise Density:** 12nV/ $\sqrt{Hz}$  at 1kHz
- **Gain-Bandwidth Product:** 8MHz
- **Low Supply Current:** 3.2mA (TYP)
- **Overload Recovery Time:** 0.7 $\mu$ s
- **$-40^{\circ}C$  to  $+125^{\circ}C$  Operating Temperature Range**
- **Available in Green SOIC-14 and TSSOP-14 Packages**

### APPLICATIONS

- Temperature Measurements
- Pressure Sensors
- Precision Current Sensing
- Electronic Scales
- Strain Gauge Amplifiers
- Medical Instrumentation
- Thermocouple Amplifiers
- Handheld Test Equipment

# 8MHz, High Voltage, High Precision, Low Noise, SGM8249-4 Rail-to-Rail Output Operational Amplifier

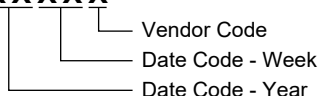
## PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8249-4	SOIC-14	-40°C to +125°C	SGM8249-4XS14G/TR	SGM82494XS14 XXXXX	Tape and Reel, 2500
	TSSOP-14	-40°C to +125°C	SGM8249-4XTS14G/TR	SGM82494 XTS14 XXXXX	Tape and Reel, 4000

## MARKING INFORMATION

NOTE: XXXXX = Date Code and Vendor Code.

**XXXXX**



Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage .....	40V
Input Voltage Range .....	$-V_S$ to $(+V_S) + 0.1V$
Differential Input Voltage Range .....	-1V to 1V
Junction Temperature .....	+150°C
Storage Temperature Range.....	-65°C to +150°C
Lead Temperature (Soldering, 10s) .....	+260°C
ESD Susceptibility	
HBM.....	6000V
MM.....	300V
CDM .....	1000V

## RECOMMENDED OPERATING CONDITIONS

Operating Voltage Range.....	4.5V to 36V
Operating Temperature Range .....	-40°C to +125°C

## OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

## ESD SENSITIVITY CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. 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.

## DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

# 8MHz, High Voltage, High Precision, Low Noise, SGM8249-4 Rail-to-Rail Output Operational Amplifier

## ELECTRICAL CHARACTERISTICS

(At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 2.25\text{V}$  to  $\pm 18\text{V}$ ,  $V_{CM} = 0\text{V}$  and  $R_L$  connected to  $0\text{V}$ , Full =  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted.)

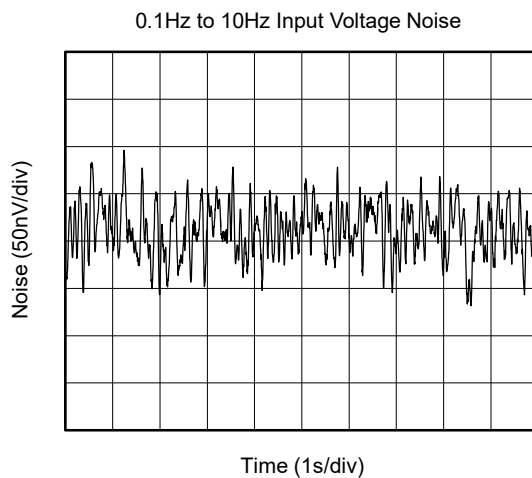
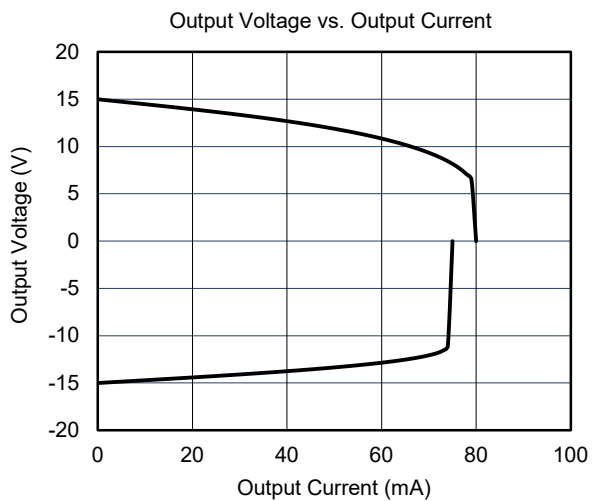
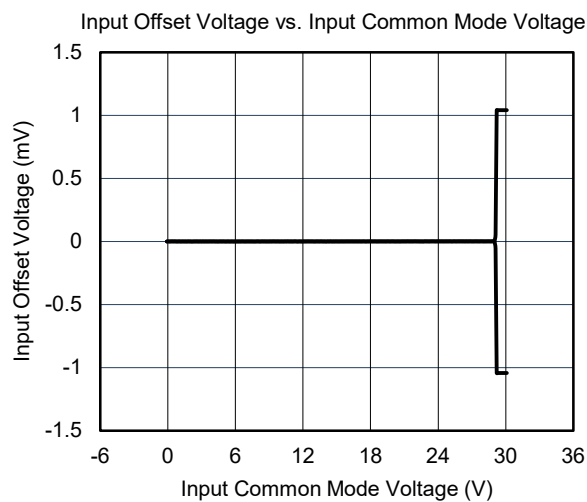
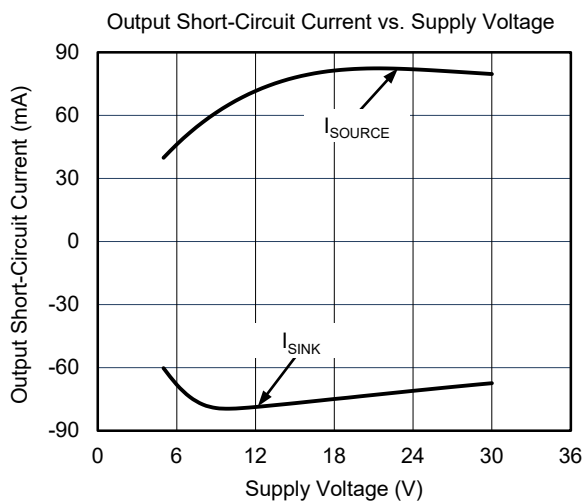
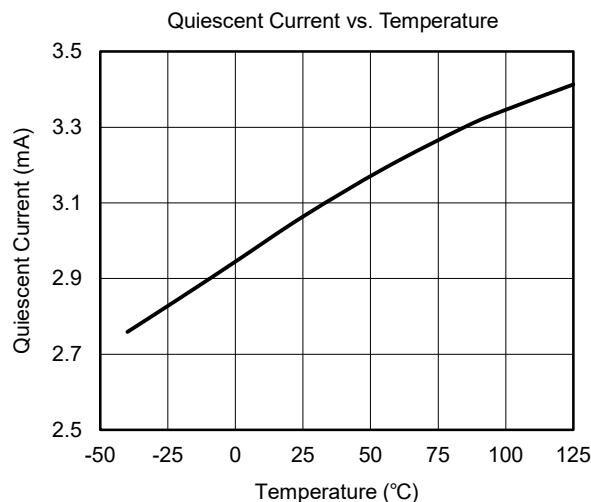
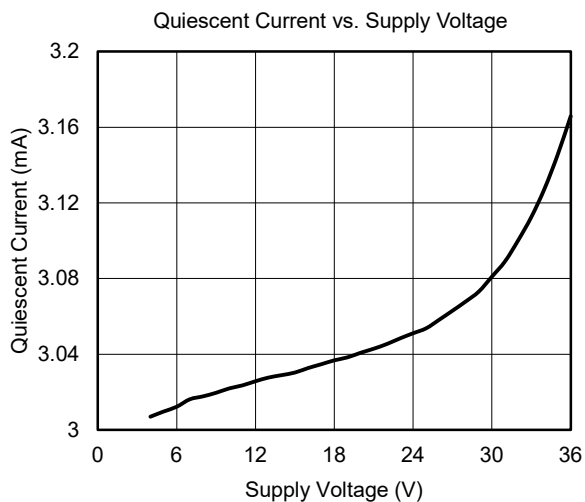
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
<b>INPUT CHARACTERISTICS</b>							
Input Offset Voltage	$V_{OS}$		+25°C		2	12	$\mu\text{V}$
			Full			18	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		Full		14		$\text{nV}/^\circ\text{C}$
Input Bias Current	$I_B$		+25°C		$\pm 100$	$\pm 450$	$\text{pA}$
Input Offset Current	$I_{OS}$		+25°C		$\pm 200$	$\pm 650$	
Input Common Mode Voltage Range	$V_{CM}$		Full	$(-V_S)$		$(+V_S) - 1.5$	V
Common Mode Rejection Ratio	CMRR	$V_{CM} = (-V_S) \text{ to } (+V_S) - 1.5\text{V}$	+25°C	117	140		dB
			Full	114			
Open-Loop Voltage Gain	$A_{OL}$	$V_S = \pm 2.25\text{V}$ , $V_{OUT} = \pm 2.0\text{V}$ , $R_L = 10\text{k}\Omega$	+25°C	119	150		dB
			Full	116			
		$V_S = \pm 18\text{V}$ , $V_{OUT} = \pm 17.5\text{V}$ , $R_L = 10\text{k}\Omega$	+25°C	128	160		
			Full	125			
<b>OUTPUT CHARACTERISTICS</b>							
Output Voltage Swing from Rail		$V_S = \pm 2.25\text{V}$ , $R_L = 10\text{k}\Omega$	+25°C		22	33	$\text{mV}$
			Full			45	
		$V_S = \pm 18\text{V}$ , $R_L = 10\text{k}\Omega$	+25°C		185	250	
			Full			350	
Output Short-Circuit Current	$I_{SC}$	$V_S = \pm 2.25\text{V}$	+25°C	$\pm 24$	$\pm 34$		$\text{mA}$
			Full	$\pm 13$			
		$V_S = \pm 18\text{V}$	+25°C	$\pm 52$	$\pm 70$		
			Full	$\pm 38$			
<b>POWER SUPPLY</b>							
Operating Voltage Range	$V_S$		Full	4.5		36	V
Quiescent Current	$I_Q$	$I_{OUT} = 0$	+25°C		3.2	4.2	$\text{mA}$
			Full			4.5	
Power Supply Rejection Ratio	PSRR	$V_S = 4.5\text{V}$ to $36\text{V}$	+25°C	128	150		dB
			Full	124			
<b>DYNAMIC PERFORMANCE</b>							
Gain-Bandwidth Product	GBP	$V_{OUT} = 100\text{mV}_{P-P}$ , $R_L = 10\text{k}\Omega$ , $C_L = 10\text{pF}$	+25°C		8		MHz
Slew Rate	SR	$R_L = 10\text{k}\Omega$	+25°C		5		$\text{V}/\mu\text{s}$
Settling Time to 0.1%	$t_S$	$V_{IN} = 1\text{V}$ Step, $R_L = 10\text{k}\Omega$ , $A_V = +1$	+25°C		0.8		$\mu\text{s}$
Overload Recovery Time		$R_L = 10\text{k}\Omega$ , $V_{IN} \times A_V > V_S$	+25°C		0.7		$\mu\text{s}$
Total Harmonic Distortion + Noise	THD+N	$V_{IN} = 2\text{V}_{P-P}$ , $A_V = +1$ , $R_L = 10\text{k}\Omega$ , $f = 1\text{kHz}$	+25°C		0.0003		%
<b>NOISE</b>							
Input Voltage Noise		$f = 0.1\text{Hz}$ to $10\text{Hz}$	+25°C		0.2		$\mu\text{V}_{P-P}$
Input Voltage Noise Density	$e_n$	$f = 0.1\text{kHz}$ , $V_{CM} = V_S/2$	+25°C		12		$\text{nV}/\sqrt{\text{Hz}}$
		$f = 1\text{kHz}$ , $V_{CM} = V_S/2$			12		
		$f = 10\text{kHz}$ , $V_{CM} = V_S/2$			13		

# SGM8249-4

## 8MHz, High Voltage, High Precision, Low Noise, Rail-to-Rail Output Operational Amplifier

### TYPICAL PERFORMANCE CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $C_L = 10\text{pF}$  and  $R_L = 5\text{k}\Omega$ , unless otherwise noted.

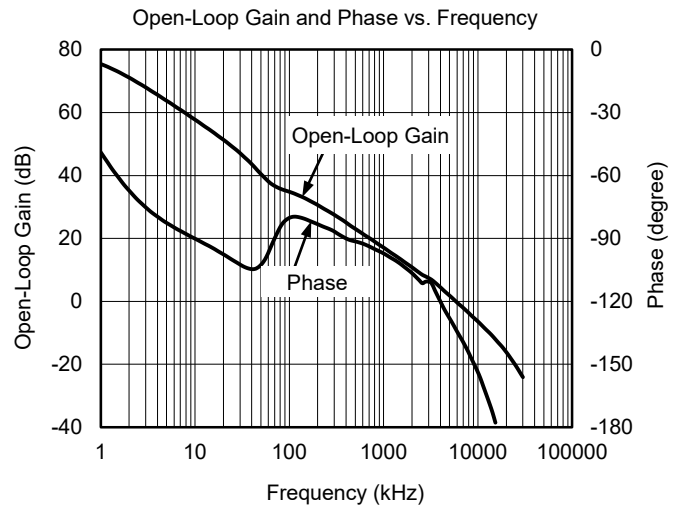
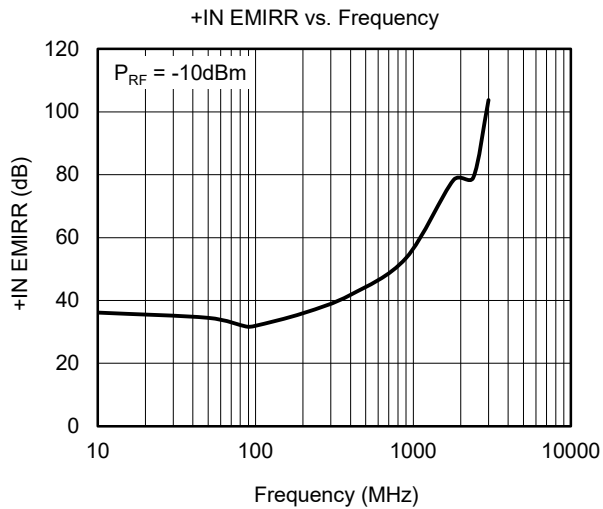
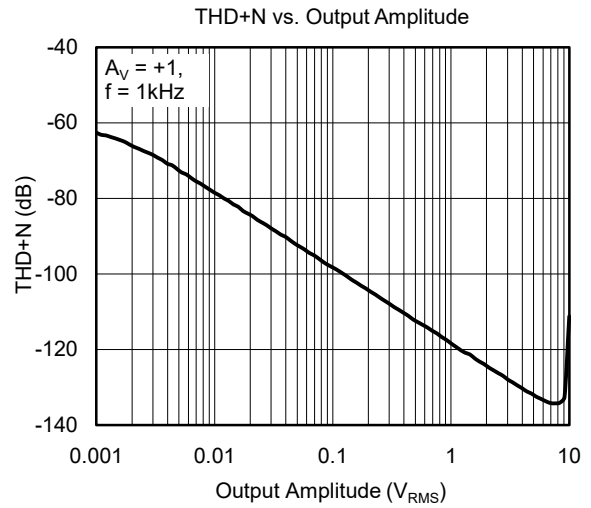
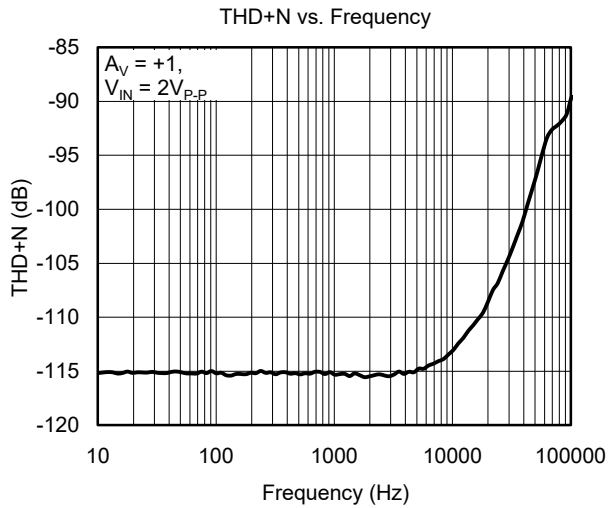
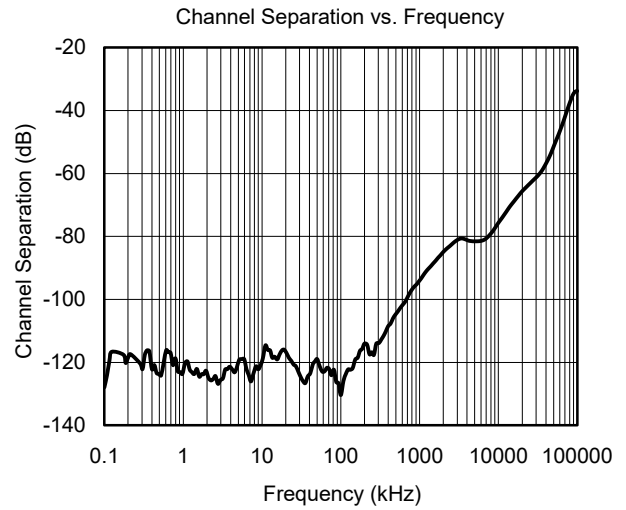
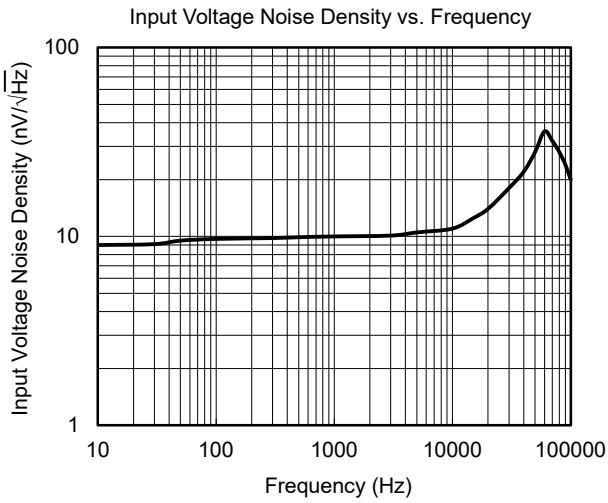


# 8MHz, High Voltage, High Precision, Low Noise, Rail-to-Rail Output Operational Amplifier

## SGM8249-4

### TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $C_L = 10\text{pF}$  and  $R_L = 5\text{k}\Omega$ , unless otherwise noted.

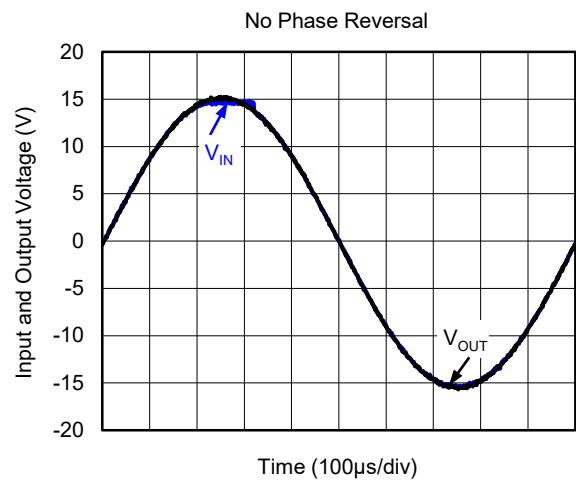
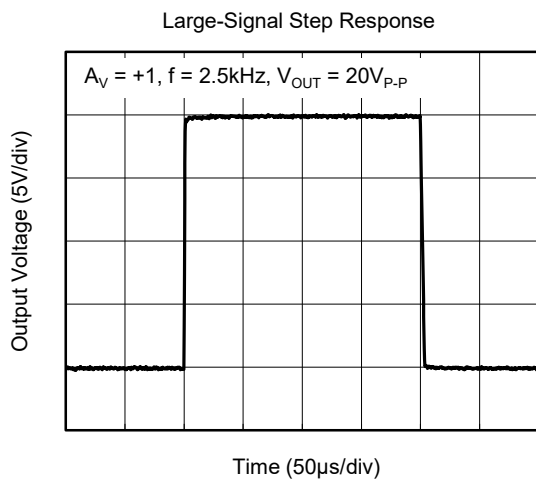
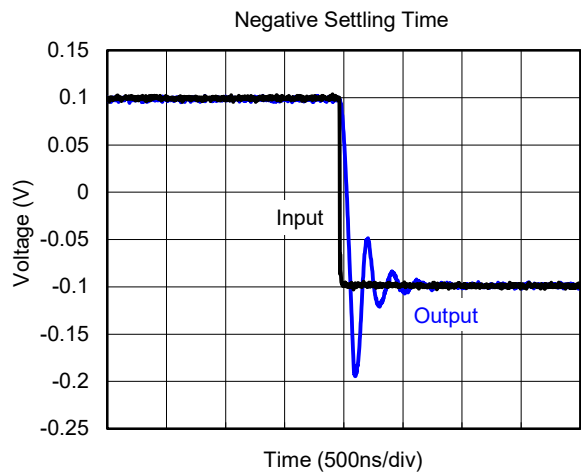
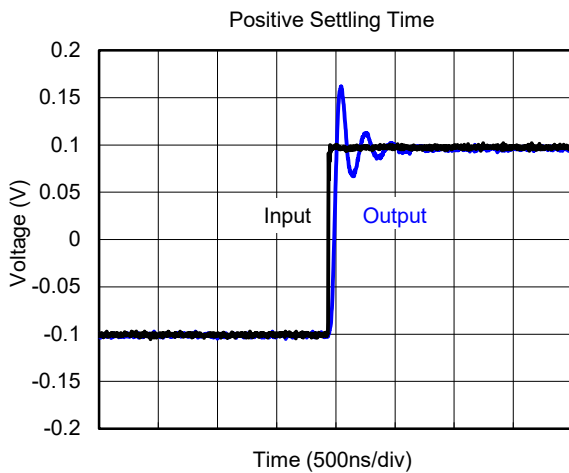
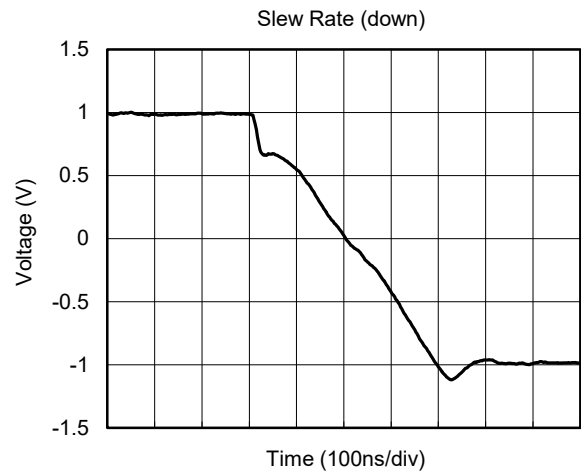
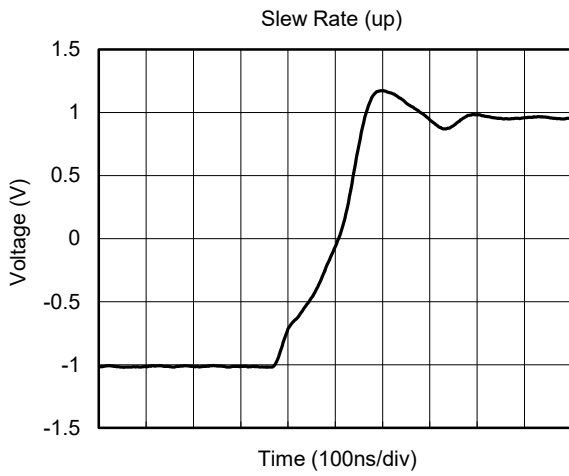


# SGM8249-4

## 8MHz, High Voltage, High Precision, Low Noise, Rail-to-Rail Output Operational Amplifier

### TYPICAL PERFORMANCE CHARACTERISTICS (continued)

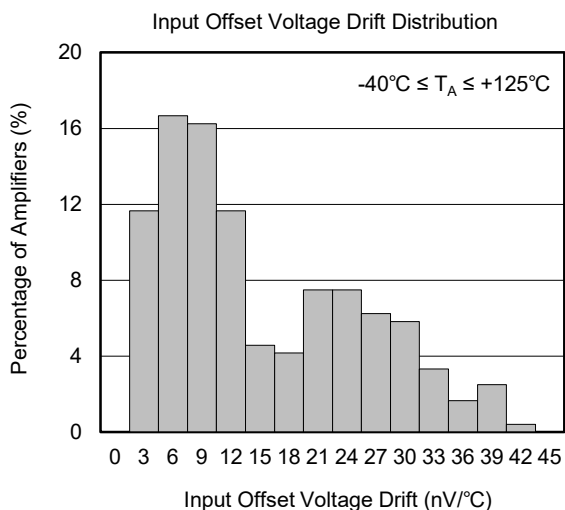
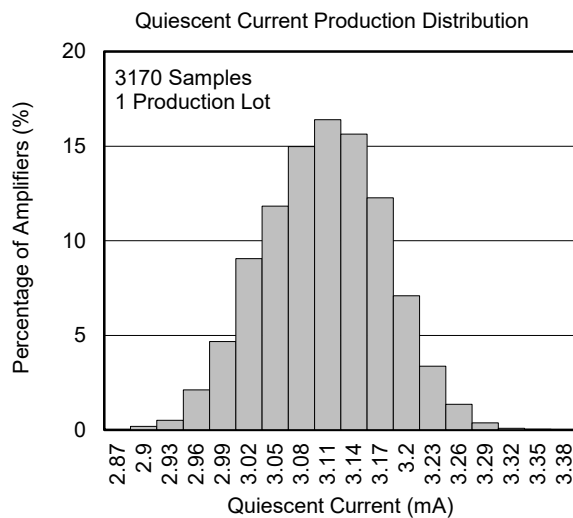
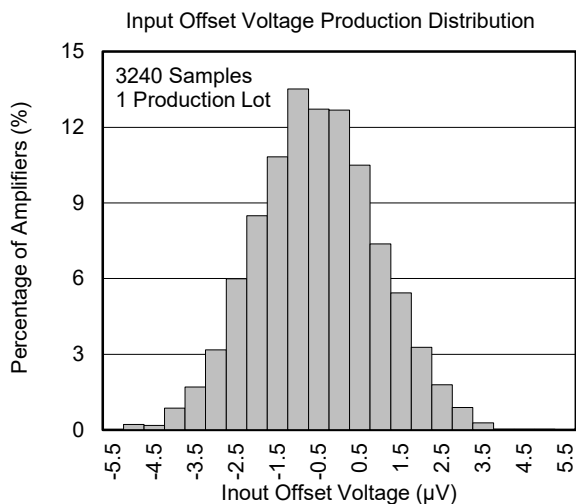
At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $C_L = 10\text{pF}$  and  $R_L = 5\text{k}\Omega$ , unless otherwise noted.



# 8MHz, High Voltage, High Precision, Low Noise, SGM8249-4 Rail-to-Rail Output Operational Amplifier

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ ,  $C_L = 10\text{pF}$  and  $R_L = 5\text{k}\Omega$ , unless otherwise noted.



# SGM8249-4 8MHz, High Voltage, High Precision, Low Noise, Rail-to-Rail Output Operational Amplifier

## APPLICATION NOTES

### Driving Capacitive Loads

The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive driving capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure 1. The isolation resistor  $R_{ISO}$  and the load capacitor  $C_L$  form a zero to increase stability. The bigger the  $R_{ISO}$  resistor value, the more stable  $V_{OUT}$  will be. Note that this method results in a loss of gain accuracy because  $R_{ISO}$  forms a voltage divider with the  $R_{LOAD}$ .

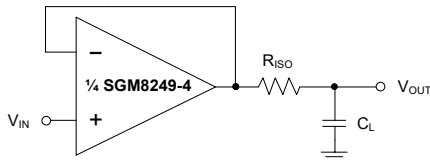


Figure 1. Indirectly Driving Heavy Capacitive Load

An improved circuit is shown in Figure 2. It provides DC accuracy as well as AC stability.  $R_F$  provides the DC accuracy by connecting the inverting input with the output.  $C_F$  and  $R_{ISO}$  serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving phase margin in the overall feedback loop.

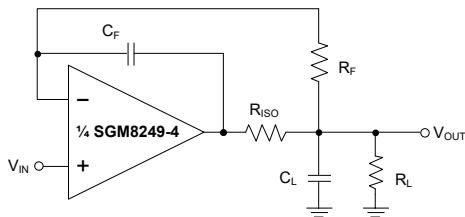


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For non-buffer configuration, there are two other ways to increase the phase margin: (a) by increasing the amplifier's closed-loop gain or (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node.

### Power Supply Bypassing and Layout

The SGM8249-4 operates from either a single 4.5V to 36V supply or dual  $\pm 2.25V$  to  $\pm 18V$  supplies. For

single-supply operation, bypass the power supply  $+V_S$  with a  $0.1\mu F$  ceramic capacitor which should be placed close to the  $+V_S$  pin. For dual-supply operation, both the  $+V_S$  and the  $-V_S$  supplies should be bypassed to ground with separate  $0.1\mu F$  ceramic capacitors.  $2.2\mu F$  tantalum capacitor can be added for better performance.

Good PC board layout techniques optimize performance by decreasing the amount of stray capacitance at the operational amplifier's inputs and output. To decrease stray capacitance, minimize trace lengths and widths by placing external components as close to the device as possible. Use surface-mount components whenever possible.

For the operational amplifier, soldering the part to the board directly is strongly recommended. Try to keep the high frequency current loop area small to minimize the EMI (electromagnetic interference).

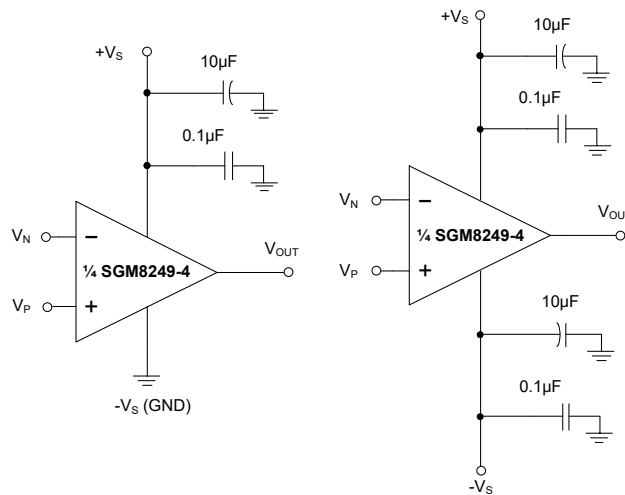


Figure 3. Amplifier with Bypass Capacitors

### Grounding

A ground plane layer is important for SGM8249-4 circuit design. The length of the current path in an inductive ground return will create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance.

### Input-to-Output Coupling

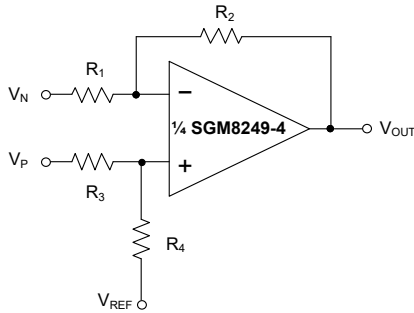
To minimize capacitive coupling, the input and output signal traces should not be in parallel. This helps reduce unwanted positive feedback.



**TYPICAL APPLICATION CIRCUITS**

**Differential Amplifier**

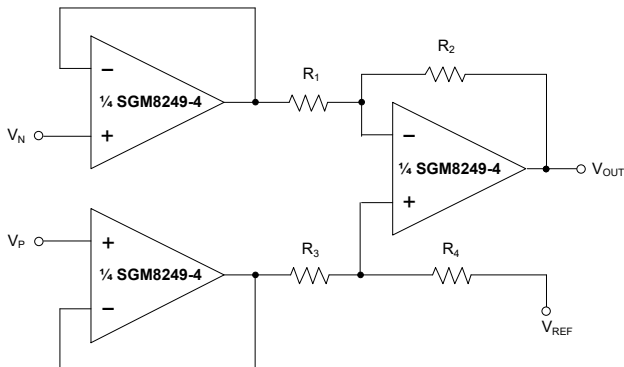
The circuit shown in Figure 4 performs the difference function. If the resistor ratios are equal ( $R_4/R_3 = R_2/R_1$ ), then  $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$ .



**Figure 4. Differential Amplifier**

**Instrumentation Amplifier**

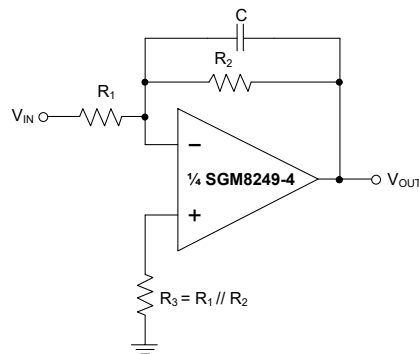
The circuit in Figure 5 performs the same function as that in Figure 4 but with a high input impedance.



**Figure 5. Instrumentation Amplifier**

**Active Low-Pass Filter**

The low-pass filter shown in Figure 6 has a DC gain of  $(-R_2/R_1)$  and the  $-3\text{dB}$  corner frequency is  $1/2\pi R_2 C$ . Make sure the filter bandwidth is within the bandwidth of the amplifier. Feedback resistors with large values can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistor values as low as possible and consistent with output loading consideration.

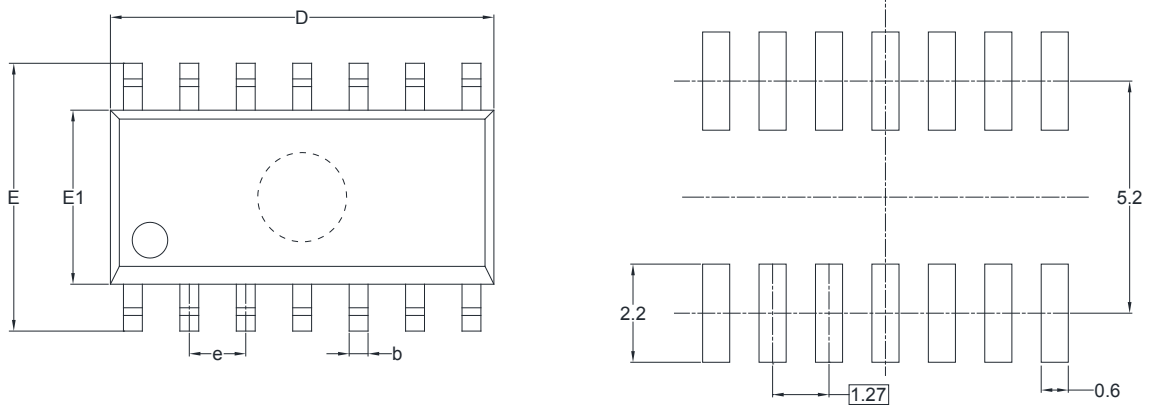


**Figure 6. Active Low-Pass Filter**

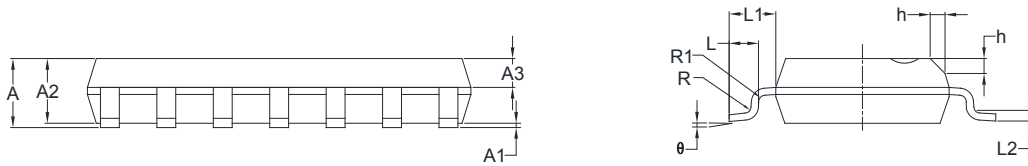
# PACKAGE INFORMATION

## PACKAGE OUTLINE DIMENSIONS

### SOIC-14



RECOMMENDED LAND PATTERN (Unit: mm)

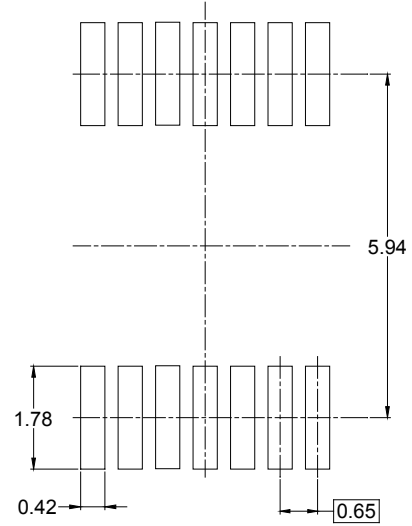
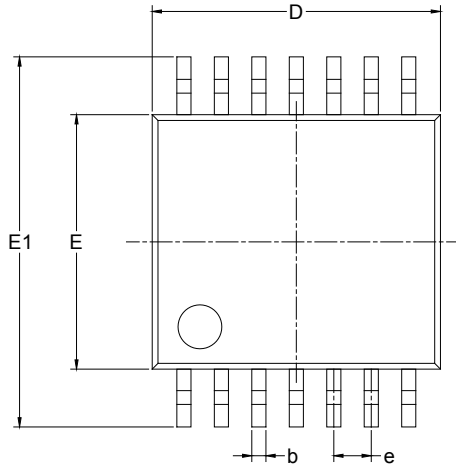


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80	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°

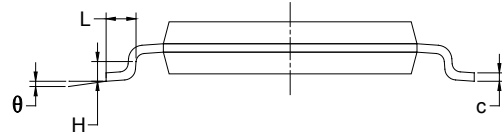
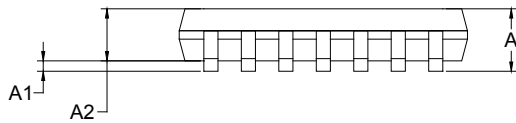
# PACKAGE INFORMATION

## PACKAGE OUTLINE DIMENSIONS

### TSSOP-14



RECOMMENDED LAND PATTERN (Unit: mm)

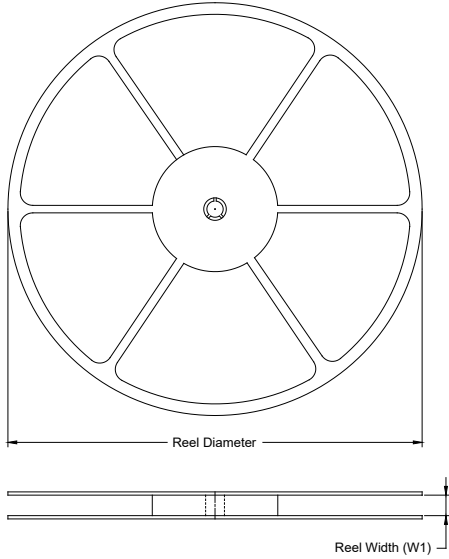


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°

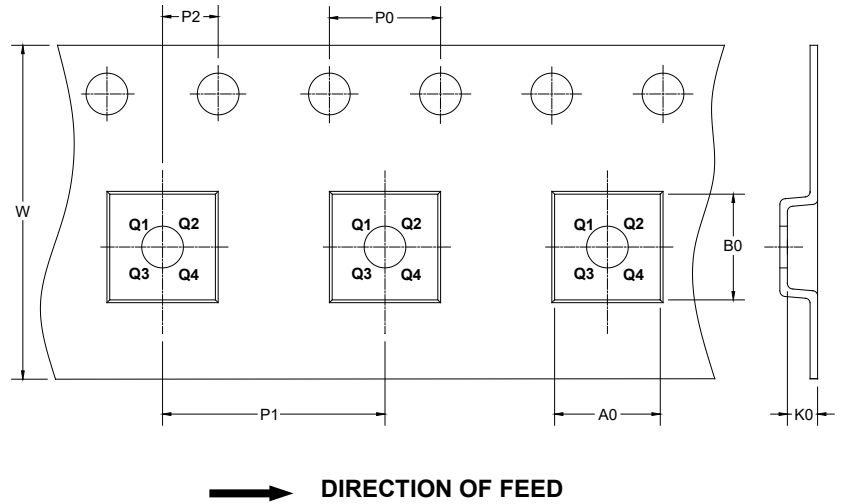
# PACKAGE INFORMATION

## 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
SOIC-14	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP-14	13"	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	Q1

DD0001

# PACKAGE INFORMATION

## CARTON BOX DIMENSIONS



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

## KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
13"	386	280	370	5

DD0002