SGM8249-1/SGM8249-2
8MHz, High Voltage, High Precision, Low Noise, Rail-to-Rail Output Operational Amplifiers

GENERAL DESCRIPTION

The SGM8249-1/2 are rail-to-rail output, low noise and high precision operational amplifiers which have low input offset voltage and bias current. These devices can operate from ±2.25V to ±18V dual power supplies or from 4.5V to 36V single supply.

The rail-to-rail output swing provided by the SGM8249-1/2 makes both high-side and low-side sensing easy. The combination of these characteristics makes the SGM8249-1/2 good choices 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 single SGM8249-1 is available in Green SOT-23-5 and SOIC-8 packages. The dual SGM8249-2 is available in Green SOIC-8 package. The SGM8249-1/2 are rated over the -40℃ to +125℃ temperature range.

FEATURES

- **Low Offset Voltage: 10μV (MAX)**
- **Rail-to-Rail Output Swing**
- **Support Single or Dual Power Supplies:**
  4.5V to 36V or ±2.25V to ±18V
- **Open-Loop Voltage Gain: 150dB (TYP)**
- **PSRR: 150dB (TYP)**
- **CMRR: 140dB (TYP)**
- **Input Voltage Noise Density: 10nV/$\sqrt{Hz}$ at 1kHz**
- **Gain-Bandwidth Product: 8MHz**
- **Low Supply Current: 0.85mA/Amplifier (TYP)**
- **Overload Recovery Time: 0.7μs**
- **-40℃ to +125℃ Operating Temperature Range**
- **Small Packaging:**
  SGM8249-1 Available in Green SOT-23-5 and SOIC-8 Packages
  SGM8249-2 Available in Green SOIC-8 Package

APPLICATIONS

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

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8249-1	SOT-23-5	-40℃ to +125℃	SGM8249-1XN5G/TR	GM7XX	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8249-1XS8G/TR	SGM 82491XS8 XXXXX	Tape and Reel, 4000
SGM8249-2	SOIC-8	-40℃ to +125℃	SGM8249-2XS8G/TR	SGM 82492XS8 XXXXX	Tape and Reel, 4000

NOTE: XX = Date Code. XXXXX = Date Code and Vendor Code.

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.

MARKING INFORMATION

GM7 X X

- Date code - Month ("A" = Jan. "B" = Feb. ⋯ "L" = Dec.)
- Date code - Year ("A" = 2010, "B" = 2011 ⋯)
- Chip I.D.

For example: GM7HA (2017, January)

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℃
Storage Temperature Range....................-65℃ to +150℃
Lead Temperature (Soldering, 10s) ....+260℃
ESD Susceptibility
HBM..6000V
MM..300V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

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

OVERSTRESS CAUTION

Stresses beyond those listed may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational section of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

ESD SENSITIVITY CAUTION

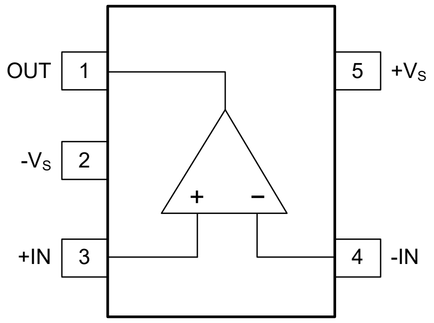
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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, specification or other related things if necessary without notice at any time.

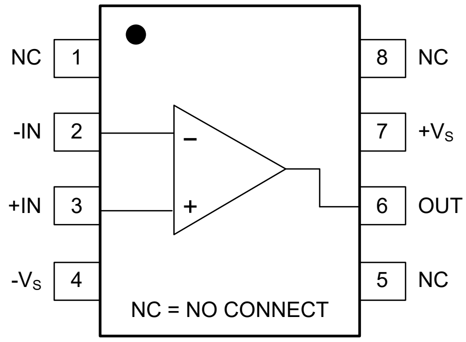
PIN CONFIGURATIONS

SGM8249-1 (TOP VIEW)



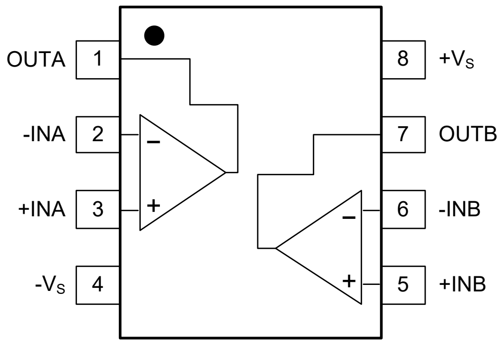
SOT-23-5

SGM8249-1 (TOP VIEW)



SOIC-8

SGM8249-2 (TOP VIEW)



SOIC-8

ELECTRICAL CHARACTERISTICS

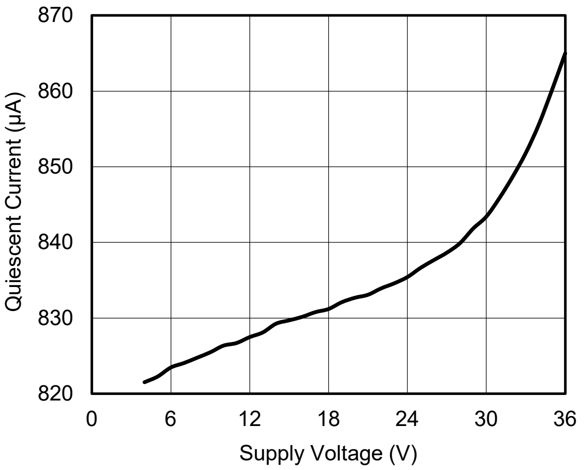
(At T_A = +25℃, V_S = ±2.25V to ±18V, V_{CM} = 0V and R_L = 5kΩ connected to 0V, Full = -40℃ to +125℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS							
Input Offset Voltage	V_{OS}		+25℃		2	10	μV
			Full			15	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		Full		12		nV/℃
Input Bias Current	I_B		+25℃		±100	±400	pA
Input Offset Current	I_{OS}		+25℃		±200	±600	pA
Input Common Mode Voltage Range	V_{CM}		Full	$(-V_S)$		$(+V_S)$ - 1.5	V
Common Mode Rejection Ratio	CMRR	V_{CM} = $(-V_S)$ to $(+V_S)$ - 1.5V	+25℃	118	140		dB
			Full	115			
Open-Loop Voltage Gain	A_{OL}	V_S = ±2.25V, V_{OUT} = ±2.0V	+25℃	120	150		dB
			Full	117			
		V_S = ±18V, V_{OUT} = ±17.5V	+25℃	128	155		
			Full	125			
OUTPUT CHARACTERISTICS							
Output Voltage Swing from Rail		V_S = ±2.25V	+25℃		22	32	mV
			Full			35	
		V_S = ±18V	+25℃		170	240	
			Full			285	
Output Short-Circuit Current	I_{SC}	V_S = ±2.25V	+25℃	±25	±35		mA
			Full	±14			
		V_S = ±18V	+25℃	±60	±70		
			Full	±44			
POWER SUPPLY							
Operating Voltage Range	V_S		Full	4.5		36	V
Quiescent Current/Amplifier	I_Q	I_{OUT} = 0	+25℃		0.85	1.2	mA
			Full			1.3	
Power Supply Rejection Ratio	PSRR	V_S = 4.5V to 36V	+25℃	128	150		dB
			Full	125			
DYNAMIC PERFORMANCE							
Gain-Bandwidth Product	GBP	V_{OUT} = 100mV_{P-P}, C_L = 10pF	+25℃		8		MHz
Slew Rate	SR		+25℃		6		V/μs
Settling Time to 0.1%	t_S	V_{IN} = 1V Step, A_V = +1	+25℃		0.8		μs
Overload Recovery Time		$V_{IN} \times A_V > V_S$	+25℃		0.7		μs
Total Harmonic Distortion + Noise	THD+N	V_{IN} = 2V_{P-P}, A_V = +1, f = 1kHz	+25℃		0.0002		%
NOISE							
Input Voltage Noise		f = 0.1Hz to 10Hz	+25℃		0.2		μV_{P-P}
Input Voltage Noise Density	e_n	f = 0.1kHz	+25℃		10		nV/$\sqrt{Hz}$
		f = 1kHz	+25℃		10		
		f = 10kHz	+25℃		11		

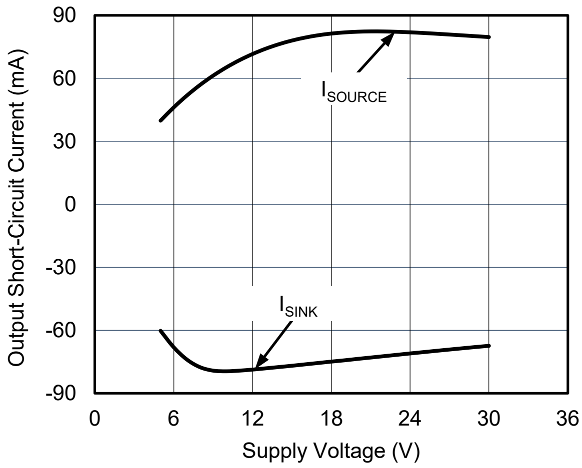
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_S = ±15V, C_L = 10pF and R_L = 5kΩ, unless otherwise noted.

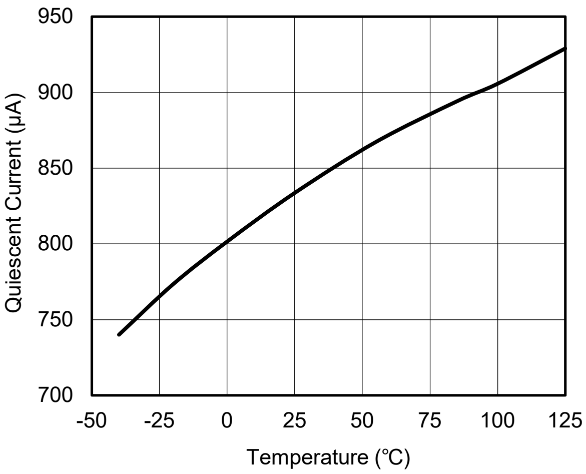
Quiescent Current vs. Supply Voltage



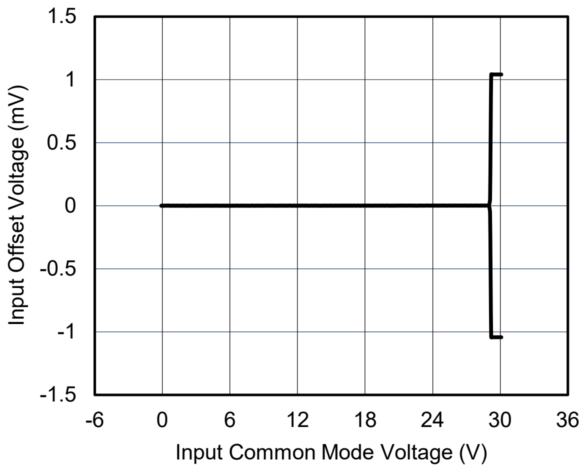
Output Short-Circuit Current vs. Supply Voltage



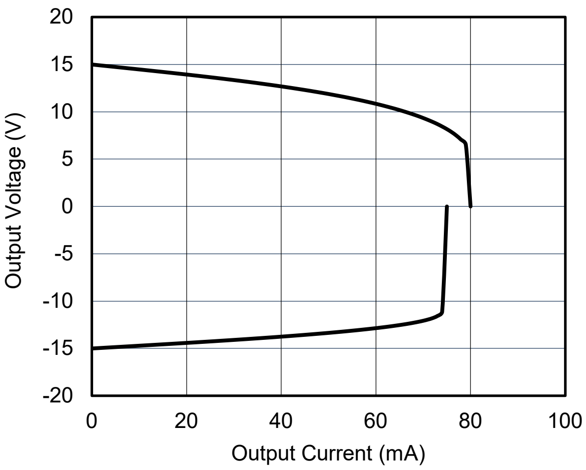
Quiescent Current vs. Temperature



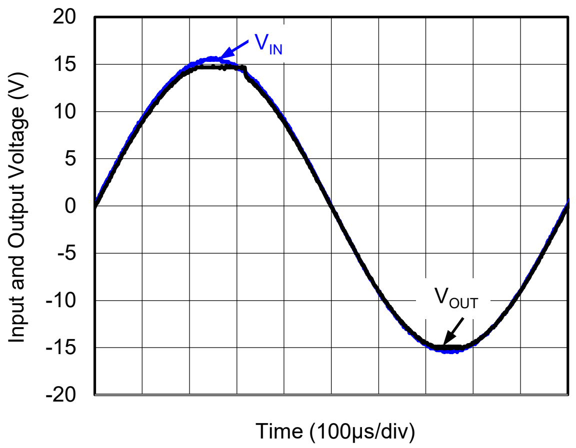
Input Offset Voltage vs. Input Common Mode Voltage



Output Voltage vs. Output Current



No Phase Reversal



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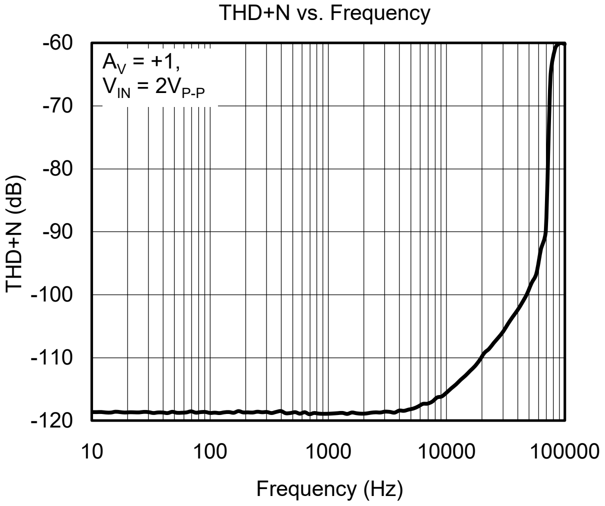

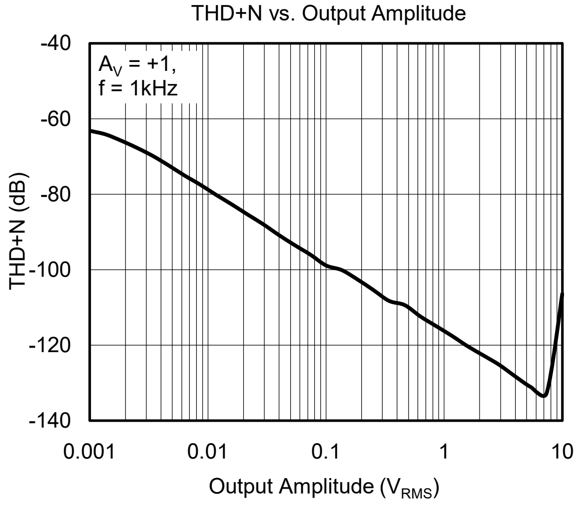

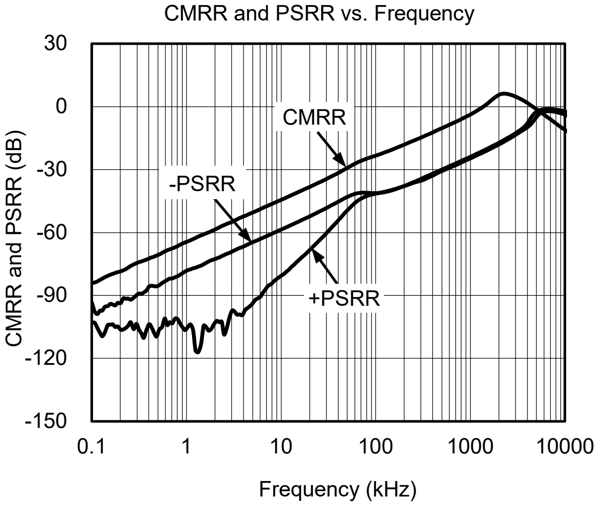

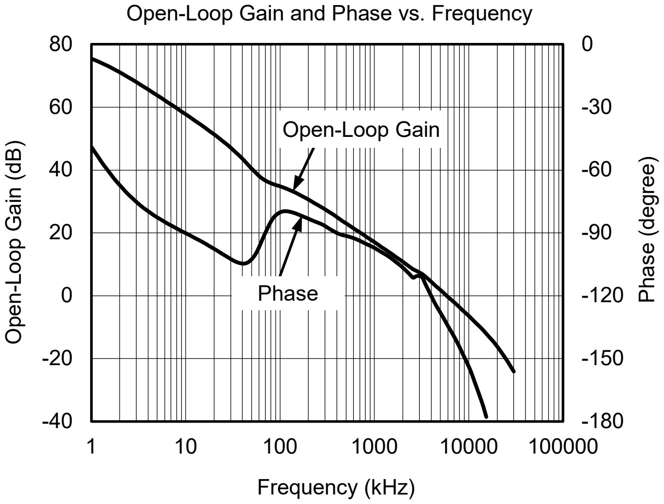

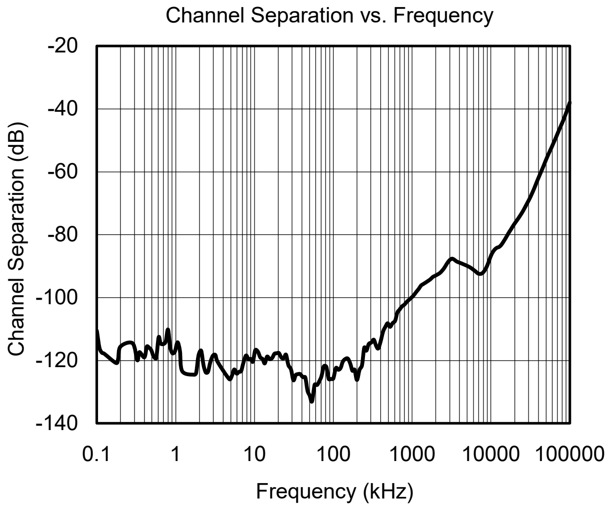

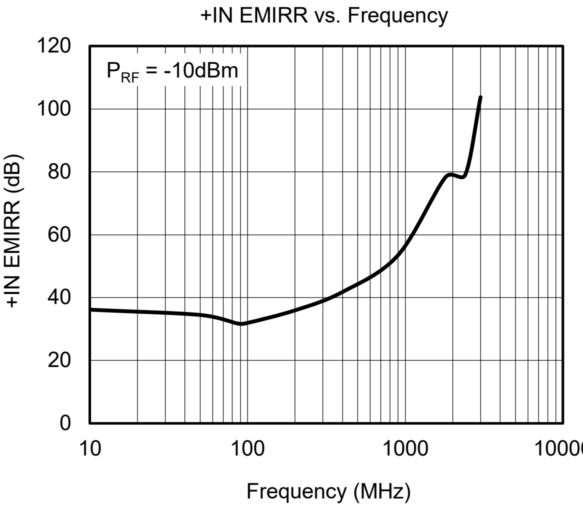

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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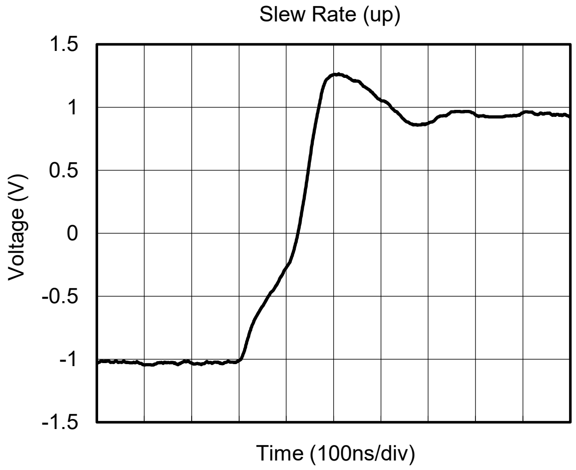

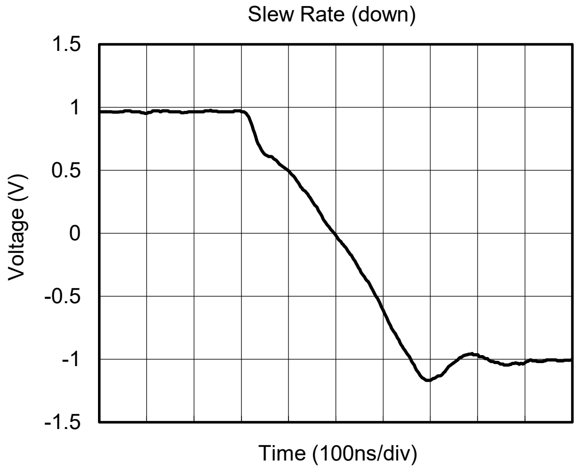

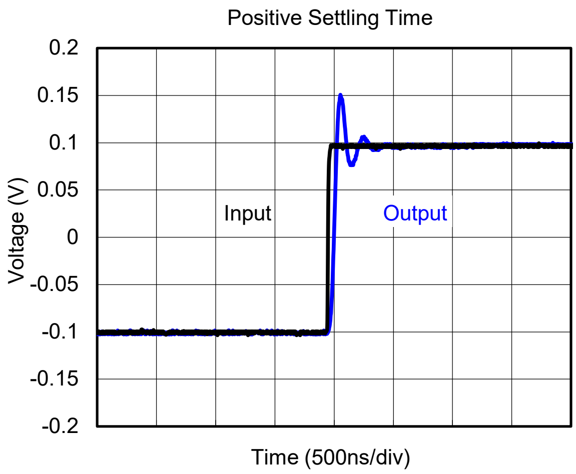

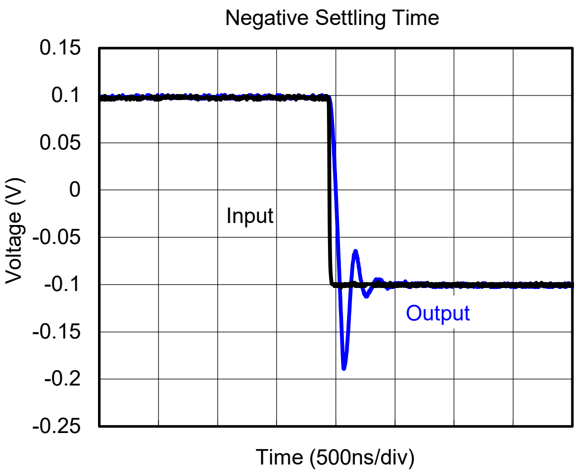

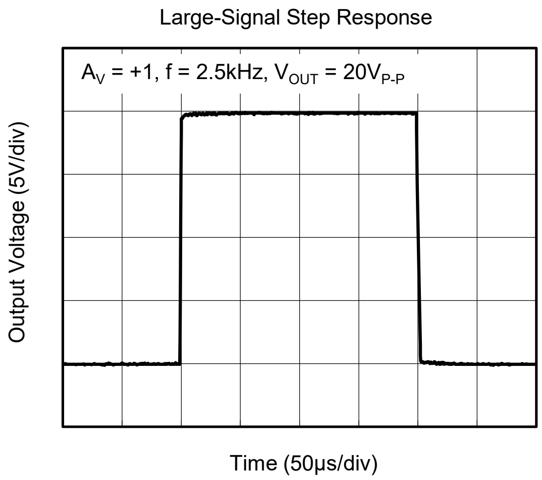

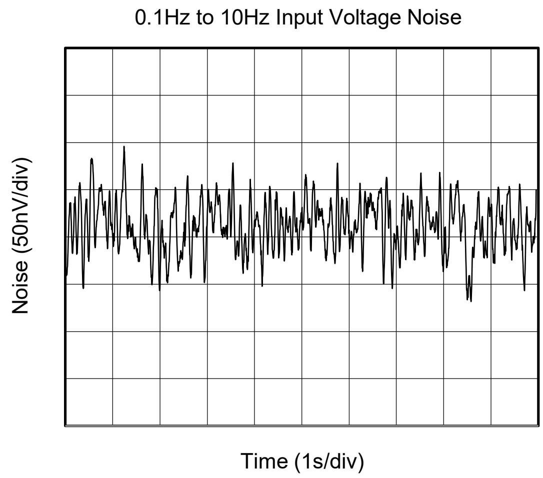

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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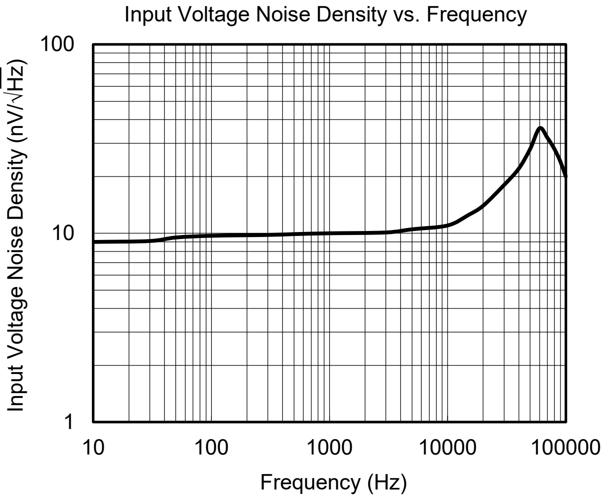
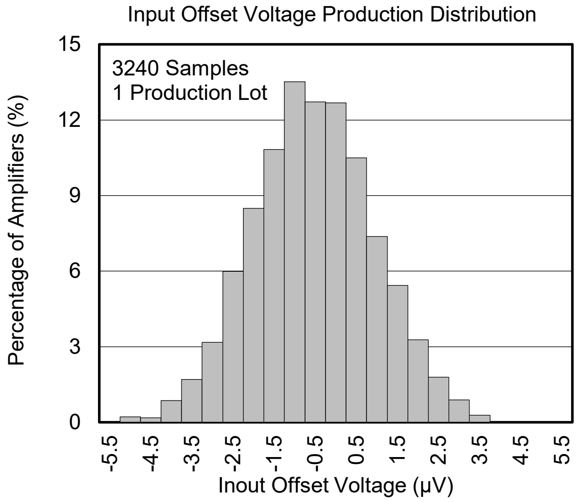
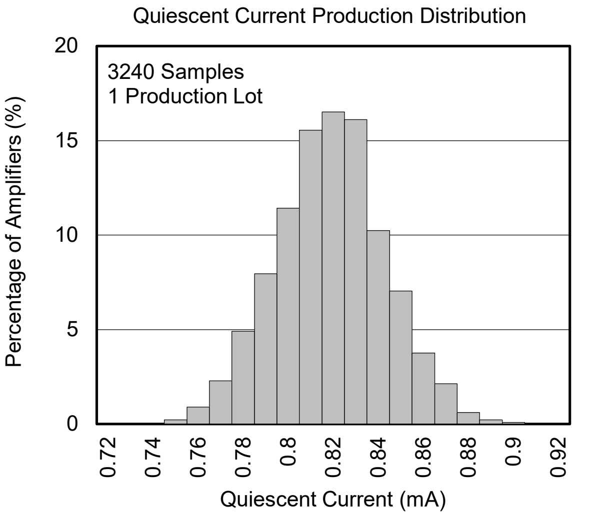
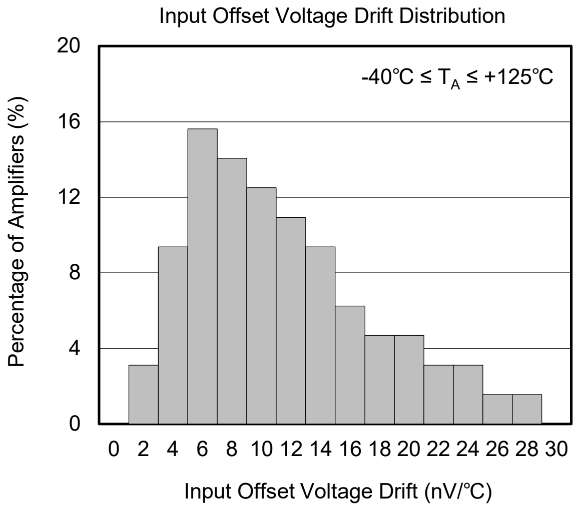








APPLICATION NOTES

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}.

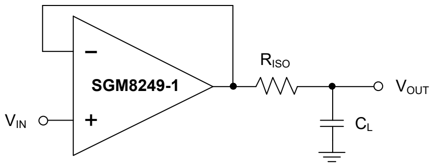


Figure 1. Indirectly Driving Heavy Capacitive Load

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.

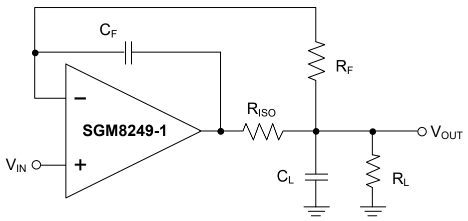


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

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 SGM8249-1/2 operate from either a single 4.5V to 36V supply or dual ±2.25V to ±18V supplies. For single-supply operation, bypass the power supply $+V_S$ with a 0.1μF 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 0.1μF ceramic capacitors. 2.2μF 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).

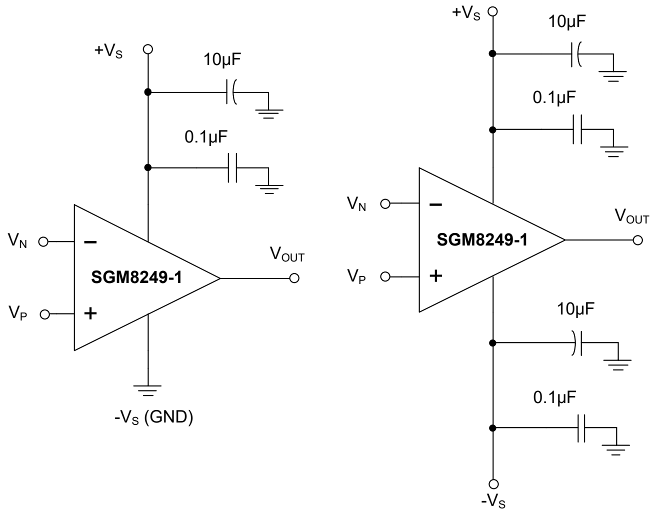


Figure 3. Amplifier with Bypass Capacitors

Grounding

A ground plane layer is important for SGM8249-1/2 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 $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$.

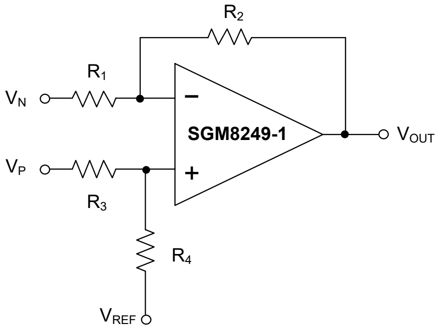


Figure 4. Differential Amplifier

Instrumentation Amplifier

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

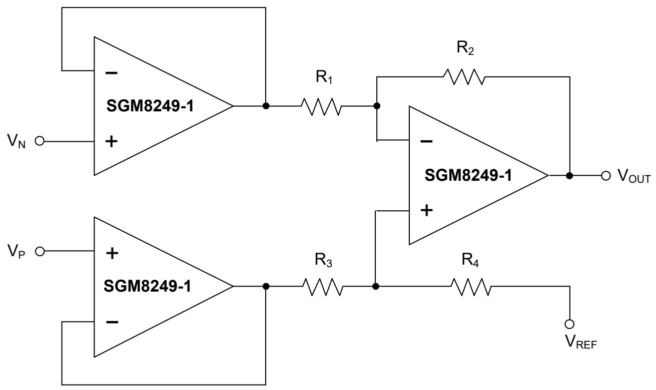


Figure 5. Instrumentation Amplifier

Active Low-Pass Filter

The low-pass filter shown in Figure 6 has a DC gain of ($-R_2/R_1$) and the -3dB corner frequency is $1/2\pi R_2C$. 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.

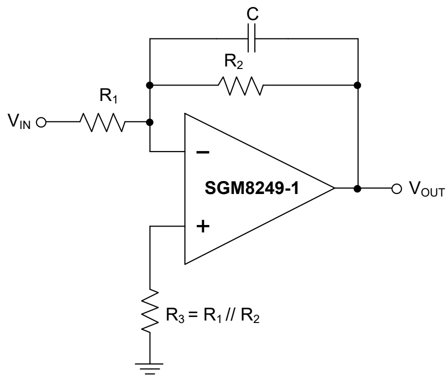


Figure 6. Active Low-Pass Filter

REVISION HISTORY

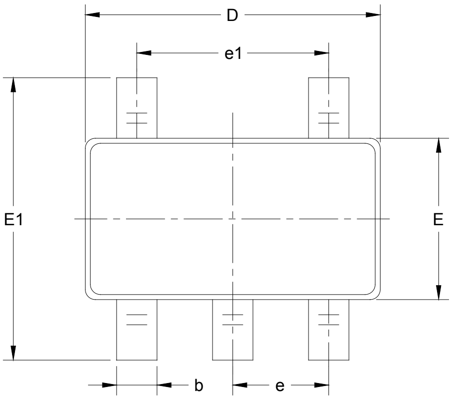
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

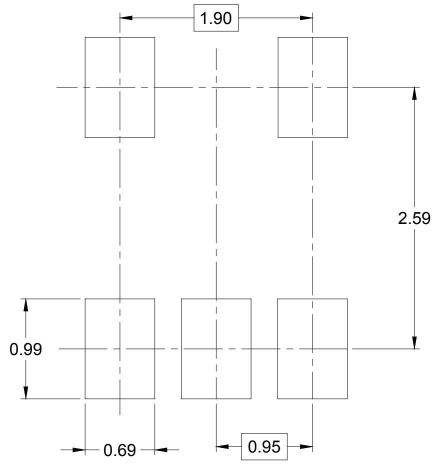
Changes from Original (DECEMBER 2017) to REV.A

Changed from product preview to production data	All

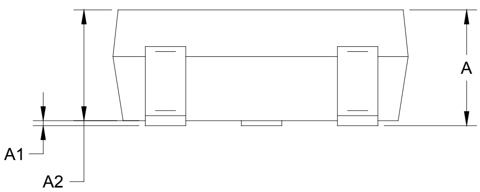
PACKAGE OUTLINE DIMENSIONS

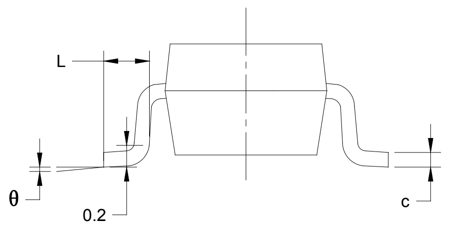
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)

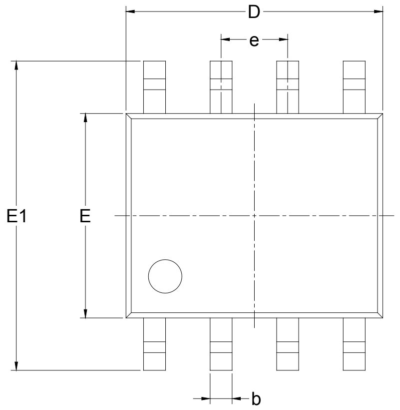


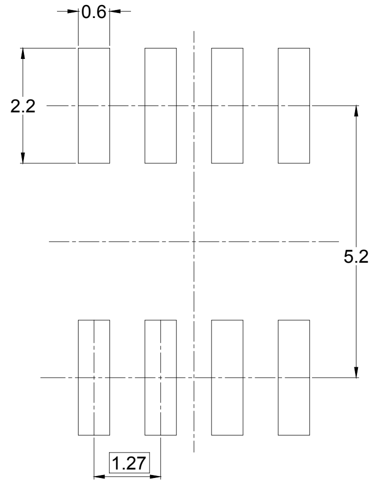


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 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°

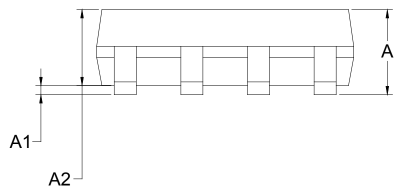
PACKAGE OUTLINE DIMENSIONS

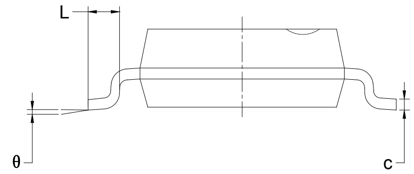
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)

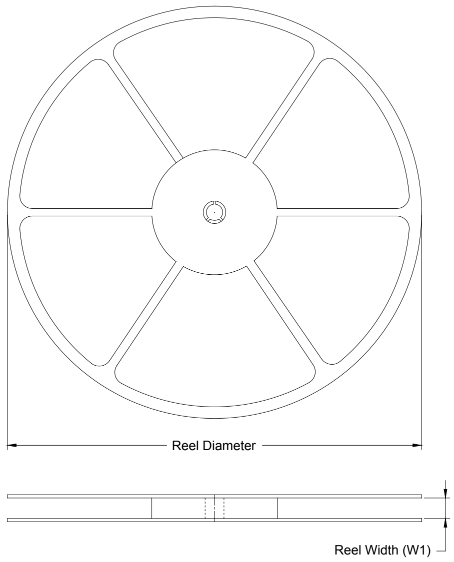




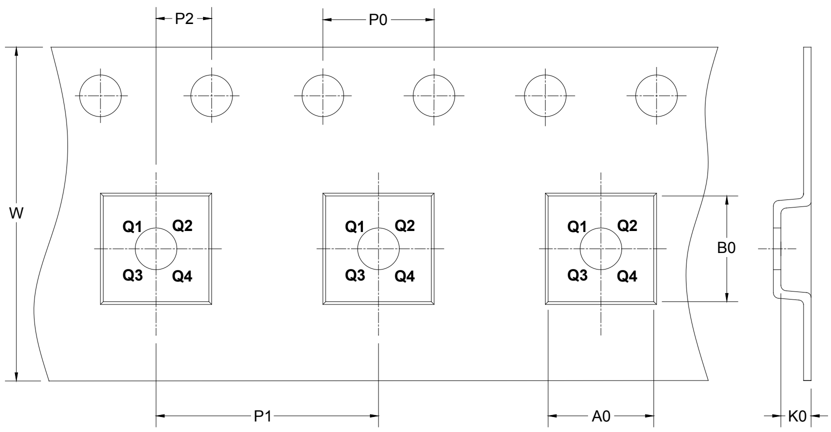
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



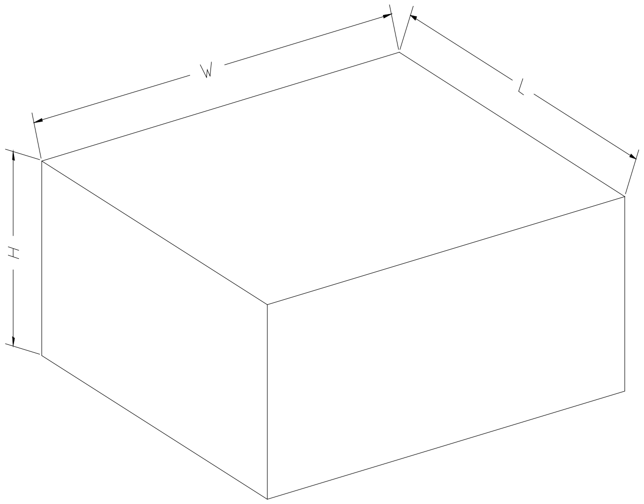
NOTE: The picture is only for reference. Please make the object as the standard.

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

DD0001

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
7″ (Option)	368	227	224	8
7″	442	410	224	18
13″	386	280	370	5

DD0002