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

GENERAL DESCRIPTION

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

The SGM8249-1/2 offer a low offset voltage less than 10μV and a low bias current. The combination of characteristics makes the SGM8249-1/2 good choices for temperature measurements, pressure and position sensors, strain gauge amplifiers and medical instrumentation, or any other 4.5V to 36V applications requiring precision and long-term stability.

The SGM8249-1 is available in Green SOT-23-5 and SOIC-8 packages. The SGM8249-2 is available in a Green SOIC-8 package. The SGM8249-1/2 are rated over the -40℃ to +125℃ temperature range.

FEATURES

- **Low Offset Voltage: 10μV (MAX)**
- **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**
- **Overload Recovery Time: 0.7μs**
- **Rail-to-Rail Output Swing**
- **Support Single or Dual Power Supplies: 4.5V to 36V or ±2.25V to ±18V**
- **Low Supply Current: 0.85mA/Amplifier (TYP)**
- **-40℃ to +125℃ Operating Temperature Range**
- **Small Packaging:**
  SGM8249-1 Available in Green SOT-23-5 and SOIC-8 Packages
  SGM8249-2 Available in a Green SOIC-8 Package

APPLICATIONS

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

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

MARKING INFORMATION

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

SOT-23-5

YYY X X
- X — Date Code - Week
- X — Date Code - Year
- YYY — Serial Number

SOIC-8

XXXXX
- X — Vendor Code
- XX — Date Code - Week
- XX — Date Code - Year

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

RECOMMENDED OPERATING CONDITIONS

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

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

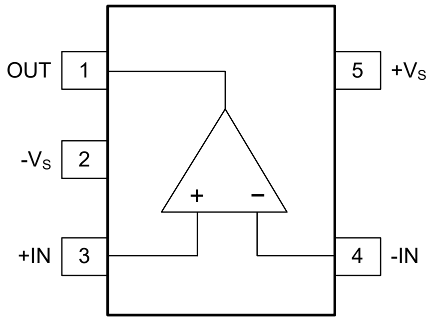
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

DISCLAIMER

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

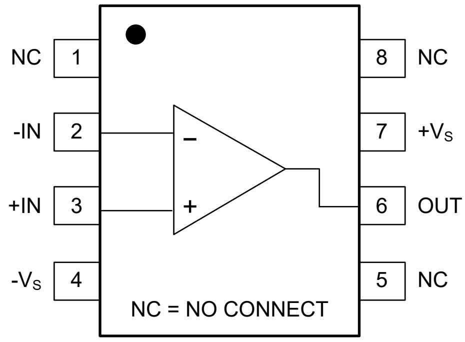
PIN CONFIGURATIONS

SGM8249-1 (TOP VIEW)



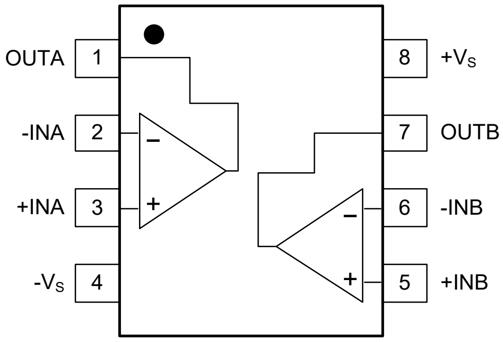
SOT-23-5

SGM8249-1 (TOP VIEW)



SOIC-8

SGM8249-2 (TOP VIEW)



SOIC-8

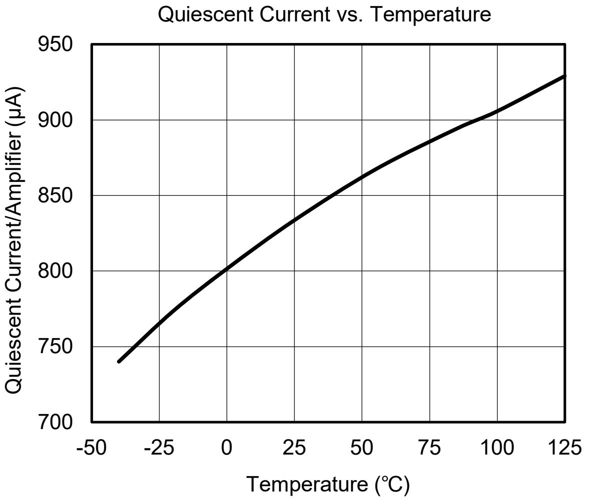
ELECTRICAL CHARACTERISTICS

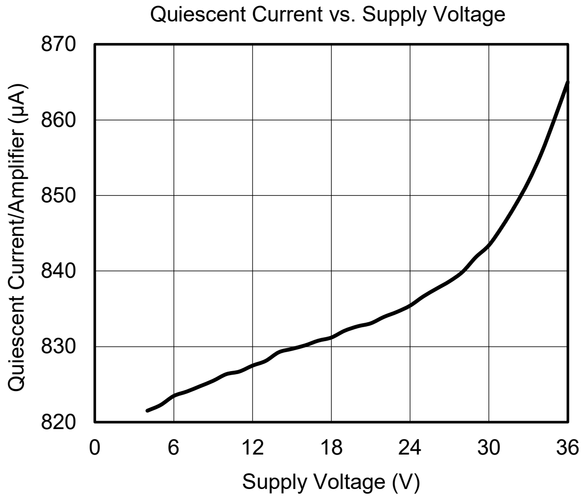
(At T_A = +25℃, V_S = ±2.25V to ±18V, V_{CM} = 0V and R_L = 5kΩ connected to 0V, Full = -40℃ to +125℃, unless otherwise noted.)

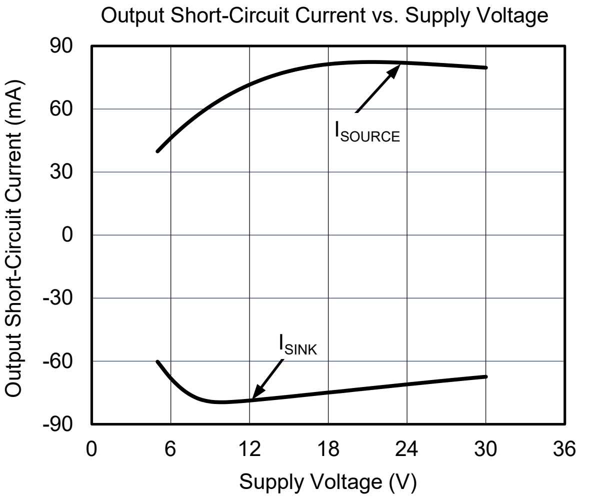
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Input Characteristics							
Input Offset Voltage	V_{OS}		+25℃		2	10	μV
			Full			15	
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		Full		12		nV/℃
Input Bias Current	I_B		+25℃		±100	±400	pA
Input Offset Current	I_{OS}		+25℃		±200	±600	pA
Input 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} = 0A	+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		

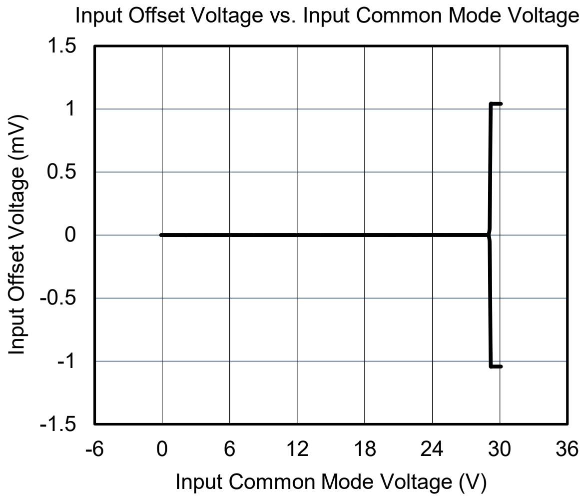
TYPICAL PERFORMANCE CHARACTERISTICS

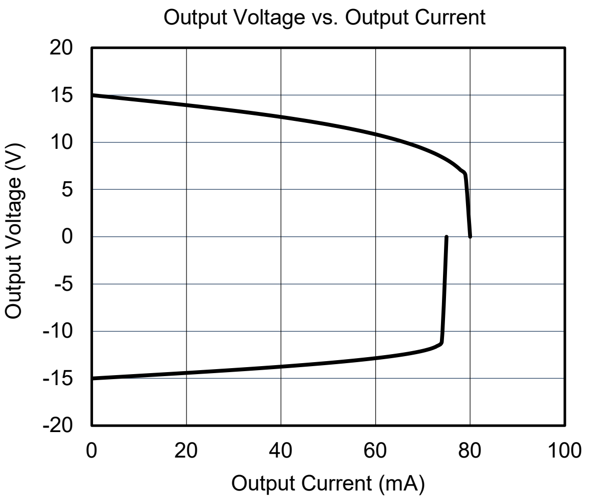
At T_A = +25℃, V_S = ±15V, C_L = 10pF and R_L = 5kΩ, unless otherwise noted.

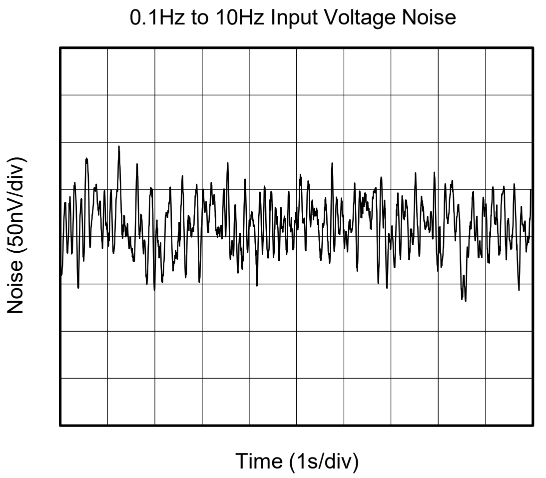








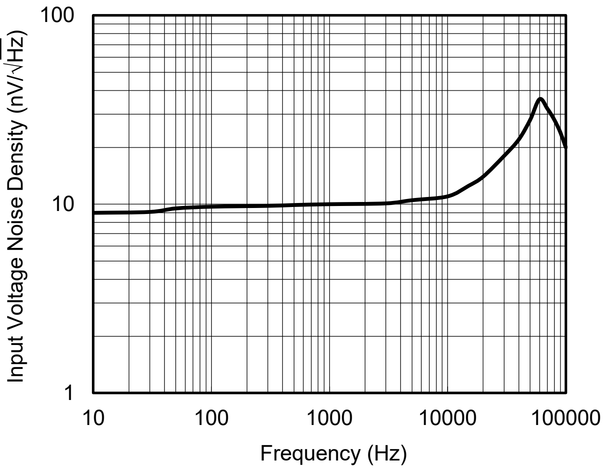




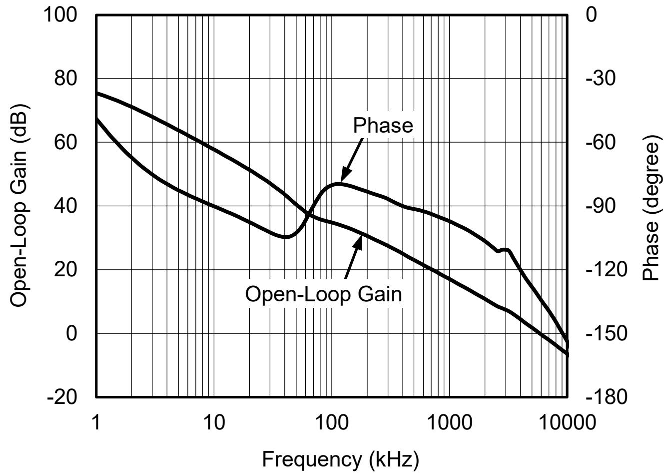
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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

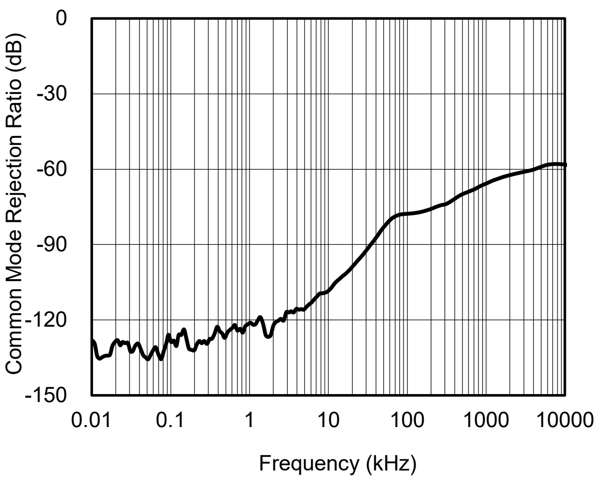
Input Voltage Noise Density vs. Frequency



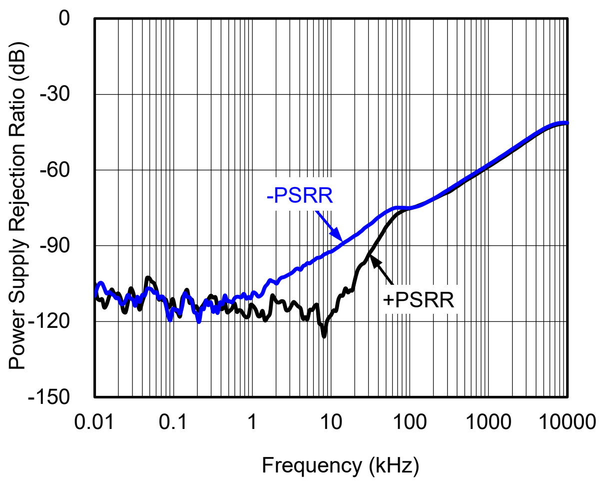
Open-Loop Gain and Phase vs. Frequency



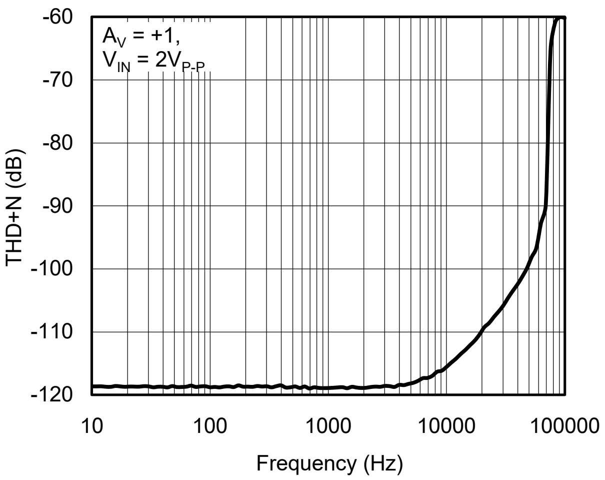
CMRR vs. Frequency



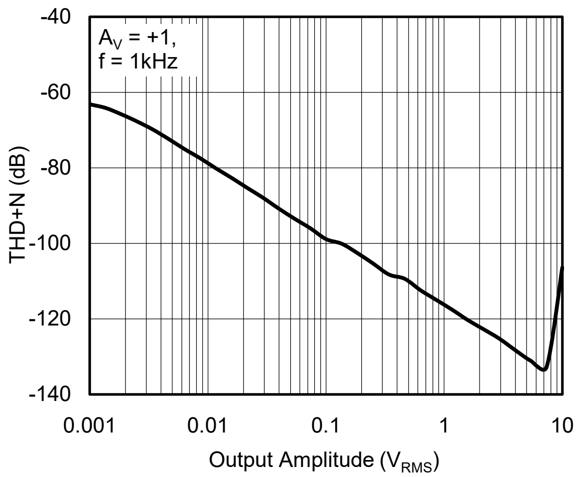
PSRR vs. Frequency



THD+N vs. Frequency

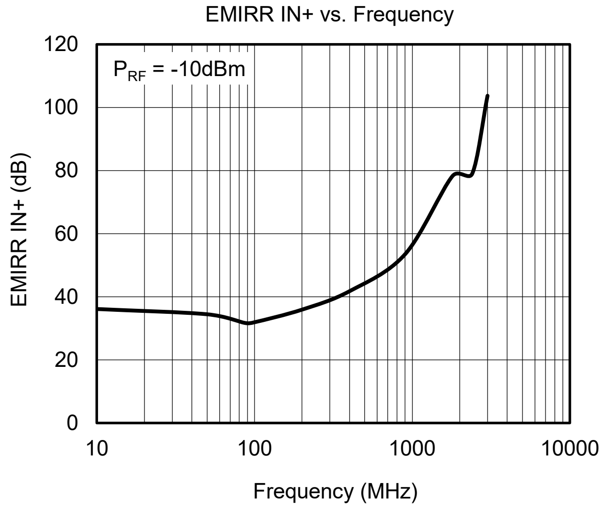


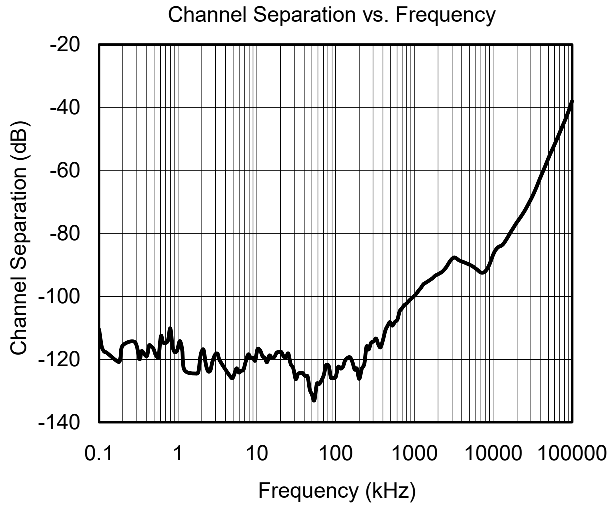
THD+N vs. Output Amplitude

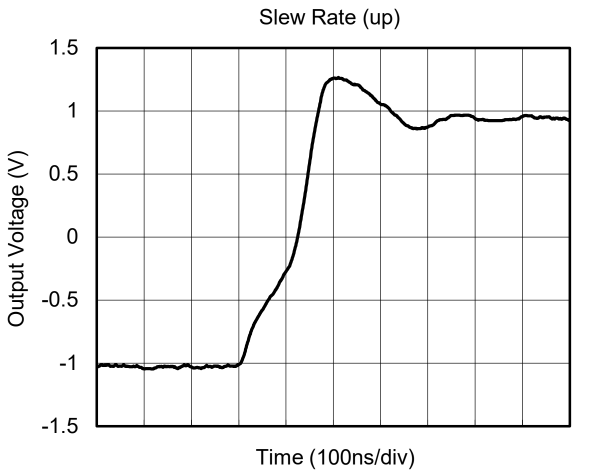


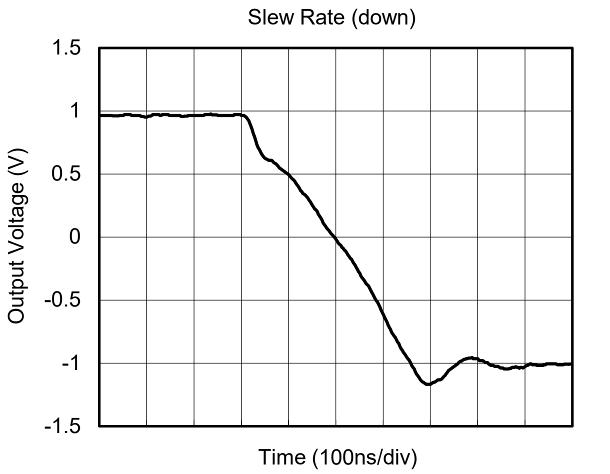
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

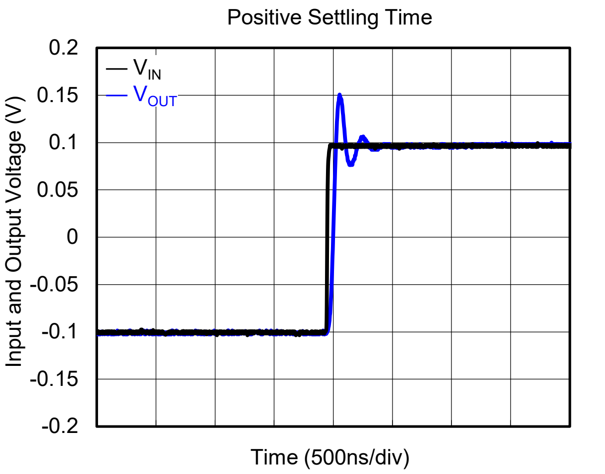
At T_A = +25℃, V_S = ±15V, C_L = 10pF and R_L = 5kΩ, unless otherwise noted.

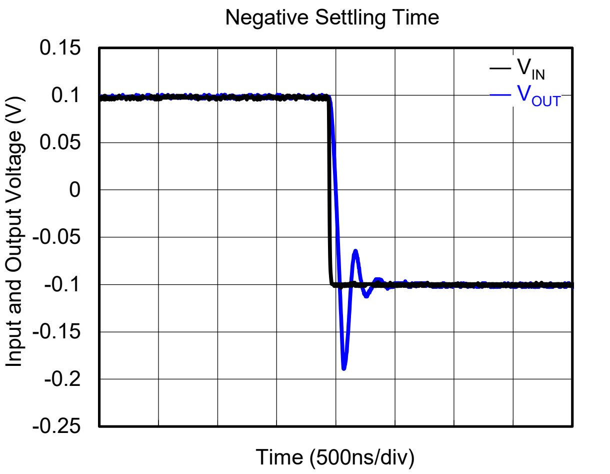






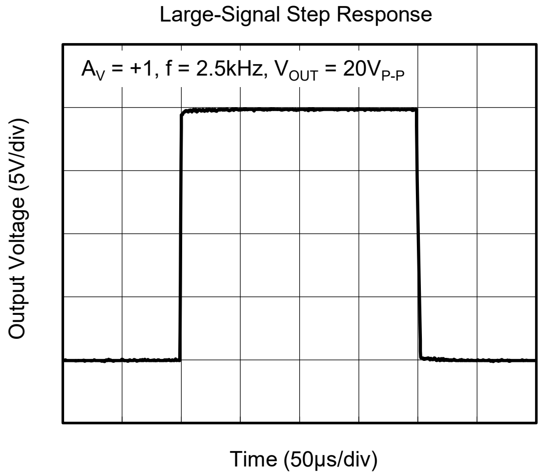


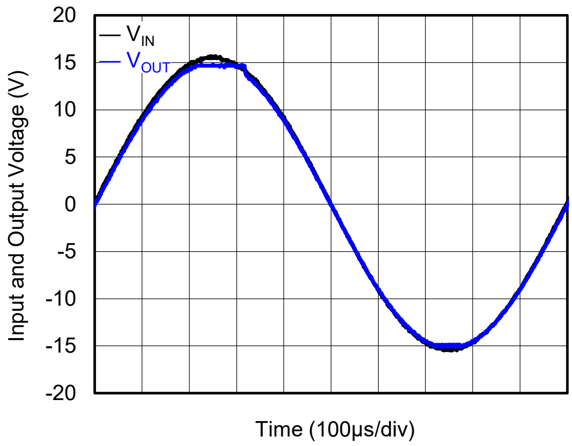


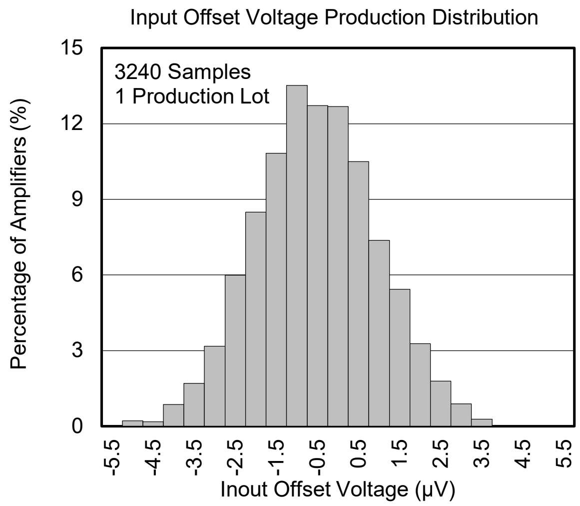


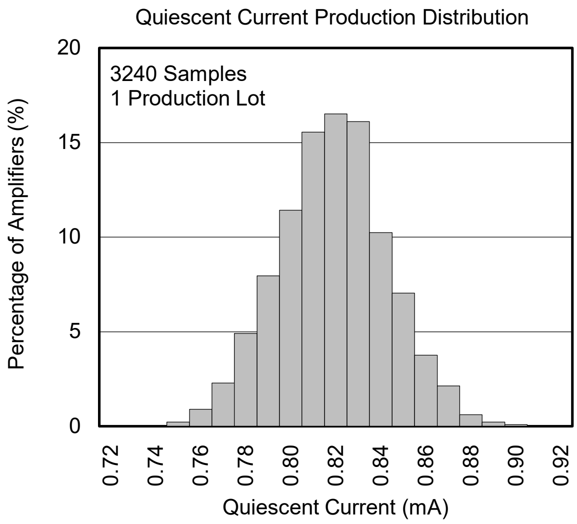
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

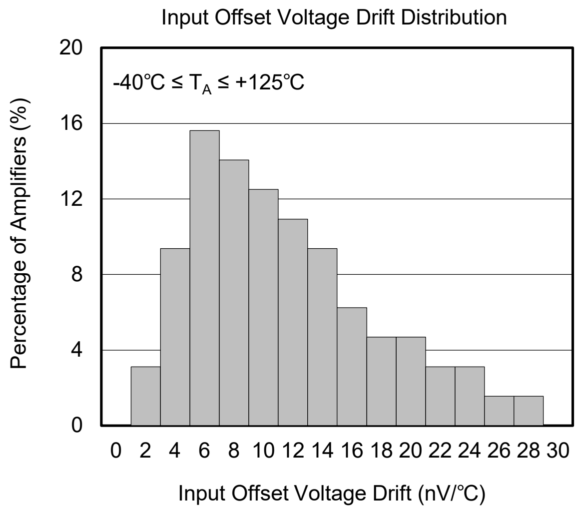
At T_A = +25℃, V_S = ±15V, C_L = 10pF and R_L = 5kΩ, unless otherwise noted.











APPLICATION INFORMATION

Rail-to-Rail Output

The SGM8249-1/2 support rail-to-rail output operation. In single power supply application, for example, when $+V_S$ = 36V, $-V_S$ = GND, 5kΩ load resistor is tied from OUT pin to ground, the typical output swing range is from 0.17V to 35.83V.

Driving Capacitive Loads

The SGM8249-1/2 are unity-gain stable with heavy capacitive load. If greater capacitive load must be driven in application, the circuit in Figure 1 can be used. In this circuit, the IR drop voltage generated by R_{ISO} is compensated by feedback loop.

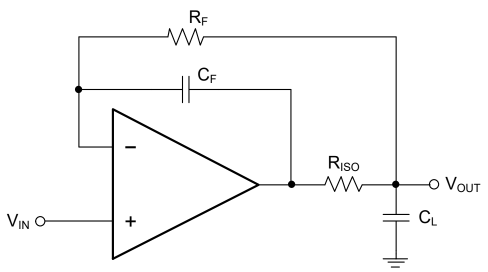


Figure 1. Circuit to Drive Heavy Capacitive Load

Power Supply Decoupling and Layout

A clean and low noise power supply is very important in amplifier circuit design, besides of input signal noise, the power supply is one of important source of noise to the amplifiers through $+V_S$ and $-V_S$ pins. Power supply bypassing is an effective method to clear up the noise at power supply, and the low impedance path to ground of decoupling capacitor will bypass the noise to GND. In application, 10μF ceramic capacitor paralleled with 0.1μF or 0.01μF ceramic capacitor is used in Figure 2. The ceramic capacitors should be placed as close as possible to $+V_S$ and $-V_S$ power supply pins.

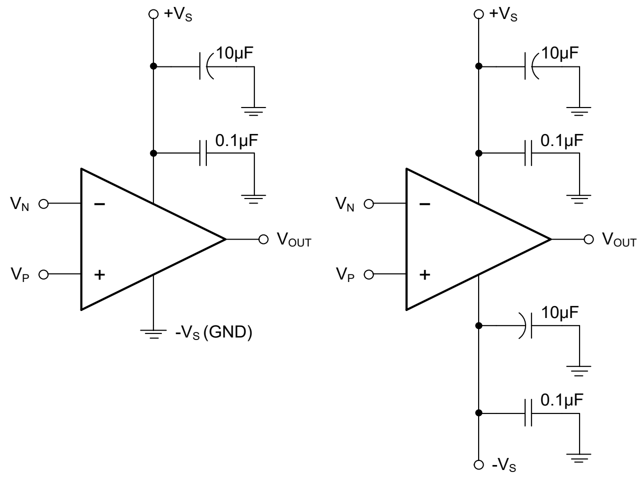


Figure 2. Amplifier Power Supply Bypassing

Grounding

In low speed application, one node grounding technique is the simplest and most effective method to eliminate the noise generated by grounding. In high speed application, the general method to eliminate noise is to use a complete ground plane technique, and the whole ground plane will help distribute heat and reduce EMI noise pickup.

Reduce Input-to-Output Coupling

To reduce the input-to-output coupling, the input traces must be placed as far away from the power supply or output traces as possible. The sensitive trace must not be placed in parallel with the noisy trace in same layer. They must be placed perpendicularly in different layers to reduce the crosstalk. These PCB layout techniques will help to reduce unwanted positive feedback and noise.

APPLICATION INFORMATION (continued)

Typical Application Circuits

Difference Amplifier

The circuit in Figure 3 is a design example of classical difference amplifier. If $R_4/R_3 = R_2/R_1$, then $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$.

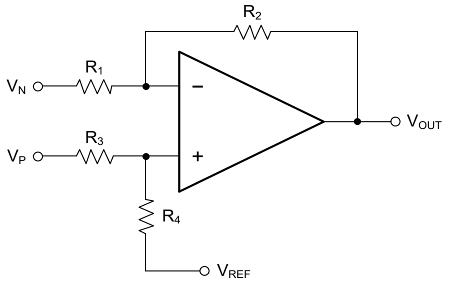


Figure 3. Difference Amplifier

High Input Impedance Difference Amplifier

The circuit in Figure 4 is a design example of high input impedance difference amplifier, the added amplifiers at the input are used to increase the input impedance and eliminate drawback of low input impedance in Figure 3.

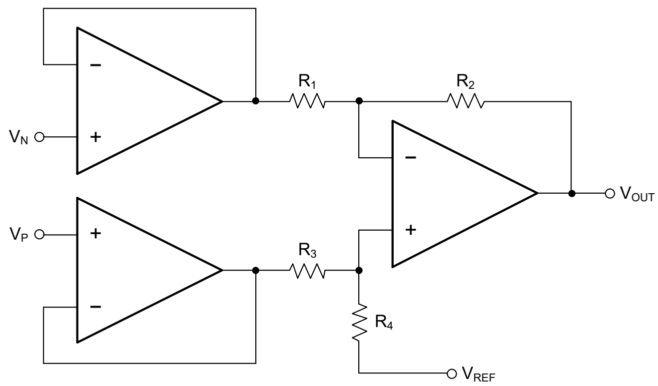


Figure 4. High Input Impedance Difference Amplifier

Active Low-Pass Filter

The circuit in Figure 5 is a design example of active low-pass filter, the DC gain is equal to $-R_2/R_1$ and the -3dB corner frequency is equal to $1/2\pi R_2C$. In this design, the filter bandwidth must be less than the bandwidth of the amplifier, the resistor values must be selected as low as possible to reduce ringing or oscillation generated by the parasitic parameters in PCB layout.

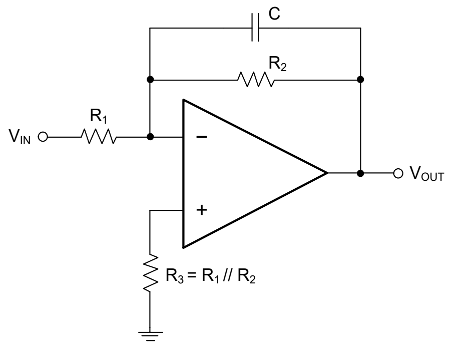


Figure 5. Active Low-Pass Filter

REVISION HISTORY

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

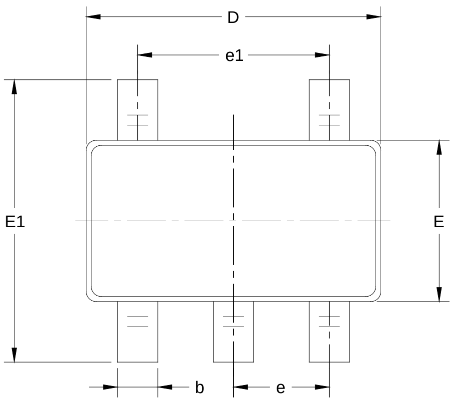
OCTOBER 2022 – REV.A.1 to REV.A.2	Page
Updated Typical Performance Characteristics section	6

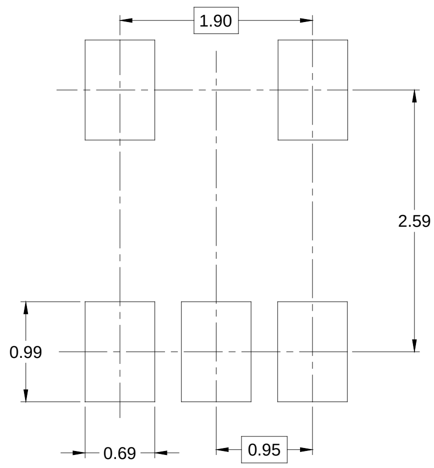
OCTOBER 2019 – REV.A to REV.A.1	Page
Updated Marking Information section	2

Changes from Original (DECEMBER 2017) to REV.A	Page
Changed from product preview to production data	All

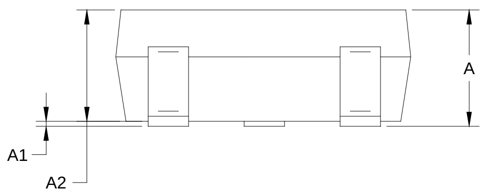
PACKAGE OUTLINE DIMENSIONS

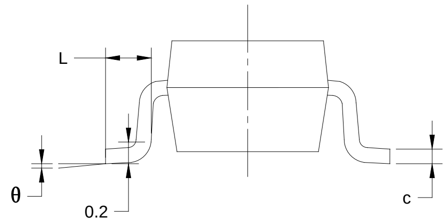
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)



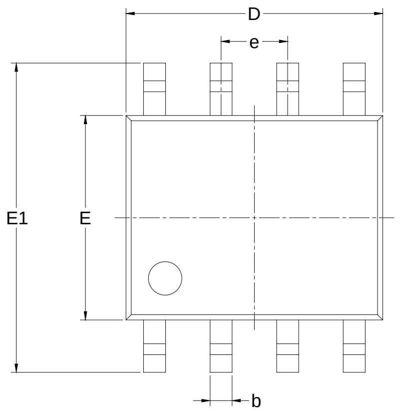


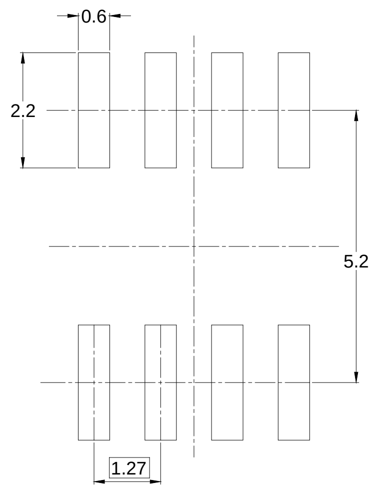
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

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

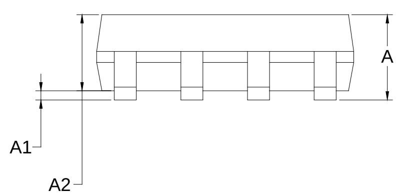
PACKAGE OUTLINE DIMENSIONS

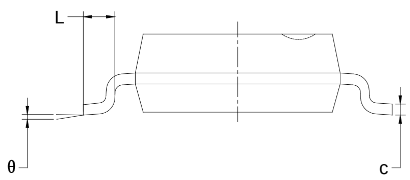
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)



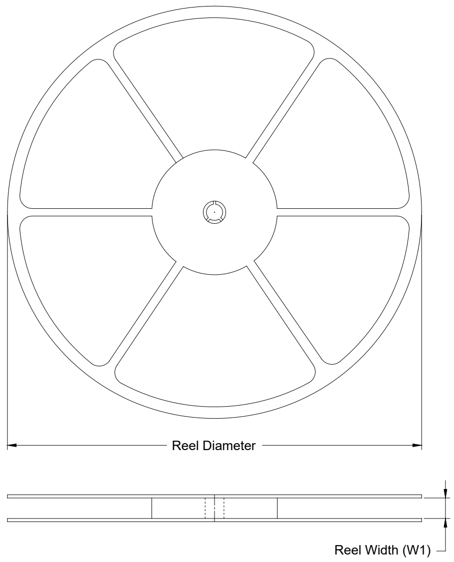


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27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

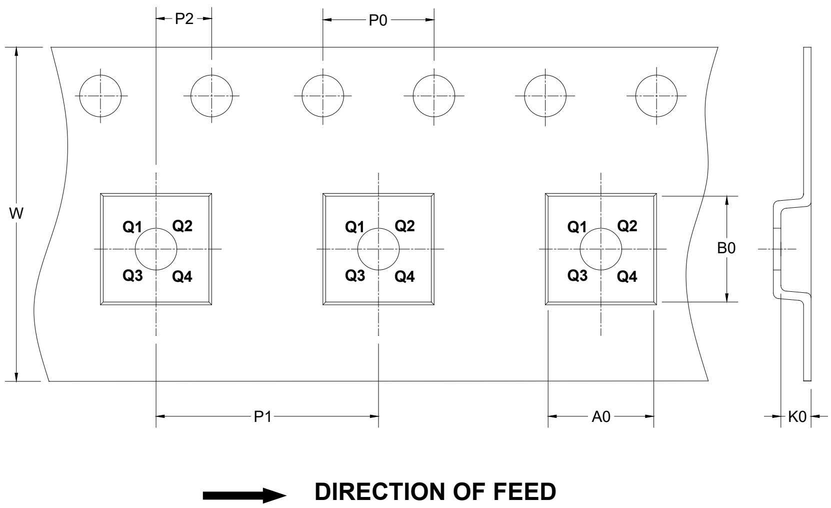
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

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

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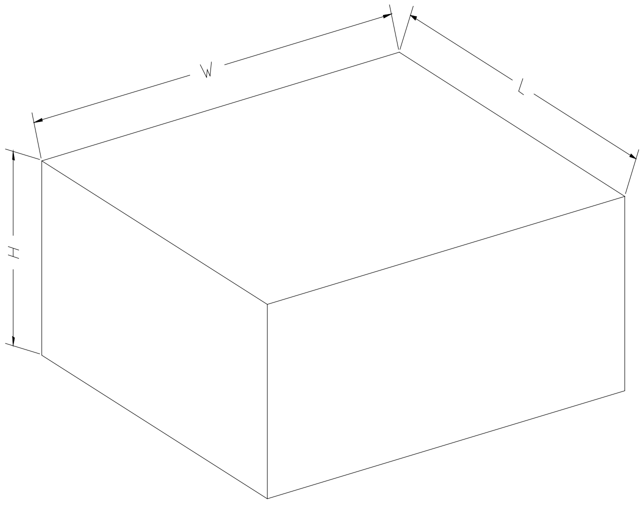
CARTON BOX DIMENSIONS



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

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