SGM8521/SGM8522/SGM8524
150kHz, 5.5µA, Rail-to-Rail I/O, CMOS Operational Amplifiers

GENERAL DESCRIPTION

The SGM8521 (single), SGM8522 (dual) and SGM8524 (quad) are low cost, voltage feedback amplifiers. These devices can operate from 2.1V to 5.5V single supply, while consuming only 5.5µA quiescent current per amplifier. They provide rail-to-rail input with a wide input common mode voltage range and rail-to-rail output voltage swing. This feature makes SGM8521/2/4 appropriate for buffering ASIC.

The SGM8521/2/4 offer a gain-bandwidth product of 150kHz and an ultra-low input bias current of 3pA. They are well suited for piezoelectric sensors, integrators and photodiode amplifiers.

The SGM8521/2/4 are designed into a wide range of applications, such as battery-powered instrumentation, safety monitoring, portable systems, and transducer interface circuits in low power systems.

The SGM8521 is available in Green SOT-23-5 and SOIC-8 packages. The SGM8522 is available in Green SOIC-8 and MSOP-8 packages. The SGM8524 is available in Green SOIC-14 and TSSOP-14 packages. They are specified over the extended -40℃ to +125℃ temperature range.

FEATURES

- **Low Cost**
- **Input Offset Voltage: 3.5mV (MAX)**
- **Unity-Gain Stable**
- **Gain-Bandwidth Product: 150kHz**
- **Rail-to-Rail Input and Output**
- **Supply Voltage Range: 2.1V to 5.5V**
- **Input Voltage Range:**
  -0.1V to 5.6V with V_S = 5.5V
- **Low Supply Current: 5.5µA/Amplifier**
- **-40℃ to +125℃ Operating Temperature Range**
- **Small Packaging:**
  SGM8521 Available in Green SOIC-8 and SOT-23-5 Packages
  SGM8522 Available in Green SOIC-8 and MSOP-8 Packages
  SGM8524 Available in Green SOIC-14 and TSSOP-14 Packages

APPLICATIONS

ASIC Input or Output Amplifiers
Piezoelectric Transducer Amplifiers
Battery-Powered Equipment
Portable Equipment
Sensor Interfaces
Medical Instrumentation
Mobile Communications
Audio Outputs
Smoke Detectors
Mobile Telephones
Notebook PCs
PCMCIA Cards

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8521	SOT-23-5	-40℃ to +125℃	SGM8521XN5/TR	8521	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8521XS/TR	SGM8521XS XXXXX	Tape and Reel, 2500
SGM8522	SOIC-8	-40℃ to +125℃	SGM8522XS/TR	SGM8522XS XXXXX	Tape and Reel, 2500
	MSOP-8	-40℃ to +125℃	SGM8522XMS/TR	SGM8522 XMS XXXXX	Tape and Reel, 3000
SGM8524	SOIC-14	-40℃ to +125℃	SGM8524XS14/TR	SGM8524XS14 XXXXX	Tape and Reel, 2500
	TSSOP-14	-40℃ to +125℃	SGM8524XTS14/TR	SGM8524 XTS14 XXXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXXX = Date Code and Vendor Code.

XXXXX
- Vendor Code
- Date Code - Week
- 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, $+V_S$ to $-V_S$ 6V
Input Common Mode Voltage Range
.... $(-V_S) - 0.3V$ to $(+V_S) + 0.3V$
Package Thermal Resistance @ T_A = +25℃
SOT-23-5, θ_{JA} .... 190℃/W
SOIC-8, θ_{JA} .... 125℃/W
MSOP-8, θ_{JA} .... 216℃/W
Junction Temperature..+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s)............................+260℃
ESD Susceptibility
HBM..4000V
MM..400V

RECOMMENDED OPERATING CONDITIONS

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

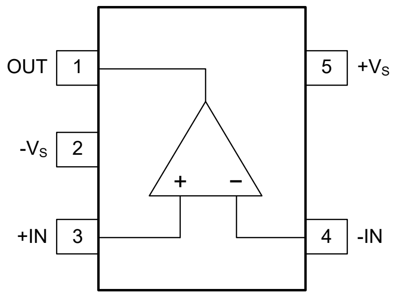
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

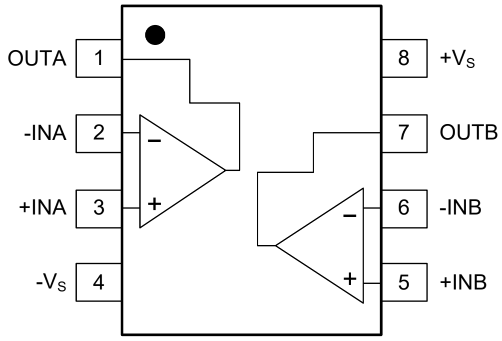
PIN CONFIGURATIONS

SGM8521 (TOP VIEW)



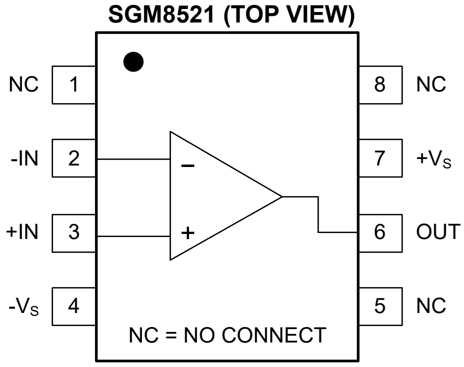
SOT-23-5

SGM8522 (TOP VIEW)



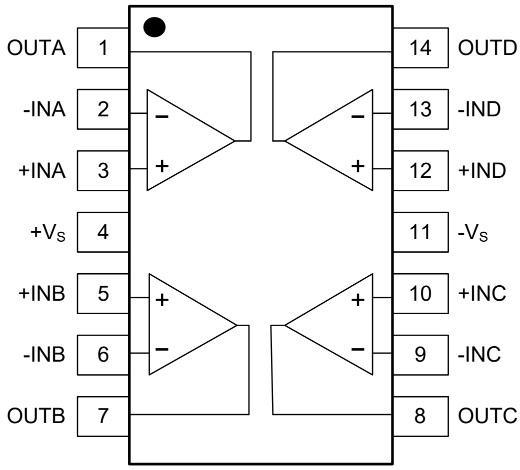
SOIC-8/MSOP-8

SGM8521 (TOP VIEW)



SOIC-8

SGM8524 (TOP VIEW)



TSSOP-14/SOIC-14

ELECTRICAL CHARACTERISTICS

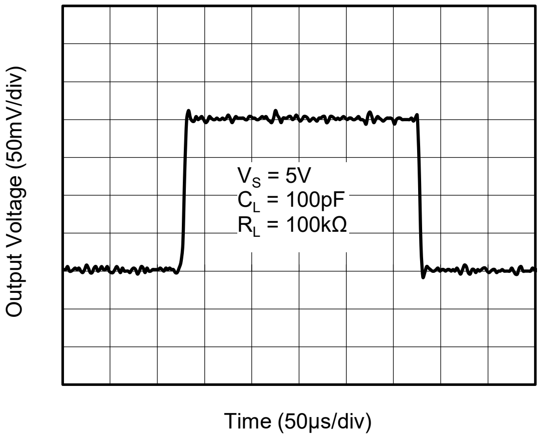
(At T_A = +25℃, V_S = 5V, R_L = 500kΩ connected to V_S/2 and V_{OUT} = V_S/2, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	V_{OS}			1	3.5	mV
Input Bias Current	I_B			3		pA
Input Offset Current	I_{OS}			3		pA
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$			2		μV/℃
Quiescent Current/Amplifier	I_Q			5.5		μA
Open-Loop Voltage Gain	A_{OL}	V_{OUT} = 0.015V to 4.985V, R_L = 500kΩ	90	110		dB
		V_{OUT} = 0.1V to 4.9V, R_L = 100kΩ	88	108		
Common Mode Rejection Ratio	CMRR	V_S = 5.5V, -0.1V < V_{CM} < 5.6V	60	87		dB
		V_S = 5.5V, -0.1V < V_{CM} < 4V	70	114		
Power Supply Rejection Ratio	PSRR	V_S = 2.5V to 5.5V, V_{CM} = 0.5V	65	94		dB
Output Current	I_{SOURCE}	R_L = 10Ω to V_S/2	61	87		mA
	I_{SINK}		60	76		
Output Voltage Swing	V_{OH}		4.990	4.997		V
	V_{OL}			0.005	0.010	
Gain-Bandwidth Product	GBP			150		kHz
Slew Rate	SR	R_L = 100kΩ		0.05		V/μs
Input Voltage Noise Density	e_n	f = 1kHz		85		nV/$\sqrt{Hz}$
		f = 10kHz		44		

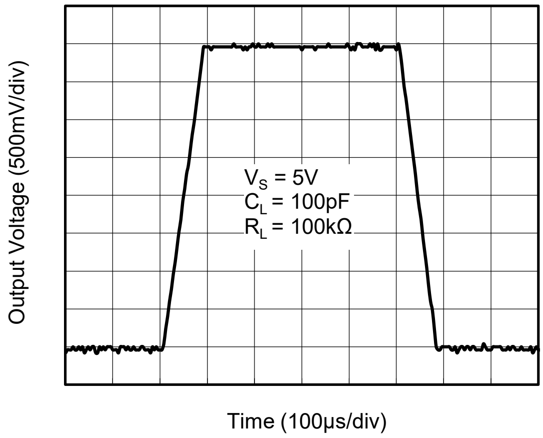
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_S = 5V and R_L = 500kΩ connected to V_S/2, unless otherwise noted.

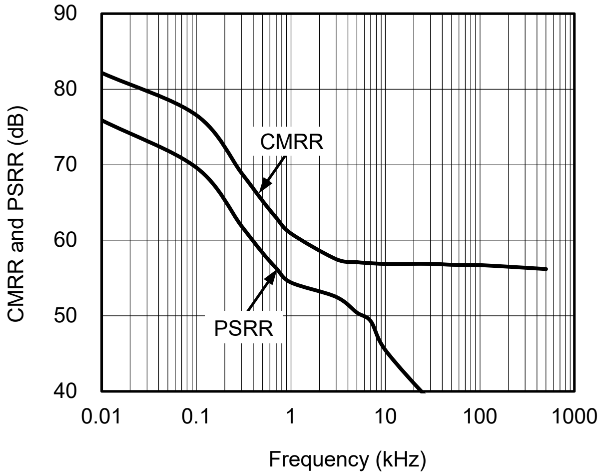
Small-Signal Step Response



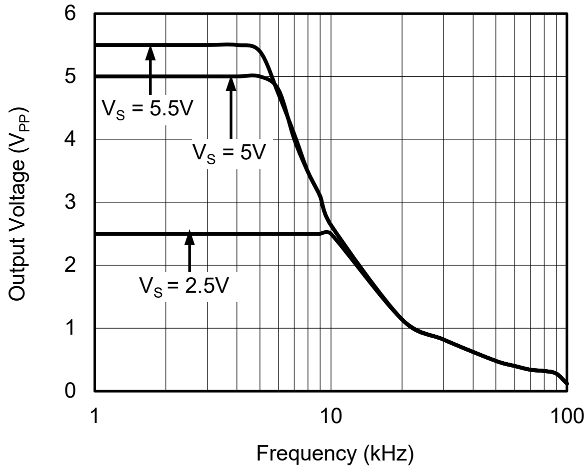
Large-Signal Step Response



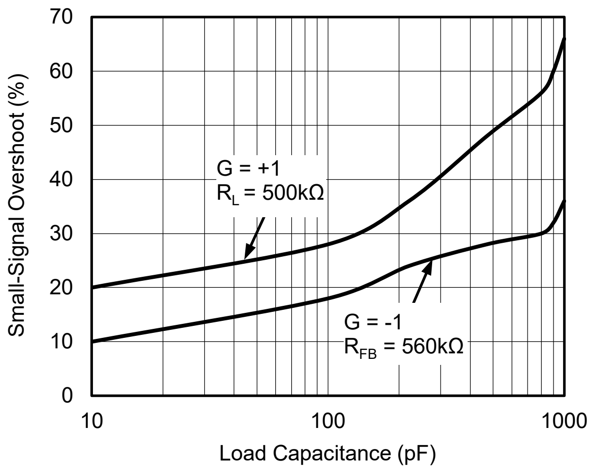
CMRR and PSRR vs. Frequency



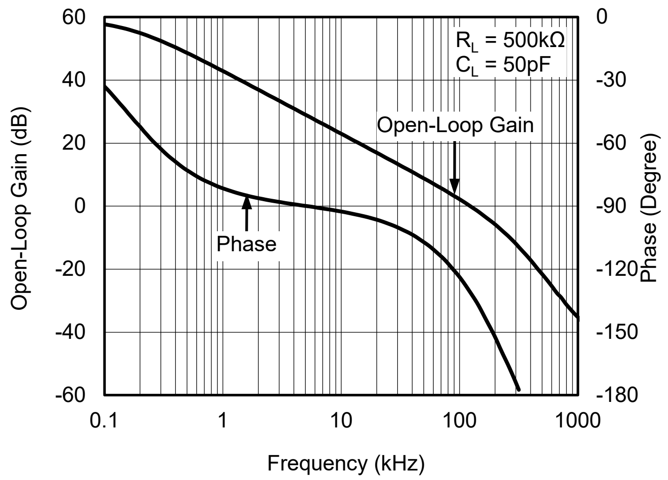
Maximum Output Voltage vs. Frequency



Small-Signal Overshoot vs. Capacitive Load

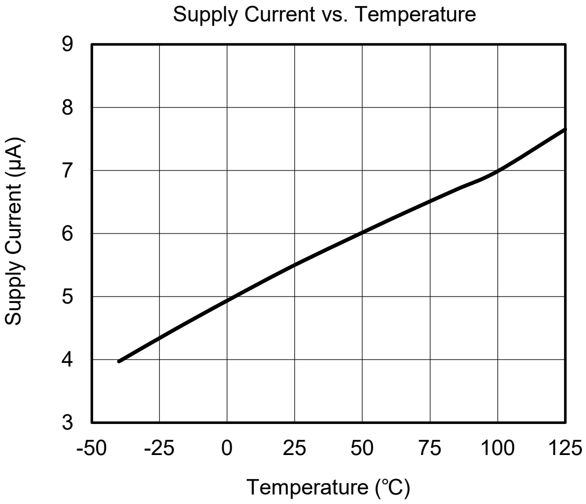


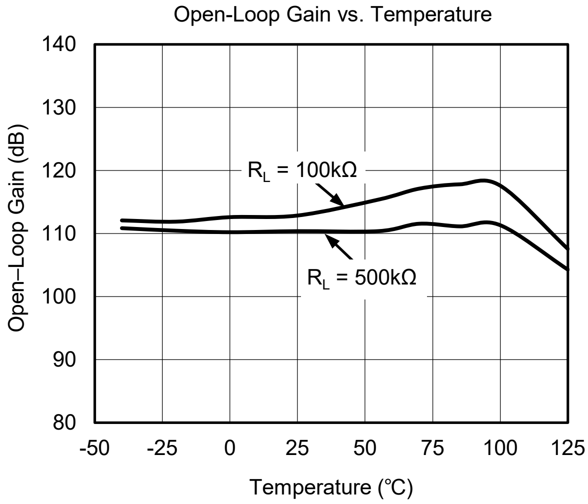
Open-Loop Gain and Phase vs. Frequency

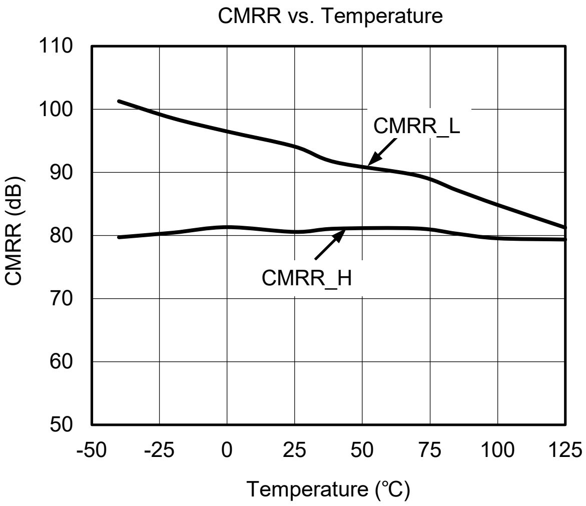


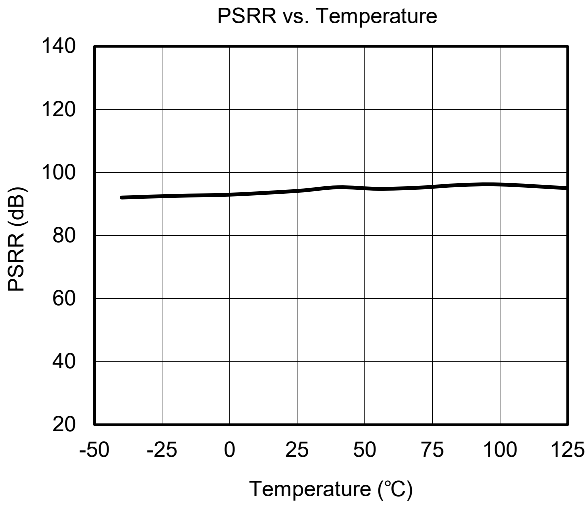
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

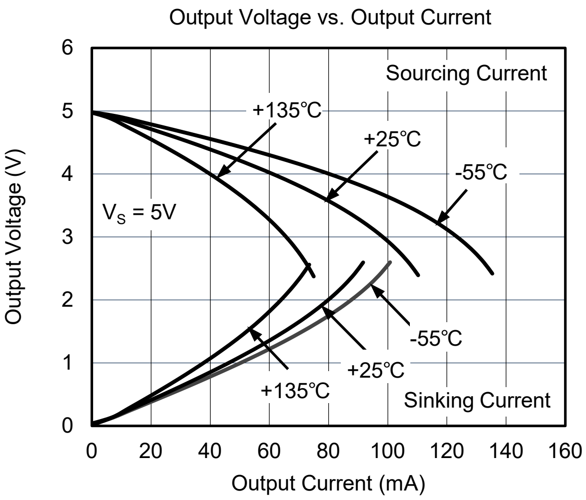
At T_A = +25℃, V_S = 5V and R_L = 500kΩ connected to V_S/2, unless otherwise noted.

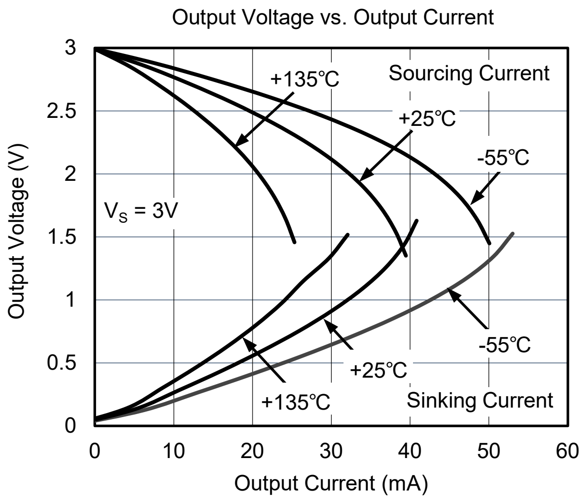






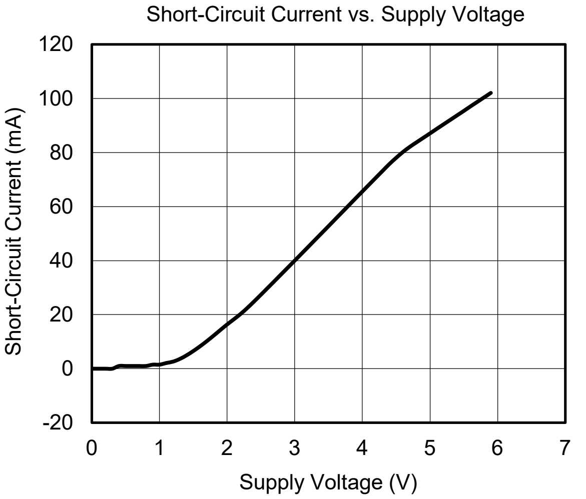


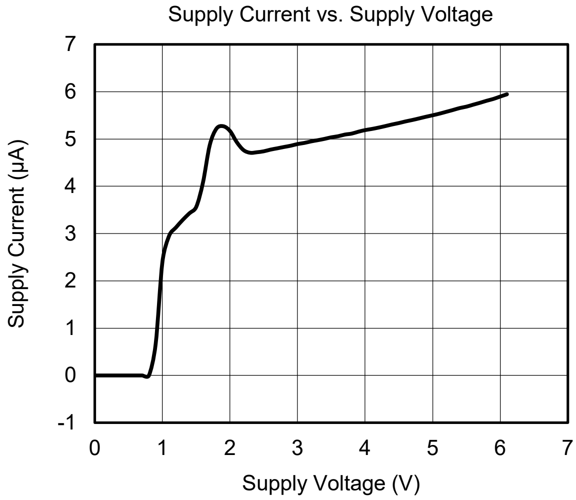


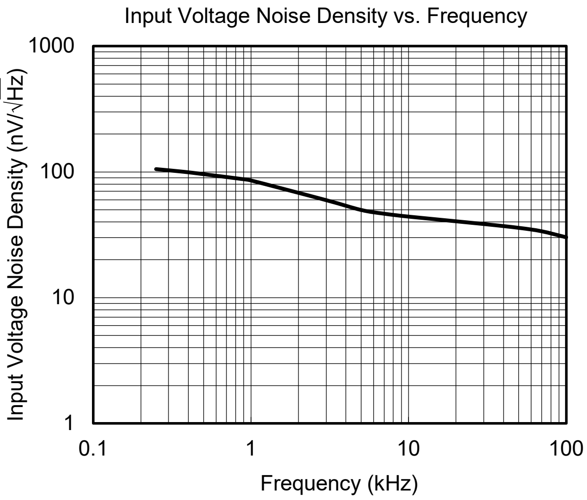


TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V and R_L = 500kΩ connected to V_S/2, unless otherwise noted.







APPLICATION INFORMATION

Rail-to-Rail Input

When SGM8521/2/4 work at the power supply between 2.1V and 5.5V, the input common mode voltage range is from $(-V_S) - 0.1V$ to $(+V_S) + 0.1V$. In Figure 1, the ESD diodes between the inputs and the power supply rails will clamp the input voltage not to exceed the rails.

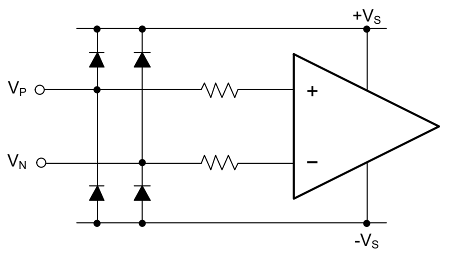


Figure 1. Input Equivalent Circuit

Rail-to-Rail Output

The SGM8521/2/4 support rail-to-rail output operation. In single power supply application, for example, when $+V_S = 5V$, $-V_S = GND$, 500kΩ load resistor is tied from OUT pin to $V_S/2$, the typical output swing range is from 0.005V to 4.997V.

Driving Capacitive Loads

The SGM8521/2/4 are designed for unity-gain stable for capacitive load up to 250pF. If greater capacitive load must be driven in application, the circuit in Figure 2 can be used. In this circuit, the IR drop voltage generated by R_{ISO} is compensated by feedback loop.

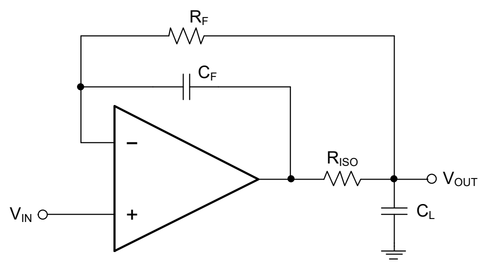


Figure 2. Circuit to Drive Heavy Capacitive Load

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 3. The ceramic capacitors should be placed as close as possible to $+V_S$ and $-V_S$ power supply pins.

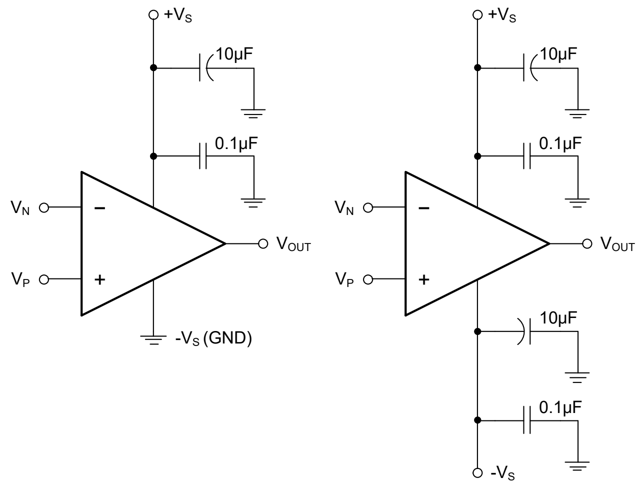


Figure 3. Amplifier Power Supply Bypassing

APPLICATION INFORMATION (continued)

Typical Application Circuits

Difference Amplifier

The circuit in Figure 4 is a design example of classical difference amplifier. If $R_4/R_3 = R_2/R_1$, then $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$.

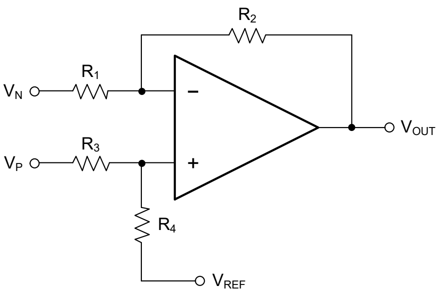


Figure 4. Difference Amplifier

High Input Impedance Difference Amplifier

The circuit in Figure 5 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 4.

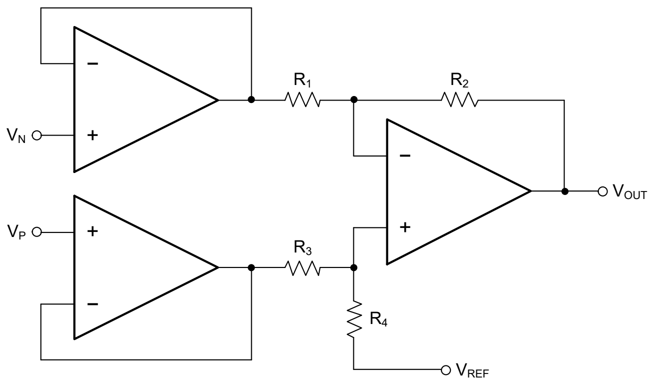


Figure 5. High Input Impedance Difference Amplifier

Active Low-Pass Filter

The circuit in Figure 6 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.

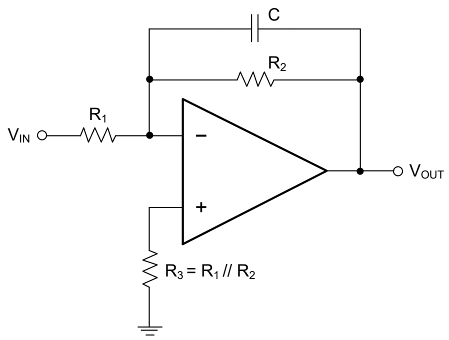


Figure 6. Active Low-Pass Filter

REVISION HISTORY

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

NOVEMBER 2018 – REV.C.4 to REV.D	Page
Changed Open-Loop Gain and Phase vs. Frequency	5

JULY 2017 – REV.C.3 to REV.C.4	Page
Added Open-Loop Gain and Phase vs. Frequency	6

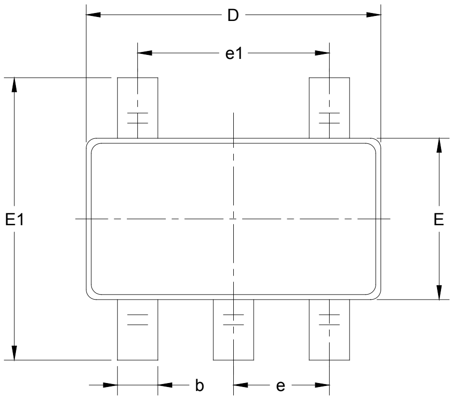
JANUARY 2017 – REV.C.2 to REV.C.3	Page
Changed Electrical Characteristics section	4
Updated SOIC-14 and TSSOP-14 packages	13, 14
Updated Tape and Reel Information section	15

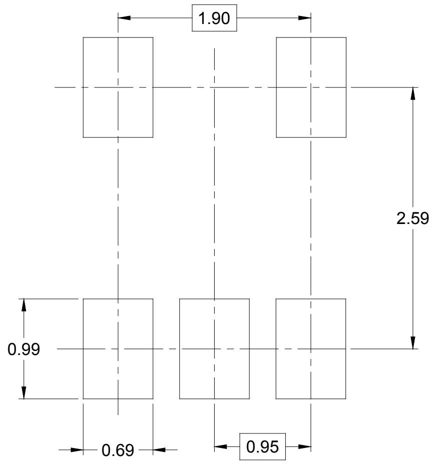
APRIL 2013 – REV.C.1 to REV.C.2	Page
Changed Electrical Characteristics section	3
Changed Input Voltage Noise Density vs. Frequency	4

NOVEMBER 2012 – REV.C to REV.C.1	Page
Added SGM8524	All

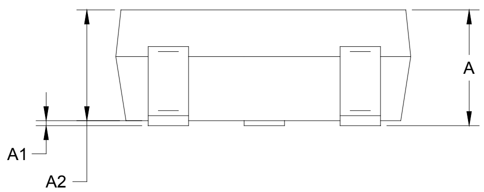
PACKAGE OUTLINE DIMENSIONS

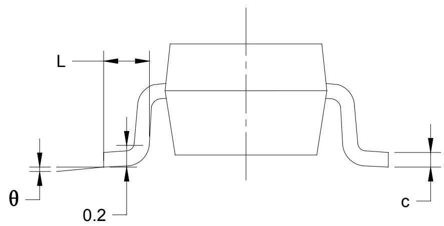
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)

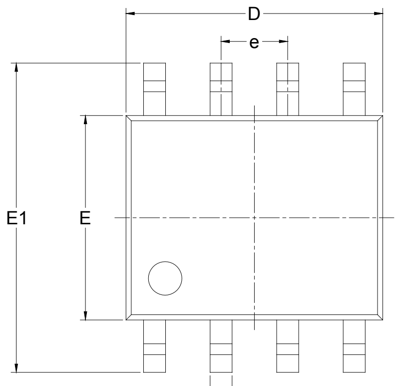


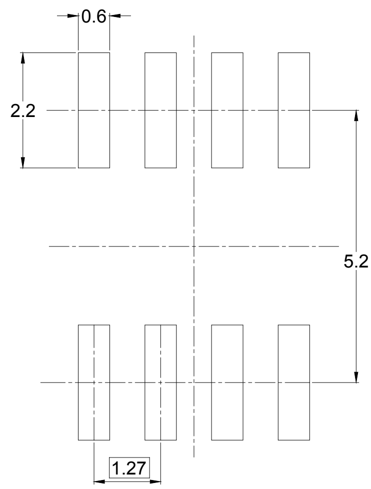


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

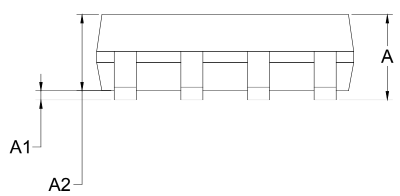
PACKAGE OUTLINE DIMENSIONS

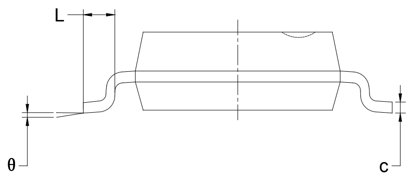
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)

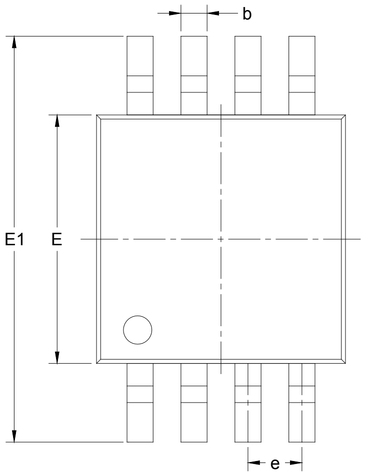


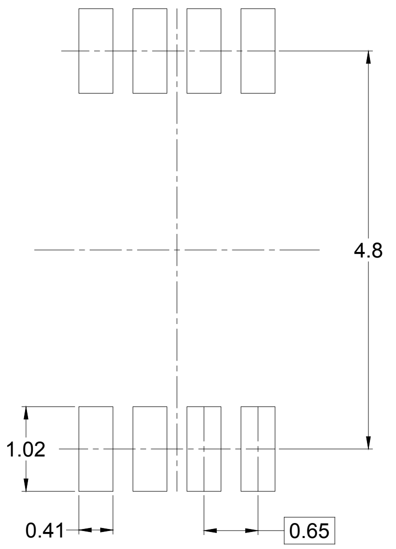


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

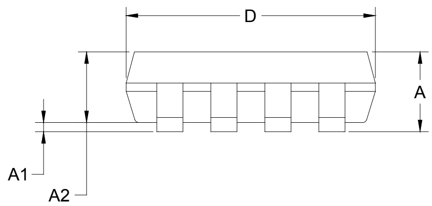
PACKAGE OUTLINE DIMENSIONS

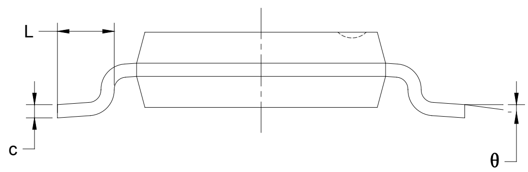
MSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)

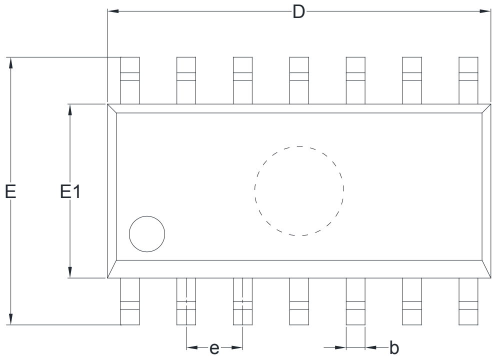


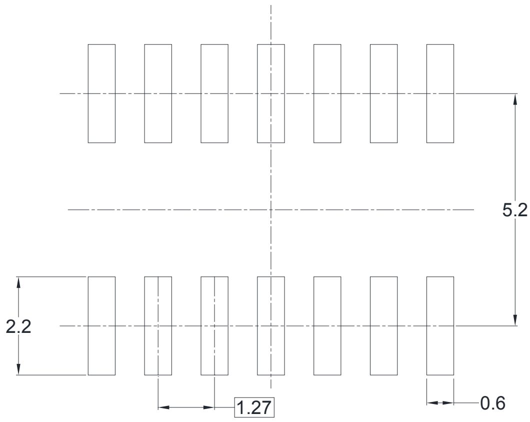


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650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

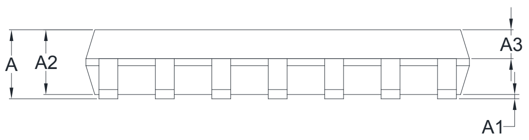
PACKAGE OUTLINE DIMENSIONS

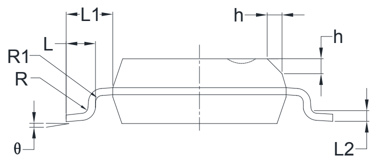
SOIC-14





RECOMMENDED LAND PATTERN (Unit: mm)

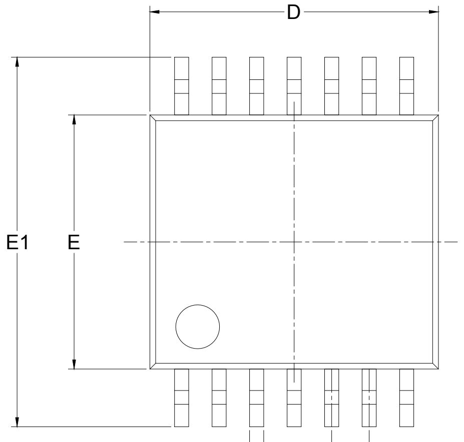


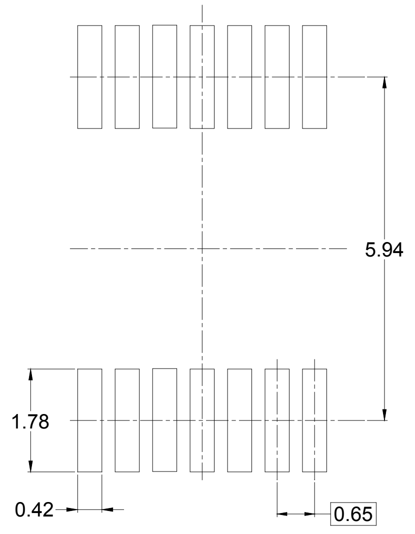


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80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

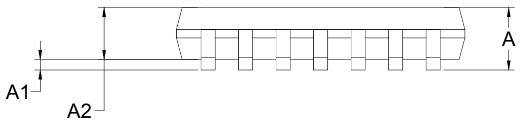
PACKAGE OUTLINE DIMENSIONS

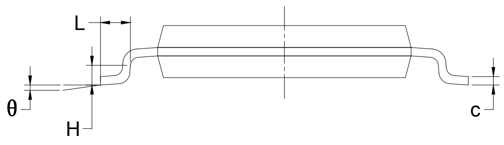
TSSOP-14





RECOMMENDED LAND PATTERN (Unit: mm)

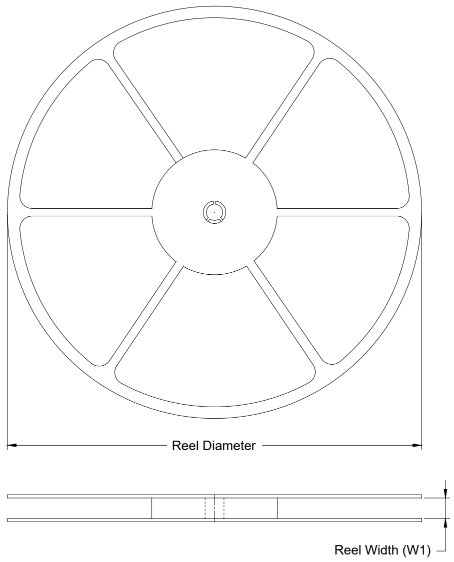




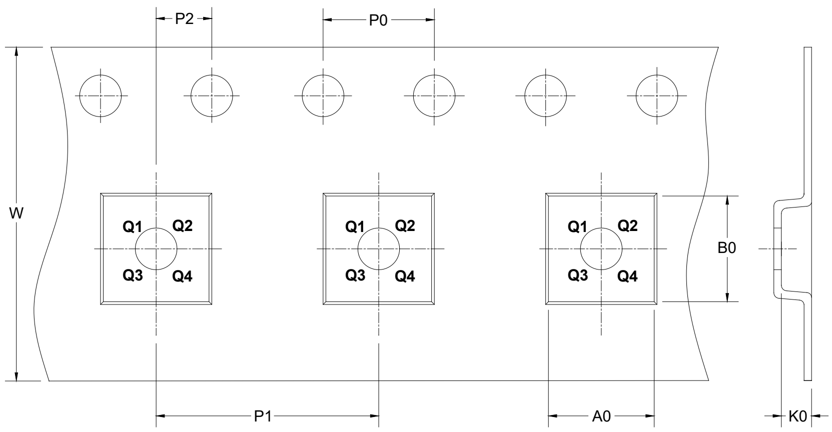
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	**MAX**	**MIN**	**MAX**
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026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

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



DIRECTION OF FEED

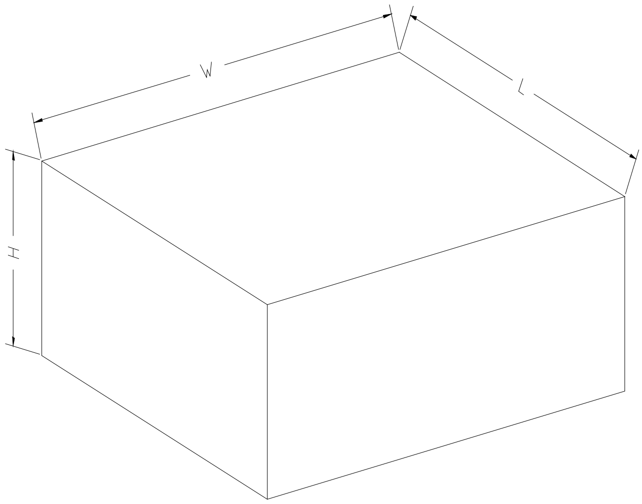
NOTE: The picture is only for reference. Please make the object as the standard.

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
TSSOP-14	13″	12.4	6.95	5.60	1.20	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