SGM2358
1MHz, Rail-to-Rail Output, CMOS Operational Amplifier

GENERAL DESCRIPTION

The SGM2358 is a dual, voltage feedback amplifier. The device can operate from 2.5V to 5.5V single supply. It provides rail-to-rail output voltage swing. This feature makes SGM2358 appropriate for buffering ASIC.

The SGM2358 offers a gain-bandwidth product of 1MHz and an ultra-low input bias current of 10pA. It is well suited for piezoelectric sensors, integrators and photodiode amplifiers.

The SGM2358 is 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 SGM2358 is available in a Green SOIC-8 package. It is specified over the extended -40℃ to +85℃ temperature range.

FEATURES

- **Low Cost**
- **Input Offset Voltage: 1.7mV (TYP)**
- **Ultra-Low Input Bias Current: 10pA**
- **Unity-Gain Stable**
- **Gain-Bandwidth Product: 1MHz**
- **Rail-to-Rail Output**
- **Supply Voltage Range: 2.5V to 5.5V**
- **Minimum Input Common Mode Voltage below 0V**
- **-40℃ to +85℃ Operating Temperature Range**
- **Available in a Green SOIC-8 Package**

APPLICATIONS

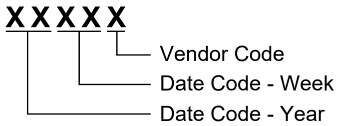
ASIC Input or Output Amplifiers
Piezoelectric Transducer Amplifiers
Battery-Powered Equipment
Portable Equipment
Sensor Interfaces
Medical Instrumentation
Mobile Communications
Smoke Detectors
Notebook PCs
PCMCIA Cards
DSP Interfaces
Set Top Boxes

PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM2358	SOIC-8	-40℃ to +85℃	SGM2358YS/TR	SGM2358YS XXXXX	Tape and Reel, 4000

MARKING INFORMATION

NOTE: 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.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$ 6.0V
Package Thermal Resistance @ T_A = +25℃
SOIC-8, θ_{JA} .... 125℃/W
Junction Temperature .... +160℃
Storage Temperature Range .... -65℃ to +150℃
Lead Temperature (Soldering, 10s) .... +260℃
ESD Susceptibility
HBM 4000V
MM 300V

RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range .... -40℃ to +85℃

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

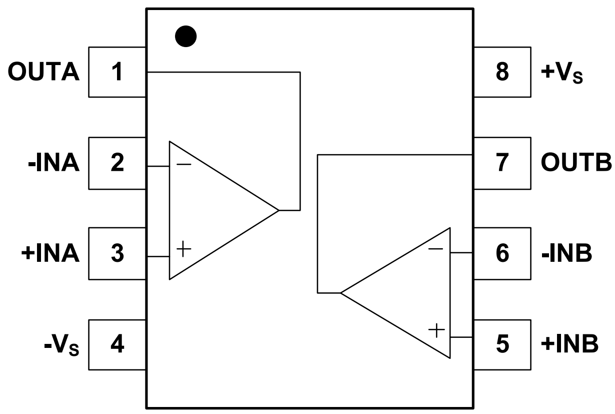
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

(TOP VIEW)



SOIC-8

ELECTRICAL CHARACTERISTICS

(V_S = 5V, at R_L = 100kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.)

PARAMETER	CONDITIONS	SGM2358				
		TYP	MIN/MAX OVER TEMPERATURE			
		+25℃	+25℃	-40℃ to +85℃	UNITS	MIN/MAX
Input Characteristics						
Input Offset Voltage (V_{OS})		1.7	10	10.5	mV	MAX
Input Bias Current (I_B)		10			pA	TYP
Input Offset Current (I_{OS})		10			pA	TYP
Input Common Mode Voltage Range	V_S = 5V		-0.1		V	MIN
			4		V	MAX
Common Mode Rejection Ratio (CMRR) (1)	V_S = 5V, V_{CM} = - 0.1V to 3.3V	88	70	65	dB	MIN
Open-Loop Voltage Gain (A_{OL})	R_L = 2kΩ, V_{OUT} = 0.1V to 4.9V	100	80	70	dB	MIN
	R_L = 10kΩ, V_{OUT} = 0.035V to 4.965V	110	80	70	dB	MIN
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta T$)		3.5			μV/℃	TYP
Output Characteristics						
Output Voltage Swing from Rail	V_{OUT} Connect R_L (600Ω) to GND	0.139			V	TYP
	V_{OUT} Connect R_L (600Ω) to $+V_S$	0.225			V	TYP
	V_{OUT} Connect R_L (2kΩ) to GND	0.080			V	TYP
	V_{OUT} Connect R_L (2kΩ) to $+V_S$	0.087			V	TYP
	V_{OUT} Connect R_L (10kΩ) to GND	0.008			V	TYP
	V_{OUT} Connect R_L (10kΩ) to $+V_S$	0.015			V	TYP
Output Current (I_{OUT})	V_{OUT} = $+V_S$ - 0.5V	13			mA	TYP
	V_{OUT} = $-V_S$ + 0.5V	-8			mA	TYP
Short-Circuit Current (I_{SC})	V_{OUT} Connect R_L (10Ω) to GND	43	35	30	mA	MIN
	V_{OUT} Connect R_L (10Ω) to $+V_S$	-33	-20	-16	mA	MAX
Power Supply						
Operating Voltage Range			2.5	2.5	V	MIN
			5.5	5.5	V	MAX
Power Supply Rejection Ratio (PSRR)	V_S = +2.5V to +5.5V					
	V_{CM} = ($-V_S$) + 0.5V	80	70	65	dB	MIN
Quiescent Current (I_Q)	I_{OUT} = 0	0.4	0.95	1	mA	MAX
Dynamic Performance	C_L = 100pF					
Gain-Bandwidth Product (GBP)		1.0			MHz	TYP
Slew Rate (SR)	G = +1, 2V Output step	0.65			V/μs	TYP
Settling Time to 0.1% (t_S)	G = +1, 2V Output step	9.0			μs	TYP
Overload Recovery Time	V_{IN} • Gain = Vs	4.0			μs	TYP
Crosstalk	f = 1kHz	-80			dB	TYP
	f = 1MHz	-65			dB	TYP
Noise Performance						
Voltage Noise Density (e_n)	f = 1kHz	42			nV/$\sqrt{Hz}$	TYP
	f = 10kHz	38			nV/$\sqrt{Hz}$	TYP

NOTE:
1. CMRR is affected by the matching between external gain-setting resistor ratios.

ELECTRICAL CHARACTERISTICS (continued)

(V_S = 2.5V, at R_L = 100kΩ connected to V_S/2, and V_{OUT} = V_S/2, unless otherwise noted.)

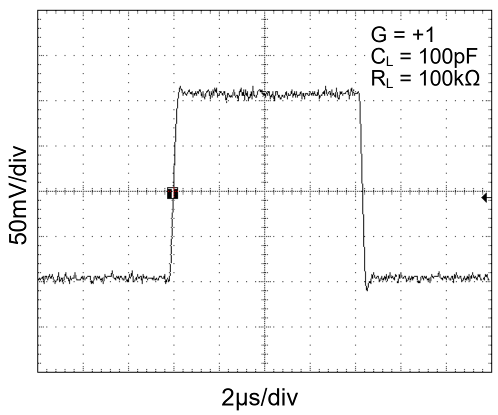
PARAMETER	CONDITIONS	SGM2358				
		TYP	MIN/MAX OVER TEMPERATURE			
		+25℃	+25℃	-40℃ to +85℃	UNITS	MIN/MAX
Input Characteristics						
Input Offset Voltage (V_{OS})		1.8			mV	MAX
Common Mode Rejection Ratio (CMRR) (1)	V_S = 2.5V, V_{CM} = - 0.1V to 0.9V	73			dB	MIN
Open-Loop Voltage Gain (A_{OL})	R_L = 2kΩ, V_{OUT} = 0.1V to 2.4V	99			dB	MIN
	R_L = 10kΩ, V_{OUT} = 0.035V to 2.465V	100			dB	MIN
Output Characteristics						
Output Voltage Swing from Rail	V_{OUT} Connect R_L (600Ω) to GND	0.130			V	TYP
	V_{OUT} Connect R_L (600Ω) to +V_S	0.146			V	TYP
	V_{OUT} Connect R_L (2kΩ) to GND	0.043			V	TYP
	V_{OUT} Connect R_L (2kΩ) to +V_S	0.049			V	TYP
	V_{OUT} Connect R_L (10kΩ) to GND	0.008			V	TYP
	V_{OUT} Connect R_L (10kΩ) to +V_S	0.010			V	TYP
Output Current (I_{OUT})	V_{OUT} = +V_S - 0.5V	5.8			mA	TYP
	V_{OUT} = -V_S + 0.5V	-6.0			mA	TYP
Short-Circuit Current (I_{SC})	V_{OUT} Connect R_L (10Ω) to GND	9.1			mA	MIN
	V_{OUT} Connect R_L (10Ω) to +V_S	-11.1			mA	MAX
Power Supply						
Quiescent Current (I_Q)	I_{OUT} = 0	0.19			mA	MAX
Dynamic Performance	C_L = 100pF					
Gain-Bandwidth Product (GBP)		1.2			MHz	TYP
Slew Rate (SR)	G = +1, 1V Output step	0.34			V/μs	TYP
Settling Time to 0.1% (t_S)	G = +1, 0.5V Output step	1.49			μs	TYP
Overload Recovery Time	V_{IN} • Gain = V_S	2.3			μs	TYP
Noise Performance						
Voltage Noise Density (e_n)	f = 1kHz	46.8			$nV/\sqrt{Hz}$	TYP
	f = 10kHz	40.5			$nV/\sqrt{Hz}$	TYP

NOTE:
1. CMRR is affected by the matching between external gain-setting resistor ratios.

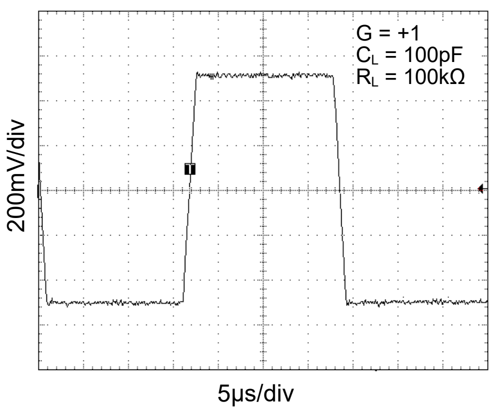
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_S = +5V, and R_L = 100kΩ connected to V_S/2, unless otherwise noted.

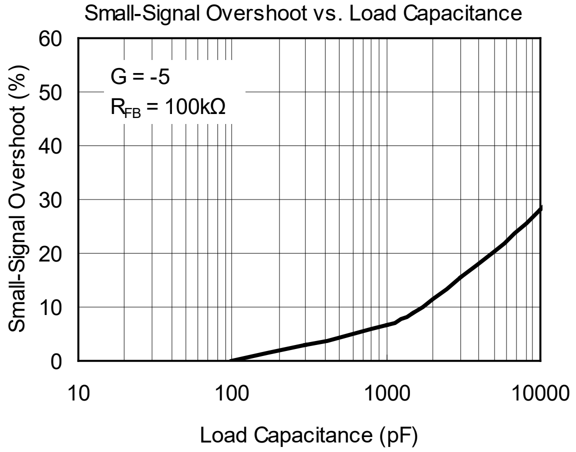
Small-Signal Step Response



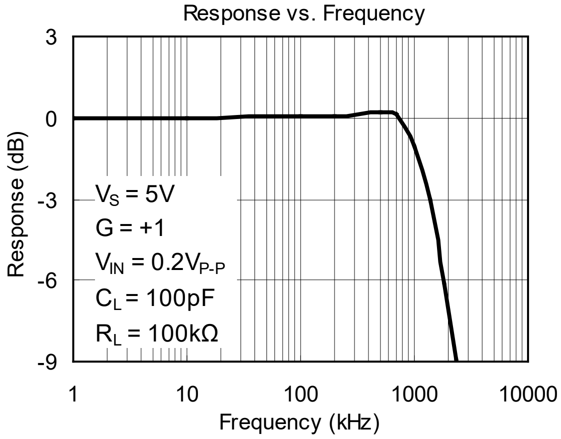
Large-Signal Step Response



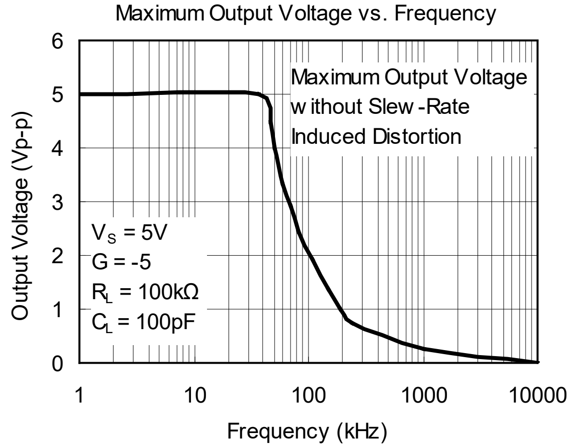
Small-Signal Overshoot vs. Load Capacitance



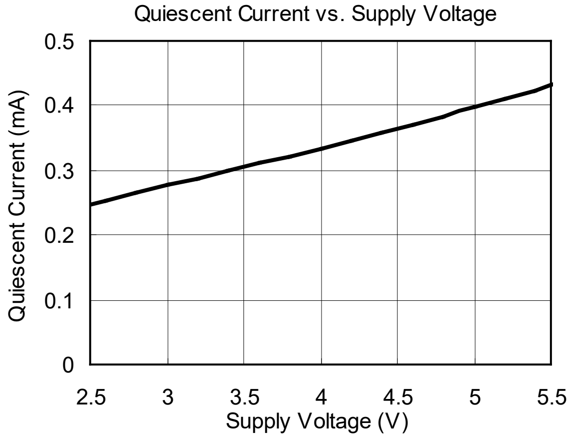
Response vs. Frequency



Maximum Output Voltage vs. Frequency



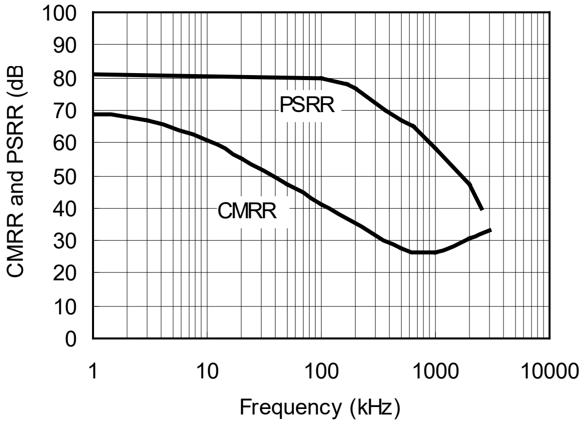
Quiescent Current vs. Supply Voltage



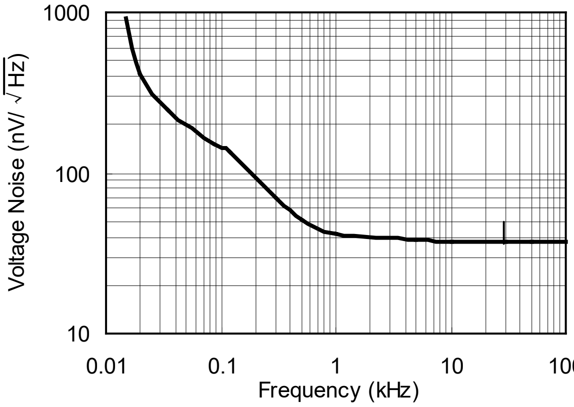
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = +5V, and R_L = 100kΩ connected to V_S/2, unless otherwise noted.

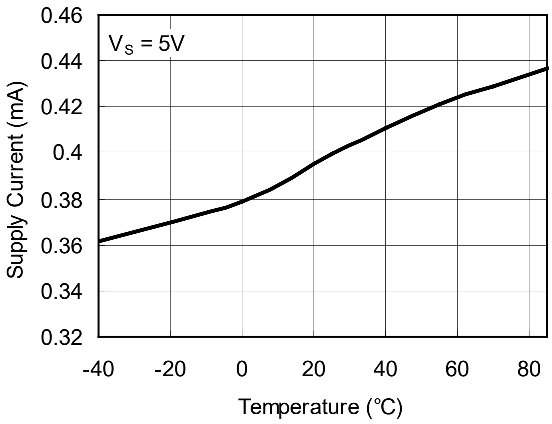
CMRR and PSRR vs. Frequency



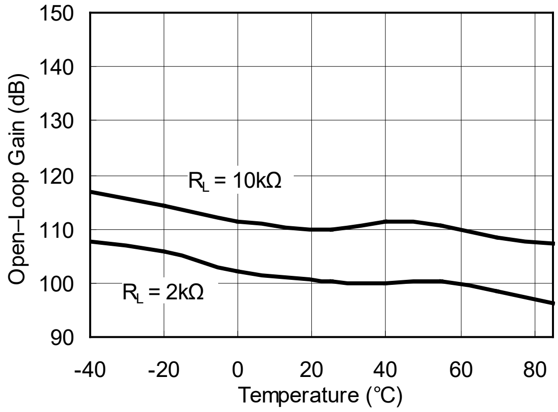
Input Voltage Noise Spectral Density vs. Frequency



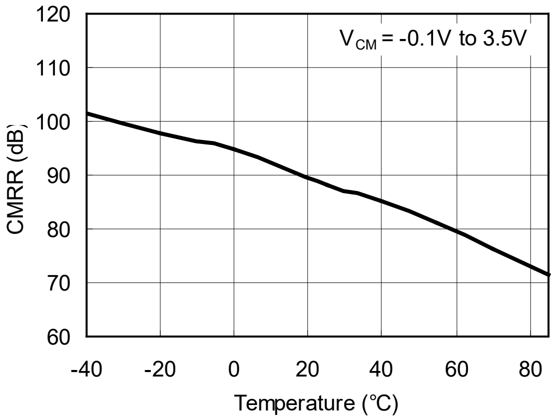
Quiescent Current vs. Temperature



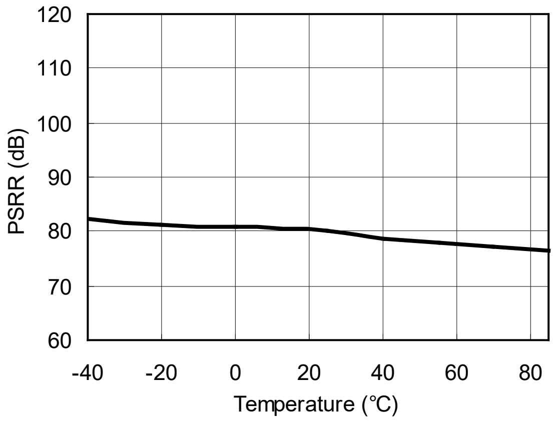
Open-Loop Gain vs. Temperature



Common Mode Rejection Ratio vs. Temperature

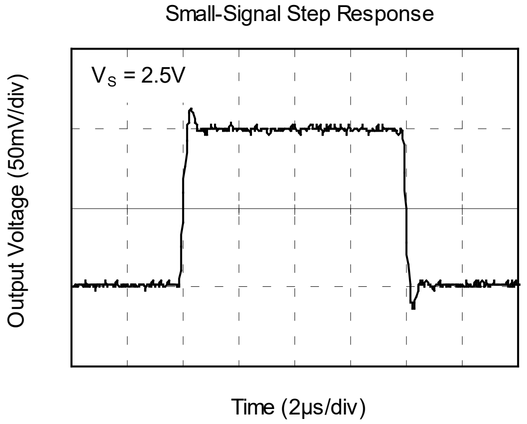


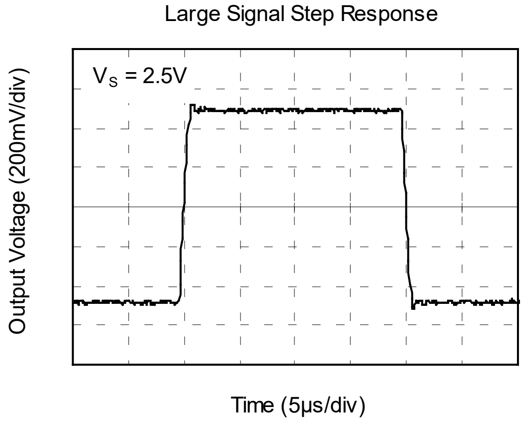
Power Supply Rejection Ratio vs. Temperature

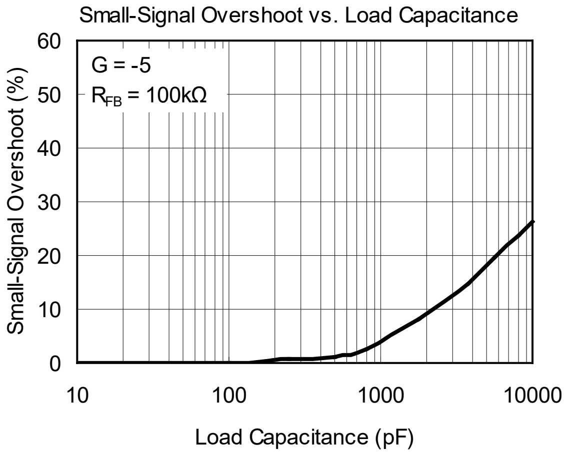


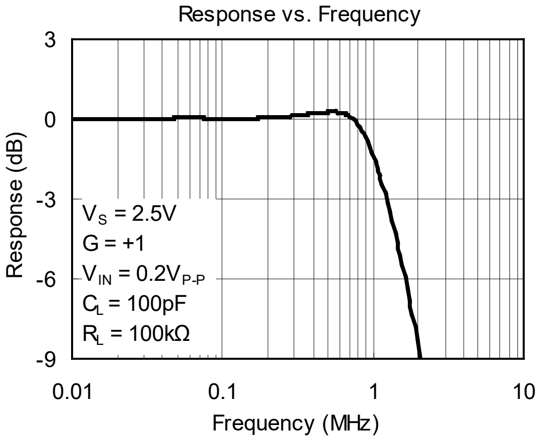
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

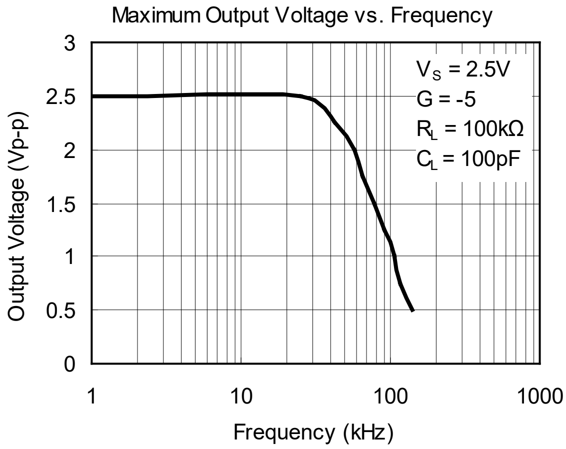
At T_A = +25℃, V_S = +5V, and R_L = 100kΩ connected to V_S/2, unless otherwise noted.

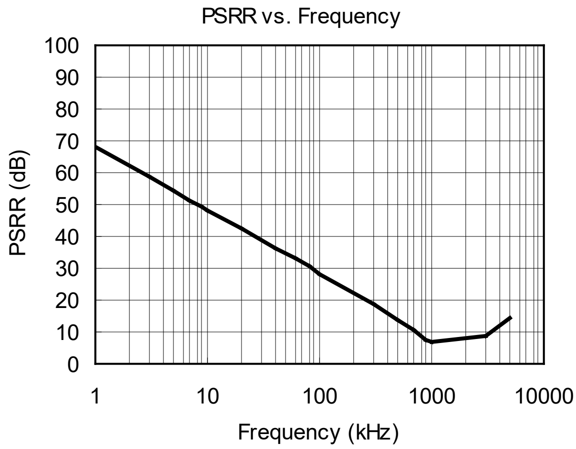






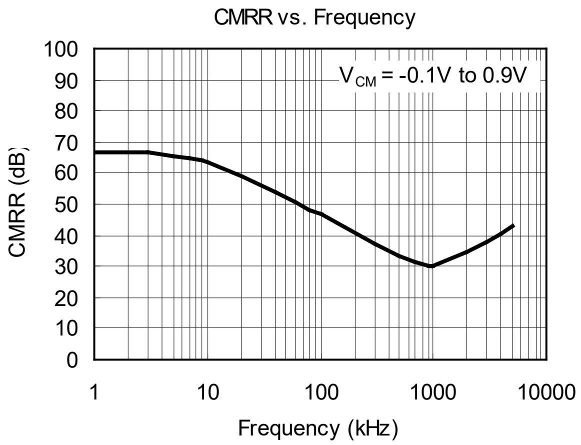


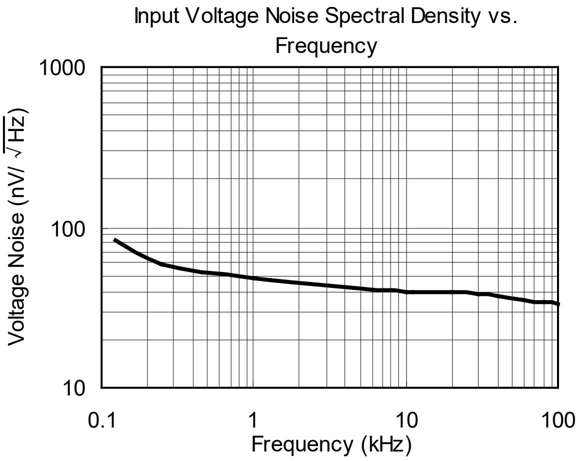


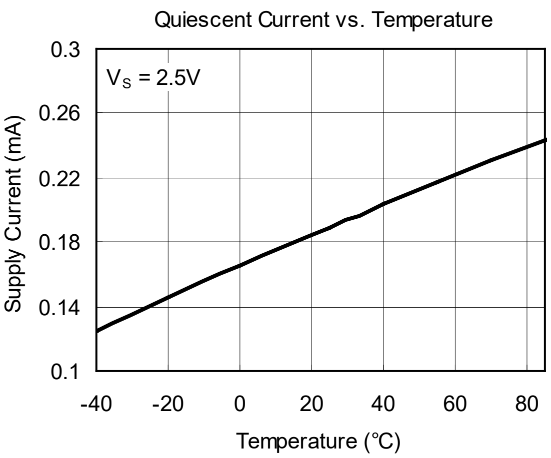


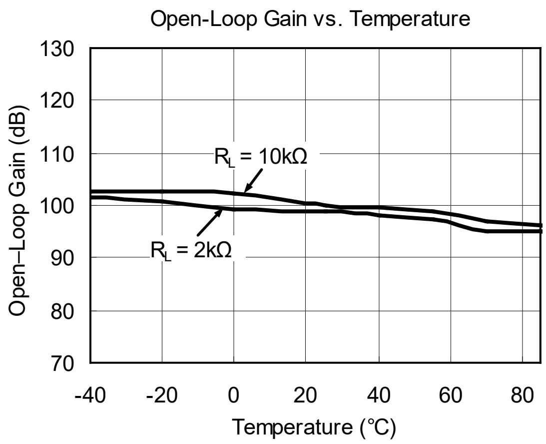
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

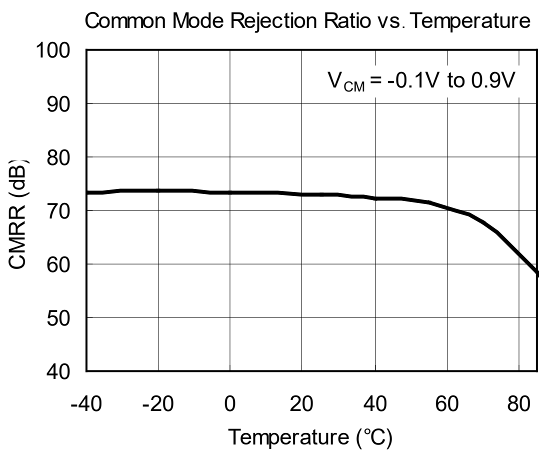
At T_A = +25℃, V_S = +5V, and R_L = 100kΩ connected to V_S/2, unless otherwise noted.

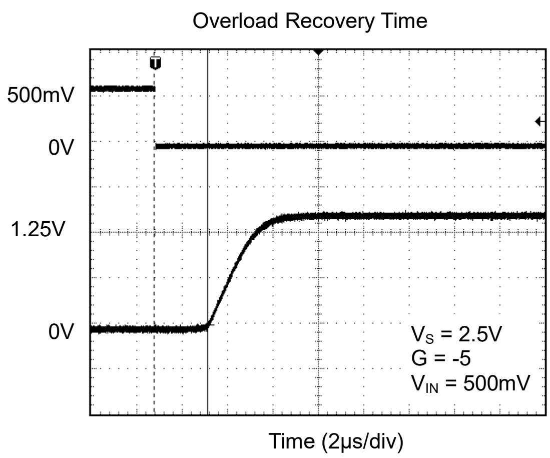








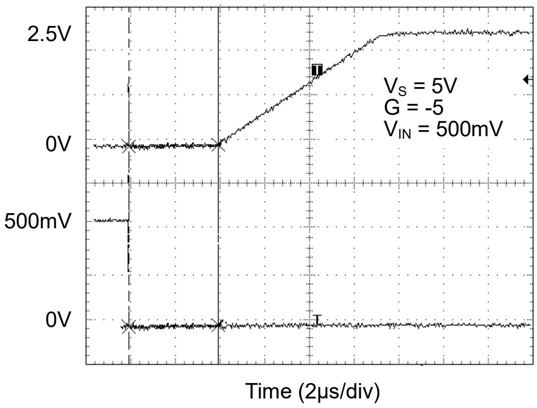




TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = +5V, and R_L = 100kΩ connected to V_S/2, unless otherwise noted.

Overload Recovery Time



APPLICATION INFORMATION

Rail-to-Rail Output

The SGM2358 supports rail-to-rail output operation. In single power supply application, for example, when $+V_S = 5V$, $-V_S$ = GND, 10kΩ load resistor is tied from OUT pin to ground, the typical output swing range is from 0.008V to 4.992V.

Driving Capacitive Loads

The SGM2358 is designed for unity-gain stable for capacitive load up to 250pF. 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.

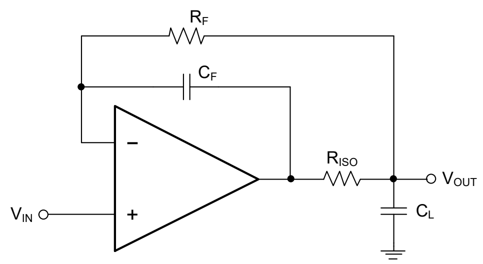


Figure 1. Circuit to Drive Heavy Capacitive Load

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 amplifier 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.

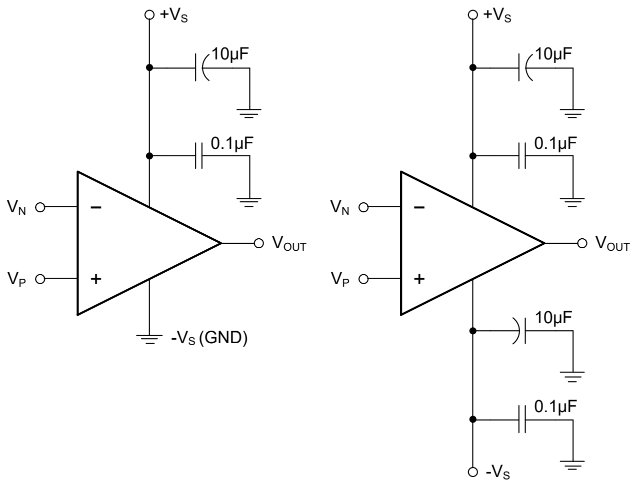


Figure 2. Amplifier Power Supply Bypassing

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 $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$.

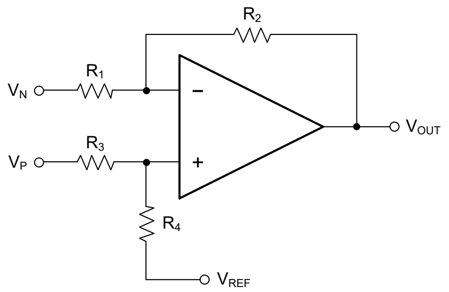


Figure 3. Difference Amplifier

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.

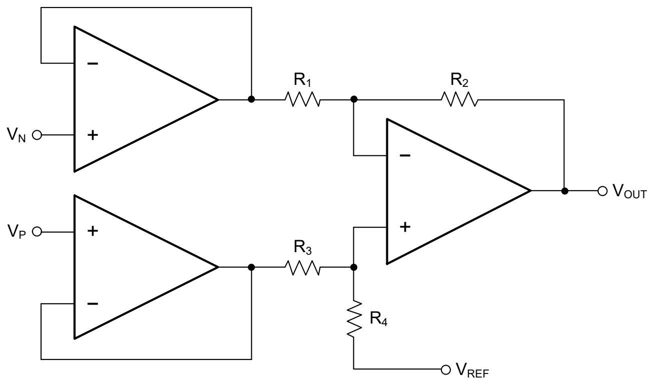


Figure 4. High Input Impedance Difference Amplifier

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.

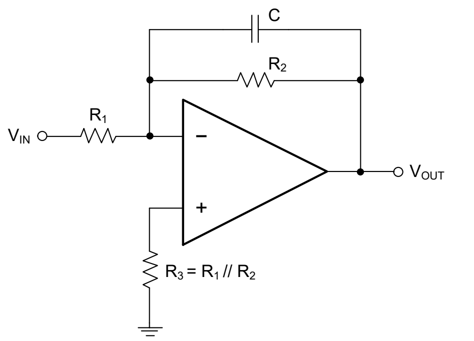


Figure 5. Active Low-Pass Filter

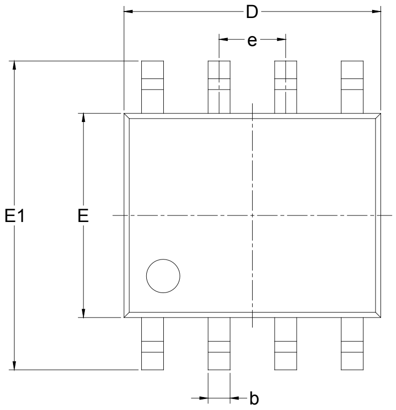
REVISION HISTORY

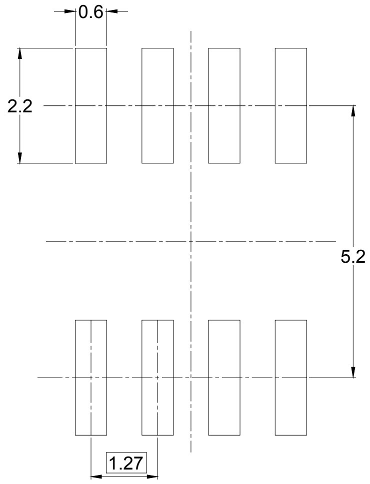
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

MARCH 2017 – REV.B.4 to REV.C	Page
Updated Package/Ordering Information section	2

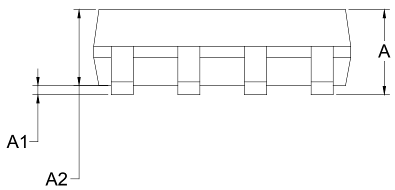
PACKAGE OUTLINE DIMENSIONS

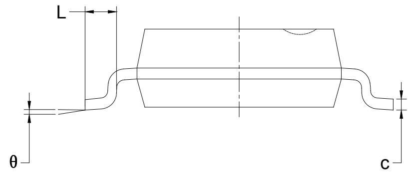
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)

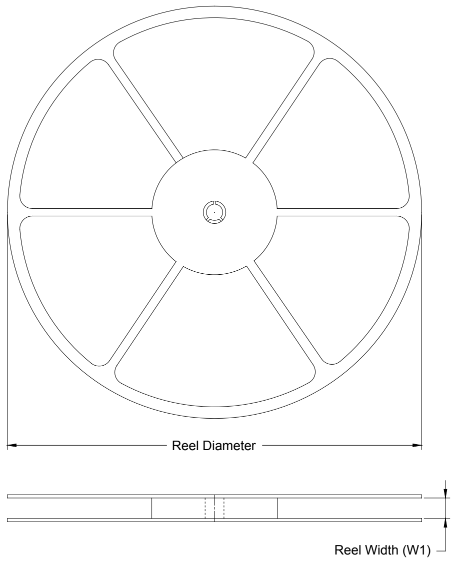




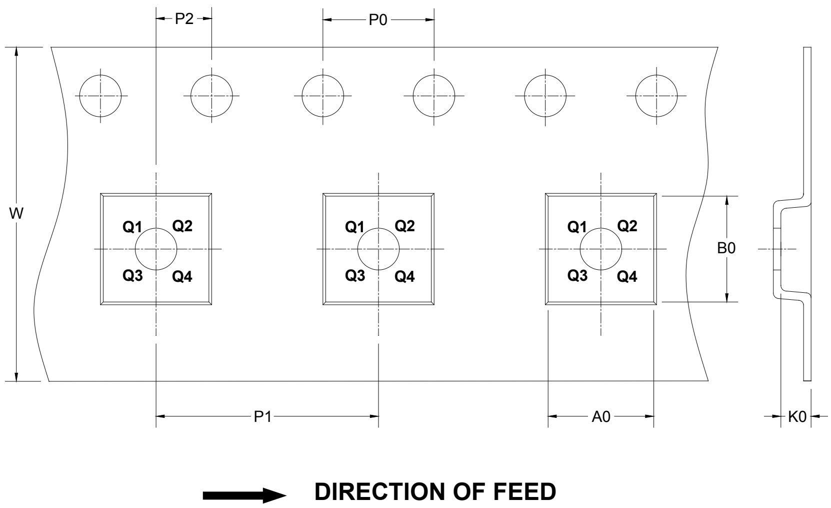
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



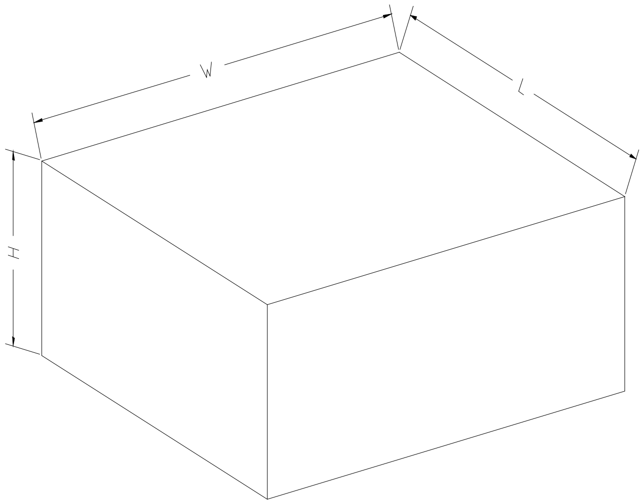
NOTE: The picture is only for reference. Please make the object as the standard.

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
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
13″	386	280	370	5

DD0002