SGM8621/SGM8622/SGM8623/SGM8624
3MHz, Rail-to-Rail I/O CMOS Operational Amplifiers

GENERAL DESCRIPTION

The SGM8621/2/3/4 are a family of single, dual and quad operational amplifiers, which are optimized for low voltage, low noise and low power operation. These devices can operate from 2V to 5.5V single supply, and consume low quiescent current. The supply current of SGM8623 is less than 1μA in power-down mode.

The SGM8621/2/3/4 feature a 3mV maximum input offset voltage. The minimum input common mode voltage is within 0.1V below the negative rail, and the output swing is rail-to-rail with heavy loads. They exhibit a high gain-bandwidth product of 3MHz and a slew rate of 1.7V/μs. These specifications make the operational amplifiers appropriate for various applications.

The SGM8621 is available in Green SC70-5, SOT-23-5 and SOIC-8 packages. The SGM8622 is available in Green SOIC-8 and MSOP-8 packages. The SGM8623 is available in Green SOT-23-6 and SOIC-8 packages. The SGM8624 is available in Green SOIC-14 and TSSOP-14 packages. They are specified over the extended industrial temperature range (-40℃ to +125℃).

FEATURES

- **Input Offset Voltage: 3mV (MAX)**
- **High Gain-Bandwidth Product: 3MHz**
- **High Slew Rate: 1.7V/μs**
- **Settling Time to 0.1% with 2V Step: 0.5μs**
- **Overload Recovery Time: 2.3μs**
- **Low Noise: 17.5nV/$\sqrt{Hz}$ at 1kHz**
- **Rail-to-Rail Input and Output**
- **Supply Voltage Range: 2V to 5.5V**
- **Input Voltage Range: -0.1V to 5.6V with V_S = 5.5V**
- **Low Supply Current:**
  SGM8621/3: 270μA (TYP)
  SGM8622/4: 210μA/Amplifier (TYP)
  SGM8623 Less than 1μA when Disabled
- **-40℃ to +125℃ Operating Temperature Range**
- **Small Packaging:**
  SGM8621 Available in Green SC70-5, SOT-23-5 and SOIC-8 Packages
  SGM8622 Available in Green MSOP-8 and SOIC-8 Packages
  SGM8623 Available in Green SOT-23-6 and SOIC-8 Packages
  SGM8624 Available in Green TSSOP-14 and SOIC-14 Packages

APPLICATIONS

Sensors
Audio
Active Filters
A/D Converters
Communications
Test Equipment
Cellular and Cordless Phones
Laptops and PDAs
Photodiode Amplification
Battery-Powered Instrumentation

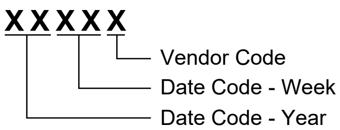
PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8621	SC70-5	-40℃ to +125℃	SGM8621XC5/TR	8621	Tape and Reel, 3000
	SOT-23-5	-40℃ to +125℃	SGM8621XN5/TR	8621	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8621XS/TR	SGM8621XS XXXXX	Tape and Reel, 2500
SGM8622	MSOP-8	-40℃ to +125℃	SGM8622XMS/TR	SGM8622 XMS XXXXX	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8622XS/TR	SGM8622XS XXXXX	Tape and Reel, 2500
SGM8623	SOT-23-6	-40℃ to +125℃	SGM8623XN6/TR	8623	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8623XS/TR	SGM8623XS XXXXX	Tape and Reel, 2500
SGM8624	SOIC-14	-40℃ to +125℃	SGM8624XS14/TR	SGM8624XS14 XXXXX	Tape and Reel, 2500
	TSSOP-14	-40℃ to +125℃	SGM8624XTS14/TR	SGM8624 XTS14 XXXXX	Tape and Reel, 3000

MARKING INFORMATION

NOTE: XXXXX = Date Code and Vendor Code.

SOIC-8/MSOP-8/SOIC-14/TSSOP-14



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℃
SC70-5, θ_{JA} .... 333℃/W
SOT-23-5, θ_{JA} .... 190℃/W
SOT-23-6, 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 (SGM8621/2/4) 8000V
HBM (SGM8623) 4000V
MM 400V
CDM 1000V

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

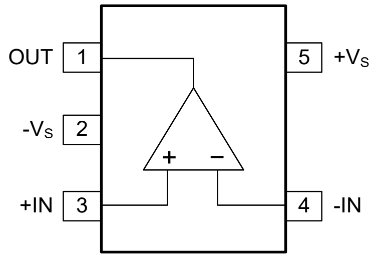
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

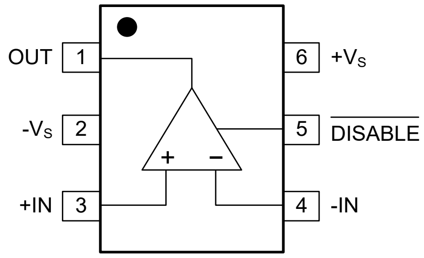
PIN CONFIGURATIONS

SGM8621 (TOP VIEW)



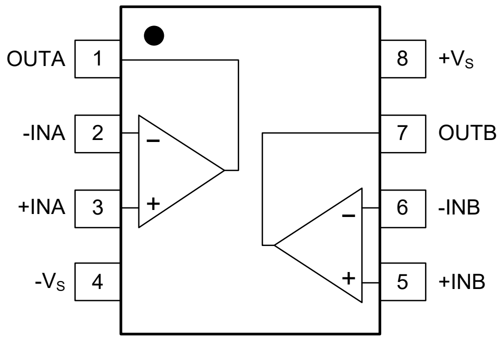
SC70-5/SOT-23-5

SGM8623 (TOP VIEW)



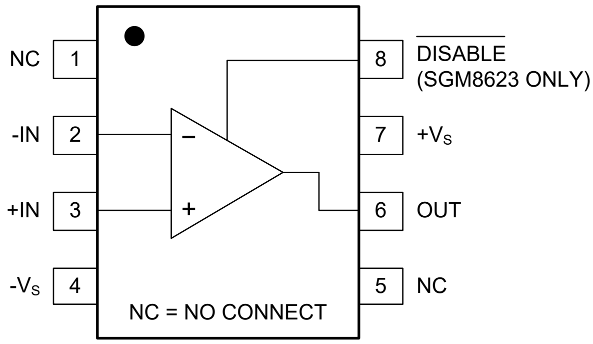
SOT-23-6

SGM8622 (TOP VIEW)



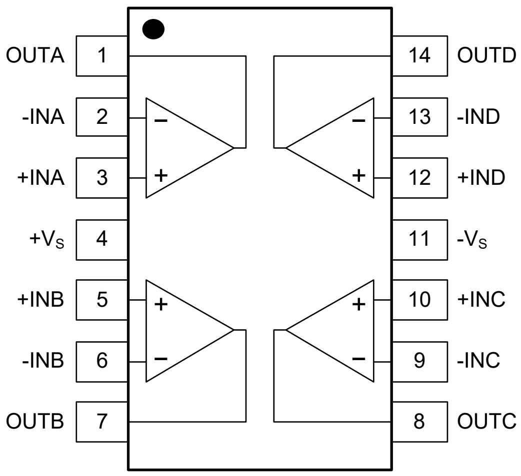
SOIC-8/MSOP-8

SGM8621/SGM8623 (TOP VIEW)



SOIC-8

SGM8624 (TOP VIEW)



SOIC-14/TSSOP-14

ELECTRICAL CHARACTERISTICS

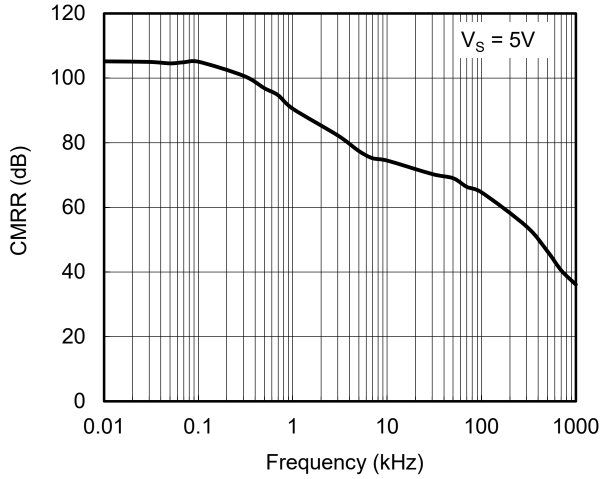
(At T_A = +25℃, V_S = 5V, V_{CM} = V_S/2, R_L = 600Ω, unless otherwise noted.)

PARAMETER		CONDITIONS	SGM8621/2/3/4					
			TYP	MIN/MAX OVER TEMPERATURE				
			+25℃	+25℃	-40℃ to +85℃	-40℃ to +125℃	UNITS	MIN/ MAX
Input Characteristics								
Input Offset Voltage (V_{OS})			0.9	3	3.2	3.4	mV	MAX
Input Bias Current (I_B)			1				pA	TYP
Input Offset Current (I_{OS})			1				pA	TYP
Input Common Mode Voltage Range (V_{CM})		V_S = 5.5V	-0.1 to 5.6				V	TYP
Common Mode Rejection Ratio (CMRR)		V_S = 5.5V, V_{CM} = -0.1V to 4V	82	65	64	63	dB	MIN
		V_S = 5.5V, V_{CM} = -0.1V to 5.6V	71	62	61	60	dB	MIN
Open-Loop Voltage Gain (A_{OL})		R_L = 600Ω, V_{OUT} = 0.15V to 4.85V	90	80	75	68	dB	MIN
		R_L = 10kΩ, V_{OUT} = 0.05V to 4.95V	100	89	85	83	dB	MIN
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta T$)			2.7				μV/℃	TYP
Output Characteristics								
Output Voltage Swing from Rail		R_L = 600Ω	0.081				V	TYP
		R_L = 10kΩ	0.007				V	TYP
Output Current (I_{OUT})			52	38	28	24	mA	MIN
Closed-Loop Output Impedance		f = 100kHz, G = 1	10.8				Ω	TYP
Power-Down Disable (SGM8623 Only)								
Turn-On Time			1.3				μs	TYP
Turn-Off Time			0.3				μs	TYP
$\overline{\text{DISABLE}}$ Voltage-Off				0.8			V	MAX
$\overline{\text{DISABLE}}$ Voltage-On				2			V	MIN
Power Supply								
Operating Voltage Range			2	2	2	2	V	MIN
			5.5	5.5	5.5	5.5	V	MAX
Power Supply Rejection Ratio (PSRR)		V_S = 2V to 5.5V, V_{CM} = (-V_S) + 0.5V	85	68	66	65	dB	MIN
Quiescent Current/ Amplifier (I_Q)	SGM8622/4	I_{OUT} = 0mA	210	300	340	360	μA	MAX
	SGM8621/3	I_{OUT} = 0mA	270	370	420	450	μA	MAX
Supply Current when Disabled (SGM8623 only)			0.47	8	9	10	μA	MAX
Dynamic Performance								
Gain-Bandwidth Product (GBP)			3				MHz	TYP
Phase Margin (φ_O)			73				°	TYP
Full Power Bandwidth (BW_P)		<1% distortion	50				kHz	TYP
Slew Rate (SR)		G= 1, 2V output step	1.7				V/μs	TYP
Settling Time to 0.1% (t_S)		G= 1, 2V output step	0.5				μs	TYP
Overload Recovery Time		V_{IN} × G = V_S	2.3				μs	TYP
Noise Performance								
Input Voltage Noise Density (e_n)		f = 1kHz	17.5				nV/$\sqrt{Hz}$	TYP

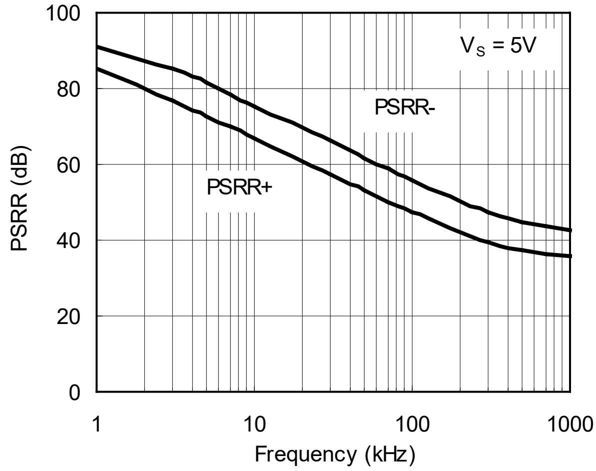
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_{CM} = V_S/2, R_L = 600Ω, unless otherwise noted.

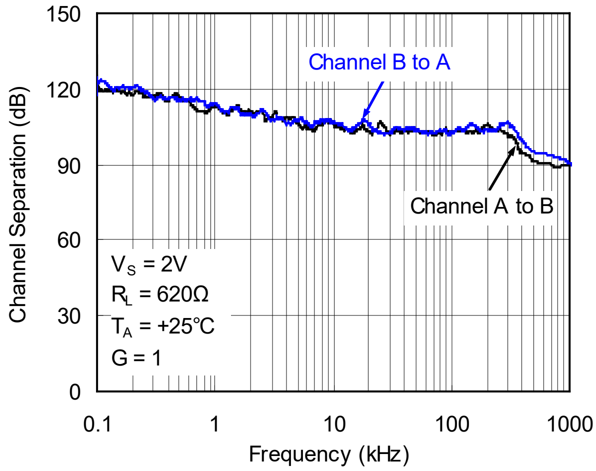
CMRR vs. Frequency



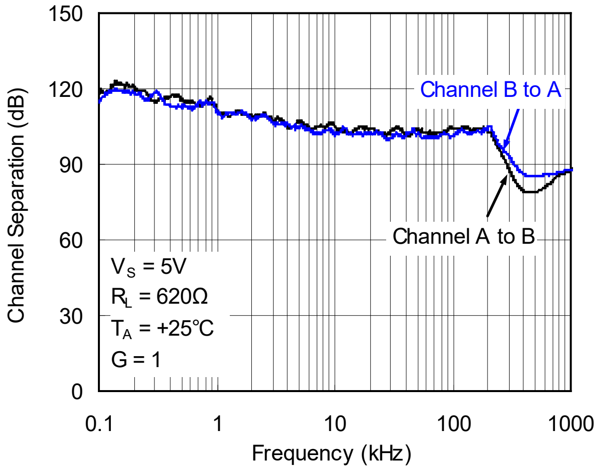
PSRR vs. Frequency



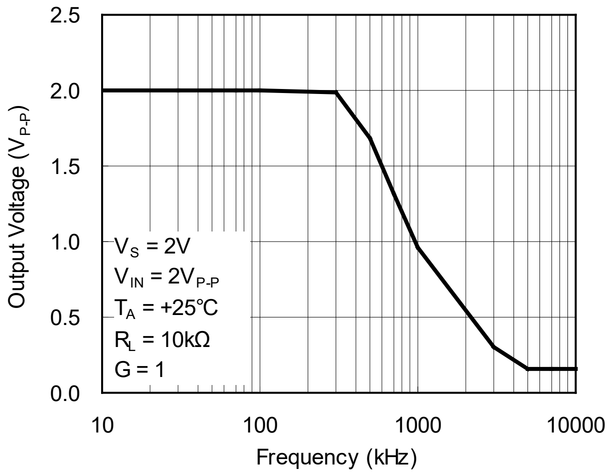
Channel Separation vs. Frequency



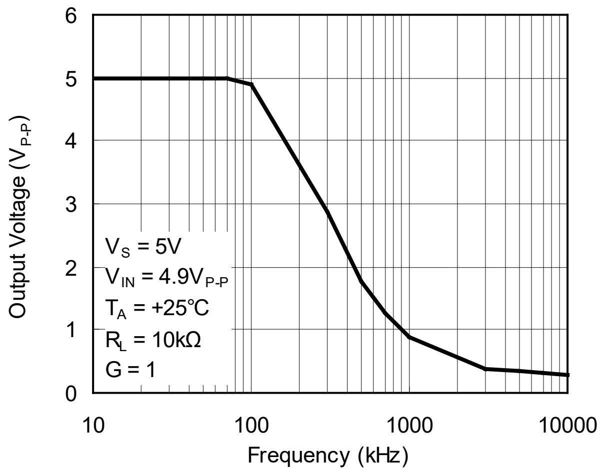
Channel Separation vs. Frequency



Closed-Loop Output Voltage Swing

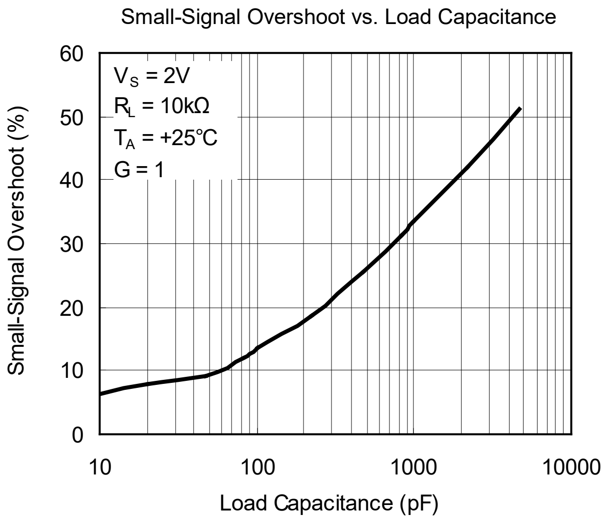


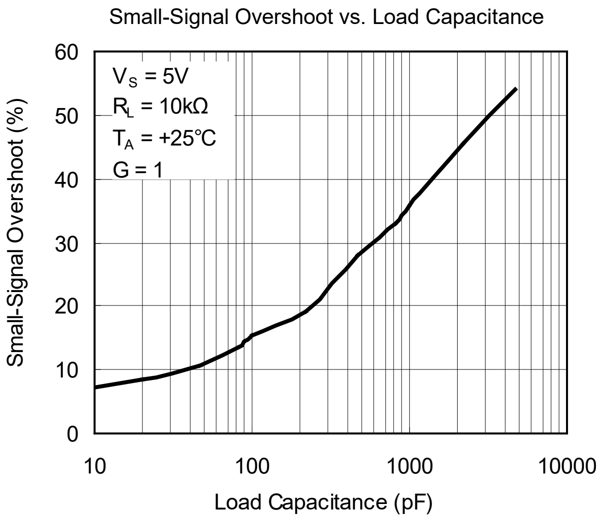
Closed-Loop Output Voltage Swing

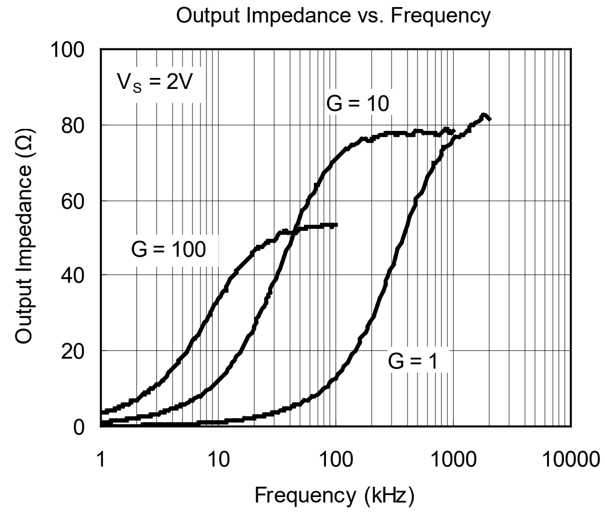


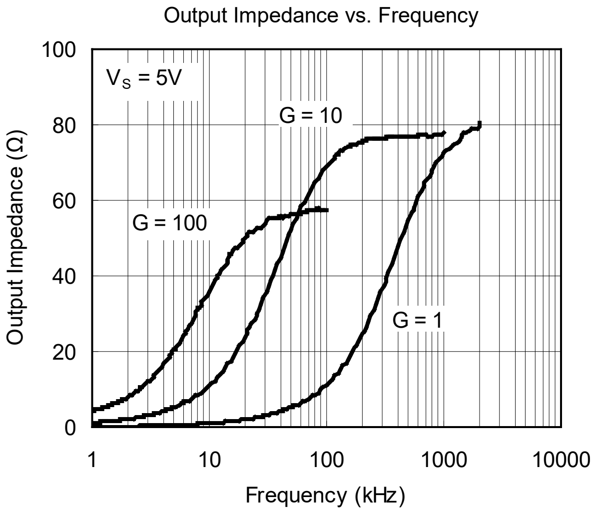
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

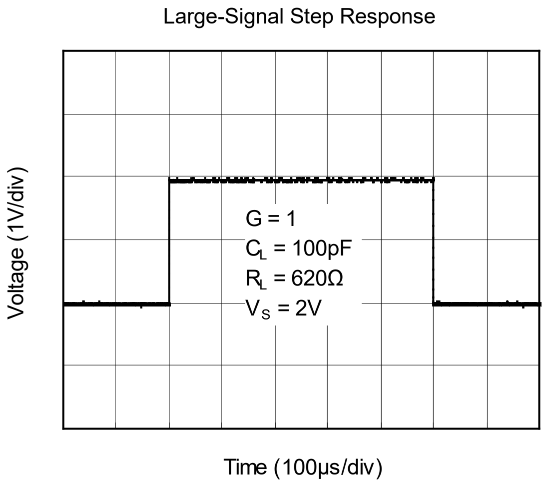
At T_A = +25℃, V_{CM} = V_S/2, R_L = 600Ω, unless otherwise noted.

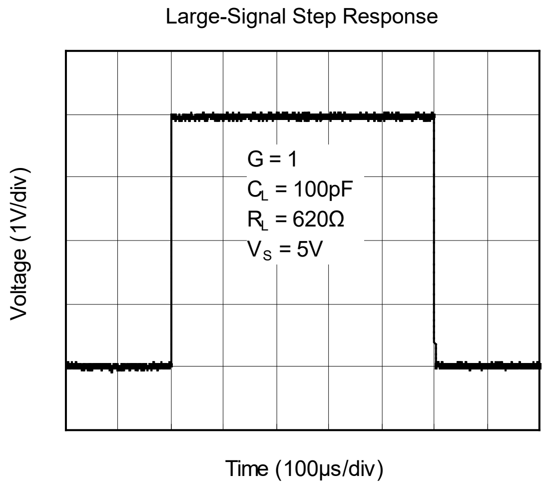








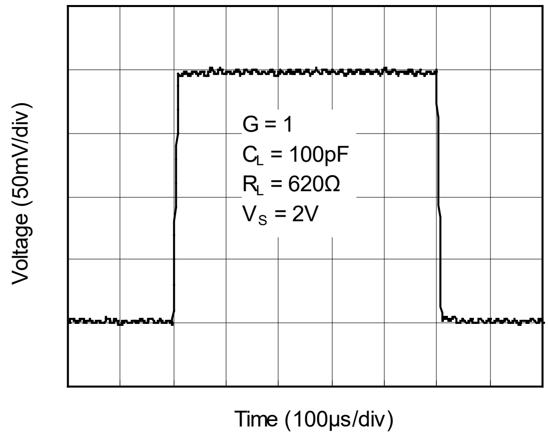




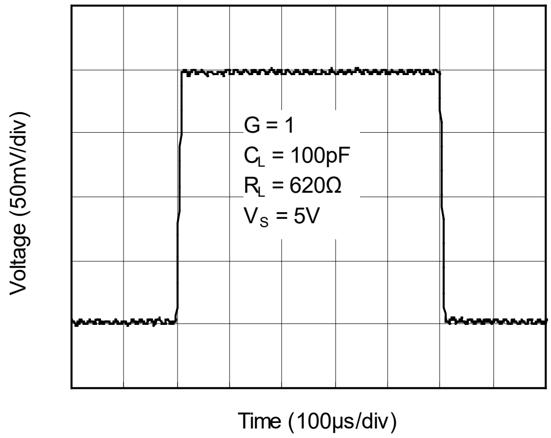
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_{CM} = V_S/2, R_L = 600Ω, unless otherwise noted.

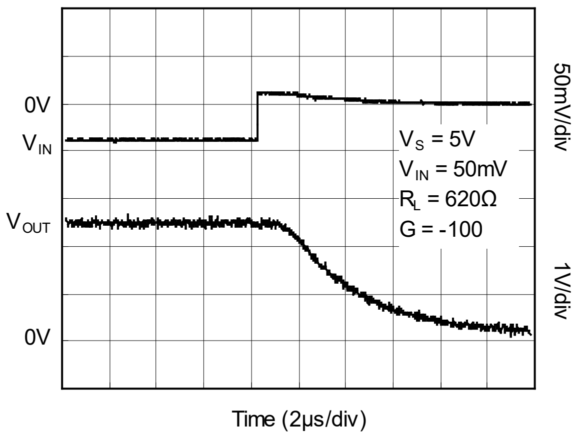
Small-Signal Step Response



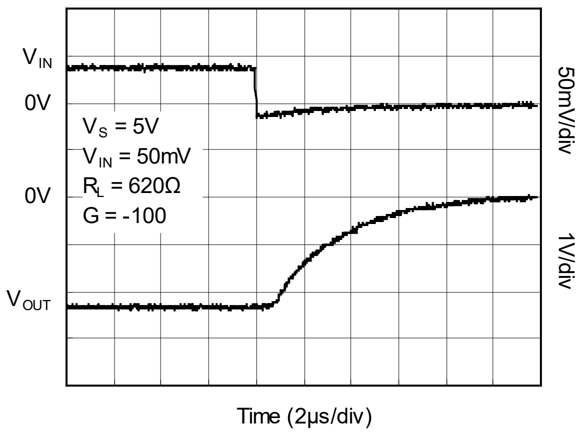
Small-Signal Step Response



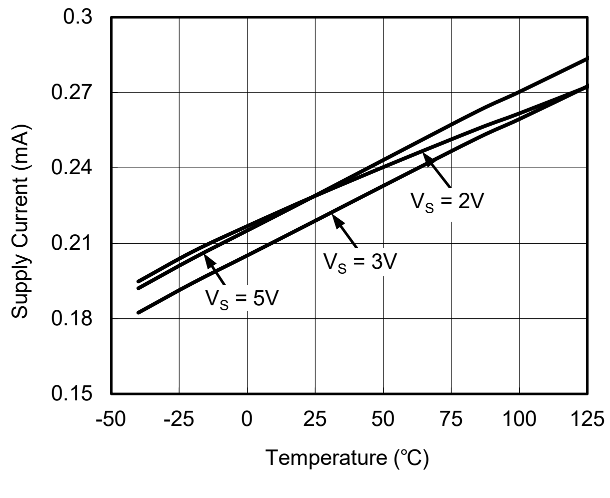
Positive Overload Recovery



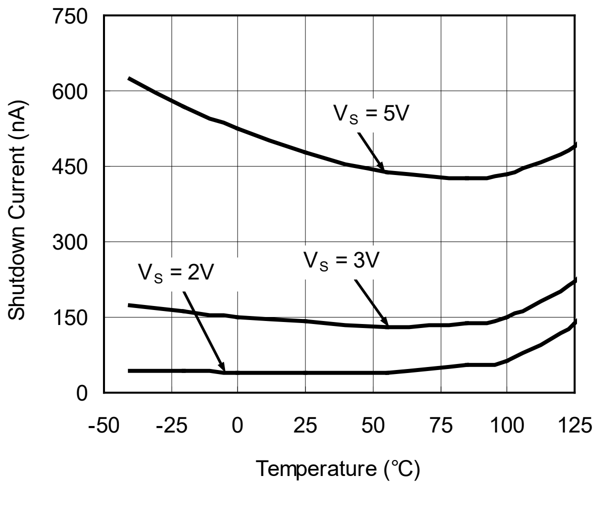
Negative Overload Recovery



Supply Current vs. Temperature

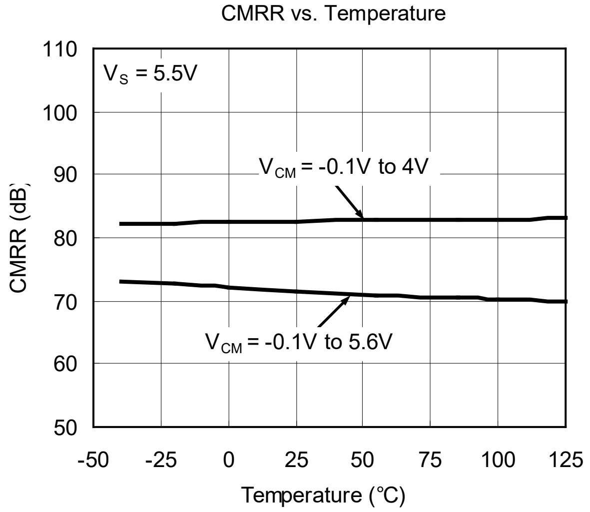


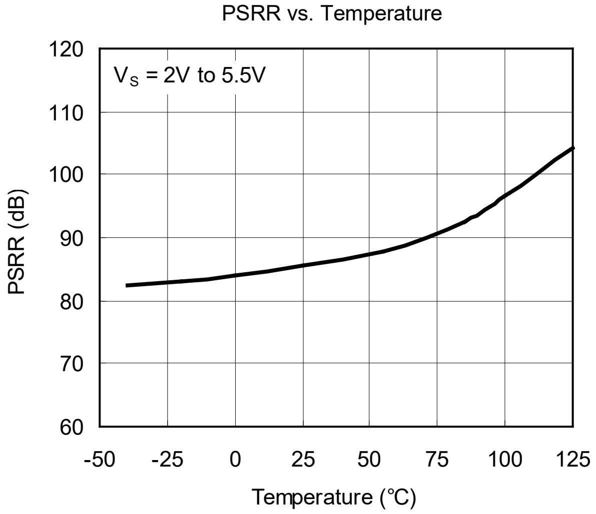
Shutdown Current vs. Temperature

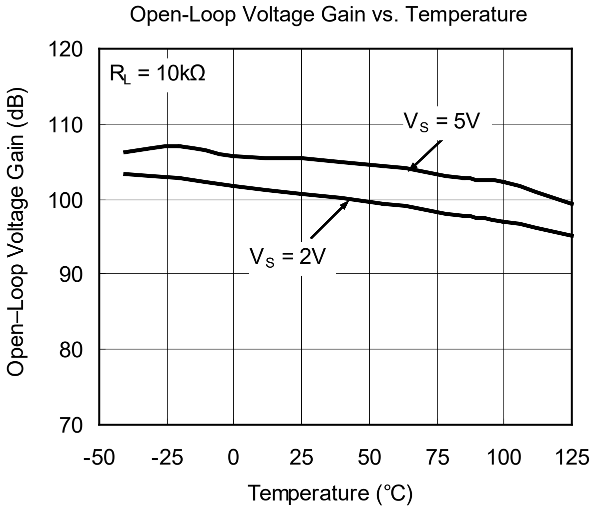


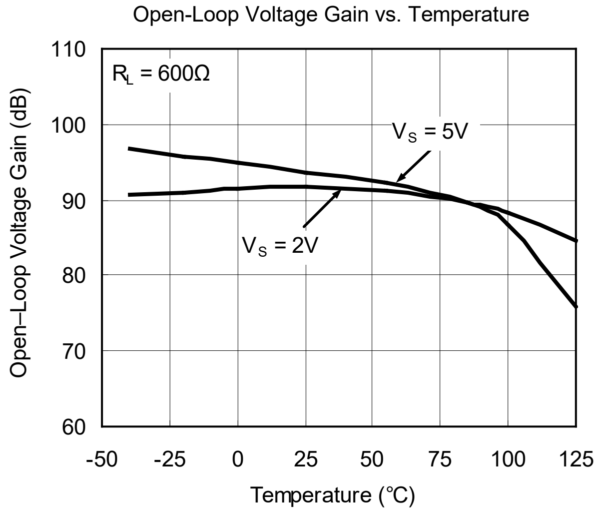
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

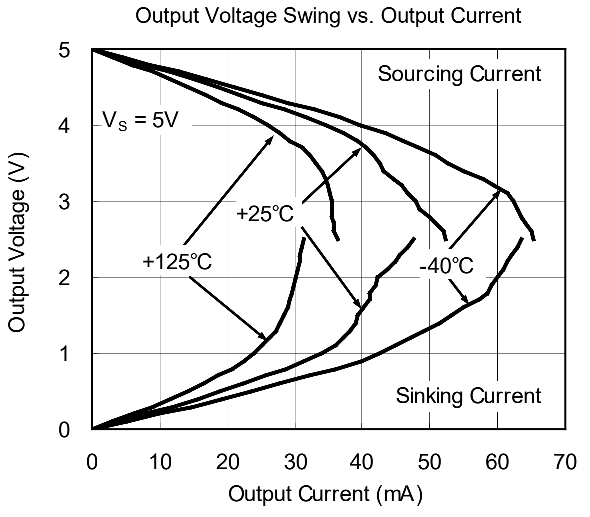
At T_A = +25℃, V_{CM} = V_S/2, R_L = 600Ω, unless otherwise noted.

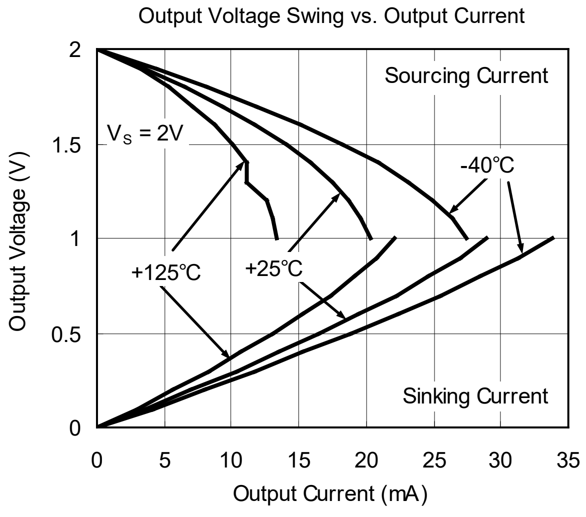








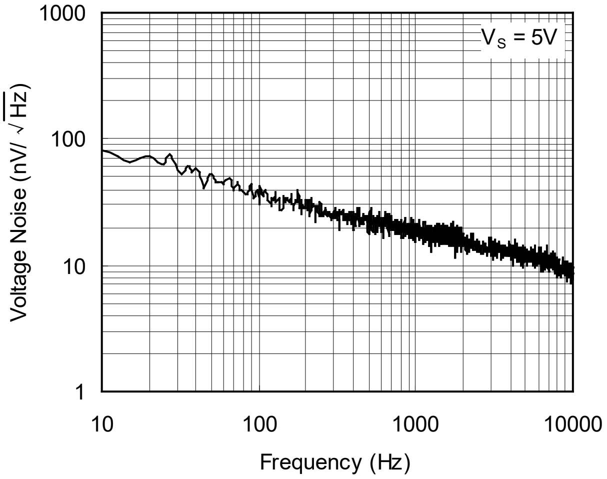




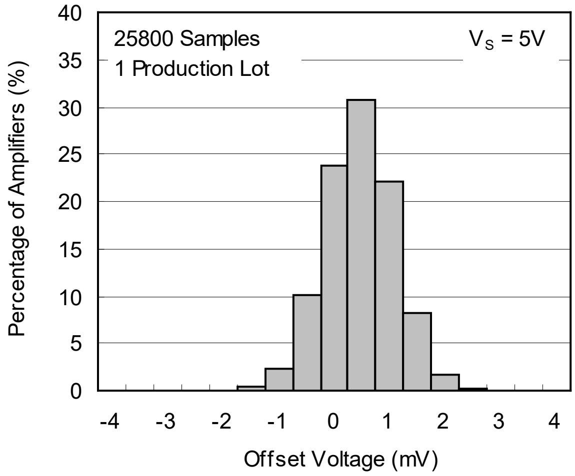
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_{CM} = V_S/2, R_L = 600Ω, unless otherwise noted.

Input Voltage Noise Spectral Density vs. Frequency



Offset Voltage Production Distribution



APPLICATION INFORMATION

Rail-to-Rail Input

When SGM8621/2/3/4 work at the power supply between 2V 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.

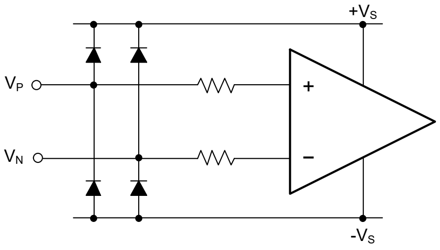


Figure 1. Input Equivalent Circuit

Rail-to-Rail Output

The SGM8621/2/3/4 support 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 0.007V to 4.993V.

Driving Capacitive Loads

The SGM8621/2/3/4 are designed for driving the 1000pF capacitive load with unity-gain stable. 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.

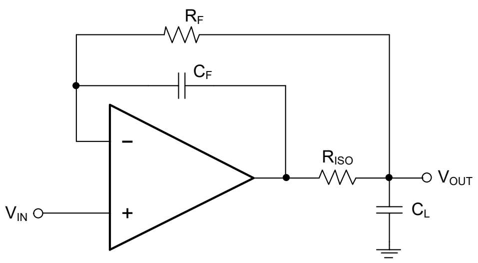


Figure 2. Circuit to Drive Heavy Capacitive Load

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.

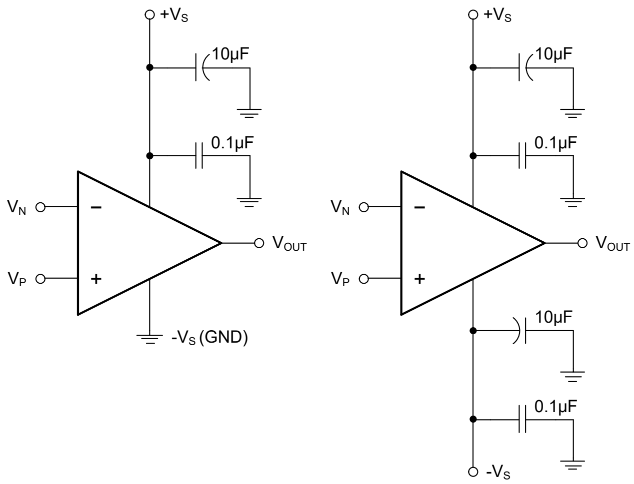


Figure 3. Amplifier Power Supply Bypassing

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

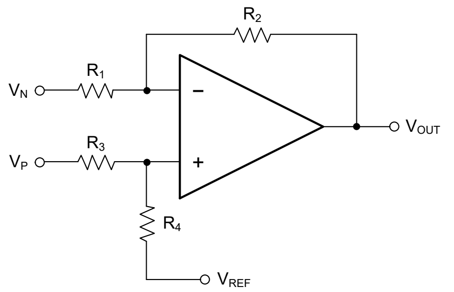


Figure 4. Difference Amplifier

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.

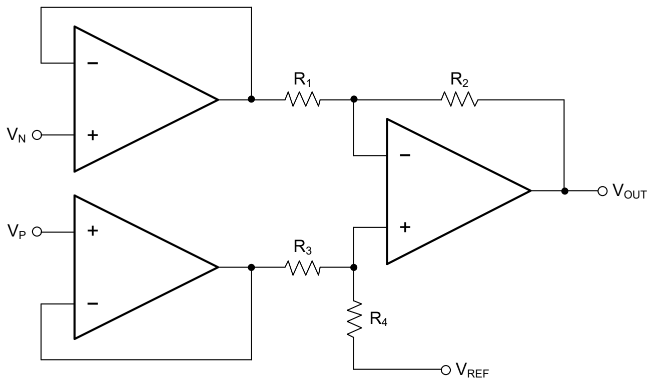


Figure 5. High Input Impedance Difference Amplifier

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.

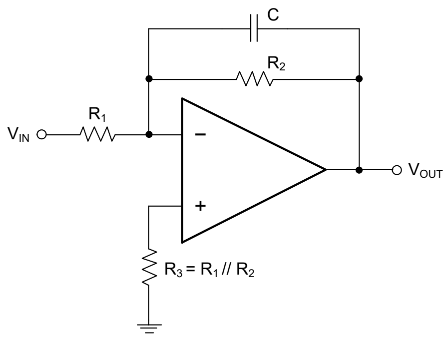


Figure 6. Active Low-Pass Filter

REVISION HISTORY

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

JULY 2023 – REV.C to REV.C.1	Page
Updated Package Outline Dimensions section	14

JULY 2016 – REV.B.4 to REV.C	Page
Updated Electrical Characteristics section	5

AUGUST 2015 – REV.B.3 to REV.B.4	Page
New Version	All

JANUARY 2013 – REV.B.2 to REV.B.3	Page
Updated Package Outline Dimensions section	11 - 17
Added Tape and Reel Information section	18, 19

MAY 2011 – REV.B.1 to REV.B.2	Page
Changed packages' name	All

APRIL 2009 – REV.B to REV.B.1	Page
Changed SGM8624 packages	All

AUGUST 2008 – REV.A to REV.B	Page
SGM8621 Added SC70-5 package	All
Changed Absolute Maximum Ratings section	3
Updated Package Outline Dimensions section	10 - 16

Changes from Original (NOVEMBER 2006) to REV.A	Page
Changed from product preview to production data	All