SGM8051/SGM8052/SGM8053 SGM8054/SGM8055 250MHz, Rail-to-Rail Output, CMOS Operational Amplifiers

GENERAL DESCRIPTION

The SGM8051/3 (single), SGM8052/5 (dual) and SGM8054 (quad) are low cost, high speed, voltage feedback amplifiers. These devices can operate from 2.5V to 5.5V single supply, and consume 2.3mA low quiescent current per amplifier. And, the supply current of SGM8053/5 is only 75μA per amplifier in power-down mode. So SGM8053/5 are suitable for battery-powered equipment and portable devices, which require low power dissipation. The SGM8051/2/3/4/5 provide a wide input common mode voltage range and rail-to-rail output voltage swing.

These devices are designed to provide optimal performance in all aspects. They exhibit a wide bandwidth of 250MHz (G = +1) and a 0.1dB gain flatness of 37MHz (G=+2). The short settling time and low distortion make the operational amplifiers appropriate for buffering high speed ADC and DAC.

The SGM8051 is available in Green SOT-23-5 and SOIC-8 packages. The SGM8052 is available in Green SOIC-8 and MSOP-8 packages. The SGM8053 is available in Green SOT-23-6 and SOIC-8 packages. The SGM8054 is available in Green SOIC-14 and TSSOP-14 packages. The SGM8055 is available in a Green MSOP-10 package. They are specified over the extended -40℃ to +125℃ temperature range.

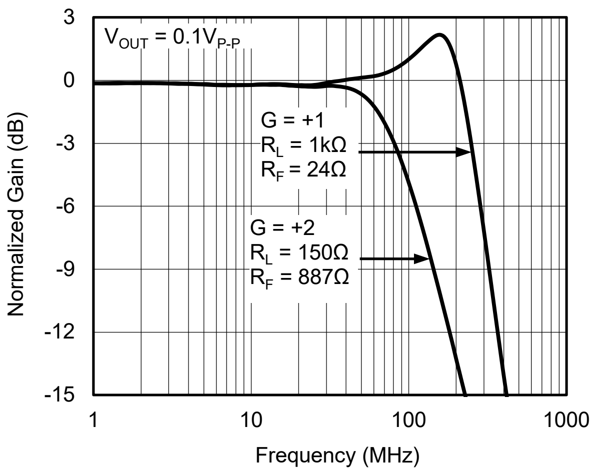
APPLICATIONS

Professional Video
Photodiode Preamplifier
ADC
Filter
Imaging
Hand Set
DVD
Base Station

FEATURES

- **Low Cost**
- **High Speed:**
  -3dB Bandwidth (G = +1): 250MHz
  Slew Rate: 130V/μs
  Settling Time to 0.1% with 2V Step: 58ns
- **Excellent Video Performance (R_L = 150Ω, G = +2):**
  0.1dB Gain Flatness: 37MHz
  Diff Gain Error: 0.03%
  Diff Phase Error: 0.08°
- **Input Offset Voltage: 8mV (MAX)**
- **Input Voltage Range: -0.2V to 3.8V with V_S = 5V**
- **Rail-to-Rail Output**
- **Supply Voltage Range: 2.5V to 5.5V**
- **Low Supply Current:**
  2.3mA/Amplifier (TYP)
  75μA/Amplifier Shutdown Current for SGM8053/5
- **-40℃ to +125℃ Operating Temperature Range**
- **Small Packaging:**
  SGM8051 Available in Green SOT-23-5 and SOIC-8 Packages
  SGM8052 Available in Green MSOP-8 and SOIC-8 Packages
  SGM8053 Available in Green SOT-23-6 and SOIC-8 Packages
  SGM8054 Available in Green TSSOP-14 and SOIC-14 Packages
  SGM8055 Available in a Green MSOP-10 Package

Small-Signal Frequency Response



PACKAGE/ORDERING INFORMATION

MODEL	CHANNEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8051	Single	SOT-23-5	-40℃ to +125℃	SGM8051XN5/TR	8051	Tape and Reel, 3000
		SOIC-8	-40℃ to +125℃	SGM8051XS/TR	SGM8051XS XXXXX	Tape and Reel, 2500
SGM8052	Dual	MSOP-8	-40℃ to +125℃	SGM8052XMS/TR	SGM8052 XMS XXXXX	Tape and Reel, 3000
		SOIC-8	-40℃ to +125℃	SGM8052XS/TR	SGM8052XS XXXXX	Tape and Reel, 2500
SGM8053	Single with Shutdown	SOT-23-6	-40℃ to +125℃	SGM8053XN6/TR	SOFXX	Tape and Reel, 3000
		SOIC-8	-40℃ to +125℃	SGM8053XS/TR	SGM8053XS XXXXX	Tape and Reel, 2500
SGM8054	Quad	SOIC-14	-40℃ to +125℃	SGM8054XS14/TR	SGM8054XS14 XXXXX	Tape and Reel, 2500
		TSSOP-14	-40℃ to +125℃	SGM8054XTS14/TR	SGM8054 XTS14 XXXXX	Tape and Reel, 3000
SGM8055	Dual with Shutdown	MSOP-10	-40℃ to +125℃	SGM8055XMS/TR	SGM8055 XMS XXXXX	Tape and Reel, 3000

MARKING INFORMATION

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

SOT-23-6

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

SOIC-8/MSOP-8/SOIC-14/TSSOP-14/MSOP-10

XXXXX
- X (last) — 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, $+V_S$ to $-V_S$ 6V
Input Common Mode Voltage Range
.... $(-V_S) - 0.1V$ to $(+V_S) + 0.1V$
Signal Input Terminals Voltage Range
.... $(-V_S) - 0.3V$ to $(+V_S) + 0.3V$
Package Thermal Resistance @ T_A = +25℃
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
MSOP-10, θ_{JA} .... 216℃/W
Junction Temperature ....+150℃
Storage Temperature Range ....-65℃ to +150℃
Lead Temperature (Soldering, 10s) ....+260℃
ESD Susceptibility
HBM...1000V
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

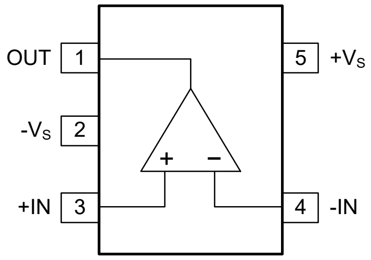
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

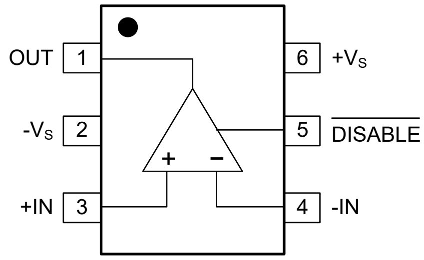
PIN CONFIGURATIONS

SGM8051 (TOP VIEW)



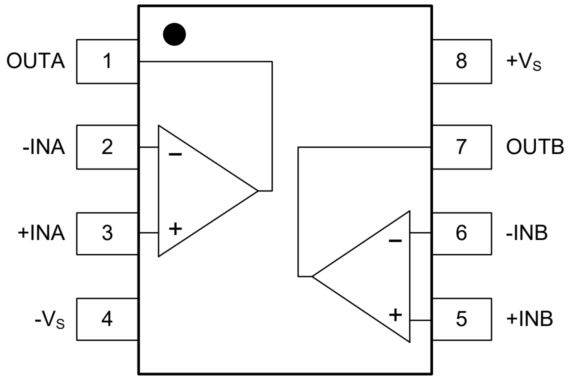
SOT-23-5

SGM8053 (TOP VIEW)



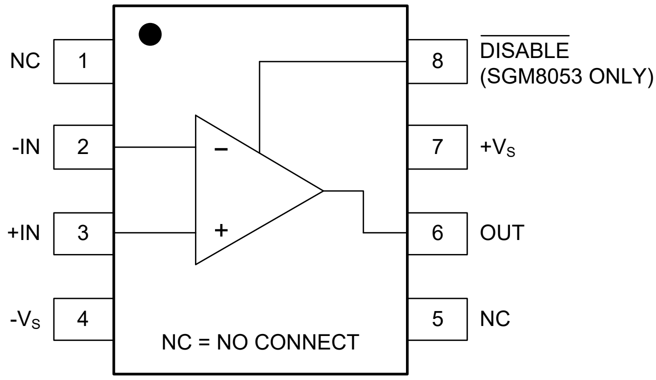
SOT-23-6

SGM8052 (TOP VIEW)



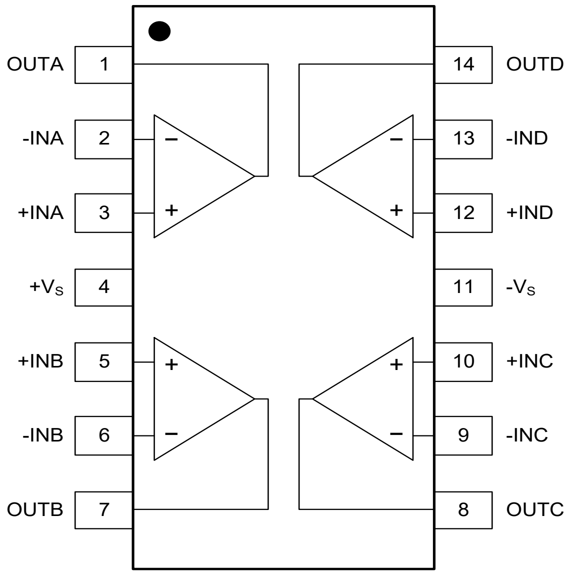
SOIC-8/MSOP-8

SGM8051/8053 (TOP VIEW)



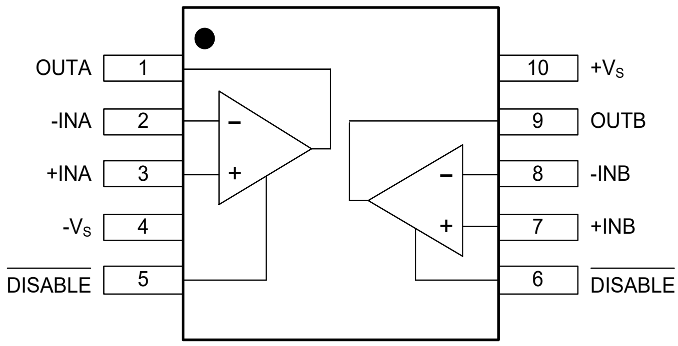
SOIC-8

SGM8054 (TOP VIEW)



TSSOP-14/SOIC-14

SGM8055 (TOP VIEW)



MSOP-10

ELECTRICAL CHARACTERISTICS

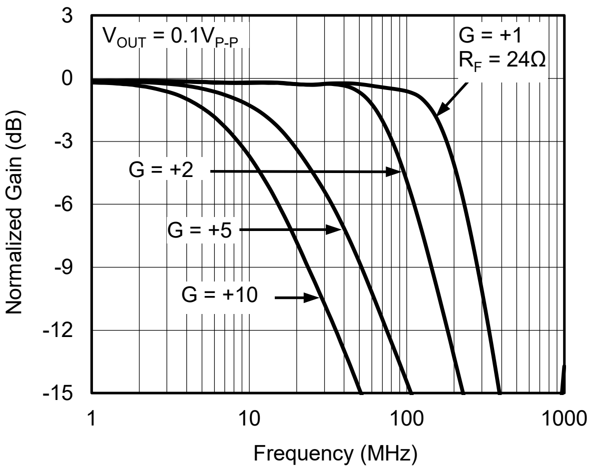
(V_S = 5V, G = +2, R_F = 887Ω, R_L = 150Ω, unless otherwise noted.)

PARAMETER	CONDITIONS	SGM8051/2/3/4/5						
		TYP	MIN/MAX OVER TEMPERATURE					
		+25℃	+25℃	0℃ to +70℃	-40℃ to +85℃	-40℃ to +125℃	UNITS	MIN/MAX
Dynamic Performance								
-3dB Small-Signal Bandwidth	G = +1, V_{OUT} = 0.1V_{P-P}, R_F = 24Ω, R_L = 150Ω	180					MHz	TYP
	G = +1, V_{OUT} = 0.1V_{P-P}, R_F = 24Ω, R_L = 1kΩ	250					MHz	TYP
	G = +2, V_{OUT} = 0.1V_{P-P}, R_L = 50Ω	40					MHz	TYP
	G = +2, V_{OUT} = 0.1V_{P-P}, R_L = 150Ω	80					MHz	TYP
	G = +2, V_{OUT} = 0.1V_{P-P}, R_L = 1kΩ	130					MHz	TYP
	G = +2, V_{OUT} = 0.1V_{P-P}, R_L = 10kΩ	160					MHz	TYP
Gain-Bandwidth Product	G = +10, R_L = 150Ω	90					MHz	TYP
	G = +10, R_L = 1kΩ	120					MHz	TYP
Bandwidth for 0.1dB Flatness	G = +2, V_{OUT} = 0.1V_{P-P}, R_L = 150Ω, R_F = 887Ω	37					MHz	TYP
Slew Rate	G = +1, 2V output step	93/-118					V/μs	TYP
	G = +2, 2V output step	116/-103					V/μs	TYP
	G = +2, 4V output step	130/-130					V/μs	TYP
Rise-and-Fall Time	G = +2, V_{OUT} = 0.2V_{P-P}, 10% to 90%	4					ns	TYP
	G = +2, V_{OUT} = 2V_{P-P}, 10% to 90%	14					ns	TYP
Settling Time to 0.1%	G = +2, 2V output step	58					ns	TYP
Overload Recovery Time	V_{IN} · G = +V_S	18					ns	TYP
Noise/Distortion Performance								
Input Voltage Noise Density	f = 1MHz	8.1					nV/$\sqrt{Hz}$	TYP
Differential Gain Error (NTSC)	G = +2, R_L = 150Ω	0.03					%	TYP
Differential Phase Error (NTSC)	G = +2, R_L = 150Ω	0.08					degree	TYP
DC Performance								
Input Offset Voltage (V_{OS})		±2	±8	±8.9	±9.5	±9.8	mV	MAX
Input Offset Voltage Drift		4.4					μV/℃	TYP
Input Bias Current (I_B)		6					pA	TYP
Input Offset Current (I_{OS})		2					pA	TYP
Open-Loop Gain (A_{OL})	V_{OUT} = 0.3V to 4.7V, R_L = 150Ω	80	75	74	74	73	dB	MIN
	V_{OUT} = 0.2V to 4.8V, R_L = 1kΩ	104	92	91	91	80	dB	MIN
Input Characteristics								
Input Common Mode Voltage Range (V_{CM})		-0.2 to 3.8					V	TYP
Common Mode Rejection Ratio (CMRR)	V_{CM} = -0.1V to 3.5V	80	66	65	65	62	dB	MIN
Output Characteristics								
Output Voltage Swing from Rail	R_L = 150Ω	0.12					V	TYP
	R_L = 1kΩ	0.03					V	TYP
Output Current		130	100	95	90	84	mA	MIN
Closed-Loop Output Impedance	f < 100kHz	0.08					Ω	TYP
Power-Down (SGM8053/5 Only)								
Turn-On Time		236					ns	TYP
Turn-Off Time		52					ns	TYP
$\overline{DISABLE}$ Voltage-Off			0.8				V	MAX
$\overline{DISABLE}$ Voltage-On			2				V	MIN
Output Leakage Current (I_{OFF}) (SGM8055 Only)	$\overline{DISABLE}$ = 0V, V_S = 5V, V_{OUT} = 5V	50					pA	TYP
Power Supply								
Operating Voltage Range			2.5	2.7	2.7	2.7	V	MIN
			5.5	5.5	5.5	5.5	V	MAX
Quiescent Current/Amplifier		2.3	3.2	3.4	3.8	4	mA	MAX
Supply Current/Amplifier when Disabled (SGM8053/5 only)		75	120	127	130	137	μA	MAX
Power Supply Rejection Ratio (PSRR)	V_S = 2.7V to 5.5V, V_{CM} = (-V_S) + 0.5V	80	67	67	65	62	dB	MIN

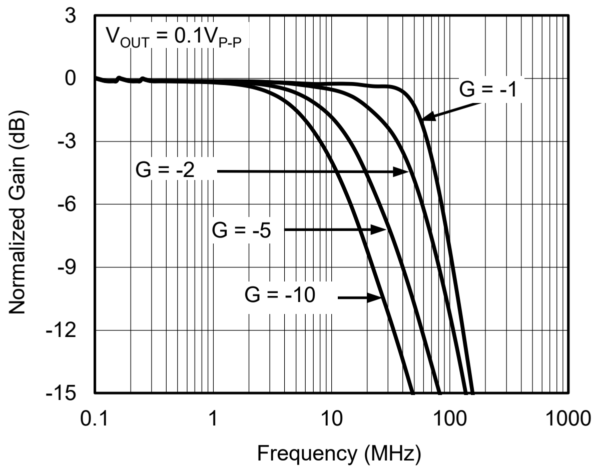
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_S = 5V, G = +2, R_F = 887Ω, R_G = 887Ω and R_L = 150Ω connected to V_S/2, unless otherwise noted.

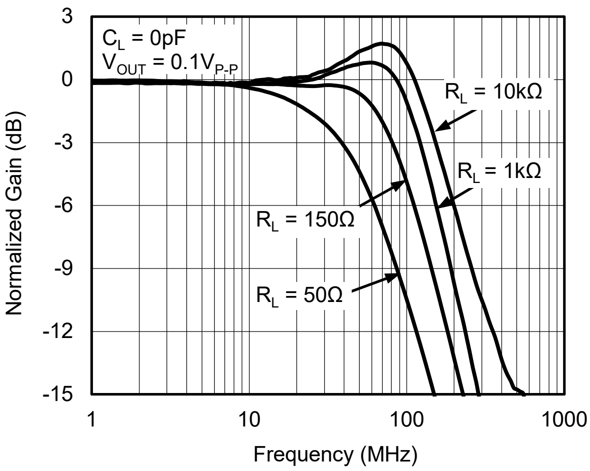
Non-Inverting Small-Signal Frequency Response



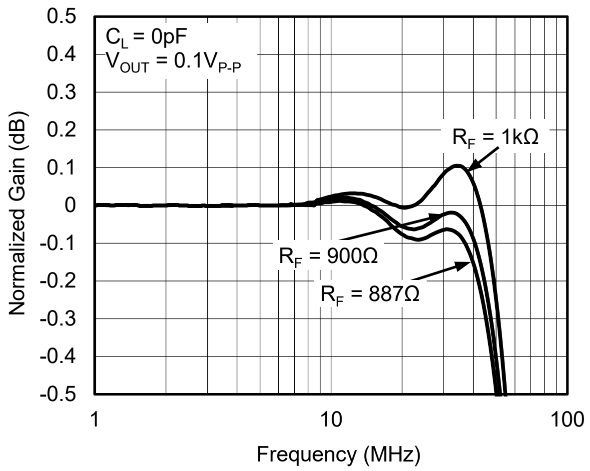
Inverting Small-Signal Frequency Response



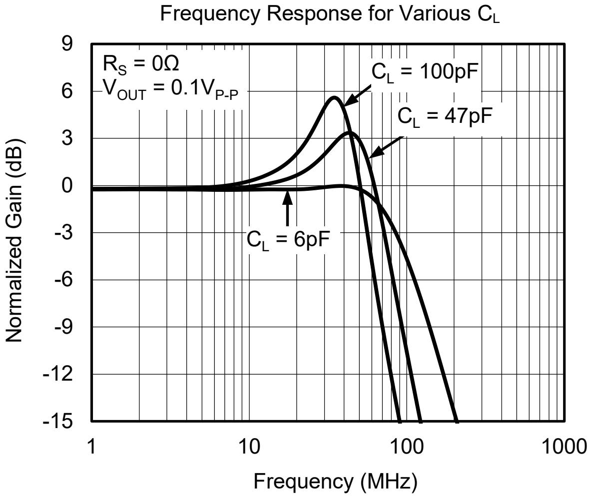
Frequency Response for Various R_L



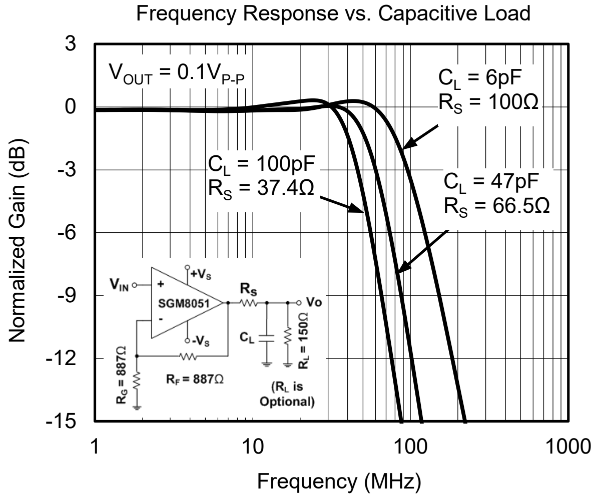
0.1dB Gain Flatness for Various R_F



Frequency Response for Various C_L



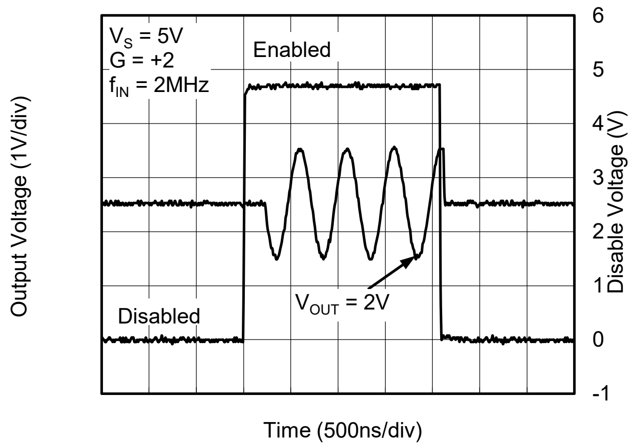
Frequency Response vs. Capacitive Load



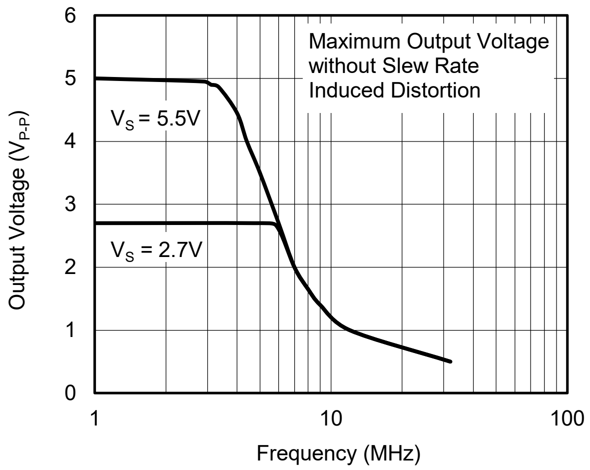
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, G = +2, R_F = 887Ω, R_G = 887Ω and R_L = 150Ω connected to V_S/2, unless otherwise noted.

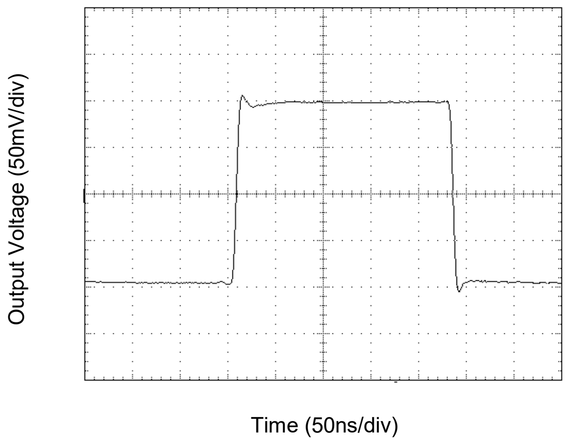
Large-Signal Disable/Enable Response



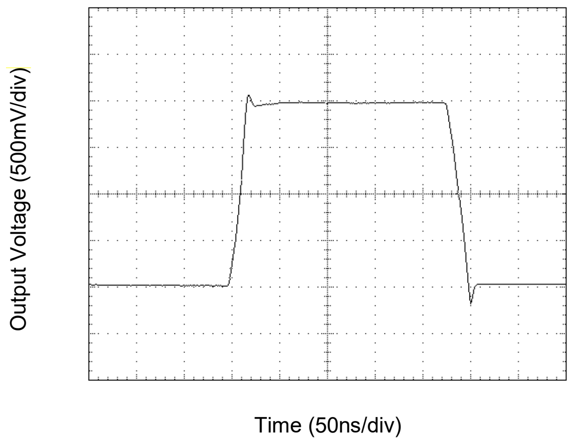
Maximum Output Voltage vs. Frequency



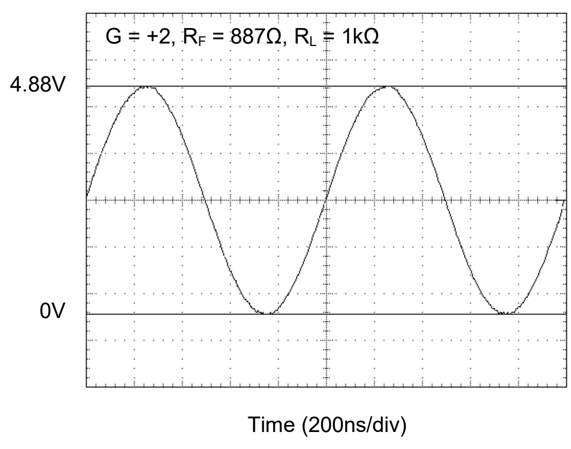
Non-Inverting Small-Signal Step Response



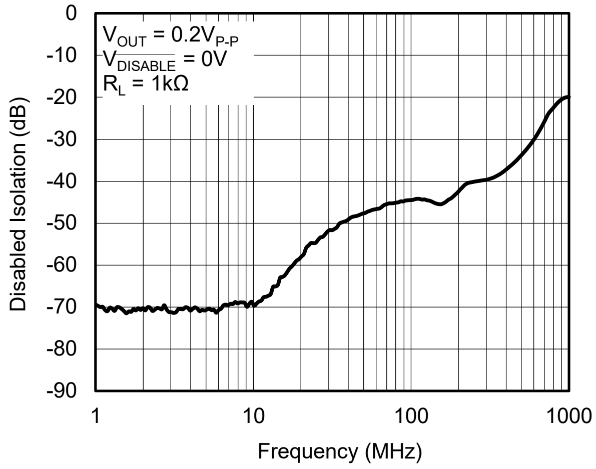
Non-Inverting Large-Signal Step Response



Rail-to-Rail



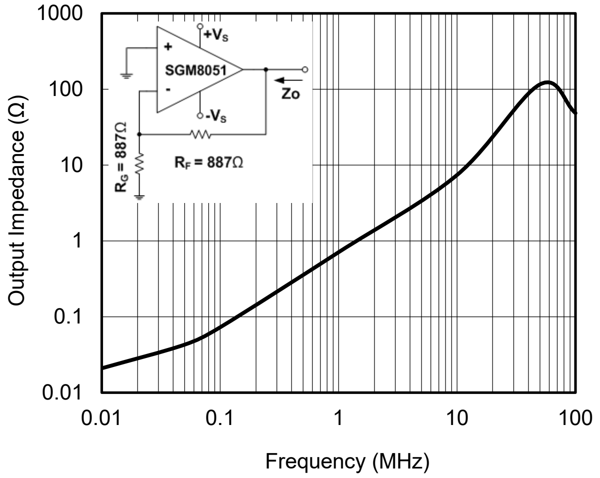
Disabled Output Isolation Frequency Response



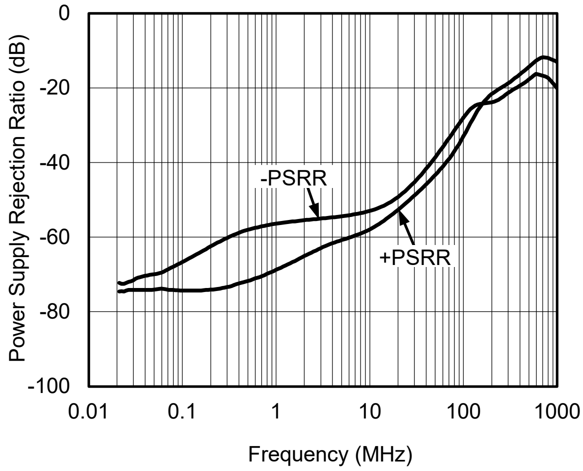
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, G = +2, R_F = 887Ω, R_G = 887Ω and R_L = 150Ω connected to V_S/2, unless otherwise noted.

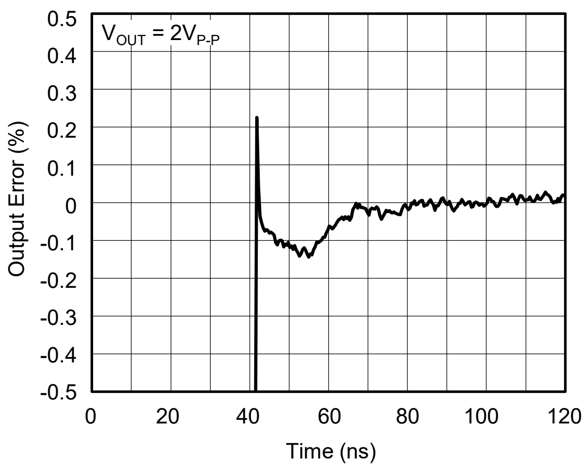
Closed-Loop Output Impedance vs. Frequency



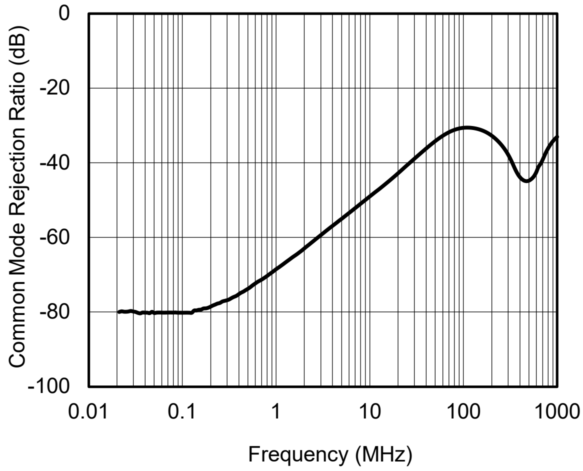
PSRR vs. Frequency



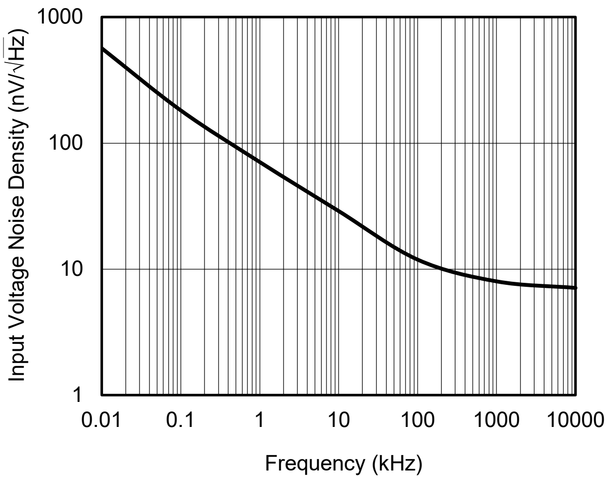
Output Settling Time to 0.1%



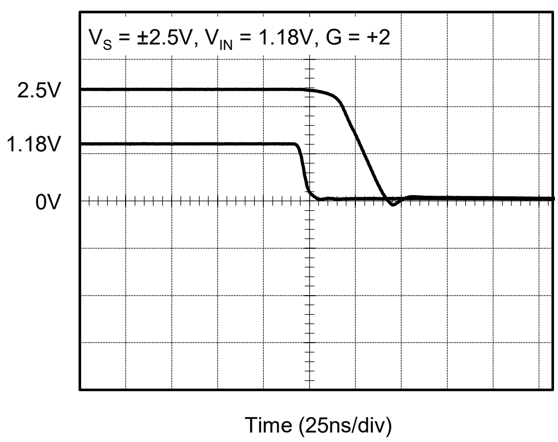
CMRR vs. Frequency



Input Voltage Noise Density vs. Frequency

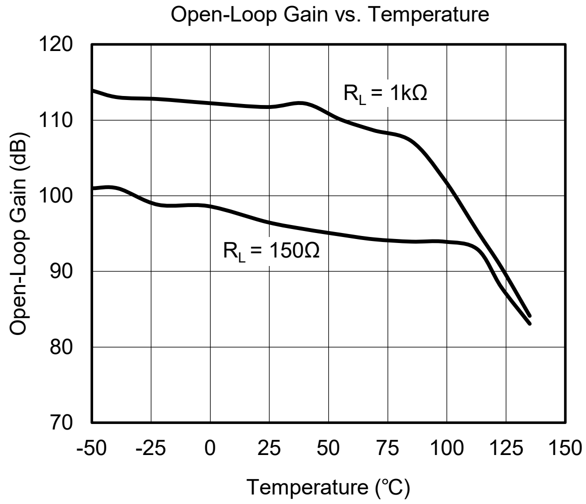


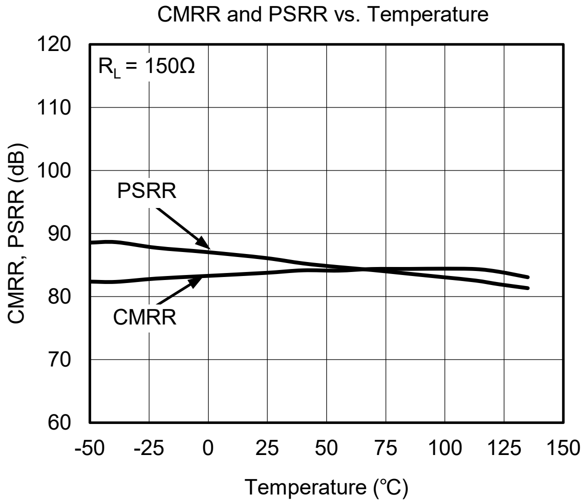
Overload Recovery Time

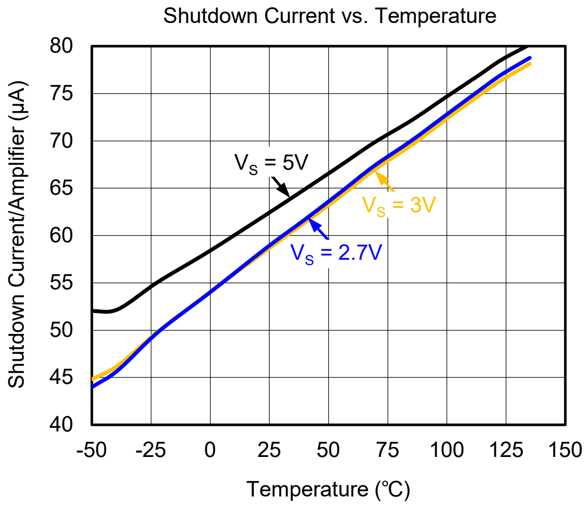


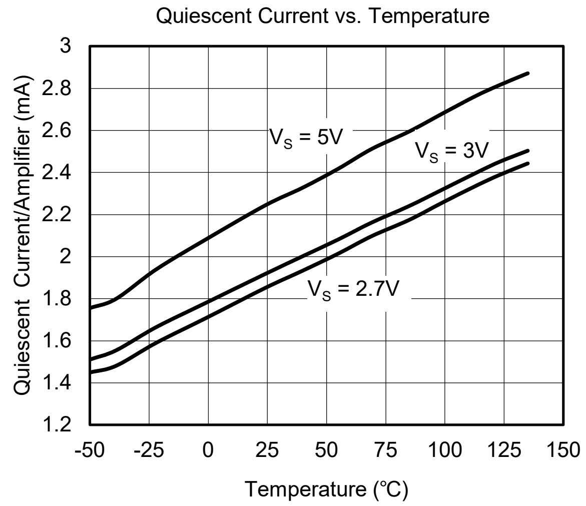
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

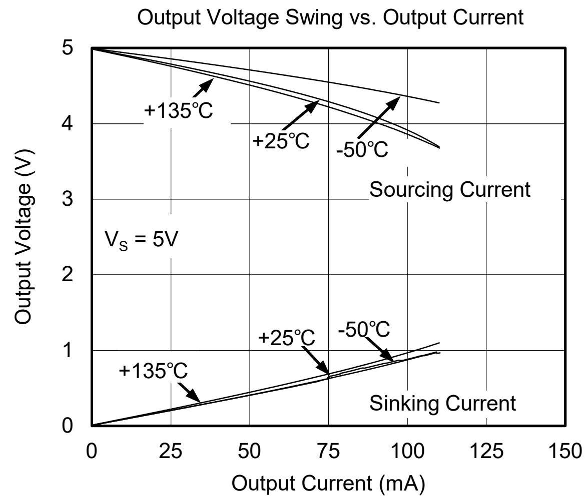
At T_A = +25℃, V_S = 5V, G = +2, R_F = 887Ω, R_G = 887Ω and R_L = 150Ω connected to V_S/2, unless otherwise noted.

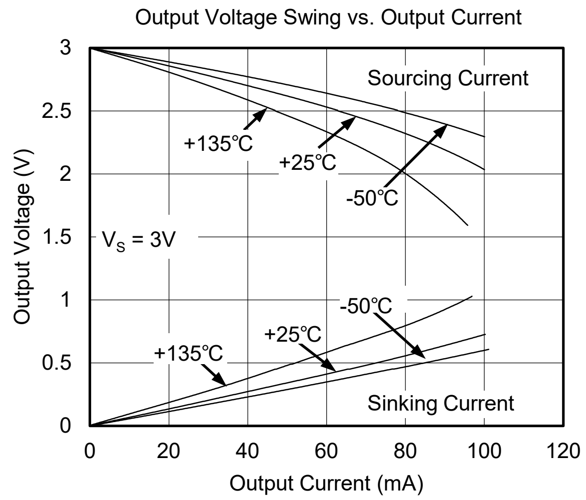






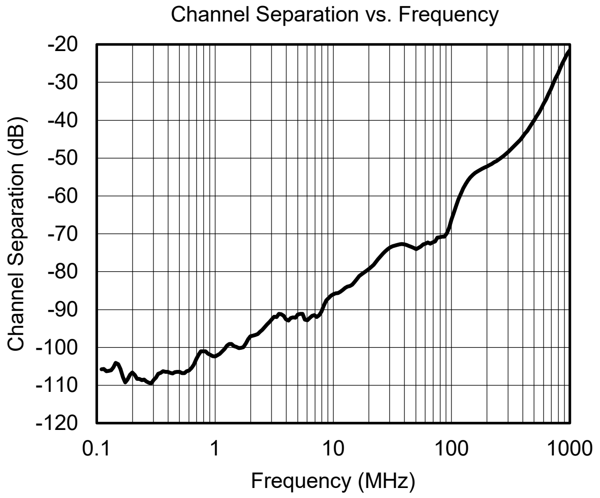


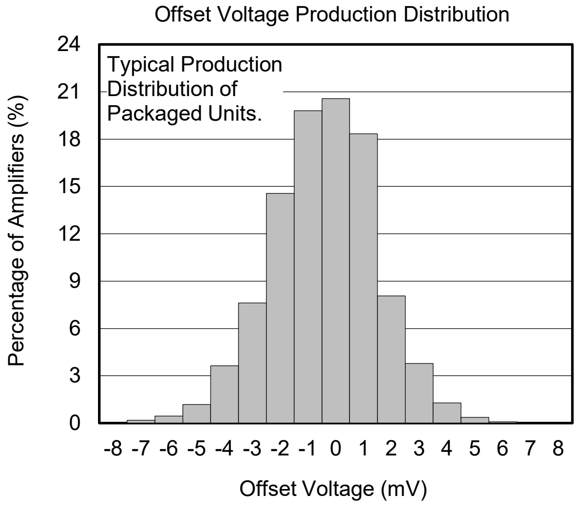




TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V, G = +2, R_F = 887Ω, R_G = 887Ω and R_L = 150Ω connected to V_S/2, unless otherwise noted.





APPLICATION INFORMATION

Rail-to-Rail Output

The SGM8051/2/3/4/5 support rail-to-rail output operation. In single power supply application, for example, when $+V_S$ = 5V, $-V_S$ = GND, 1kΩ load resistor is tied from OUT pin to ground, the typical output swing range is from 0.03V to 4.97V.

Driving Capacitive Loads

The SGM8051/2/3/4/5 are not designed for driving 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.

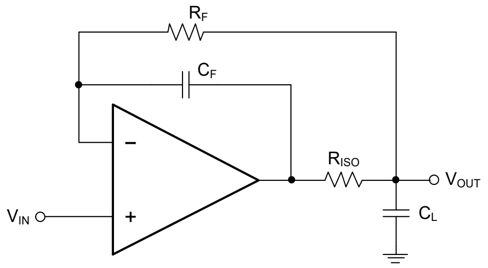


Figure 1. Circuit to Drive Heavy Capacitive Load

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.

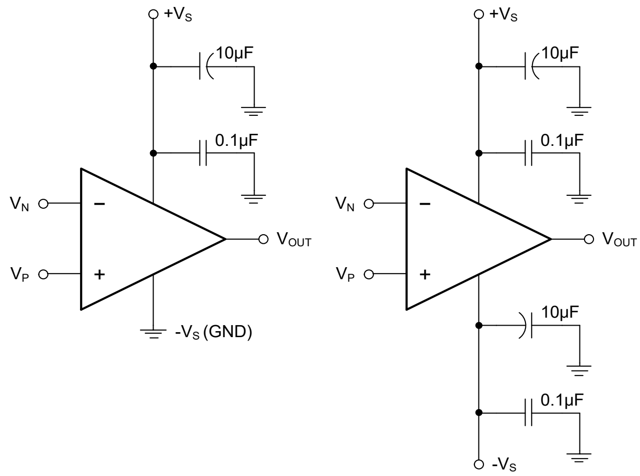


Figure 2. Amplifier Power Supply Bypassing

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

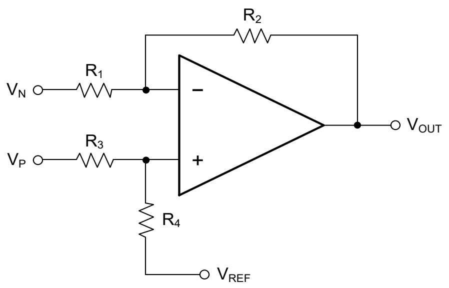


Figure 3. Difference Amplifier

Active Low-Pass Filter

The circuit in Figure 4 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.

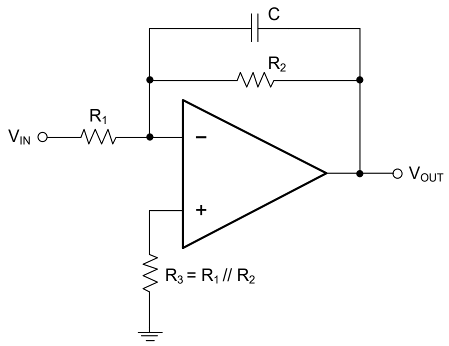


Figure 4. Active Low-Pass Filter

Driving Video

The SGM8051/2/3/4/5 can be used in video applications as shown in Figure 5.

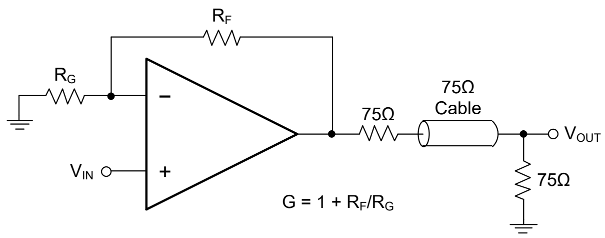


Figure 5. Typical Video Driving

REVISION HISTORY

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

JUNE 2017 – REV.E to REV.E.1	Page
Changed Package/Ordering Information section	2
Changed Absolute Maximum Ratings section	3
Updated Electrical Characteristics section	5

MAY 2014 – REV.D.4 to REV.E	Page
Changed Package/Ordering Information section	2

JANUARY 2013 – REV.D.3 to REV.D.4	Page
Updated Package Outline Dimensions section	12 ~ 18
Added Tape and Reel Information section	19, 20