# SGM8061/2/3
# 500MHz, Rail-to-Rail Output CMOS Operational Amplifiers

## PRODUCT DESCRIPTION

The SGM8061, SGM8062, SGM8063 are rail-to-rail output voltage feedback amplifiers offering ease of use and low cost. They have bandwidth and slew rate typically found in current feedback amplifiers. All have a wide input common-mode voltage range and output voltage swing, making them easy to use on single supplies as low as 2.5V.

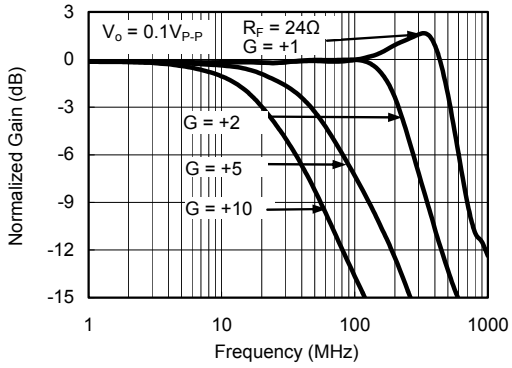
Despite being low cost, the SGM8061 series provide excellent overall performance. They offer wide bandwidth to 500MHz (G = +1) along with 0.1dB flatness out to 130MHz (G = +1) and offer a typical low power of 8.2mA/amplifier.

The SGM8061 series is low distortion and fast settling make it ideal for buffering high speed A/D or D/A converters. The SGM8063 has a power-down disable feature that reduces the supply current to 75μA. These features make the SGM8063 ideal for portable and battery-powered applications where size and power are critical. All are specified over the extended –40℃ to +125℃ temperature range.

## APPLICATIONS

Imaging
Photodiode Preamp
Professional Video and Cameras
Hand Sets
DVD/CD
Base Stations
Filters
A-to-D Driver

Non-Inverting Small Signal Frequency Response

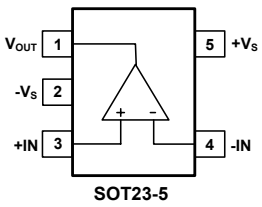



## FEATURES

- **Low Cost**
- **Rail-to-Rail Output**
  **2mV Typical $V_{OS}$**
- **High Speed**
  **500MHz, –3dB Bandwidth (G = +1)**
  **420V/μs, Slew Rate**
  **16ns Settling Time to 0.1% with 2V Step**
- **Operates on 2.5V to 5.5V Supplies**
- **Input Voltage Range = –0.2V to + 3.8V with $V_S$ = 5V**
- **Excellent Video Specs ($R_L$ = 150Ω, G = +2)**
  **Gain Flatness 0.1dB to 80MHz**
  **Diff Gain: 0.015%, Diff Phase: 0.05 degree**
- **Low Power**
  **8.2mA/Amplifier Typical Supply Current**
  **SGM8063 75μA when Disabled**
- **Small Packaging**
  **SGM8061 Available in SO-8 and SOT23-5**
  **SGM8062 Available in SO-8**
  **SGM8063 Available in SO-8 and SOT23-6**

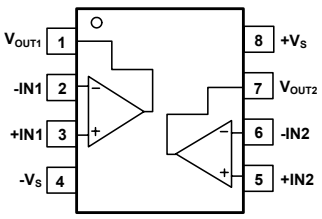
## PIN CONFIGURATIONS (Top View)

**SGM8061**



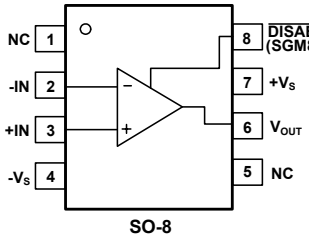

SOT23-5

**SGM8062**




SO-8

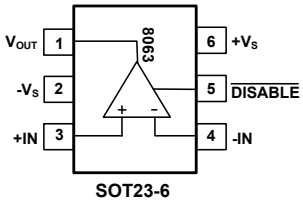
**SGM8061/8063**




SO-8

NC = NO CONNECT

**SGM8063**




SOT23-6

## PACKAGE/ORDERING INFORMATION

| MODEL | ORDER NUMBER | PACKAGE DESCRIPTION | PACKAGE OPTION | MARKING INFORMATION |
|---|---|---|---|---|
| SGM8061 | SGM8061XN5/TR | SOT23-5 | Tape and Reel, 3000 | 8061 |
| | SGM8061XS/TR | SO-8 | Tape and Reel,2500 | SGM8061XS |
| SGM8062 | SGM8062XS/TR | SO-8 | Tape and Reel, 2500 | SGM8062XS |
| SGM8063 | SGM8063XN6/TR | SOT23-6 | Tape and Reel,3000 | 8063 |
| | SGM8063XS/TR | SO-8 | Tape and Reel,2500 | SGM8063XS |

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V+ to V- .....7.5V
Common-Mode Input Voltage…..... ($-V_S$) – 0.5V to ($+V_S$) +0.5V
Storage Temperature Range .....–65℃ to +150℃
Junction Temperature ..... 160℃
Operating Temperature Range ..... –55℃ to +150℃
Package Thermal Resistance @ $T_A$ = 25℃
SOT23-5, $\theta_{JA}$..... 190℃/W
SOT23-6, $\theta_{JA}$..... 190℃/W
SO-8, $\theta_{JA}$..... 125℃/W
Lead Temperature Range (Soldering 10 sec)..... 260℃
ESD Susceptibility
HBM.....1000V
MM.....400V

NOTES
1. Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. 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 very small parametric changes could cause the device not to meet its published specifications

# ELECTRICAL CHARACTERISTICS: $V_S$ = +5V

(G = +2, $R_F$ = 402Ω, $R_L$ = 150Ω, unless otherwise noted.)

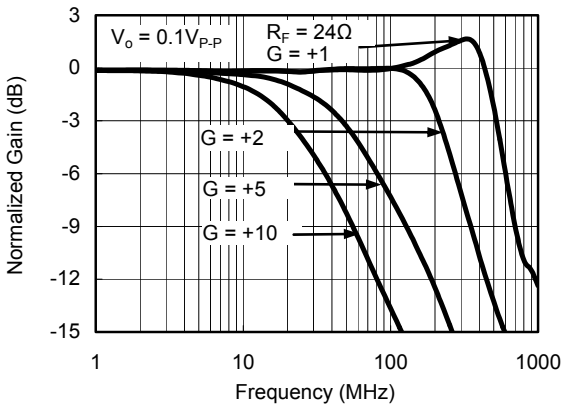
| PARAMETER | CONDITIONS | SGM8061/2/3 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | TYP | MIN/MAX OVER TEMPERATURE | | | | | |
| | | +25℃ | +25℃ | 0℃ to 70℃ | -40℃ to 85℃ | -40℃ to 125℃ | UNITS | MIN/ MAX |
| **DYNAMIC PERFORMANCE** | | | | | | | | |
| -3dB Small Signal Bandwidth | G = +1, Vo = 0.1Vp-p, $R_F$ = 24Ω, | 500 | | | | | MHz | TYP |
| | G = +1, Vo = 0.1Vp-p, $R_F$ = 24Ω, $R_L$ = 1KΩ | 550 | | | | | MHz | TYP |
| | G = +2, Vo = 0.1Vp-p, $R_L$ = 50Ω | 130 | | | | | MHz | TYP |
| | G = +2, Vo = 0.1Vp-p, $R_L$ = 150Ω | 210 | | | | | MHz | TYP |
| | G = +2, Vo = 0.1Vp-p, $R_L$ = 1KΩ | 250 | | | | | MHz | TYP |
| | G = +2, Vo = 0.1Vp-p, $R_L$ = 10KΩ | 420 | | | | | MHz | TYP |
| Gain-Bandwidth Product | G = +10, $R_L$ = 150Ω | 200 | | | | | MHz | TYP |
| | G = +10, $R_L$ = 1KΩ | 230 | | | | | MHz | TYP |
| Bandwidth for 0.1dB Flatness | G = +1, Vo = 0.1V p-p, $R_F$ = 24Ω | 130 | | | | | MHz | TYP |
| | G = +2, Vo = 0.1V p-p, $R_F$ = 330Ω | 80 | | | | | MHz | TYP |
| Slew Rate | G = +1, 2V Output Step | 320/-370 | | | | | V/μs | TYP |
| | G = +2, 2V Output Step | 350/-320 | | | | | V/μs | TYP |
| | G = +2, 4V Output Step | 420/-390 | | | | | V/μs | TYP |
| Rise-and-Fall Time | G = +2, $V_O$ = 0.2Vp-p, 10% to 90% | 4 | | | | | ns | TYP |
| | G = +2, $V_O$ = 2Vp-p, 10% to 90% | 4.5 | | | | | ns | TYP |
| Settling Time to 0.1% | G = +2, 2V Output Step | 16 | | | | | ns | TYP |
| Overload Recovery Time | $V_{IN}$·G = $+V_S$ | 6.2 | | | | | ns | TYP |
| **NOISE/DISTORTION PERFORMANCE** | | | | | | | | |
| Input Voltage Noise | f = 1MHz | 5.6 | | | | | nV/$\sqrt{Hz}$ | TYP |
| Differential Gain Error (NTSC) | G = +2, $R_L$ = 150Ω | 0.015 | | | | | % | TYP |
| Differential Phase Error (NTSC) | G = +2, $R_L$ = 150Ω | 0.05 | | | | | degree | TYP |
| **DC PERFORMANCE** | | | | | | | | |
| Input Offset Voltage ($V_{OS}$) | | ±2 | ±8 | ±8.5 | ±9 | ±9.3 | mV | MAX |
| Input Offset Voltage Drift | | 3 | | | | | μV/℃ | TYP |
| Input Bias Current ( $I_B$ ) | | 6 | | | | | pA | TYP |
| Input offset Current ( $I_{OS}$ ) | | 2 | | | | | pA | TYP |
| Open-Loop Gain ($A_{OL}$) | $V_O$ = 0.3V to 4.7V, $R_L$ = 150Ω | 80 | 75 | 75 | 74 | 70 | dB | MIN |
| | $V_O$ = 0.2V to 4.8V, $R_L$ = 1KΩ | 104 | 90 | 90 | 89 | 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 | 64 | 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 | | 120 | 100 | 98 | 93 | 87 | mA | MIN |
| Closed-Loop Output Impedance | f < 100kHz | 0.015 | | | | | Ω | TYP |
| **POWER-DOWN DISABLE** | | | | | | | | |
| Turn-On Time | | 50 | | | | | ns | TYP |
| Turn-Off Time | | 44 | | | | | ns | TYP |
| $\overline{DISABLE}$ Voltage-Off | | | 0.8 | | | | V | MAX |
| $\overline{DISABLE}$ Voltage-On | | | 2 | | | | V | MIN |
| **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 (per amplifier) | | 8.2 | 10 | 10.3 | 10.5 | 11 | mA | MAX |
| Supply Current when Disabled (SGM8063 only) | | 75 | 120 | 127 | 130 | 139 | μA | MAX |
| Power Supply Rejection Ratio (PSRR) | ΔVs = + 2.7V to + 5.5V, $V_{CM}$ = ($-V_S$) + 0.5 | 80 | 66 | 66 | 65 | 63 | dB | MIN |

Specifications subject to change without notice.

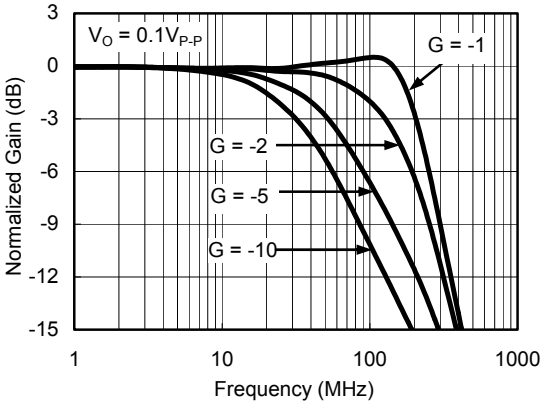
# TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A$ = +25℃, $V_S$ = +5V, G = +2, $R_F$ = 402Ω, $R_G$ = 402Ω, and $R_L$=150Ω connected to Vs/2, unless otherwise noted.

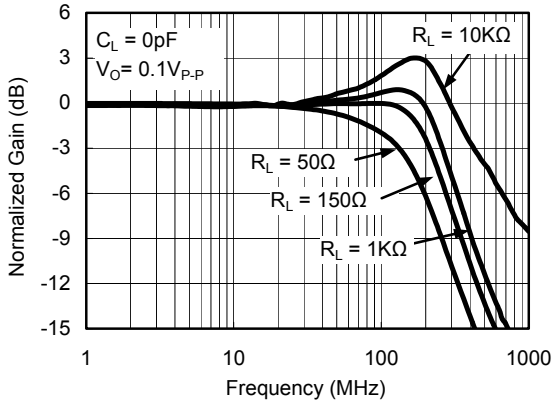
Non-Inverting Small Signal Frequency Response



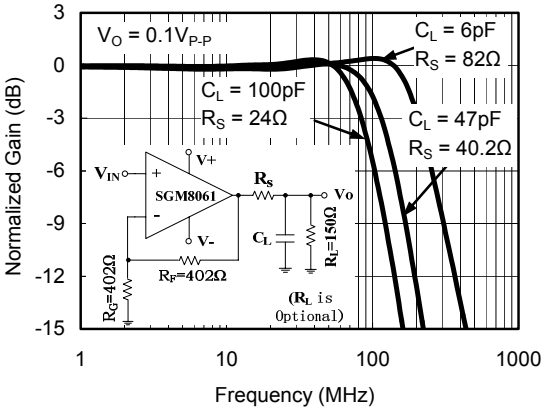

Inverting Small Signal Frequency Response



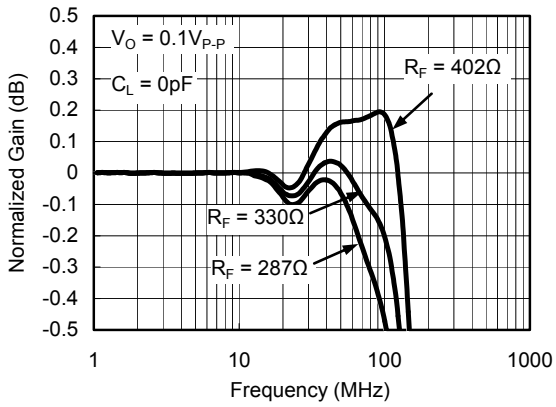

Frequency Response for Various $R_L$



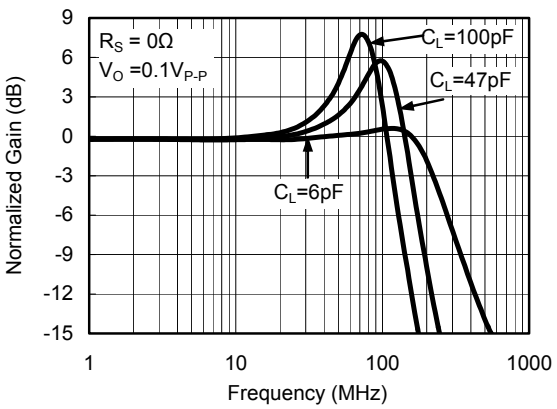

Frequency Response vs. Capacitive Load




0.1dB Gain Flatness for Various $R_F$




Frequency Response for Various $C_L$



# TYPICAL PERFORMANCE CHARACTERISTICS

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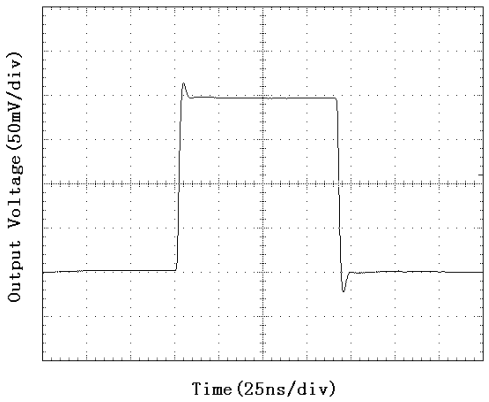
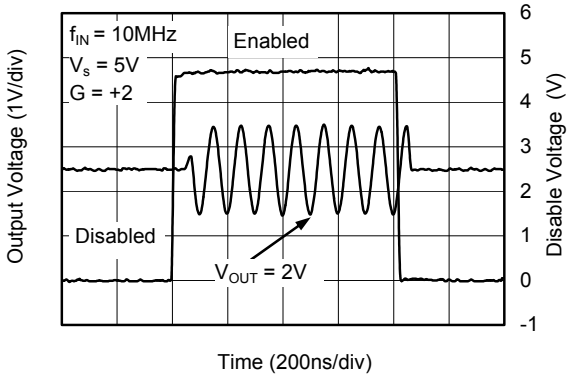
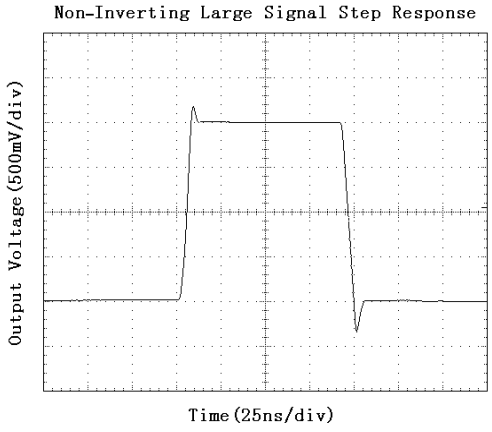
Non-Inverting Small Signal Step Response



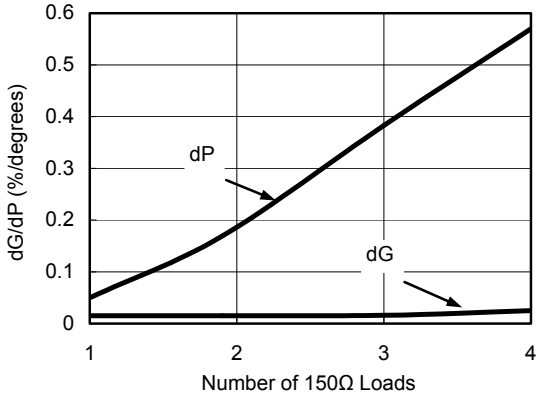

Large-Signal Disable/Enable Response



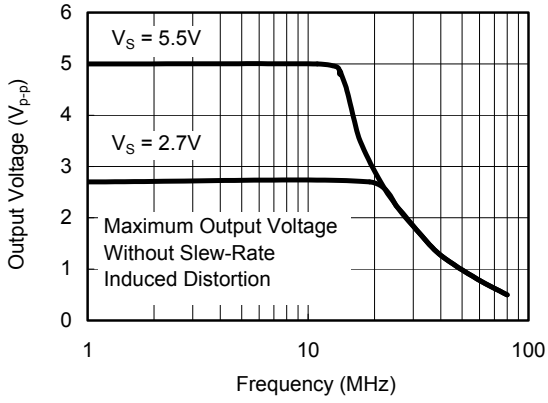

Non-Inverting Large Signal Step Response



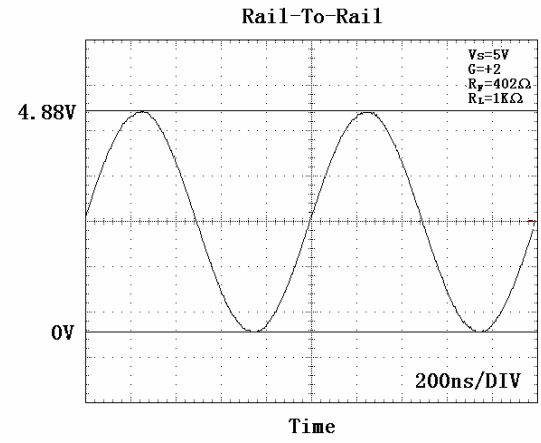

Composite Video Differential Gain and Phase




Maximum Output Voltage vs. Frequency




Rail-To-Rail



# TYPICAL PERFORMANCE CHARACTERISTICS

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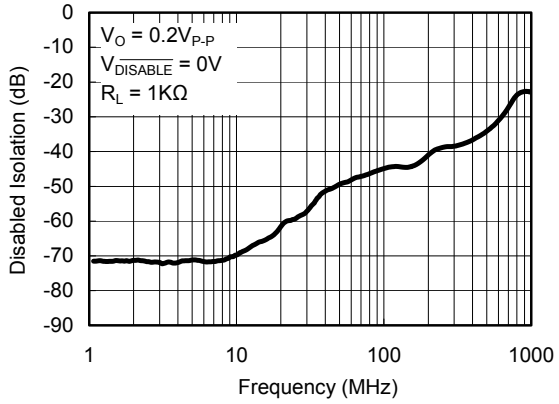
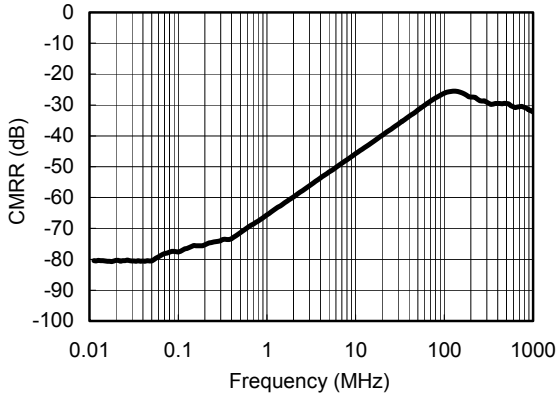
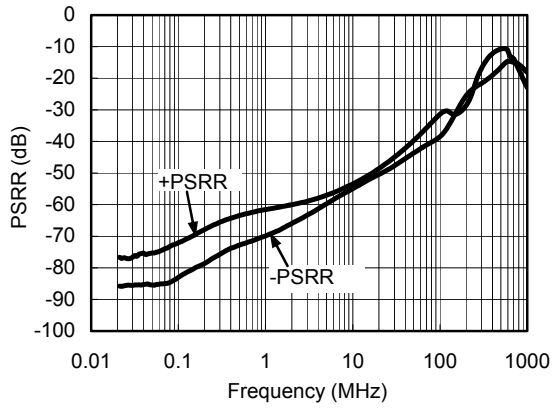
Disabled Output Isolation Frequency Response



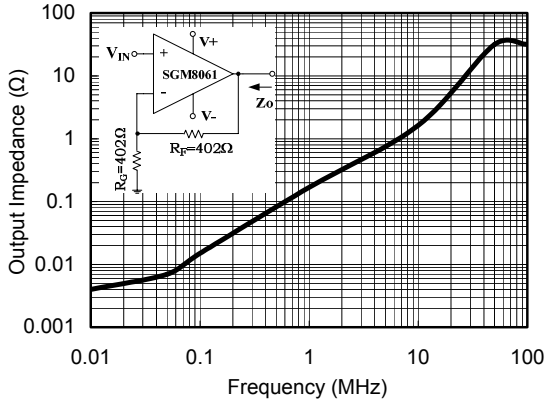

Common-Mode Rejection Ratio vs. Frequency



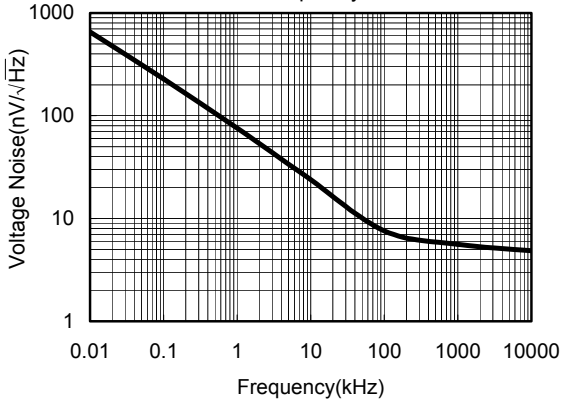

Power-Supply Rejection Ratio vs. Frequency



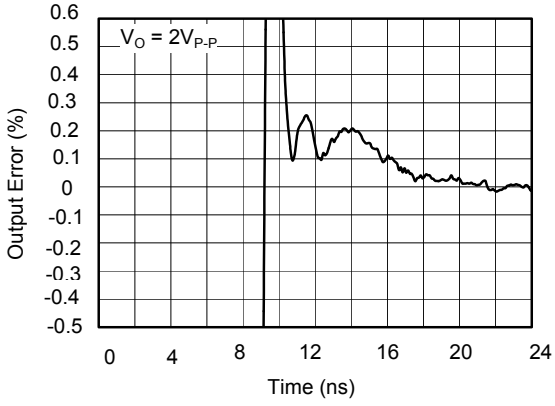

Closed-Loop Output Impedance vs. Frequency




Input Voltage Noise Spectral Density vs.Frequency




Output Settling Time to 0.1%



# TYPICAL PERFORMANCE CHARACTERISTICS

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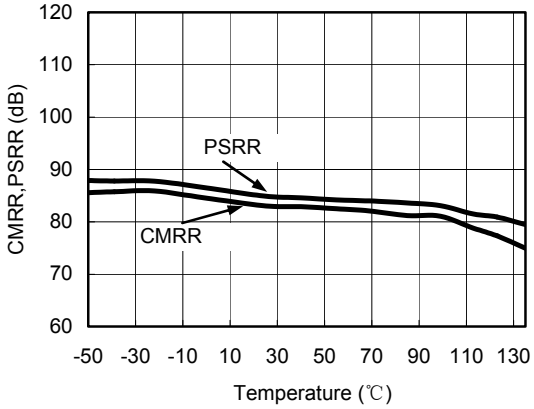
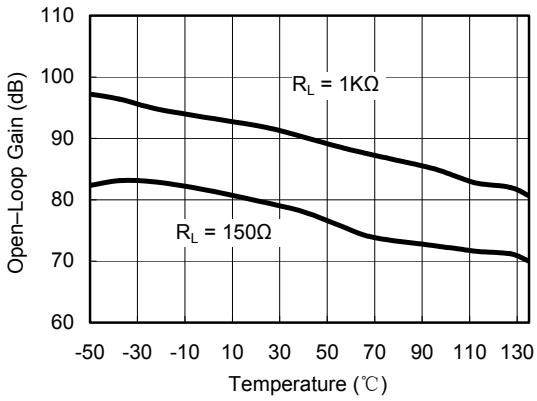
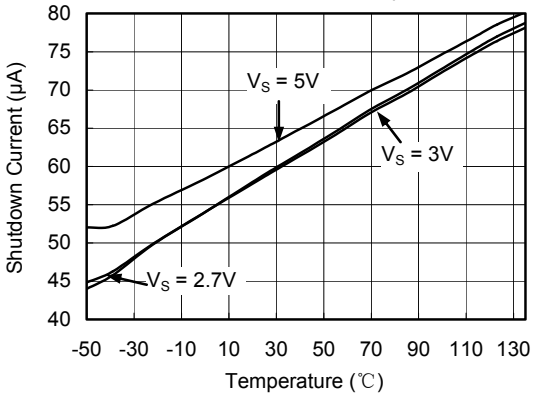
CMRR and PSRR vs. Temperature



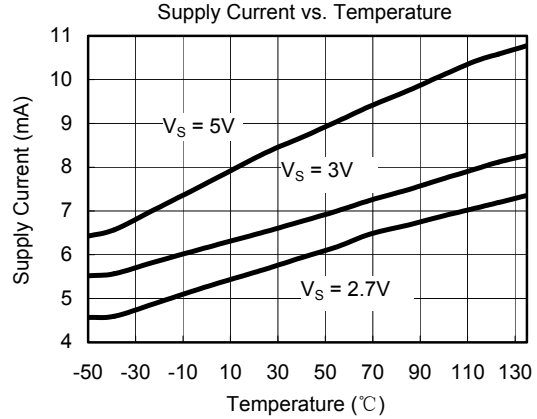

Open-Loop Gain vs. Temperature



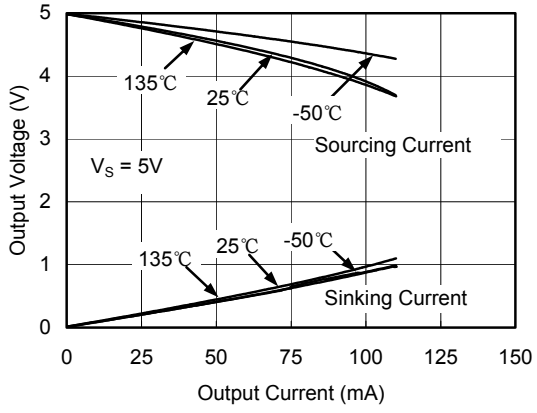

Shudown Current vs. Temperature



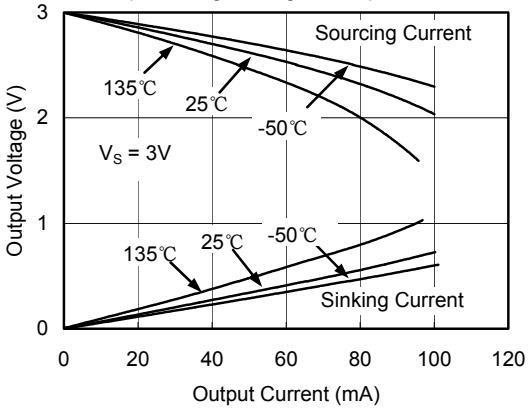

Supply Current vs. Temperature




Output Voltage Swing vs.Output Current




Output Voltage Swing vs. Output Current



## TYPICAL PERFORMANCE CHARACTERISTICS

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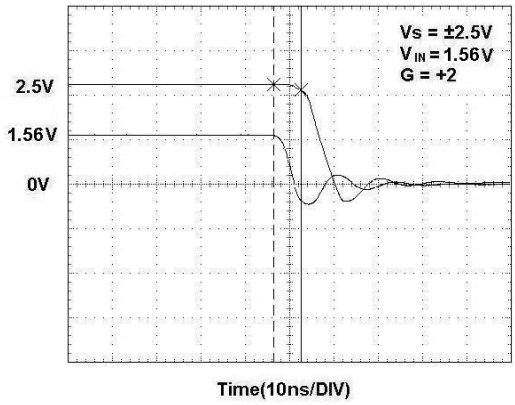
Overload Recovery Time



# APPLICATION NOTES

## Driving Capacitive Loads

The SGM806x family is optimized for bandwidth and speed, not for driving capacitive loads. Output capacitance will create a pole in the amplifier's feedback path, leading to excessive peaking and potential oscillation. If dealing with load capacitance is a requirement of the application, the two strategies to consider are (1) using a small resistor in series with the amplifier's output and the load capacitance and (2) reducing the bandwidth of the amplifier's feedback loop by increasing the overall noise gain.

Figure 1 shows a unity gain follower using the series resistor strategy. The resistor isolates the output from the capacitance and, more importantly, creates a zero in the feedback path that compensates for the pole created by the output capacitance.

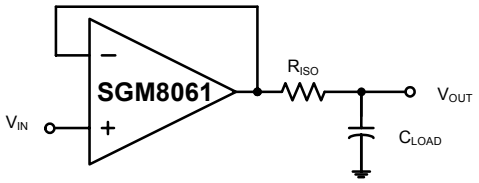



**Figure 1. Series Resistor Isolating Capacitive Load**

## Power-Supply Bypassing and Layout

The SGM806x family operates from either a single +2.7V to +5.5V supply or dual ±1.35V to ±2.75V supplies. For single-supply operation, bypass the power supply $V_{DD}$ with a 0.1μF ceramic capacitor which should be placed close to the $V_{DD}$ pin. For dual-supply operation, both the $V_{DD}$ and the $V_{SS}$ supplies should be bypassed to ground with separate 0.1μF ceramic capacitors. 2.2μF tantalum capacitor can be added for better performance.

Good PC board layout techniques optimize performance by decreasing the amount of stray capacitance at the op amp's inputs and output. To decrease stray capacitance, minimize trace lengths and widths by placing external components as close to the device as possible. Use surface-mount components whenever possible.

For the high speed operational amplifier, soldering the part to the board directly is strongly recommended. Try to keep the high frequency big current loop area small to minimize the EMI (electromagnetic interfacing).

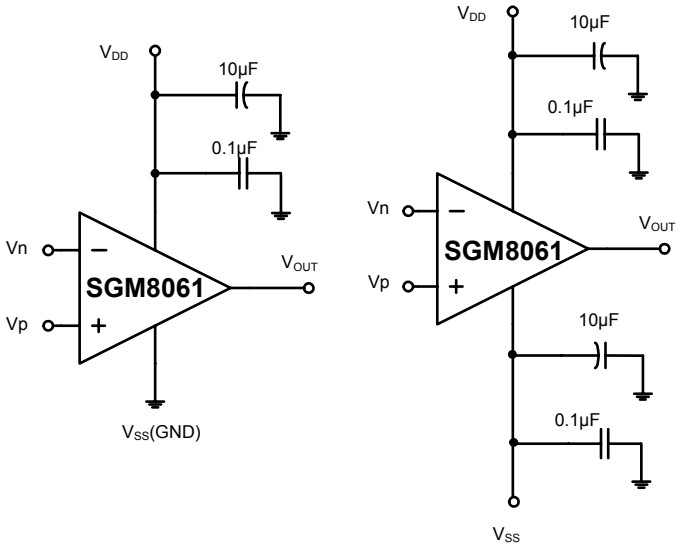



**Figure 2. Amplifier with Bypass Capacitors**

## Grounding

A ground plane layer is important for high speed circuit design. The length of the current path speed currents in an inductive ground return will create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance.

## Input-to-Output Coupling

To minimize capacitive coupling, the input and output signal traces should not be parallel. This helps reduce unwanted positive feedback.

# TYPICAL APPLICATION CIRCUITS

## Differential Amplifier

The circuit shown in Figure 3 performs the difference function. If the resistors ratios are equal ($R_4$ / $R_3$ = $R_2$ / $R_1$), then $V_{OUT}$ = (Vp – Vn) × $R_2$ / $R_1$ + $V_{REF}$.

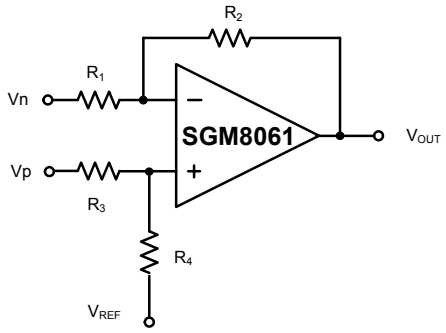



**Figure 3. Differential Amplifier**

## Low Pass Active Filter

The low pass filter shown in Figure 4 has a DC gain of ( - $R_2$ / $R_1$ ) and the –3dB corner frequency is 1/2π$R_2$C. Make sure the filter is within the bandwidth of the amplifier. The Large values of feedback resistors can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistors value as low as possible and consistent with output loading consideration.

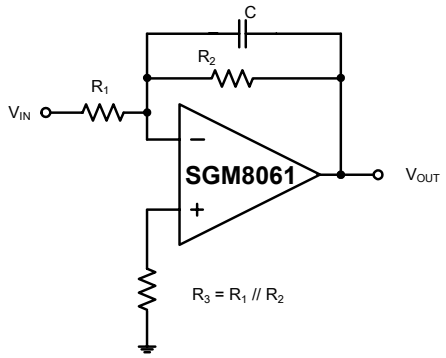



**Figure 4. Low Pass Active Filter**

## Driving Video

The SGM806x can be used in video applications like in Figure 5.

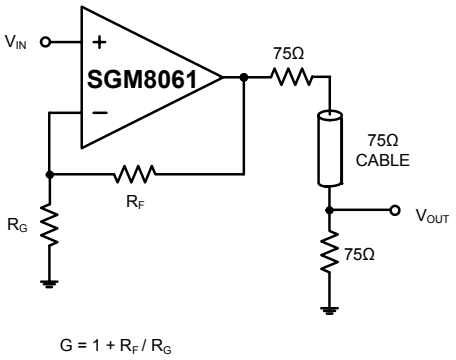
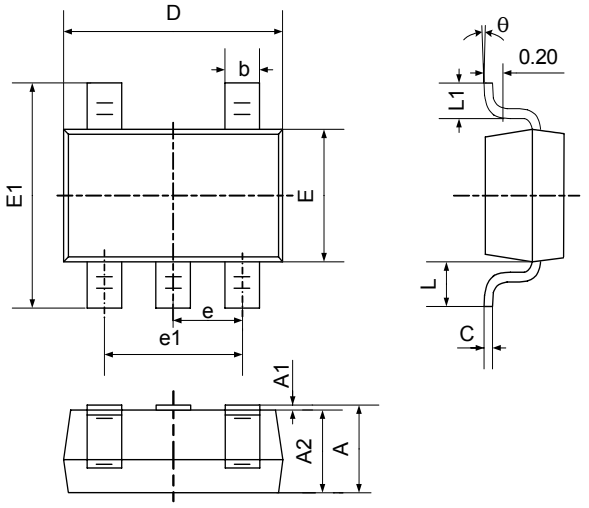



**Figure 5. Typical Video Driving**

# PACKAGE OUTLINE DIMENSIONS

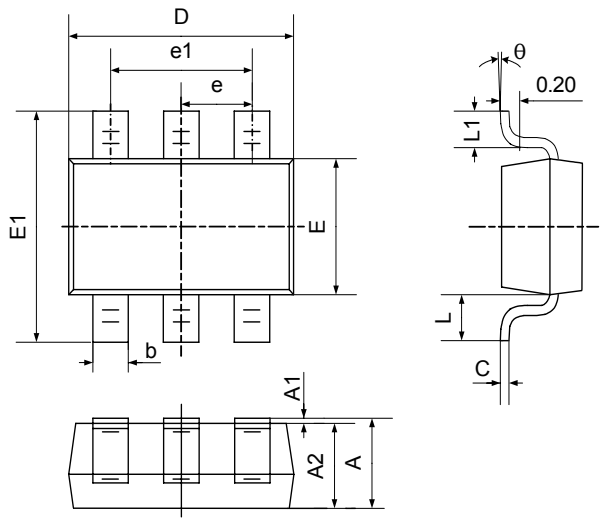
## SOT23-5




| 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 | 0.400 | 0.012 | 0.016 |
| 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 | 0.950TYP | | 0.037TYP | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.700REF | | 0.028REF | |
| L1 | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |

# PACKAGE OUTLINE DIMENSIONS

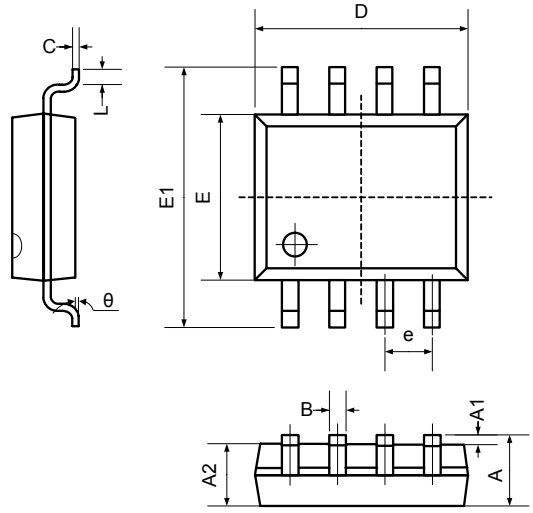
## SOT23-6




| 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 | 0.400 | 0.012 | 0.016 |
| 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 | 0.950TYP | | 0.037TYP | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.700REF | | 0.028REF | |
| L1 | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |

# PACKAGE OUTLINE DIMENSIONS

## SO-8




| 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 | 0.190 | 0.250 | 0.007 | 0.010 |
| D | 4.780 | 5.000 | 0.188 | 0.197 |
| E | 3.800 | 4.000 | 0.150 | 0.157 |
| E1 | 5.800 | 6.300 | 0.228 | 0.248 |
| e | 1.270TYP | | 0.050TYP | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

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