# SGM8091/SGM8092
# SGM8093/SGM8094
# 350MHz, Rail-to-Rail Output CMOS Operational Amplifiers

## GENERAL DESCRIPTION

The SGM8091/3 (single), SGM8092 (dual) and SGM8094 (quad) 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 supply as low as 2.5V.

Despite being low cost, the SGM8091 series provide excellent overall performance. They offer wide bandwidth to 350MHz (G = +1) along with 0.1dB flatness out to 125MHz (G = +1) and offer a typical low power of 4.3mA/amplifier.

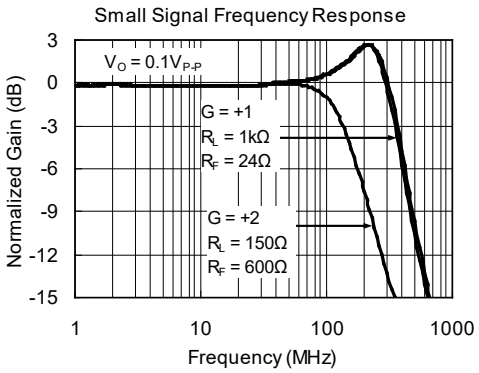
The SGM8091 series are low distortion and fast settling, making them ideal for buffering high speed A/D or D/A converters. The SGM8093 has a power-down disable feature that reduces the supply current to 75μA. These features make the SGM8093 ideal for portable and battery-powered applications where size and power are critical. All are specified over the extended -40℃ to +125℃ temperature range.

## FEATURES

- **Rail-to-Rail Output**
- **Input Offset Voltage: 8mV (MAX)**
- **High Speed:**
  **350MHz, -3dB Bandwidth (G = +1)**
  **265V/μs, Slew Rate**
  **32ns Settling Time to 0.1% with 2V Step**
- **Supply Voltage Range: 2.5V to 5.5V**
- **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 70MHz**
  **Diff Gain: 0.004%, Diff Phase: 0.08 Degree**
- **Low Supply Current:**
  **4.3mA/Amplifier (TYP)**
  **75μA Shutdown Current for SGM8093**
- **-40℃ to +125℃ Operating Temperature Range**
- **Small Packaging:**
  **SGM8091 Available in SOIC-8 and SOT-23-5**
  **SGM8092 Available in SOIC-8 and MSOP-8**
  **SGM8093 Available in SOIC-8 and SOT-23-6**
  **SGM8094 Available in SOIC-14 and TSSOP-14**

## APPLICATIONS

Imaging
Photodiode Preamp
Professional Video and Camera
Hand Set
DVD/CD
Base Station
Filter
A-to-D Driver



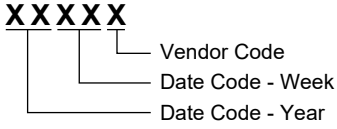
# PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM8091 | SOT-23-5 | -40℃ to +125℃ | SGM8091XN5/TR | 8091 | Tape and Reel, 3000 |
| | SOIC-8 | -40℃ to +125℃ | SGM8091XS/TR | SGM8091XS<br>XXXXX | Tape and Reel, 2500 |
| SGM8092 | SOIC-8 | -40℃ to +125℃ | SGM8092XS/TR | SGM8092XS<br>XXXXX | Tape and Reel, 2500 |
| | MSOP-8 | -40℃ to +125℃ | SGM8092XMS/TR | SGM8092<br>XMS<br>XXXXX | Tape and Reel, 3000 |
| SGM8093 | SOT-23-6 | -40℃ to +125℃ | SGM8093XN6/TR | 8093 | Tape and Reel, 3000 |
| | SOIC-8 | -40℃ to +125℃ | SGM8093XS/TR | SGM8093XS<br>XXXXX | Tape and Reel, 2500 |
| SGM8094 | SOIC-14 | -40℃ to +125℃ | SGM8094XS14/TR | SGM8094XS14<br>XXXXX | Tape and Reel, 2500 |
| | TSSOP-14 | -40℃ to +125℃ | SGM8094XTS14/TR | SGM8094<br>XTS14<br>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 $-V_S$ ..... 7.5V
Input Common Mode Voltage Range
..... $(-V_S)$ - 0.5V to $(+V_S)$ + 0.5V
Package Thermal Resistance @ $T_A$ = +25℃
SOT-23-5, $\theta_{JA}$ ..... 190℃/W
SOT-23-6, $\theta_{JA}$ ..... 190℃/W
SOIC-8, $\theta_{JA}$... ..... 125℃/W
MSOP-8, $\theta_{JA}$ ..... 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

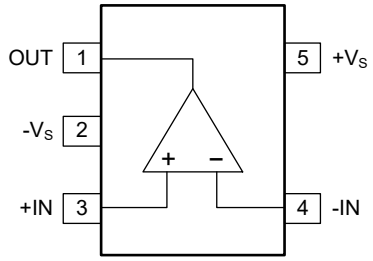
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

## DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

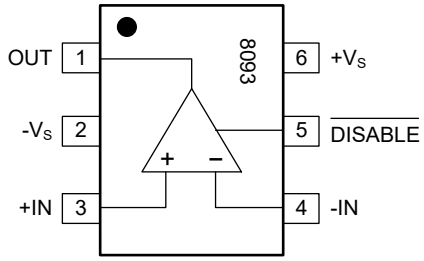
## PIN CONFIGURATIONS

**SGM8091 (TOP VIEW)**



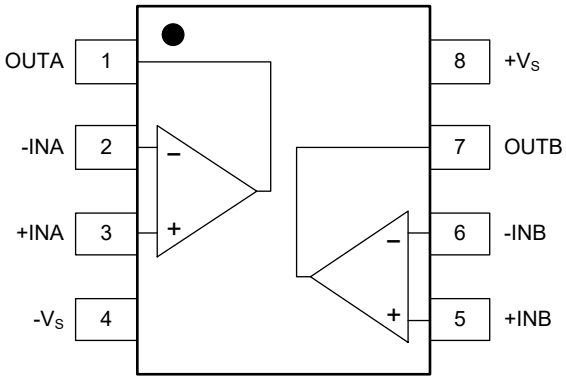

**SOT-23-5**

**SGM8093 (TOP VIEW)**



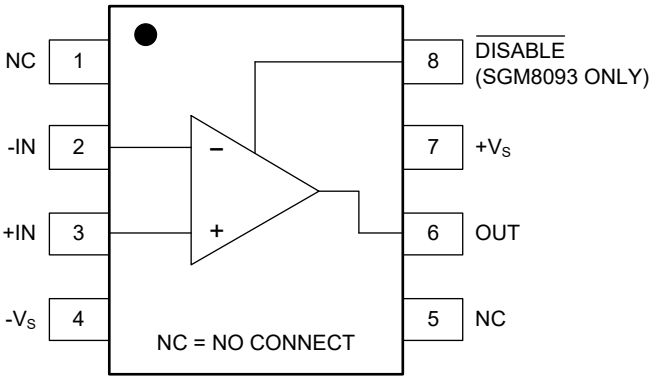

**SOT-23-6**

**SGM8092 (TOP VIEW)**



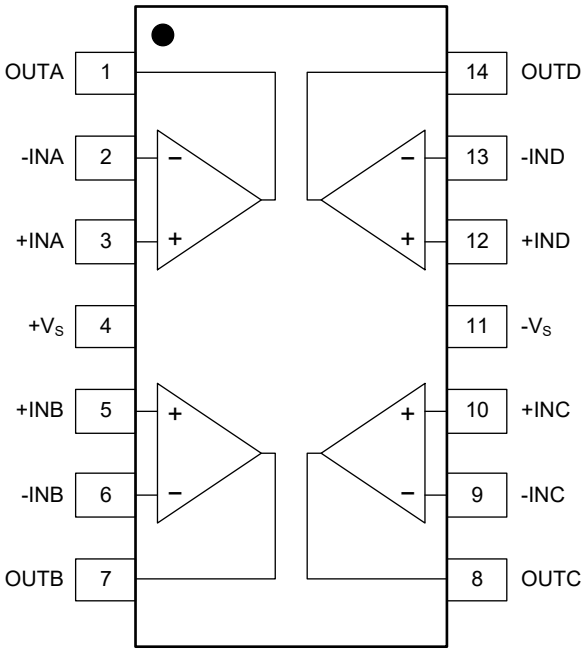

**SOIC-8/MSOP-8**

**SGM8091/8093 (TOP VIEW)**




**SOIC-8**

**SGM8094 (TOP VIEW)**




**SOIC-14/TSSOP-14**

# ELECTRICAL CHARACTERISTICS

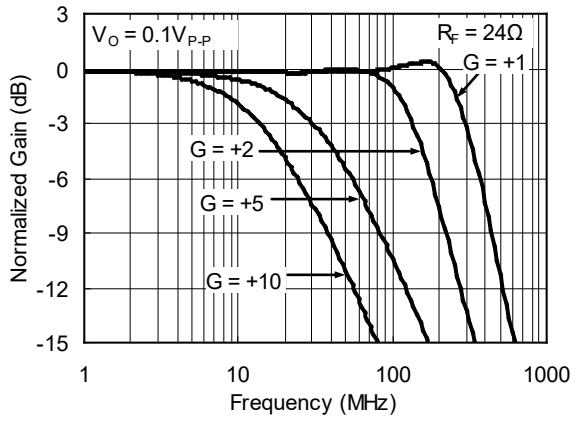
($V_S$ = 5V, G = +2, $R_F$ =600Ω, $R_L$ = 150Ω, unless otherwise noted.)

| PARAMETER | CONDITIONS | SGM8091/2/3/4 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | TYP | MIN/MAX OVER TEMPERATURE | | | | | |
| | | +25℃ | +25℃ | 0℃ to +70℃ | -40℃ to +70℃ | -40℃ to +125℃ | UNITS | MIN/ MAX |
| **Dynamic Performance** | | | | | | | | |
| -3dB Small Signal Bandwidth | G = +1, $V_O$ = 0.1$V_{P-P}$, $R_F$ = 24Ω, $R_L$ = 150Ω | 300 | | | | | MHz | TYP |
| | G = +1, $V_O$ = 0.1$V_{P-P}$, $R_F$ = 24Ω, $R_L$ = 1kΩ | 350 | | | | | MHz | TYP |
| | G = +2, $V_O$ = 0.1$V_{P-P}$, $R_L$ = 50Ω | 70 | | | | | MHz | TYP |
| | G = +2, $V_O$ = 0.1$V_{P-P}$, $R_L$ = 150Ω | 140 | | | | | MHz | TYP |
| | G = +2, $V_O$ = 0.1$V_{P-P}$, $R_L$ = 1kΩ | 170 | | | | | MHz | TYP |
| | G = +2, $V_O$ = 0.1$V_{P-P}$, $R_L$ = 10kΩ | 230 | | | | | MHz | TYP |
| Gain-Bandwidth Product | G = +10, $R_L$ =150Ω | 135 | | | | | MHz | TYP |
| | G = +10, $R_L$ =1kΩ | 170 | | | | | MHz | TYP |
| Bandwidth for 0.1dB Flatness | G = +1, $V_O$ = 0.1$V_{P-P}$ | 125 | | | | | MHz | TYP |
| | G = +2, $V_O$ = 0.1$V_{P-P}$, $R_F$ = 600Ω | 70 | | | | | MHz | TYP |
| Slew Rate | G = +1, 2V output step | 194/-204 | | | | | V/μs | TYP |
| | G = +2, 2V output step | 236/-170 | | | | | V/μs | TYP |
| | G = +2, 4V output step | 265/-218 | | | | | V/μs | TYP |
| Rise-and-Fall Time | G = +2, $V_O$ = 0.2$V_{P-P}$, 10% to 90% | 3.8 | | | | | ns | TYP |
| | G = +2, $V_O$ = 2$V_{P-P}$, 10% to 90% | 7.8 | | | | | ns | TYP |
| Settling Time to 0.1% | G = +2, 2V output step | 32 | | | | | ns | TYP |
| Overload Recovery Time | $V_{IN}$ · G = +$V_S$ | 14.5 | | | | | ns | TYP |
| **Noise/Distortion Performance** | | | | | | | | |
| Input Voltage Noise | f = 1MHz | 5.9 | | | | | nV/$\sqrt{Hz}$ | TYP |
| Differential Gain Error (NTSC) | G = +2, $R_L$ = 150Ω | 0.004 | | | | | % | 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 | | 3.7 | | | | | 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 | 74 | 74 | 73 | dB | MIN |
| | $V_O$ = 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 | 66 | 65 | 64 | 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 | | 115 | 98 | 97 | 94 | 88 | mA | MIN |
| Closed-Loop Output Impedance | f < 100kHz | 0.02 | | | | | Ω | TYP |
| **Power-Down Disable** | | | | | | | | |
| Turn-On Time | | 108 | | | | | ns | TYP |
| Turn-Off Time | | 60 | | | | | 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) | | 4.3 | 7.5 | 8.0 | 8.0 | 8.1 | mA | MAX |
| Supply Current when Disabled (SGM8093 only) | | 75 | 120 | 127 | 130 | 137 | μA | MAX |
| Power Supply Rejection Ratio (PSRR) | $\Delta V_S$ = 2.7V to 5.5V, $V_{CM}$ = (-$V_S$) + 0.5 | 80 | 66 | 66 | 64 | 62 | dB | MIN |

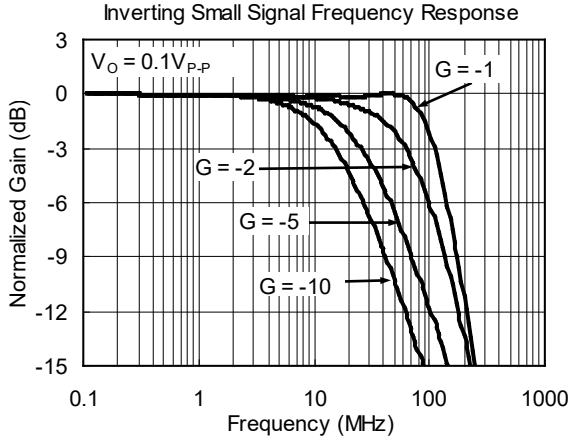
## TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A$ = +25℃, $V_S$ = 5V, G = +2, $R_F$ = 600Ω, $R_G$ = 600Ω, and $R_L$ = 150Ω connected to $V_S$/2, unless otherwise noted.

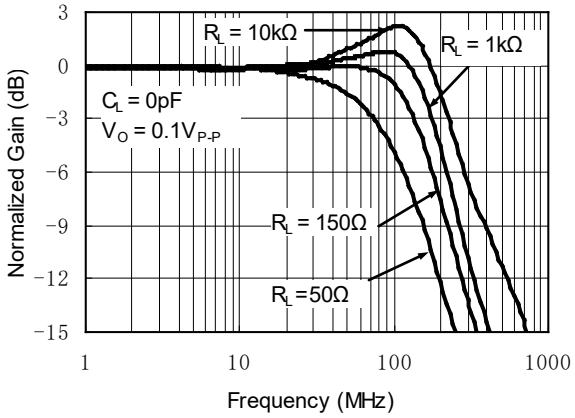
Non-Inverting Small Signal Frequency Response



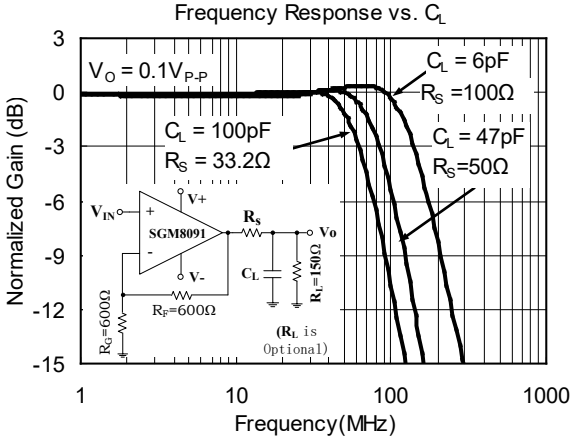

Inverting Small Signal Frequency Response



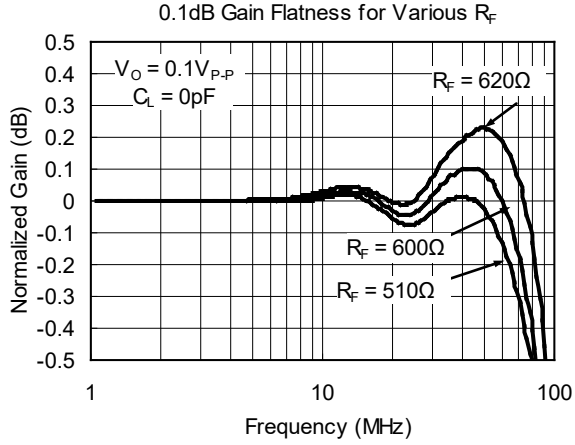

Frequency Response for Various $R_L$



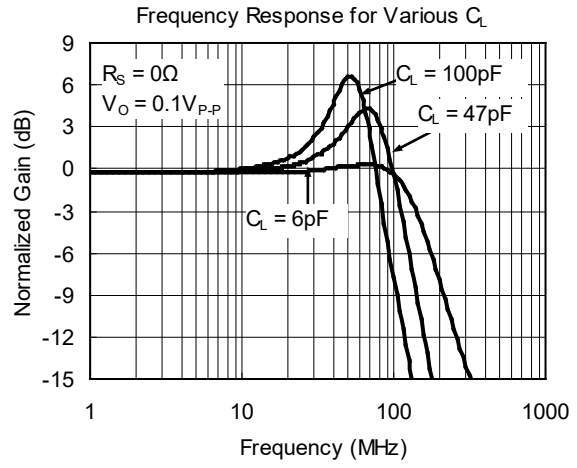

Frequency Response vs. $C_L$




0.1dB Gain Flatness for Various $R_F$



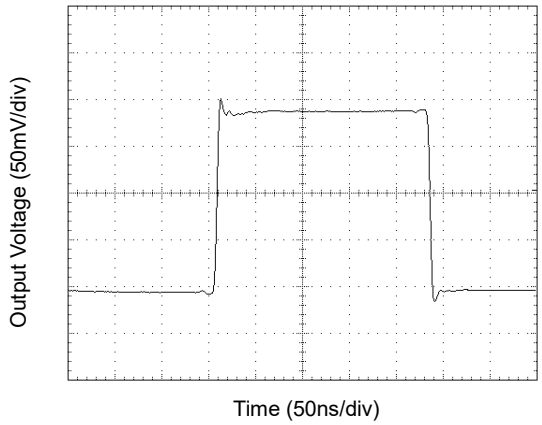

Frequency Response for Various $C_L$



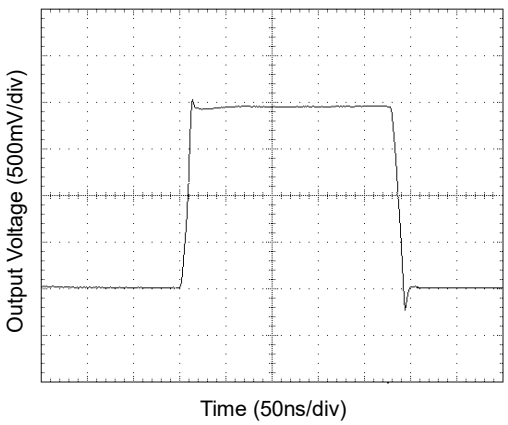
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A$ = +25℃, $V_S$ = 5V, G = +2, $R_F$ = 600Ω, $R_G$ = 600Ω, and $R_L$ = 150Ω connected to $V_S$/2, unless otherwise noted.

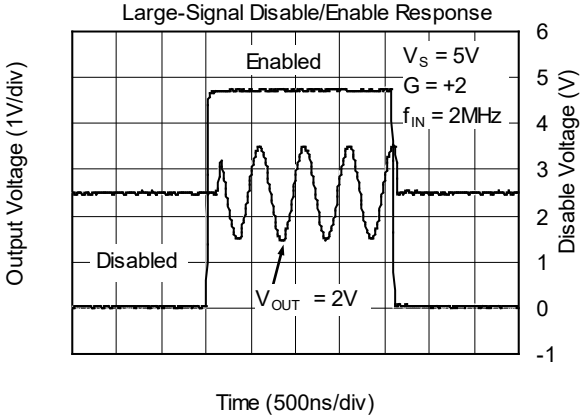
Non-Inverting Small Signal Step Response



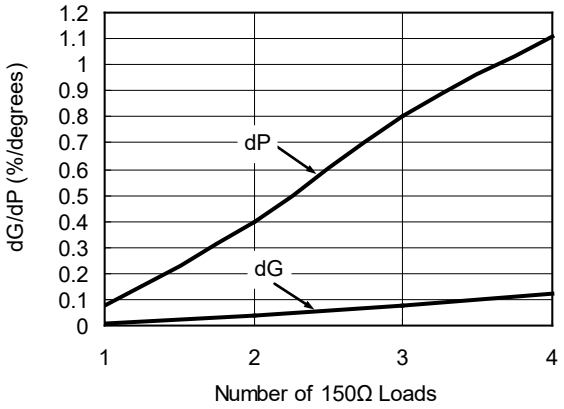

Non-Inverting Large Signal Step Response



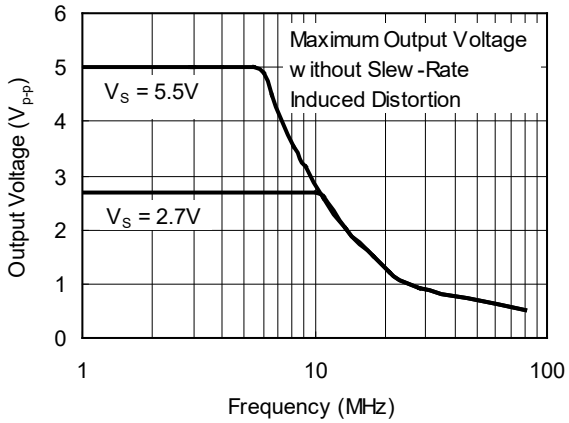

Large-Signal Disable/Enable Response



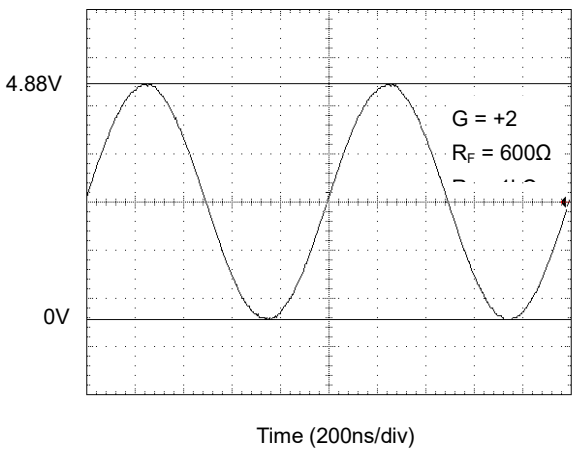

Composite Video Differential Gain and Phase




Maximum Output Voltage vs. Frequency



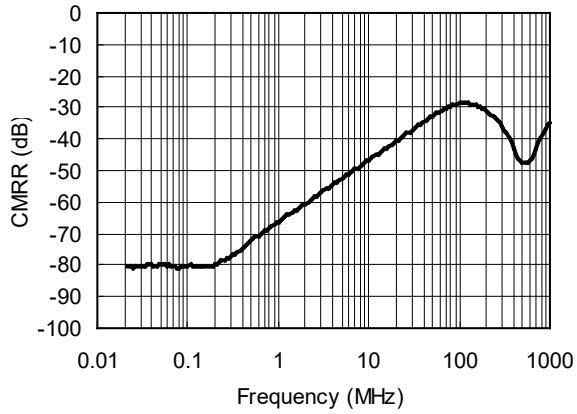

Rail-to-Rail



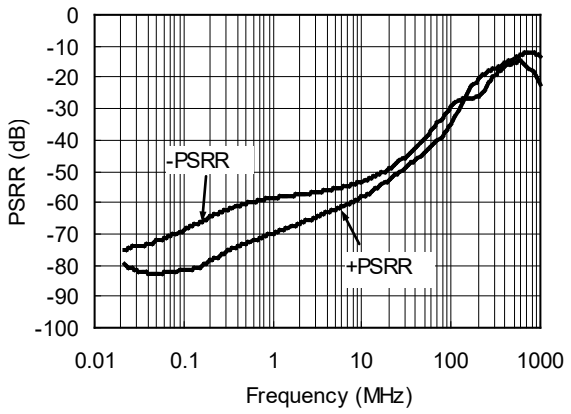
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A$ = +25℃, $V_S$ = 5V, G = +2, $R_F$ = 600Ω, $R_G$ = 600Ω, and $R_L$ = 150Ω connected to $V_S$/2, unless otherwise noted.

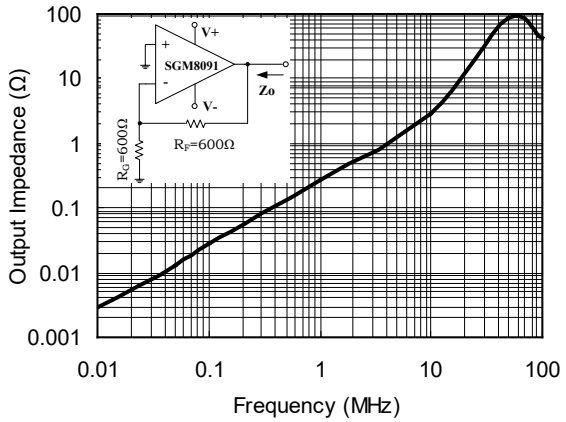
Common Mode Rejection Ratio vs. Frequency



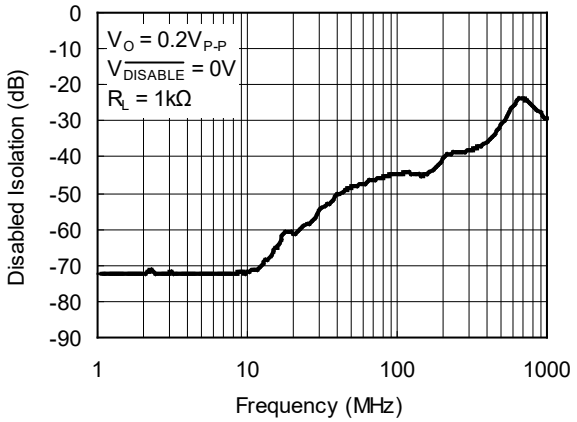

Pow er Supply Rejection Ratio vs. Frequency



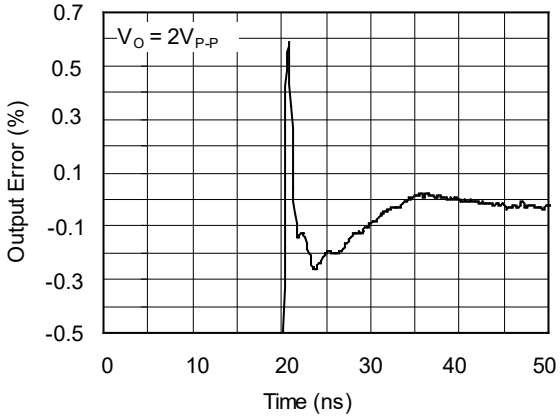

Closed-Loop Output Impedance vs. Frequency



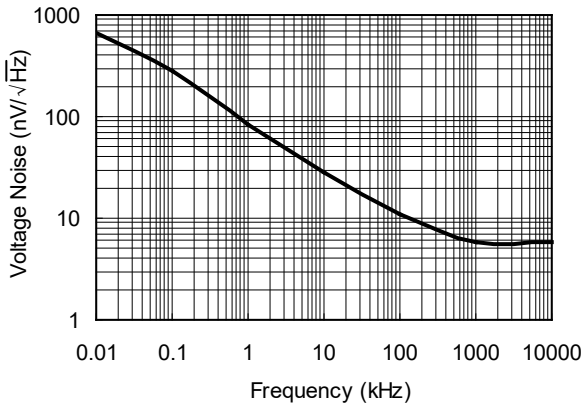

Disabled Output Isolation Frequency Response




Output Settling Time to 0.1%



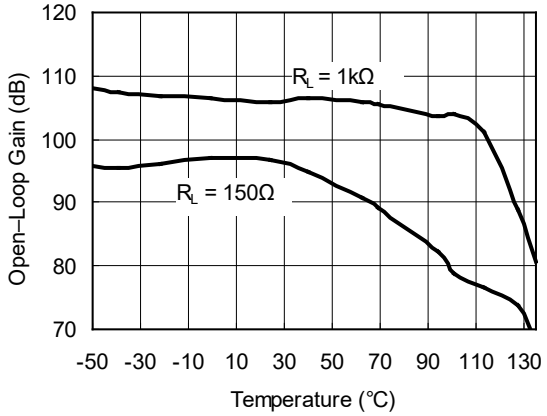

Input Voltage Noise Spectral Density vs. Frequency



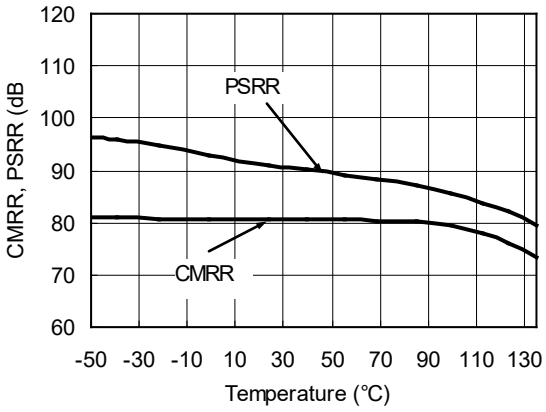
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A$ = +25℃, $V_S$ = 5V, G = +2, $R_F$ = 600Ω, $R_G$ = 600Ω, and $R_L$ = 150Ω connected to $V_S$/2, unless otherwise noted.

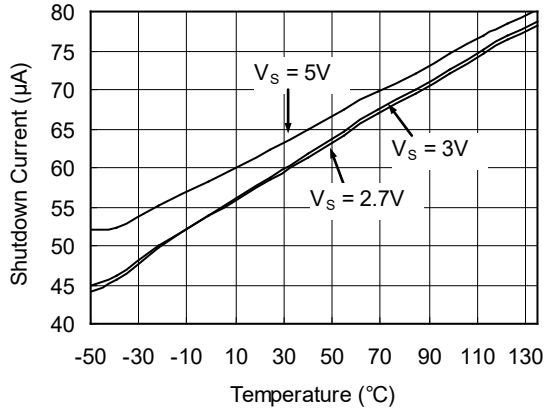
Open-Loop Gain vs. Temperature



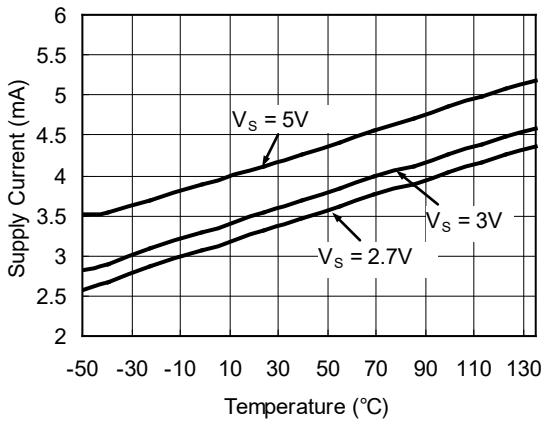

CMRR and PSRR vs. Temperature



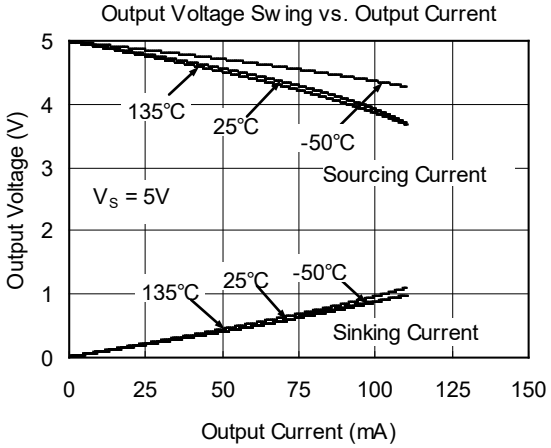

Shudow n Current vs. Temperature



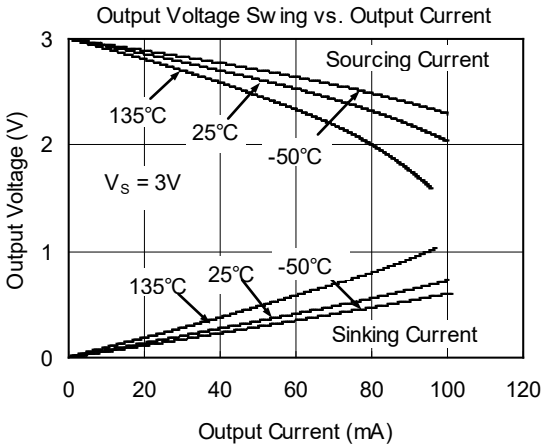

Supply Current vs. Temperature




Output Voltage Sw ing vs. Output Current



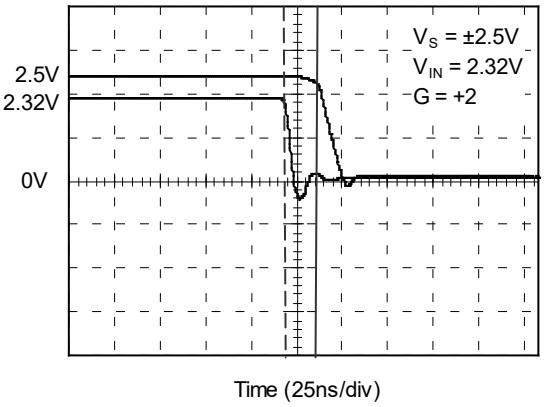

Output Voltage Sw ing vs. Output Current



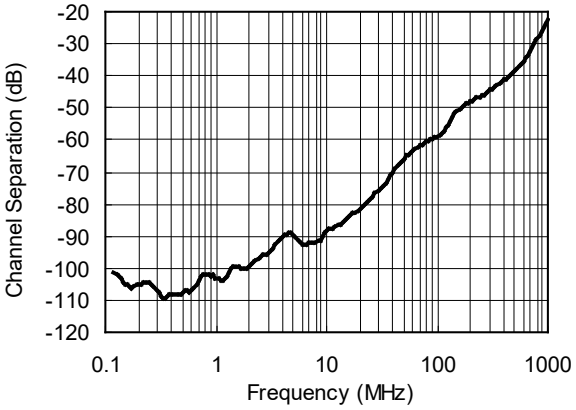
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At $T_A$ = +25℃, $V_S$ = 5V, G = +2, $R_F$ = 600Ω, $R_G$ = 600Ω, and $R_L$ = 150Ω connected to $V_S$/2, unless otherwise noted.

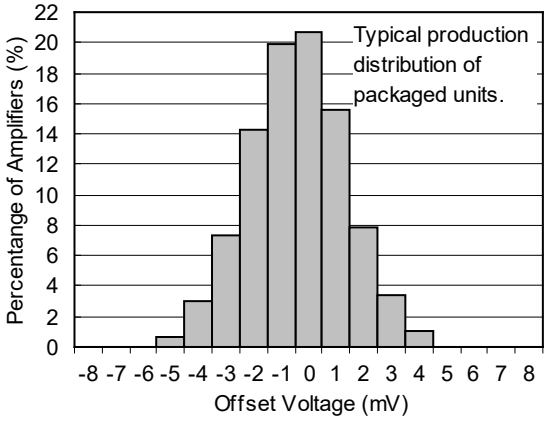
Overload Recovery Time




Channel Separation vs. Frequency




Offset Voltage Production Distribution



# APPLICATION NOTES

## Driving Capacitive Loads

The SGM8091/2/3/4 are 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.

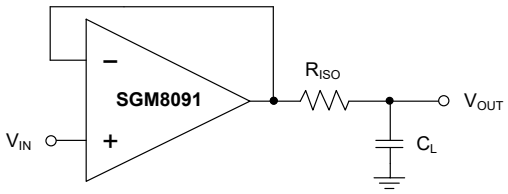



**Figure 1. Series Resistor Isolating Capacitive Load**

## Power Supply Bypassing and Layout

The SGM8091/2/3/4 operate 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 $+V_S$ with a 0.1μF ceramic capacitor which should be placed close to the $+V_S$ pin. For dual-supply operation, both the $+V_S$ and the $-V_S$ 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 operational amplifier'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 current loop area small to minimize the EMI (electromagnetic interference).

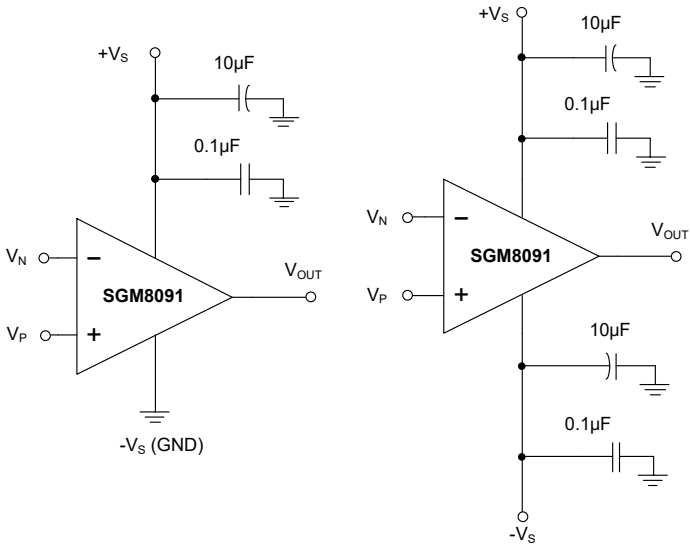



**Figure 2. Amplifier with Bypass Capacitors**

## Grounding

A ground plane layer is important for high speed circuit design. The length of the current path 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 in parallel. This helps reduce unwanted positive feedback.

# TYPICAL APPLICATION CIRCUITS

## Differential Amplifier

The circuit shown in Figure 3 performs the difference function. If the resistor ratios are equal ($R_4/R_3 = R_2/R_1$), then $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$.

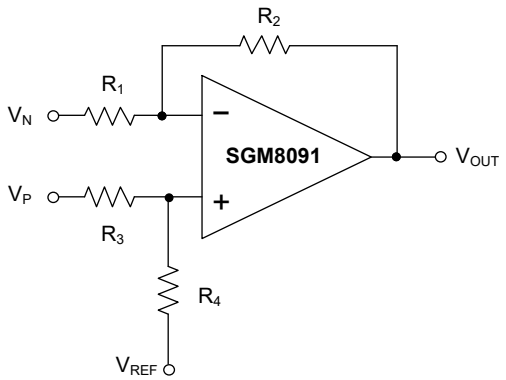



**Figure 3. Differential Amplifier**

## Active Low-Pass Filter

The low-pass filter shown in Figure 4 has a DC gain of ($-R_2/R_1$) and the -3dB corner frequency is $1/2\pi R_2C$. Make sure the filter bandwidth is within the bandwidth of the amplifier. Feedback resistors with large values can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistor values as low as possible and consistent with output loading consideration.

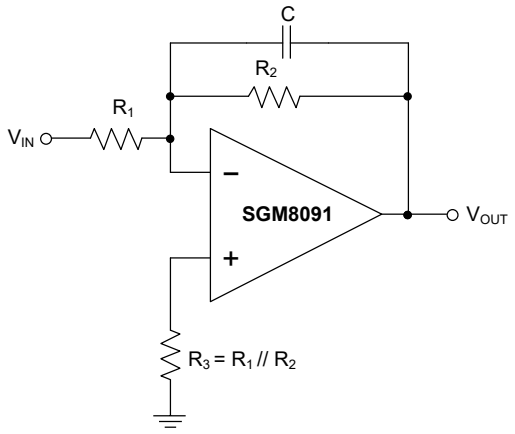



**Figure 4. Active Low-Pass Filter**

## Driving Video

The SGM8091/2/3/4 can be used in video applications as shown in Figure 5.

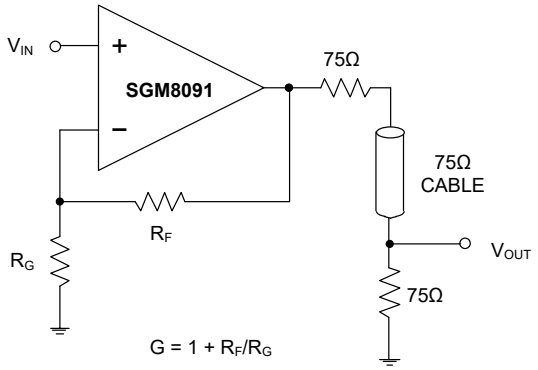



**Figure 5. Typical Video Driving**

# REVISION HISTORY

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

| JANUARY 2013 – REV.B.3 to REV.B.4 | Page |
|---|---|
| Updated Package Outline Dimensions section | 14~19 |
| Added Tape and Reel Information section | 20, 21 |

| MAY 2011 – REV.B.2 to REV.B.3 | Page |
|---|---|
| Changed packages' name | All |

| JUNE 2010 – REV.B.1 to REV.B.2 | Page |
|---|---|
| Changed Electrical Characteristics section | 3 |
| Changed Package Outline Dimensions section | 11~16 |

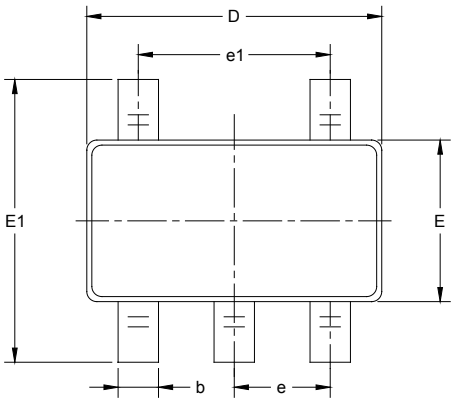
| APRIL 2009 – REV.B to REV.B.1 | Page |
|---|---|
| Changed 16pin packages to 14pin packages | All |

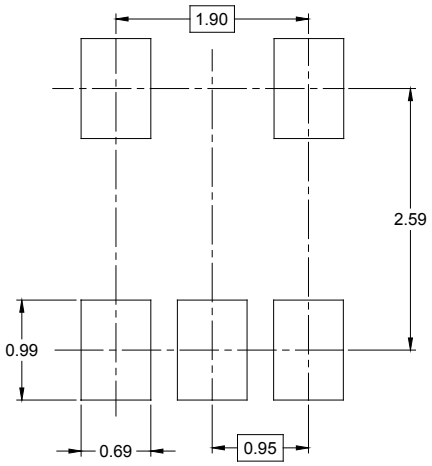
| AUGUST 2008 – REV.A to REV.B | Page |
|---|---|
| Changed Absolute Maximum Ratings section | 3 |

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

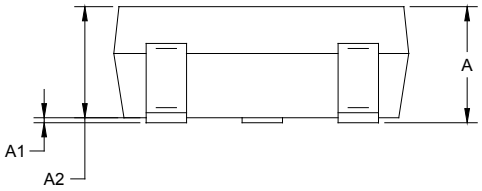
# PACKAGE OUTLINE DIMENSIONS

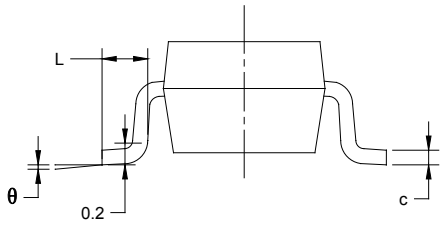
## SOT-23-5




**RECOMMENDED LAND PATTERN** (Unit: mm)

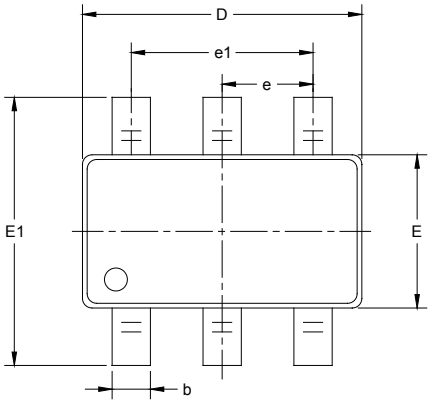


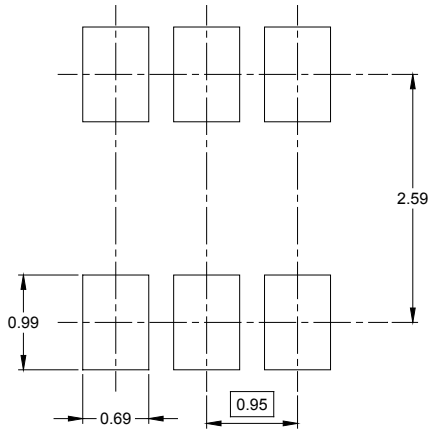




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| 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° |

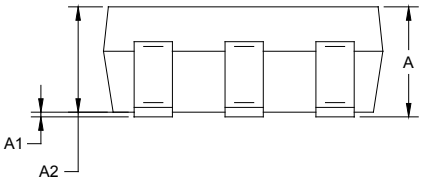
# PACKAGE OUTLINE DIMENSIONS

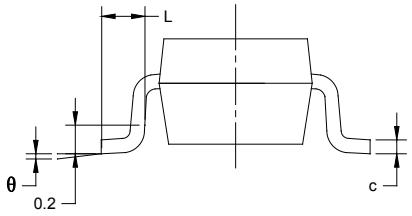
## SOT-23-6




**RECOMMENDED LAND PATTERN** (Unit: mm)

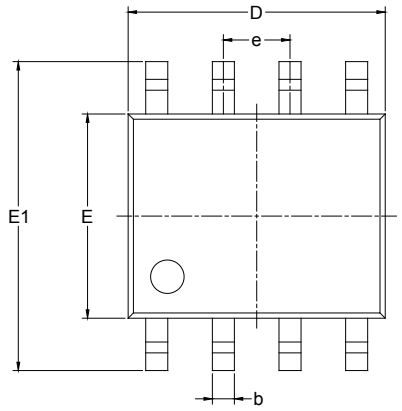


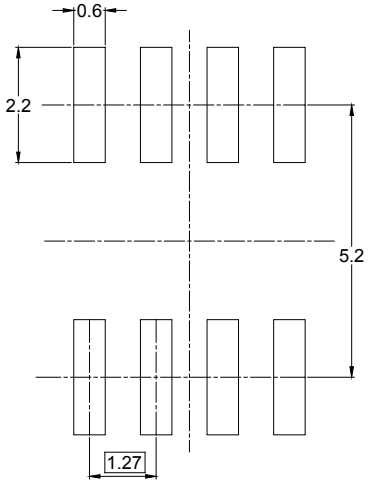




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| 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° |

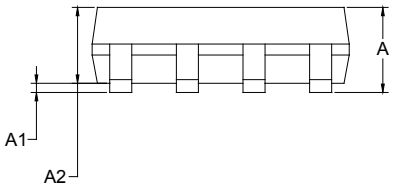
# PACKAGE OUTLINE DIMENSIONS

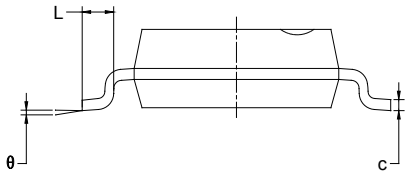
## SOIC-8




**RECOMMENDED LAND PATTERN** (Unit: mm)

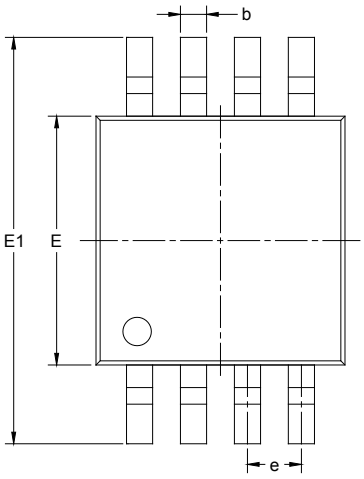


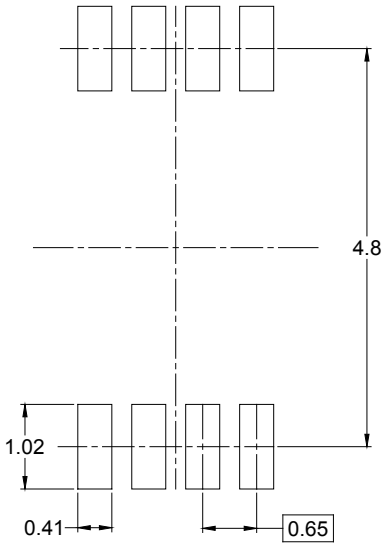




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.006 | 0.010 |
| 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° |

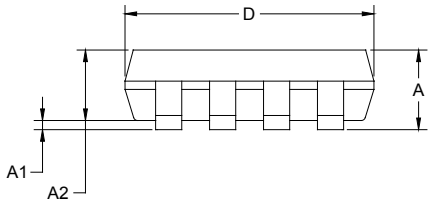
# PACKAGE OUTLINE DIMENSIONS

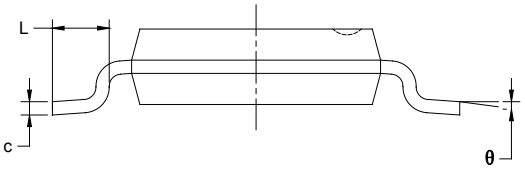
## MSOP-8




**RECOMMENDED LAND PATTERN** (Unit: mm)

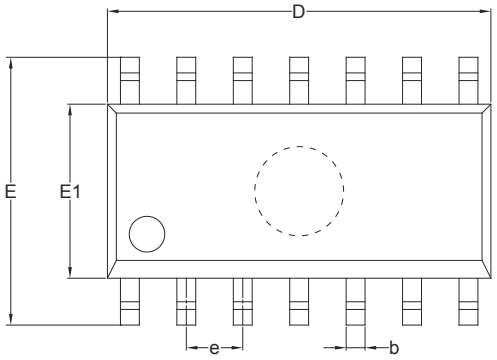


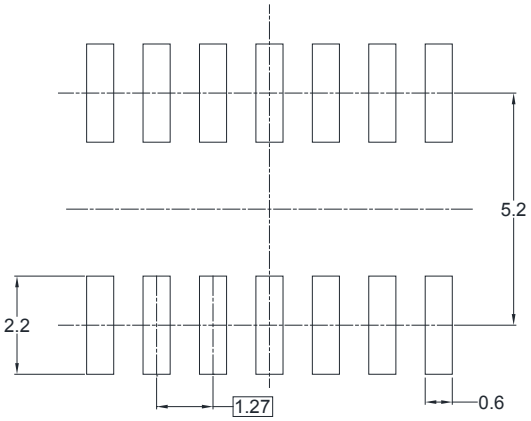




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.820 | 1.100 | 0.032 | 0.043 |
| A1 | 0.020 | 0.150 | 0.001 | 0.006 |
| A2 | 0.750 | 0.950 | 0.030 | 0.037 |
| b | 0.250 | 0.380 | 0.010 | 0.015 |
| c | 0.090 | 0.230 | 0.004 | 0.009 |
| 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° |

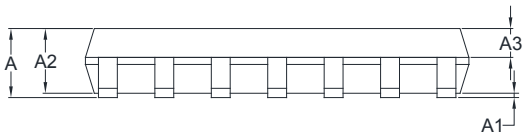
# PACKAGE OUTLINE DIMENSIONS

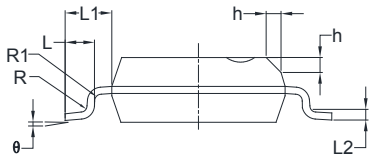
## SOIC-14




**RECOMMENDED LAND PATTERN** (Unit: mm)

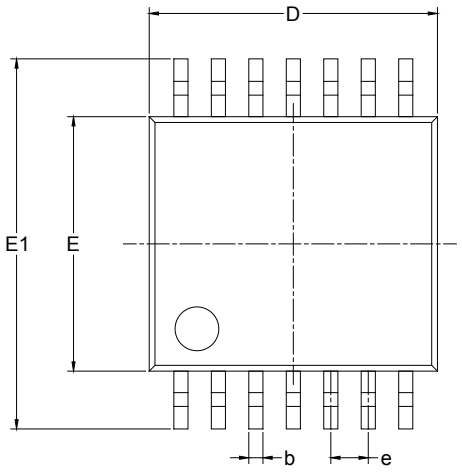


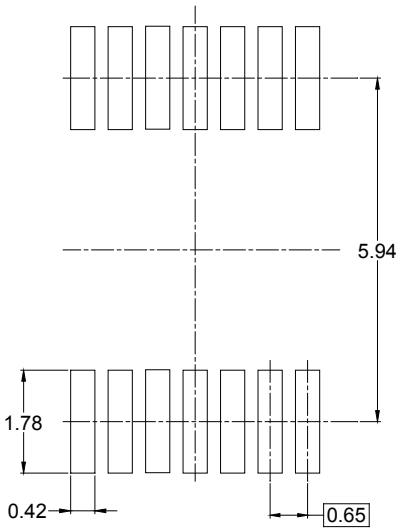




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.35 | 1.75 | 0.053 | 0.069 |
| A1 | 0.10 | 0.25 | 0.004 | 0.010 |
| A2 | 1.25 | 1.65 | 0.049 | 0.065 |
| A3 | 0.55 | 0.75 | 0.022 | 0.030 |
| b | 0.36 | 0.49 | 0.014 | 0.019 |
| 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° |

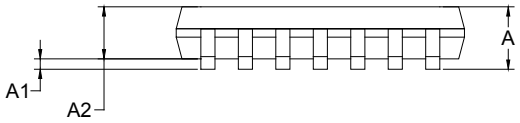
# PACKAGE OUTLINE DIMENSIONS

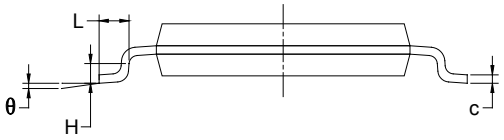
## TSSOP-14




**RECOMMENDED LAND PATTERN** (Unit: mm)

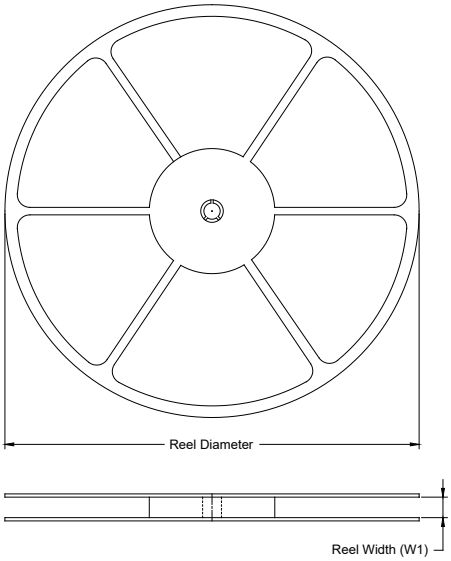


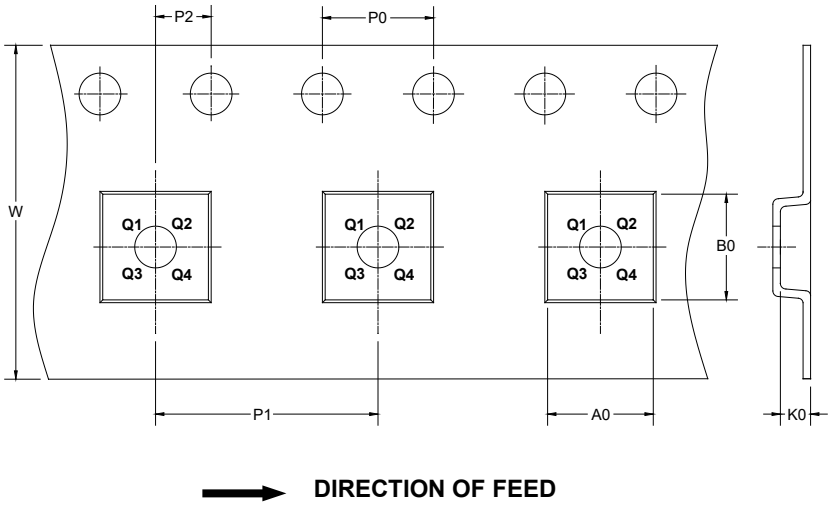

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | | 1.200 | | 0.047 |
| A1 | 0.050 | 0.150 | 0.002 | 0.006 |
| A2 | 0.800 | 1.050 | 0.031 | 0.041 |
| b | 0.190 | 0.300 | 0.007 | 0.012 |
| c | 0.090 | 0.200 | 0.004 | 0.008 |
| D | 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



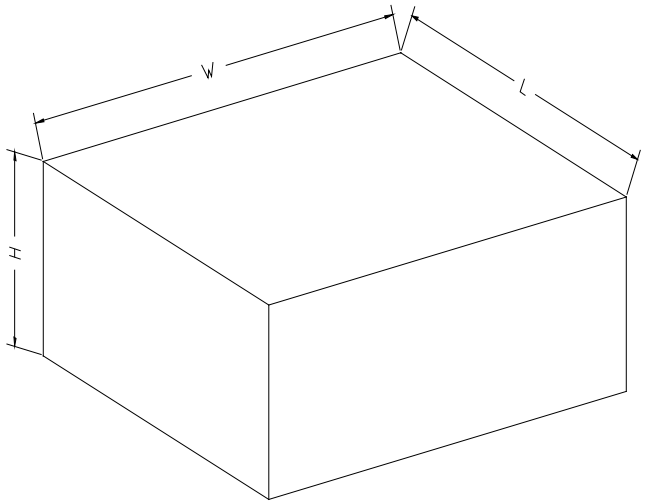

NOTE: The picture is only for reference. Please make the object as the standard.

## 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 |
| SOT-23-6 | 7″ | 9.5 | 3.17 | 3.23 | 1.37 | 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