

SGM8091 SGM8092 SGM8093 SGM8094

350MHz, Rail-to-Rail Output CMOS Operational Amplifier

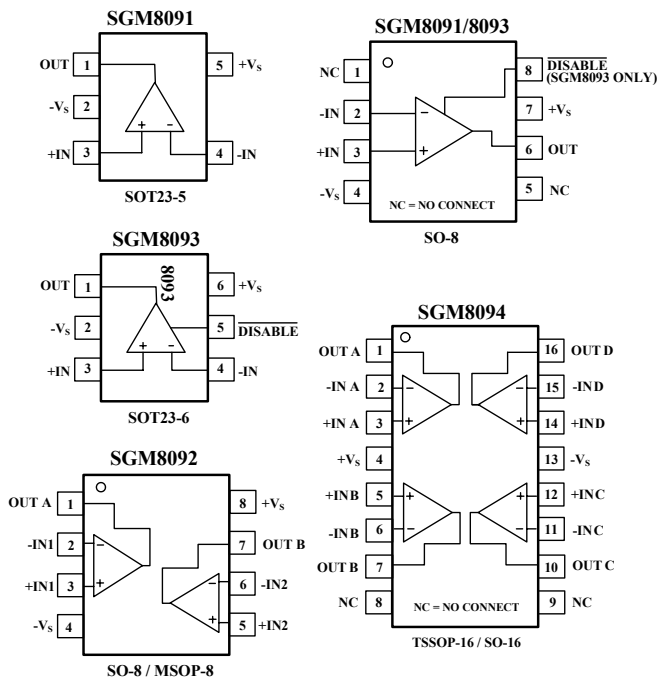
PRODUCT DESCRIPTION

The SGM8091/8093(single), SGM8092 (dual), 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 supplies as low as 2.5 V.

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

The SGM8091 series are low distortion and fast settling make 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 75 μ A. 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°C to $+125^{\circ}\text{C}$ temperature range.

PIN CONFIGURATIONS (Top View)

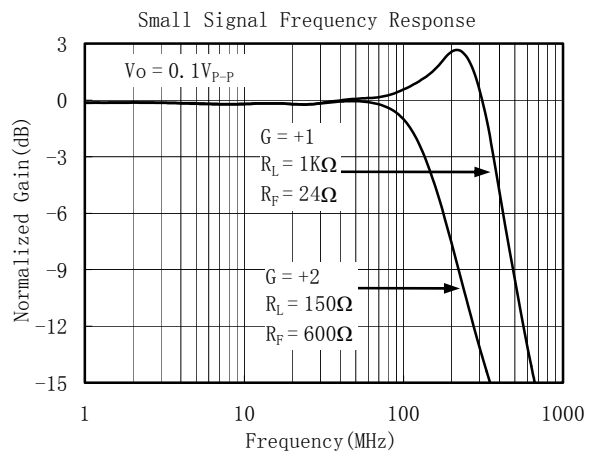


FEATURES

- Low Cost
- Rail-to-Rail Output
2mV Typical V_{os}
- High Speed
350 MHz, -3 dB Bandwidth ($G = +1$)
265 V/ μ s, Slew Rate
32 ns Settling Time to 0.1% with 2V Step
- Operates on 2.5V to 5.5 V Supplies
- Input Voltage Range = -0.2 V to $+3.8$ V with $V_s = 5$ V
- Excellent Video Specs ($R_L = 150\Omega$, $G = +2$)
Gain Flatness 0.1dB to 70 MHz
Diff Gain: 0.004 % , Diff Phase: 0.08 degree
- Low Power
4.3 mA/Amplifier Typical Supply Current
SGM8093 75 μ A when Disabled
- Small Packaging
SGM8091 Available in SO-8 and SOT23-5
SGM8092 Available in SO-8 and MSOP-8
SGM8093 Available in SO-8 and SOT23-6
SGM8094 Available in SO-16 and TSSOP-16

APPLICATIONS

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



ELECTRICAL CHARACTERISTICS : $V_S = +5V$

($G=+2$, $R_F=600\Omega$, $R_L = 150\Omega$, unless otherwise noted)

| PARAMETER | CONDITION | SGM8091/2/3/4 | | | | | | | |
|--|--|---------------|--------------------------|----------------|------------------|-------------------|--|-----------------------|-------------|
| | | TYP | MIN/MAX OVER TEMPERATURE | | | | | UNITS | MIN/ MAX |
| | | +25°C | +25 °C | 0°C to 70°C | -40°C to 70°C | -40°C to 125°C | | | |
| DYNAMIC PERFORMANCE | | | | | | | | | |
| -3dB Small Signal Bandwidth | $G = +1, V_o = 0.1 V$ p-p, $R_F = 24\Omega, R_L = 150\Omega$ | 300 | | | | | | MHz | TYP |
| | $G = +1, V_o = 0.1 V$ p-p, $R_F = 24\Omega, R_L = 1K\Omega$ | 350 | | | | | | MHz | TYP |
| | $G = +2, V_o = 0.1 V$ p-p, $R_L = 50\Omega$ | 70 | | | | | | MHz | TYP |
| | $G = +2, V_o = 0.1 V$ p-p, $R_L = 150\Omega$ | 140 | | | | | | MHz | TYP |
| | $G = +2, V_o = 0.1 V$ p-p, $R_L = 1k\Omega$ | 170 | | | | | | MHz | TYP |
| | $G = +2, V_o = 0.1 V$ p-p, $R_L = 10k\Omega$ | 230 | | | | | | MHz | TYP |
| Gain-Bandwidth Product | $G = +10, R_L = 150\Omega$ | 135 | | | | | | MHz | TYP |
| | $G = +10, R_L = 1K\Omega$ | 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, $R_F = 600\Omega$ | 70 | | | | | | MHz | TYP |
| Slew Rate | $G = +1, 2V$ Output Step | 194/-204 | | | | | | V/ μ S | TYP |
| | $G = +2, 2V$ Output Step | 236/-170 | | | | | | V/ μ S | TYP |
| | $G = +2, 4V$ Output Step | 265/-218 | | | | | | V/ μ S | 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% | $G = +2, 2 V$ Output Step | 32 | | | | | | ns | TYP |
| Overload Recovery Time | $V_{IN} \cdot G = +V_S$ | 14.5 | | | | | | ns | TYP |
| NOISE/DISTORTION PERFORMANCE | | | | | | | | | |
| Harmonic Distortion | | | | | | | | | |
| 2nd-Harmonic | $G = +2, f = 1MHz, V_o = 2V$ p-p, $R_L = 150\Omega$ | | | | | | | dBc | TYP |
| 3rd-Harmonic | $G = +2, f = 1MHz, V_o = 2V$ p-p, $R_L = 150\Omega$ | | | | | | | dBc | TYP |
| Input Voltage Noise | $f = 1MHz$ | 5.9 | | | | | | nV/ \sqrt{Hz} | TYP |
| Input Current Noise | $f = 1MHz$ | | | | | | | fA/ \sqrt{Hz} | TYP |
| Differential Gain Error (NTSC) | $G = +2, R_L = 150\Omega$ | 0.004 | | | | | | % | TYP |
| Differential Phase Error (NTSC) | $G = +2, R_L = 150\Omega$ | 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 | | | | | | μ V/ $^{\circ}$ C | TYP |
| Input Bias Current (I_B) | | 6 | | | | | | PA | TYP |
| Input offset Current (I_{OS}) | | 2 | | | | | | PA | TYP |
| Open-Loop Gain (A_{OL}) | $V_o = 0.3 V$ to $4.7 V, R_L = 150\Omega$ | 80 | 75 | 74 | 74 | 73 | | dB | MIN |
| | $V_o = 0.2 V$ to $4.8 V, R_L = 1K\Omega$ | 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) | $V_{CM} = -0.1 V$ to $+3.5 V$ | 80 | 66 | 66 | 65 | 64 | | dB | MIN |
| OUTPUT CHARACTERISTICS | | | | | | | | | |
| Output Voltage Swing from Rail | $R_L = 150\Omega$ | 0.12 | | | | | | V | TYP |
| | $R_L = 1K\Omega$ | 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 | 5.3 | 5.6 | 5.6 | 6.1 | | mA | MAX |
| Supply Current when Disabled (SGM8093 only) | | 75 | 120 | 127 | 130 | 137 | | μ A | 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 |

Specifications subject to change without notice.

PACKAGE/ORDERING INFORMATION

| MODEL | ORDER NUMBER | PACKAGE DESCRIPTION | PACKAGE OPTION | MARKING INFORMATION |
|---------|---------------|---------------------|---------------------|---------------------|
| SGM8091 | SGM8091XN5/TR | SOT23-5 | Tape and Reel, 3000 | 8091 |
| | SGM8091XS/TR | SO-8 | Tape and Reel, 2500 | SGM8091XS |
| SGM8092 | SGM8092XS/TR | SO-8 | Tape and Reel, 2500 | SGM8092XS |
| | SGM8092XMS/TR | MSOP-8 | Tape and Reel, 3000 | SGM8092XMS |
| SGM8093 | SGM8093XN6/TR | SOT23-6 | Tape and Reel, 3000 | 8093 |
| | SGM8093XS/TR | SO-8 | Tape and Reel, 2500 | SGM8093XS |
| SGM8094 | SGM8094XS/TR | SO-16 | Tape and Reel, 2500 | SGM8094XS |
| | SGM8094XTS | TSSOP-16 | Tape and Reel, 3000 | SGM8094XTS |

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ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V+ to V- 7.5 V
 Common-Mode Input Voltage
 (-V_s) - 0.5 V to (+V_s) + 0.5V
 Storage Temperature Range -65°C to +150°C
 Junction
 Temperature 160°C
 Operating Temperature Range -55°C to +150°C
 Package Thermal Resistance @ T_A = 25°C
 SOT23-5, θ_{JA}..... 190°C/W
 SOT23-6, θ_{JA}..... 190°C/W
 SO-8, θ_{JA}..... 125°C/W
 MSOP-8, θ_{JA}..... 216°C/W
 SO-16, θ_{JA}..... 82°C/W
 TSSOP-16, θ_{JA}..... 105°C/W
 Lead Temperature Range (Soldering 10 sec)
 260°C
 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.

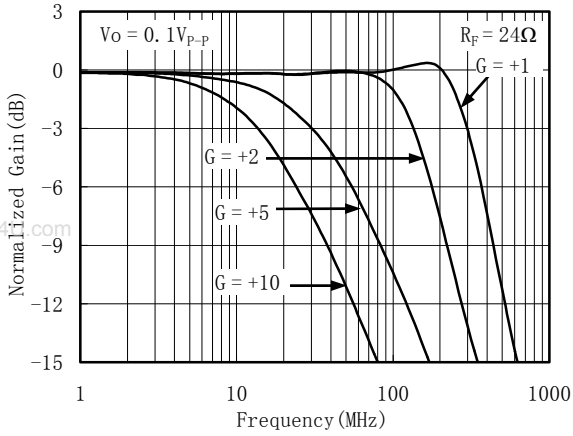
CAUTION

This integrated circuit can be damaged by ESD. Shengbang Micro-electronics 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.

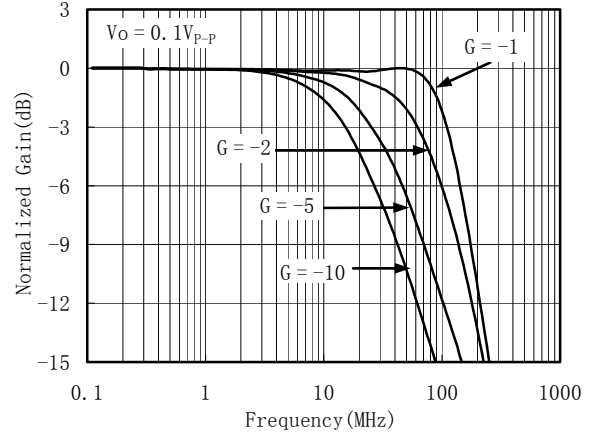
TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, $G = +2$, $R_F = 600\Omega$, $R_G = 600\Omega$, and $R_L = 150\Omega$ connected to $V_S/2$, unless otherwise noted.

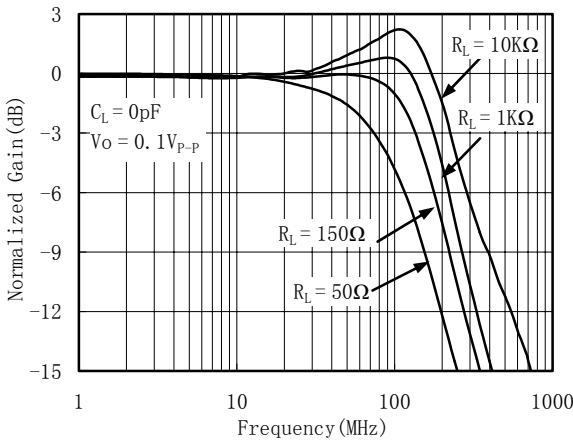
Non-Inverting Small Signal Frequency Response



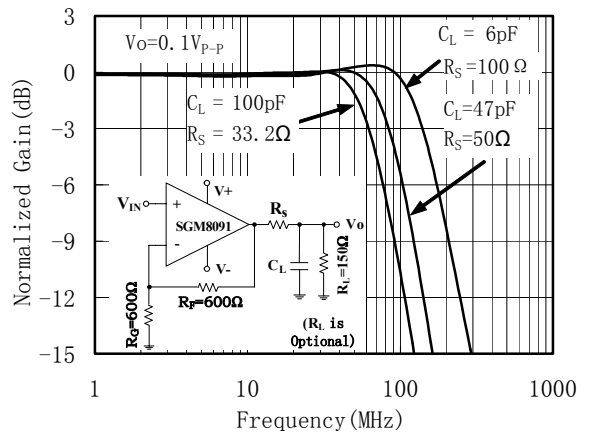
Inverting Small Signal Frequency Response



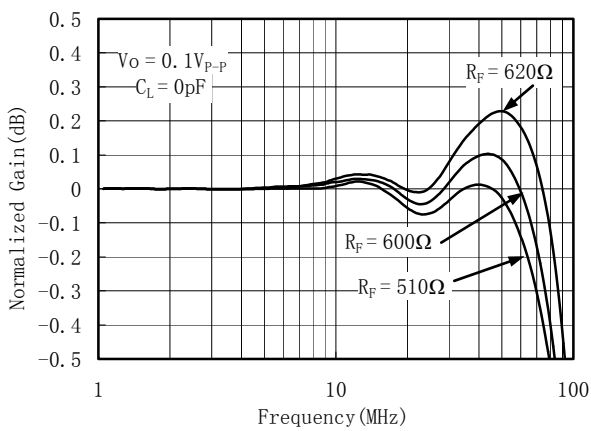
Frequency Response For Various R_L



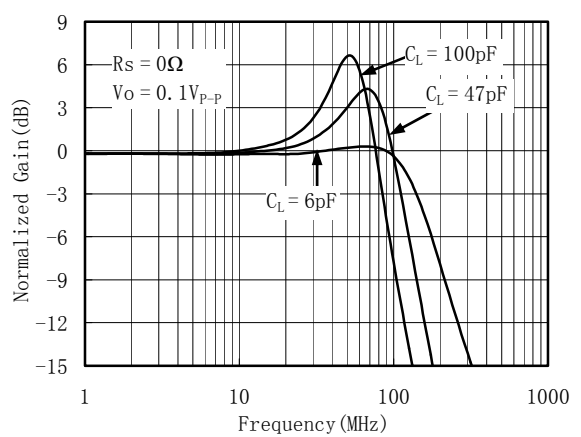
Frequency Response vs C_L



0.1dB Gain Flatness For Various R_F



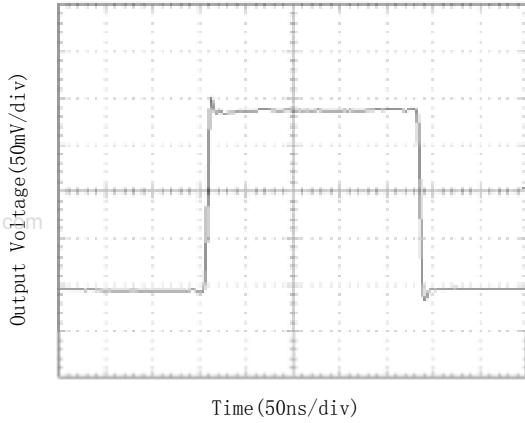
Frequency Response For Various C_L



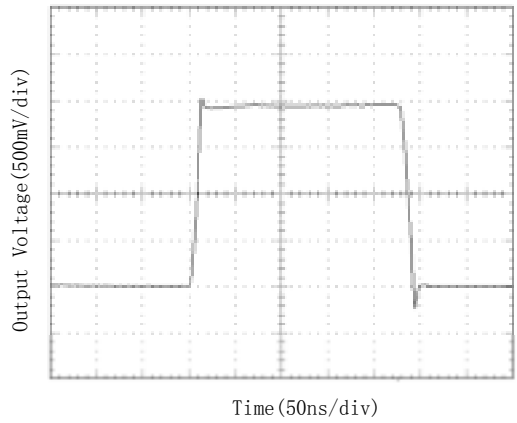
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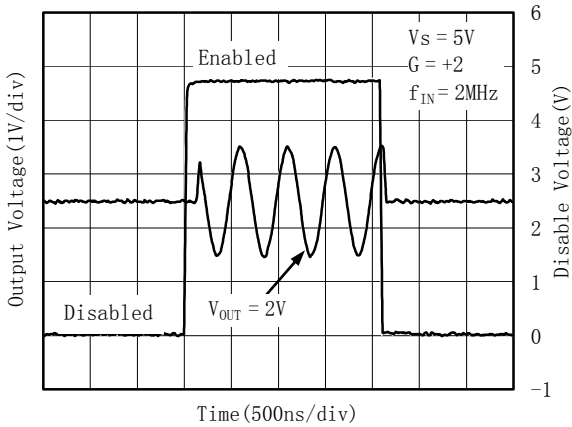
Non-Inverting Small Signal Step Response



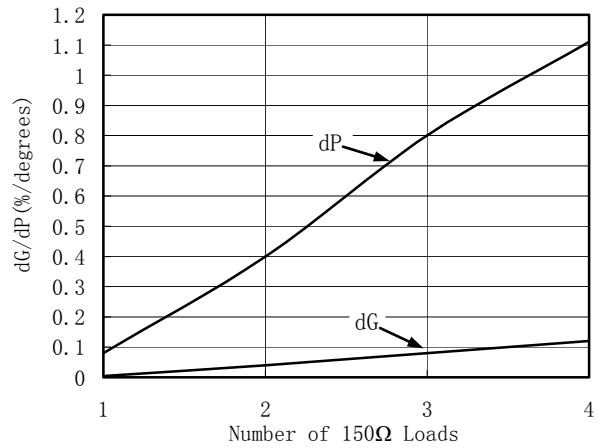
Non-Inverting Large Signal Step Response



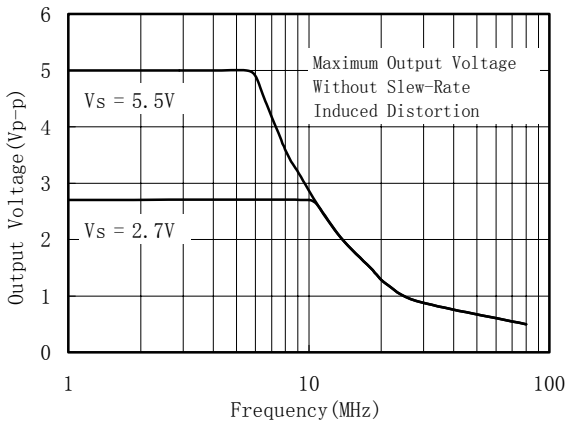
Large-Signal Disable/Enable Response



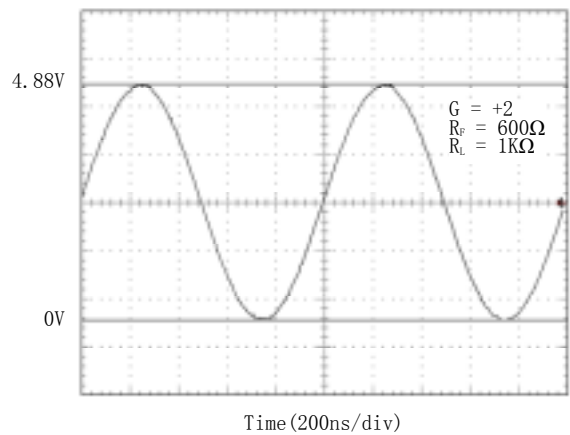
Composite Video Differential Gain And Phase



Maximum Output Voltage vs. Frequency

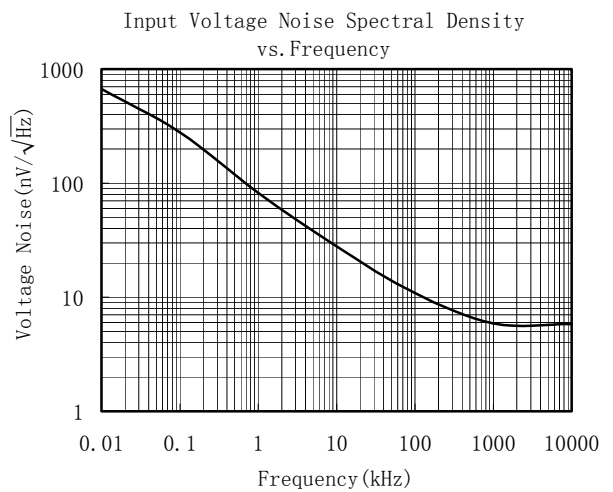
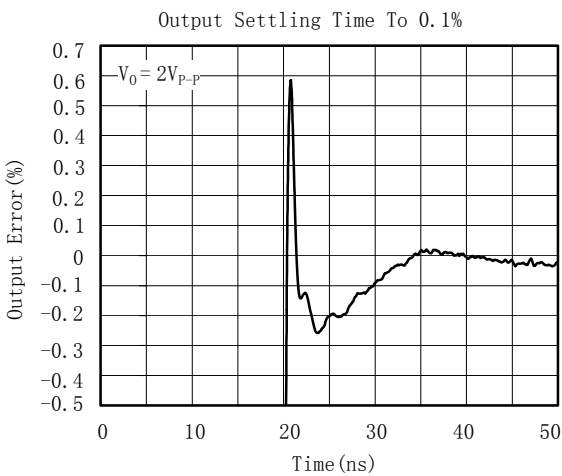
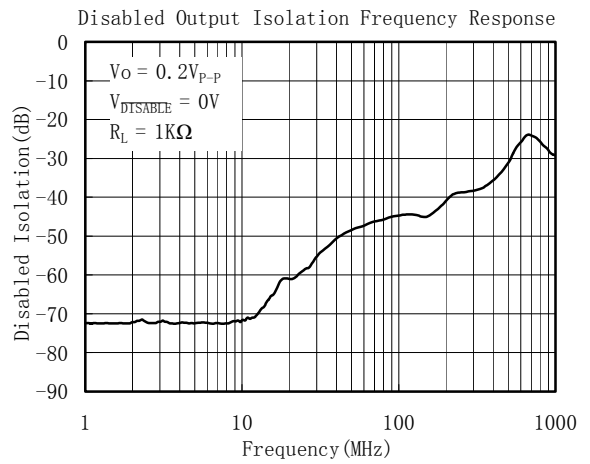
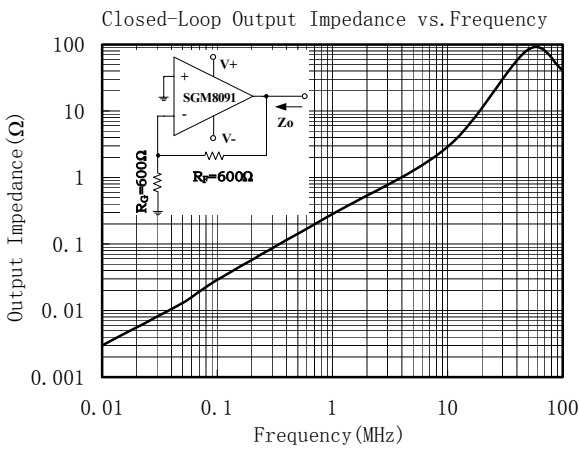
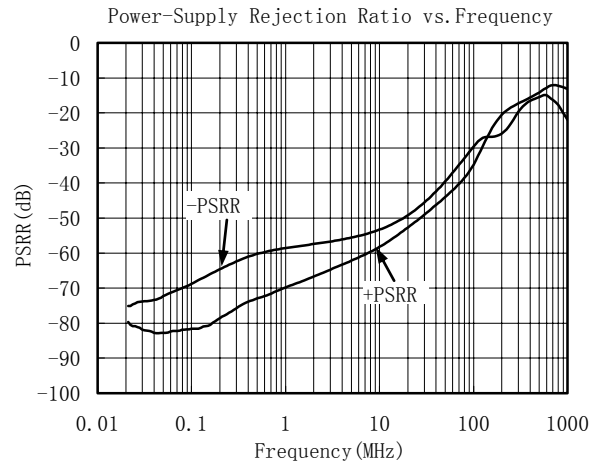
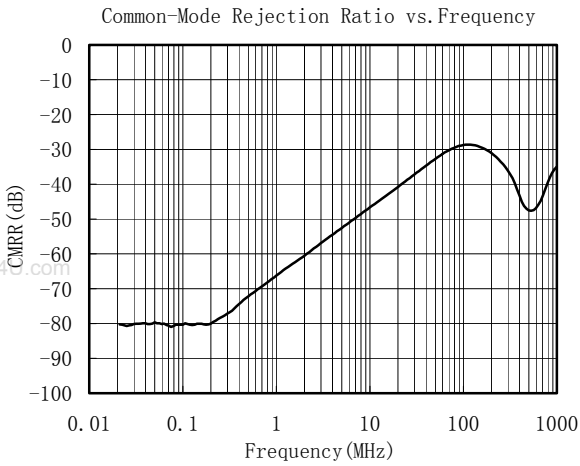


Rail-To-Rail



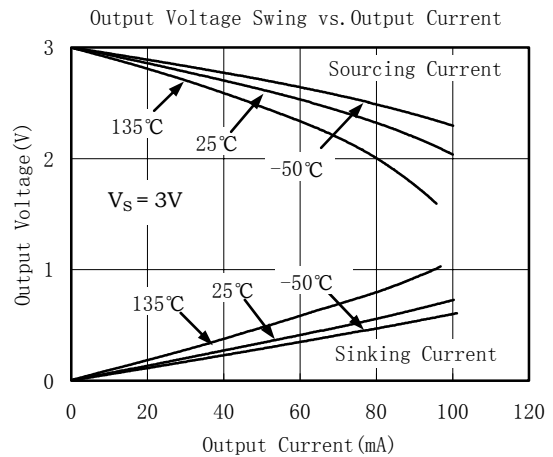
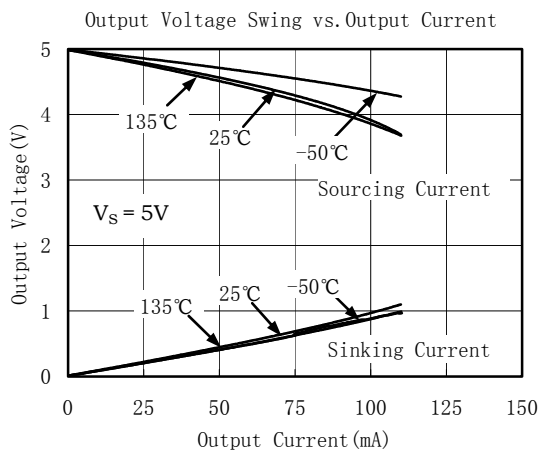
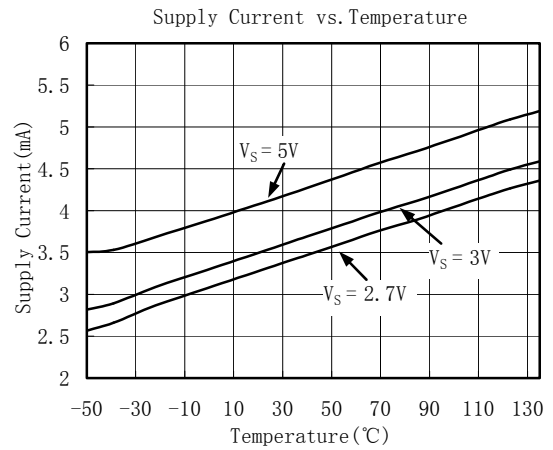
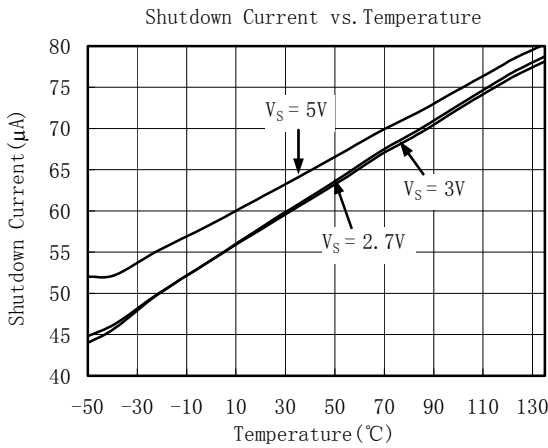
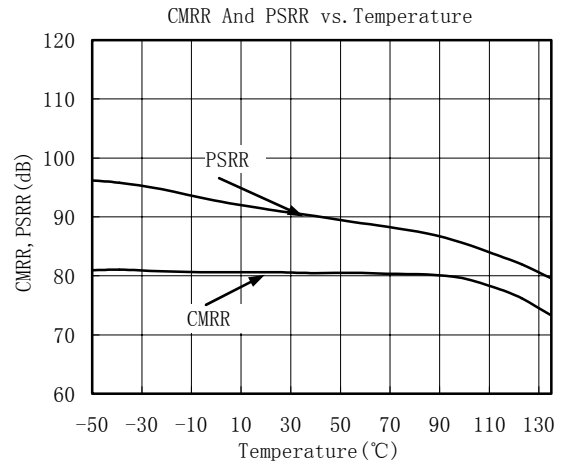
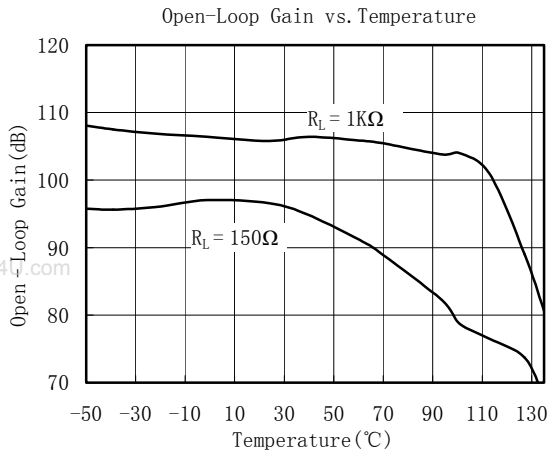
TYPICAL PERFORMANCE CHARACTERISTICS

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TYPICAL PERFORMANCE CHARACTERISTICS

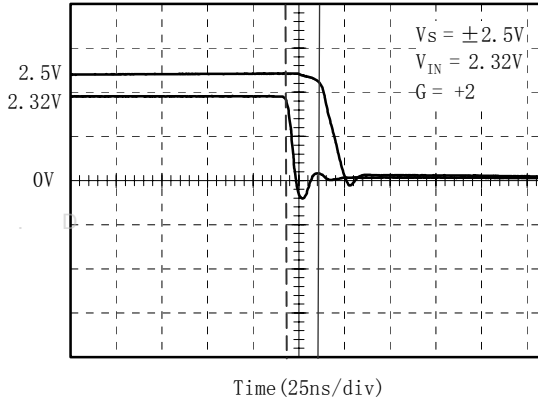
At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, $G = +2$, $R_F = 600\Omega$, $R_G = 600\Omega$, and $R_L = 150\Omega$ connected to $V_S/2$, unless otherwise noted.



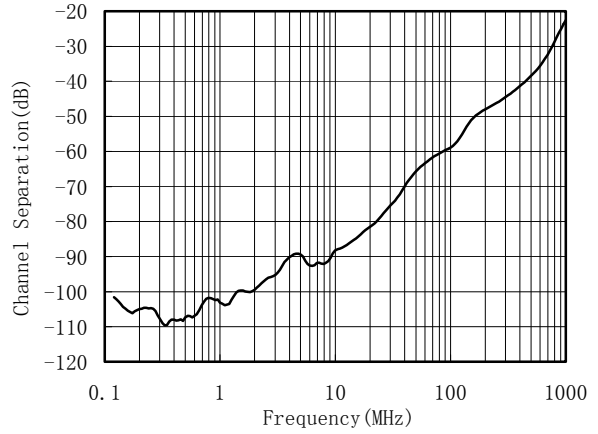
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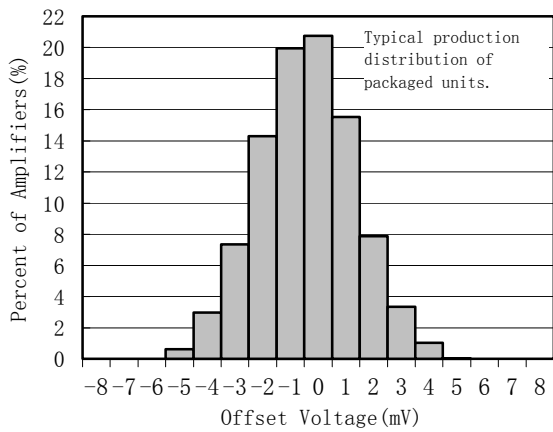
Overload Recovery Time



Channel Separation vs. Frequency



Offset Voltage Production Distribution



APPLICATION NOTES

Driving Capacitive Loads

The SGM809x 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.

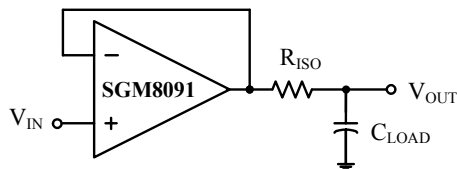


Figure 1. Series Resistor Isolating Capacitive Load

Power-Supply Bypassing and Layout

The SGM809x family operates from either a single +2.7V to +5.5V supply or dual $\pm 1.35V$ to $\pm 2.75V$ supplies. For single-supply operation, bypass the power supply V_{DD} with a $0.1\mu F$ 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 $0.1\mu F$ ceramic capacitors. $2.2\mu F$ 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).

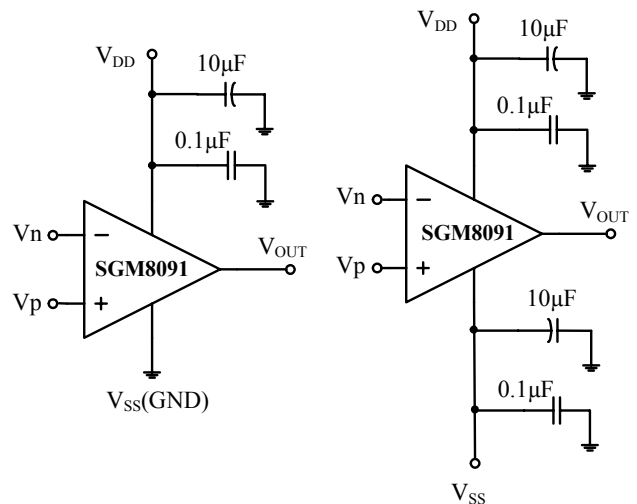


Figure 2. Amplifier with Bypass Capacitors

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 $V_{OUT} = (V_p - V_n) \times R_2 / R_1 + V_{ref}$.

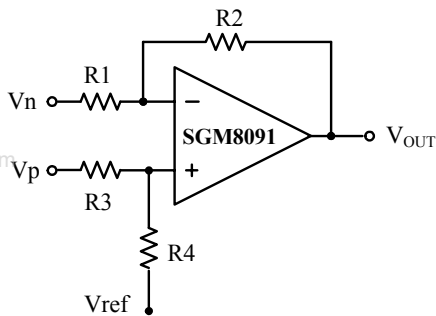


Figure 3. Differential Amplifier

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 $1/2\pi R_2 C$. 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.

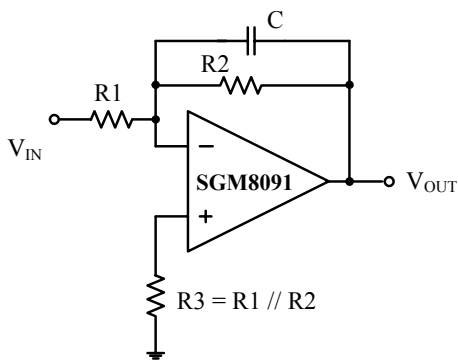
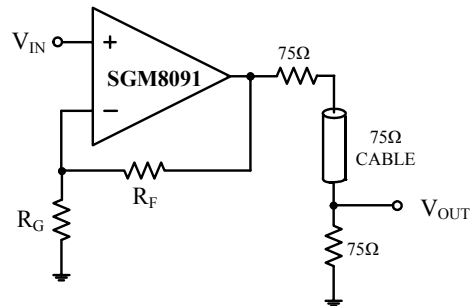


Figure 4. Low Pass Active Filter

Driving Video

The SGM809x can be used in video applications like in Figure 5.

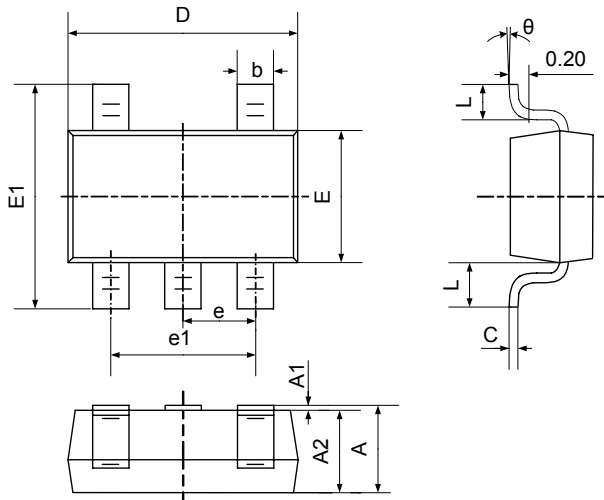


$$G = 1 + R_F / R_G$$

Figure 5. Typical Video Driving

PACKAGE OUTLINE DIMENSIONS

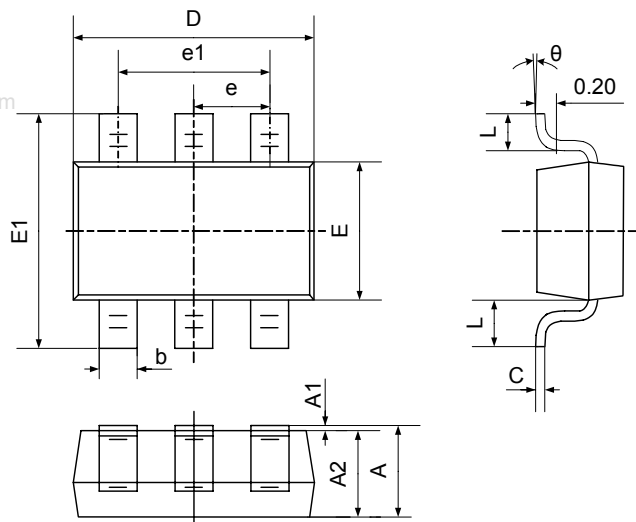
SOT23-5



| 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

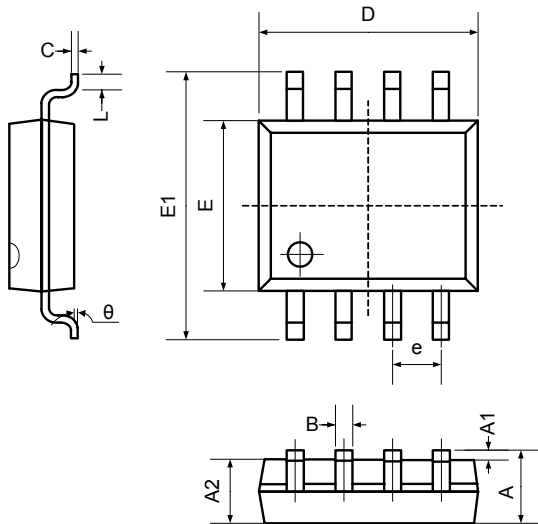
SOT23-6



| 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

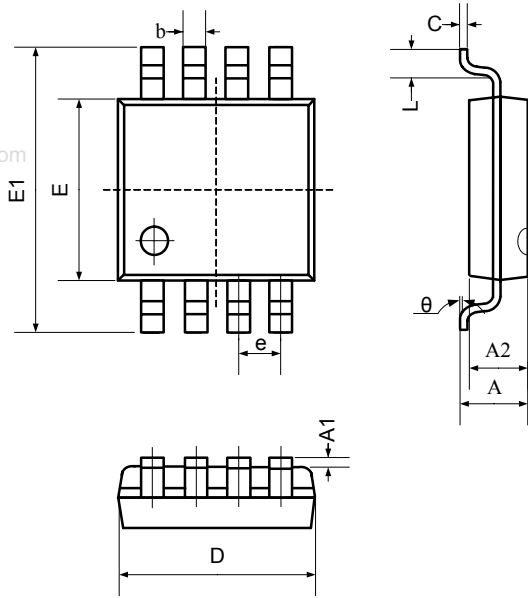
SO-8



| 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 |
| theta | 0° | 8° | 0° | 8° |

PACKAGE OUTLINE DIMENSIONS

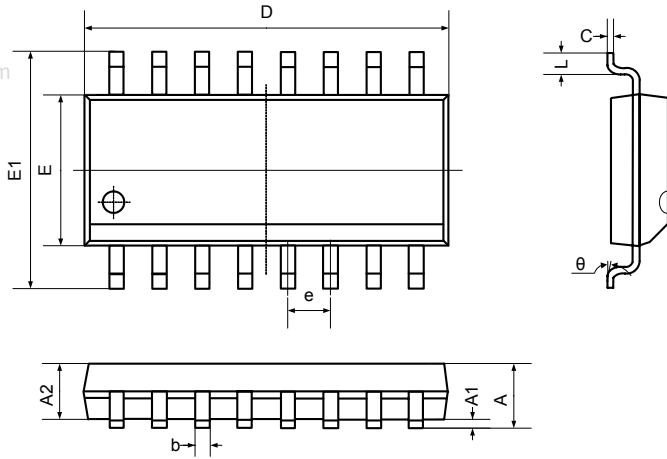
MSOP-8



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|------------------------------|-------|-------------------------|-------|
| | Min | Max | Min | Max |
| A | 0.800 | 1.200 | 0.031 | 0.047 |
| A1 | 0.000 | 0.200 | 0.000 | 0.008 |
| A2 | 0.760 | 0.970 | 0.030 | 0.038 |
| b | 0.30 TYP | | 0.012 TYP | |
| c | 0.15 TYP | | 0.006 TYP | |
| D | 2.900 | 3.100 | 0.114 | 0.122 |
| e | 0.65 TYP | | 0.026 TYP | |
| E | 2.900 | 3.100 | 0.114 | 0.122 |
| E1 | 4.700 | 5.100 | 0.185 | 0.201 |
| L | 0.410 | 0.650 | 0.016 | 0.026 |
| θ | 0° | 6° | 0° | 6° |

PACKAGE OUTLINE DIMENSIONS

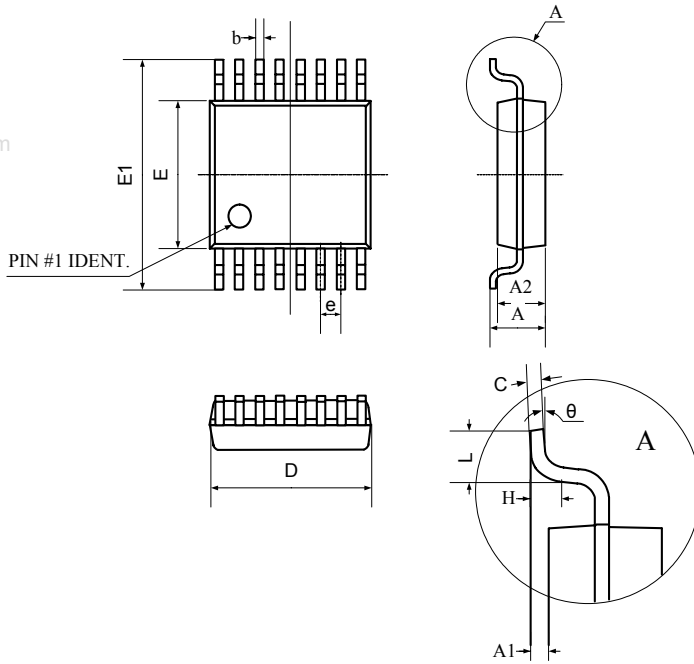
SO-16



| 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 | 0.007 | 0.010 |
| D | 9.800 | 10.20 | 0.386 | 0.402 |
| E | 3.800 | 4.000 | 0.150 | 0.157 |
| E1 | 5.800 | 6.200 | 0.228 | 0.244 |
| e | 1.270 (BSC) | | 0.050 (BSC) | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

PACKAGE OUTLINE DIMENSIONS

TSSOP-16



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|-------|----------------------|-------|
| | Min | Max | Min | Max |
| D | 4.900 | 5.100 | 0.193 | 0.201 |
| E | 4.300 | 4.500 | 0.169 | 0.177 |
| b | 0.190 | 0.300 | 0.007 | 0.012 |
| c | 0.090 | 0.200 | 0.004 | 0.008 |
| E1 | 6.250 | 6.550 | 0.246 | 0.258 |
| A | | 1.100 | | 0.043 |
| A2 | 0.800 | 1.000 | 0.031 | 0.039 |
| A1 | 0.020 | 0.150 | 0.001 | 0.006 |
| e | 0.65 (BSC) | | 0.026 (BSC) | |
| L | 0.500 | 0.700 | 0.020 | 0.028 |
| H | 0.25(TYP) | | 0.01(TYP) | |
| θ | 1° | 7° | 1° | 7° |

REVISION HISTORY

| Location | Page |
|--|-------------|
| 11/06— Data Sheet changed from REV. A to REV. B | |
| Changes to ABSOLUTE MAXIMUM RATINGS | 3 |

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Shengbang Microelectronics Co, Ltd

Unit 3, ChuangYe Plaza
No.5, TaiHu Northern Street, YingBin Road Centralized Industrial Park
Harbin Development Zone
Harbin, HeiLongJiang 150078
P.R. China
Tel.: 86-451-84348461
Fax: 86-451-84308461
www.sg-micro.com