

SGM8621 SGM8622 SGM8623 SGM8624

250µA, 3MHz, Rail-to-Rail I/O CMOS Operational Amplifier

PRODUCT DESCRIPTION

The SGM8621(single), SGM8622 (dual), SGM8623 (single with shutdown) and SGM8624 (quad) are low noise, low voltage, and low power operational amplifiers, that can be designed into a wide range of applications. The SGM8621/2/3/4 have a high gain-bandwidth product of 3MHz, a slew rate of 1.7V/µs, and a quiescent current of 250µA/amplifier at 5V. The SGM8623 has a power-down disable feature that reduces the supply current to 150nA.

The SGM8621/2/3/4 are designed to provide optimal performance in low voltage and low noise systems. They provide rail-to-rail output swing into heavy loads. The input common-mode voltage range includes ground, and the maximum input offset voltage is 3mV for SGM8621/2/3/4. They are specified over the extended industrial temperature range (-40°C to +125°C). The operating range is from 2.5V to 5.5V.

The single version, SGM8621/8623, is available in SC70-5, SO-8 and SOT23-5(6) packages. The dual version SGM8622 is available in SO-8 and MSOP-8 packages. The quad version SGM8624 is available in SO-16 and TSSOP-16 packages.

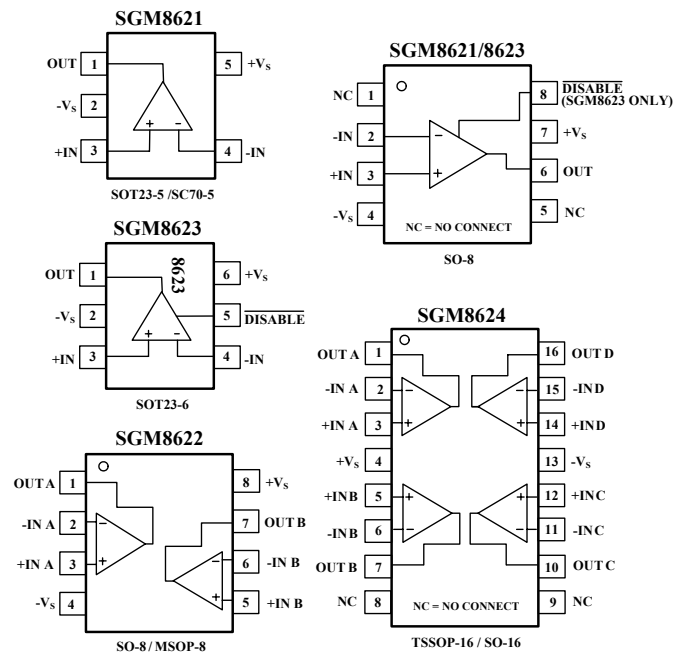
APPLICATIONS

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

FEATURES

- Low Cost
- Rail-to-Rail Input and Output
0.7mV Typical V_{OS}
- High Gain-Bandwidth Product: 3MHz
- High Slew Rate: 1.7V/µs
- Settling Time to 0.1% with 2V Step: 2.1 µs
- Overload Recovery Time: 1µs
- Low Noise : 12 nV/ \sqrt{Hz}
- Operates on 2.5 V to 5.5V Supplies
- Input Voltage Range = - 0.1 V to +5.6 V with $V_S = 5.5 V$
- Low Power
250µA/Amplifier Typical Supply Current
SGM8623 150nA when Disabled
- Small Packaging
SGM8621 Available in SC70-5, SOT23-5 and SO-8
SGM8622 Available in MSOP-8 and SO-8
SGM8623 Available in SOT23-6 and SO-8
SGM8624 Available in TSSOP-16 and SO-16

PIN CONFIGURATIONS (Top View)



ELECTRICAL CHARACTERISTICS :V_S = +5V

(At T_A = +25°C, V_{CM} = V_S/2, R_L = 600Ω, unless otherwise noted)

| PARAMETER | CONDITION | SGM8621/2/3/4 | | | | | | | |
|---|---|---------------|--------------------------|-------------|---------------|----------------|---------|-------|---------|
| | | TYP | MIN/MAX OVER TEMPERATURE | | | | | UNITS | MIN/MAX |
| | | +25°C | +25°C | 0°C to 70°C | -40°C to 85°C | -40°C to 125°C | | | |
| INPUT CHARACTERISTICS | | | | | | | | | |
| Input Offset Voltage (V _{OS}) | | 0.7 | 3 | 3.1 | 3.3 | 3.5 | mV | MAX | |
| Input Bias Current (I _B) | | 1 | | | | | pA | TYP | |
| Input Offset Current (I _{OS}) | | 1 | | | | | pA | TYP | |
| Common-Mode Voltage Range (V _{CM}) | V _S = 5.5V | -0.1 to +5.6 | | | | | V | TYP | |
| Common-Mode Rejection Ratio(CMRR) | V _S = 5.5V, V _{CM} = -0.1V to 4 V | 90 | 75 | 74 | 73 | 73 | dB | MIN | |
| | V _S = 5.5V, V _{CM} = -0.1V to 5.6 V | 92 | 66 | 65 | 65 | 64 | dB | MIN | |
| Open-Loop Voltage Gain(A _{OL}) | R _L = 600Ω, V _o = 0.15V to 4.85V | 100 | 92 | 90 | 89 | 78 | dB | MIN | |
| | R _L = 10KΩ, V _o = 0.05V to 4.95V | 110 | 100 | 99 | 98 | 82 | dB | MIN | |
| Input Offset Voltage Drift (ΔV _{OS} /ΔT) | | 2.7 | | | | | μV/°C | TYP | |
| OUTPUT CHARACTERISTICS | | | | | | | | | |
| Output Voltage Swing from Rail | R _L = 600Ω | 0.1 | | | | | V | TYP | |
| | R _L = 10KΩ | 0.015 | | | | | V | TYP | |
| Output Current (I _{OUT}) | | 48 | 45 | 42 | 40 | 30 | mA | MIN | |
| Closed-Loop Output Impedance | F = 100KHz, G = +1 | 2.6 | | | | | Ω | TYP | |
| POWER-DOWN DISABLE | | | | | | | | | |
| Turn-On Time | | 6.2 | | | | | ns | TYP | |
| Turn-Off Time | | 1.4 | | | | | ns | TYP | |
| $\overline{DISABLE}$ Voltage-Off | | | 0.8 | | | | V | MAX | |
| $\overline{DISABLE}$ Voltage-On | | | 2 | | | | V | MIN | |
| POWER SUPPLY | | | | | | | | | |
| Operating Voltage Range | | | 2.5 | 2.5 | 2.5 | 2.5 | V | MIN | |
| | | | 5.5 | 5.5 | 5.5 | 5.5 | V | MAX | |
| Power Supply Rejection Ratio (PSRR) | V _S = +2.5 V to + 5.5 V V _{CM} = (-V _S) + 0.5V | 94 | 79 | 78 | 77 | 76 | dB | MIN | |
| Quiescent Current/ Amplifier (I _Q) | I _{OUT} = 0 | 250 | 300 | 345 | 350 | 380 | μA | MAX | |
| Supply Current when Disabled (SGM8623 only) | | 150 | | | | | nA | MAX | |
| DYNAMIC PERFORMANCE | | | | | | | | | |
| Gain-Bandwidth Product (GBP) | R _L = 10KΩ | 3 | | | | | MHz | TYP | |
| Phase Margin(φ _o) | | 67 | | | | | degrees | TYP | |
| Full Power Bandwidth(BW _p) | <1% distortion, R _L = 600Ω | 50 | | | | | KHz | TYP | |
| Slew Rate (SR) | G = +1, 2V Step, R _L = 10KΩ | 1.7 | | | | | V/μs | TYP | |
| Settling Time to 0.1%(t _s) | G = +1, 2 V Step, R _L = 600Ω | 2.1 | | | | | μs | TYP | |
| Overload Recovery Time | V _{IN} ·Gain = V _S , R _L = 600Ω | 1 | | | | | μs | TYP | |
| NOISE PERFORMANCE | | | | | | | | | |
| Voltage Noise Density (e _n) | f = 1kHz | 12 | | | | | nV/√Hz | TYP | |
| Current Noise Density(i _n) | f = 1kHz | 3 | | | | | fA/√Hz | TYP | |

Specifications subject to change without notice.

PACKAGE/ORDERING INFORMATION

| MODEL | ORDER NUMBER | PACKAGE DESCRIPTION | PACKAGE OPTION | MARKING INFORMATION |
|---------|---------------|---------------------|---------------------|---------------------|
| SGM8621 | SGM8621XC5/TR | SC70-5 | Tape and Reel, 3000 | 8621 |
| | SGM8621XN5/TR | SOT23-5 | Tape and Reel, 3000 | 8621 |
| | SGM8621XS/TR | SO-8 | Tape and Reel, 2500 | SGM8621XS |
| SGM8622 | SGM8622XMS/TR | MSOP-8 | Tape and Reel, 3000 | SGM8622XMS |
| | SGM8622XS/TR | SO-8 | Tape and Reel, 2500 | SGM8622XS |
| SGM8623 | SGM8623XN6/TR | SOT23-6 | Tape and Reel, 3000 | 8623 |
| | SGM8623XS/TR | SO-8 | Tape and Reel, 2500 | SGM8623XS |
| SGM8624 | SGM8624XS/TR | SO-16 | Tape and Reel, 2500 | SGM8624XS |
| | SGM8624XTS | TSSOP-16 | Tape and Reel, 3000 | SGM8624XTS |

ABSOLUTE MAXIMUM RATINGS

| | |
|---|------------------------------|
| Supply Voltage, V+ to V- | 7.5 V |
| Common-Mode Input Voltage | (-Vs) - 0.5 V to (+Vs) +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 @ TA = 25°C | |
| SC70-5, θJA | 333°C/W |
| SOT23-5, θJA | 190°C/W |
| SOT23-6, θJA | 190°C/W |
| SO-8, θJA | 125°C/W |
| MSOP-8, θJA | 216°C/W |
| SO-16, θJA | 82°C/W |
| TSSOP-16, θJA | 105°C/W |
| Lead Temperature Range (Soldering 10 sec) | 260°C |
| ESD Susceptibility | |
| HBM | 1500V |
| 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.

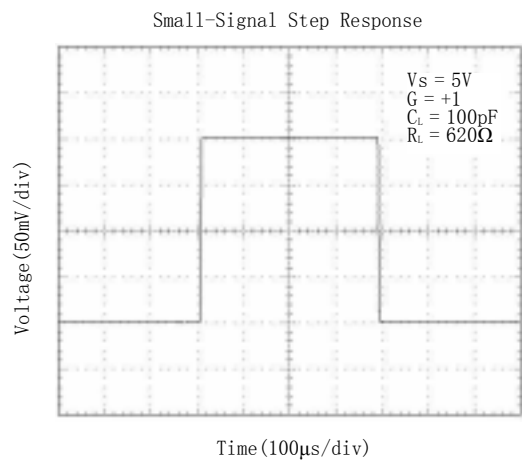
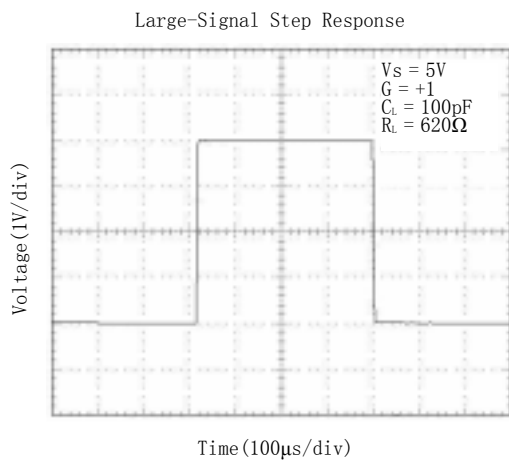
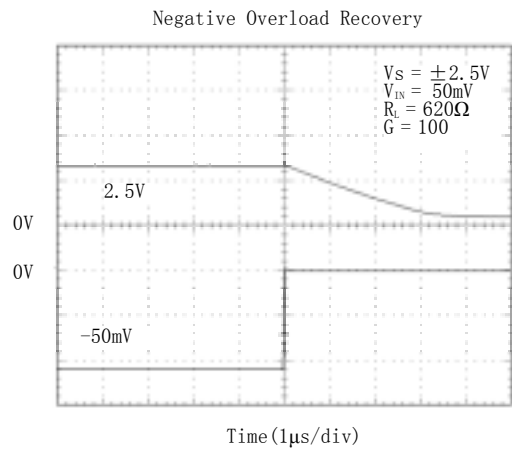
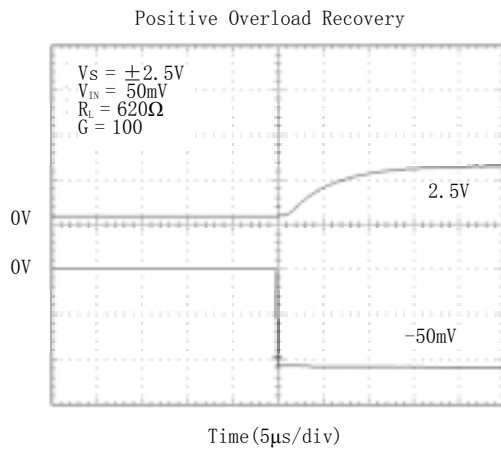
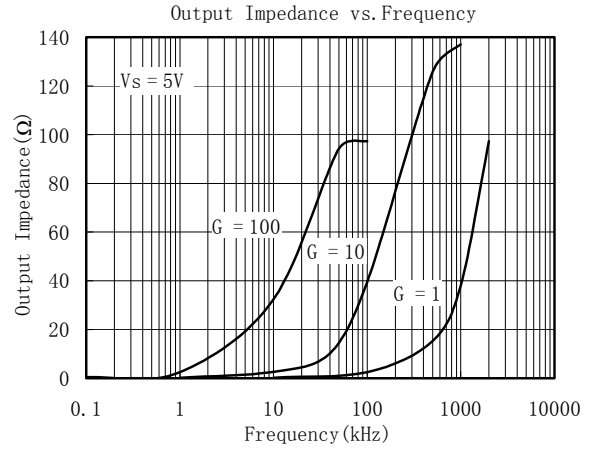
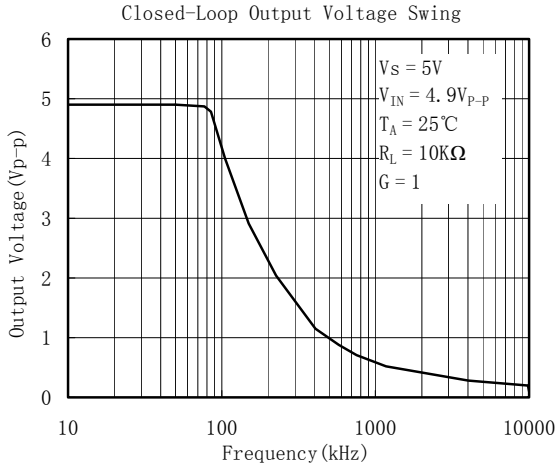
CAUTION

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.

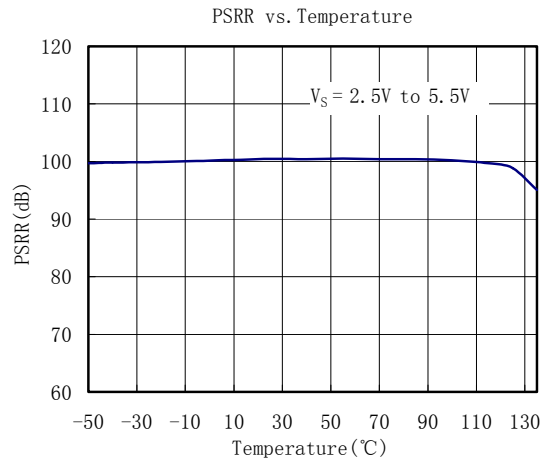
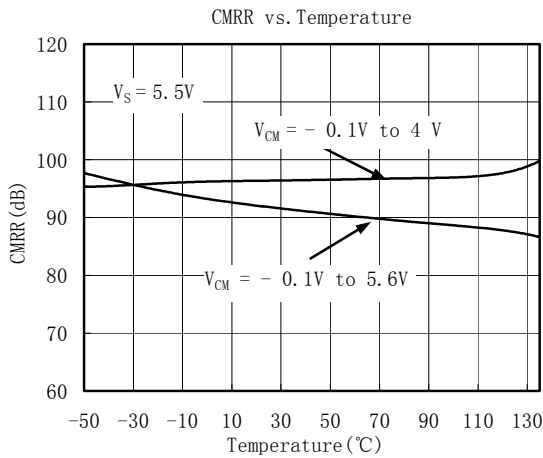
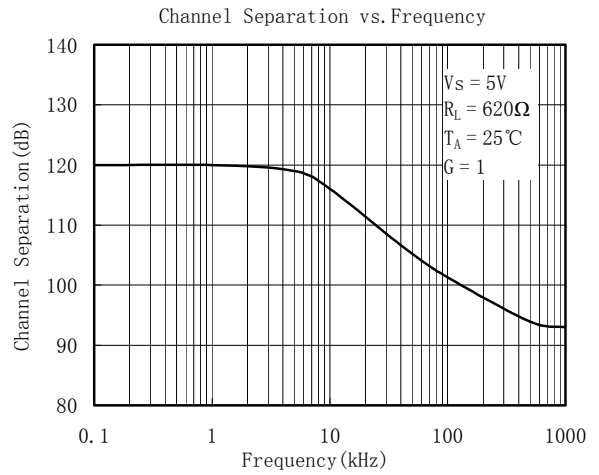
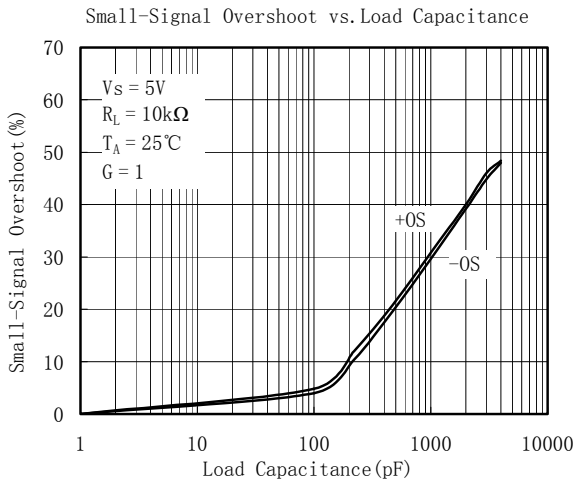
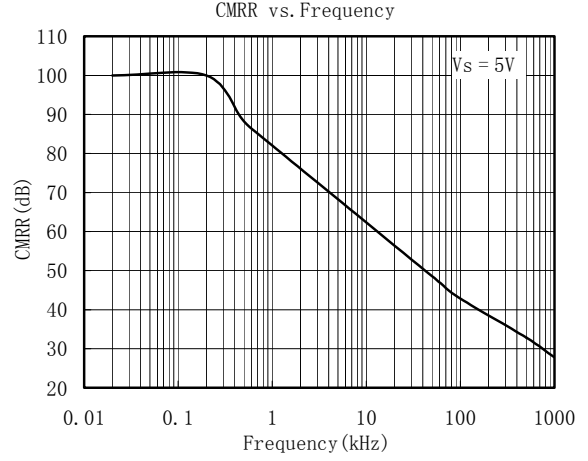
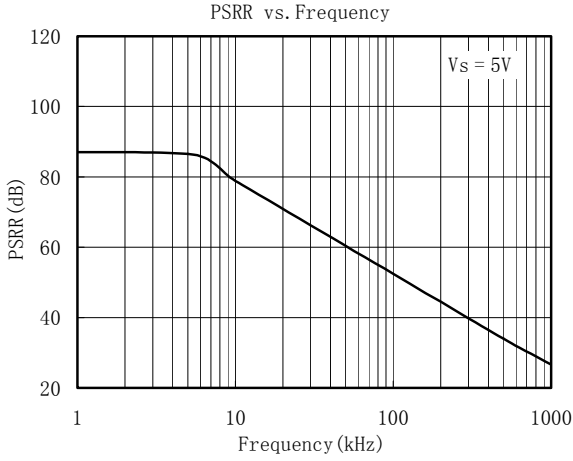
TYPICAL PERFORMANCE CHARACTERISTICS

(At $T_A = +25^\circ\text{C}$, $V_{CM} = V_S/2$, $R_L = 600\Omega$, unless otherwise noted)



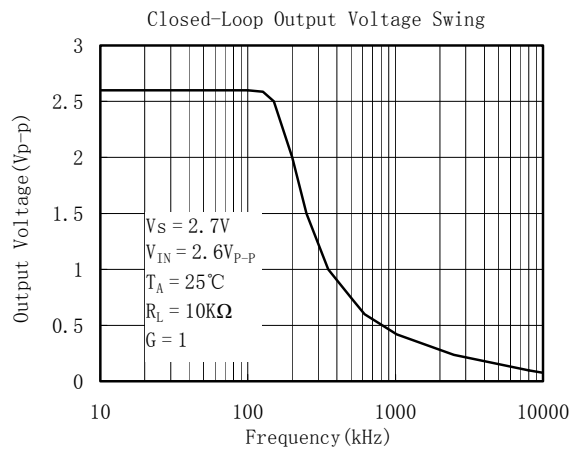
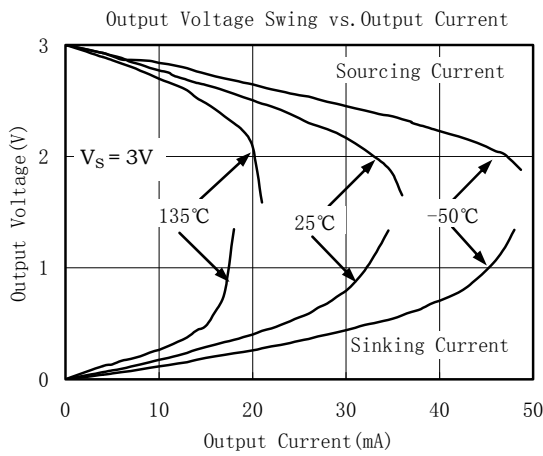
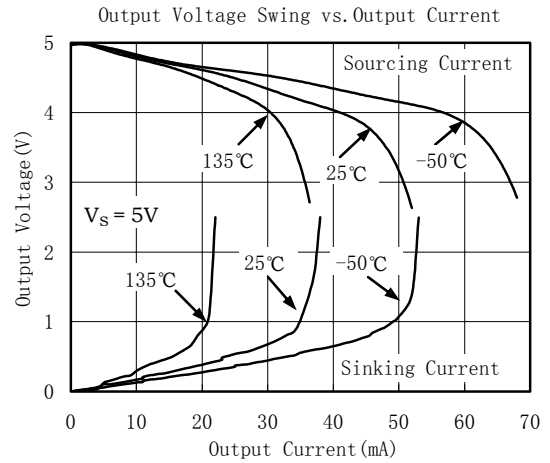
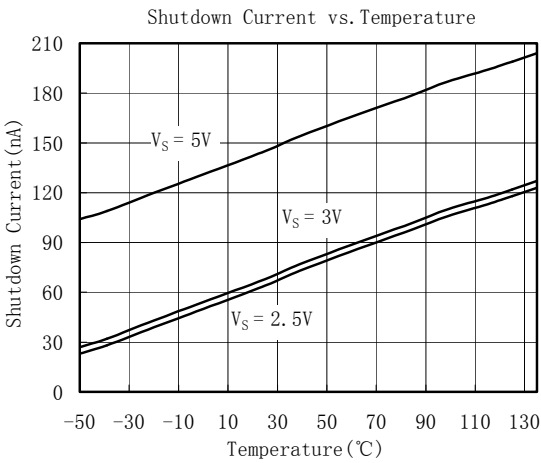
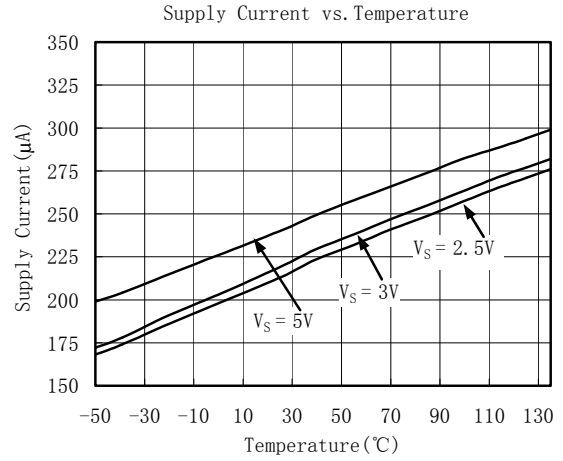
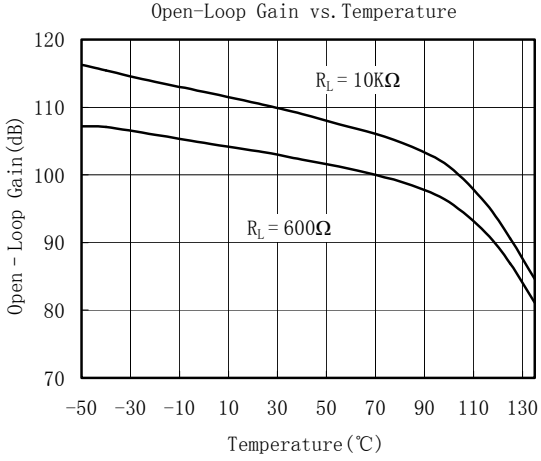
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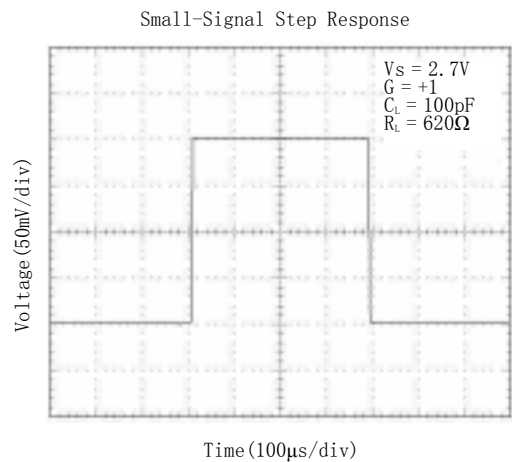
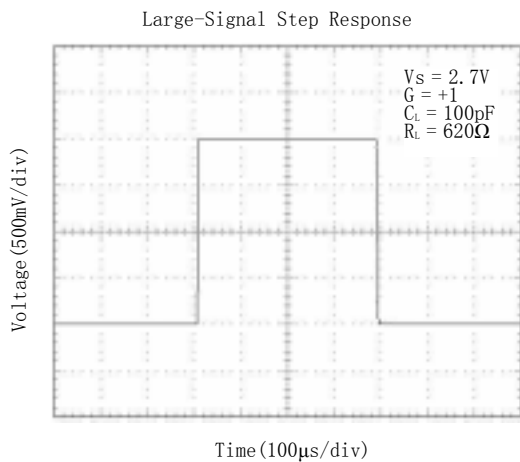
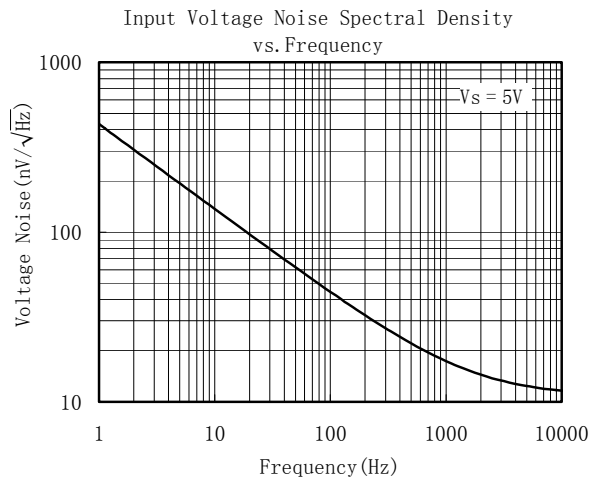
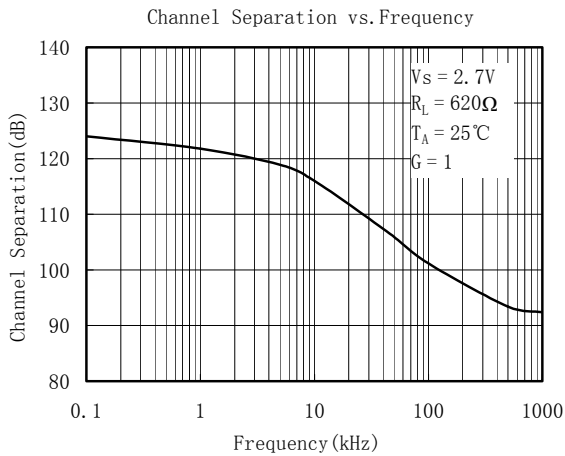
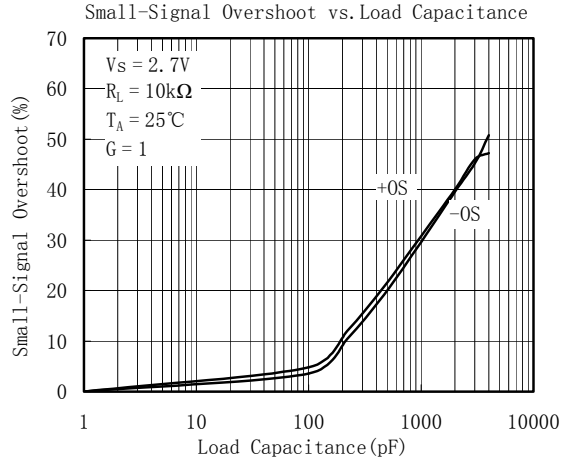
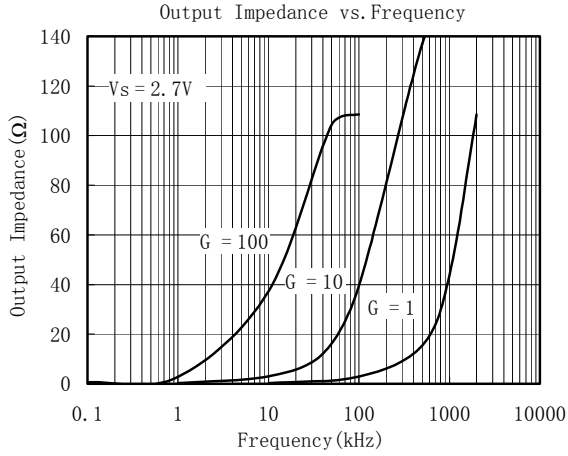
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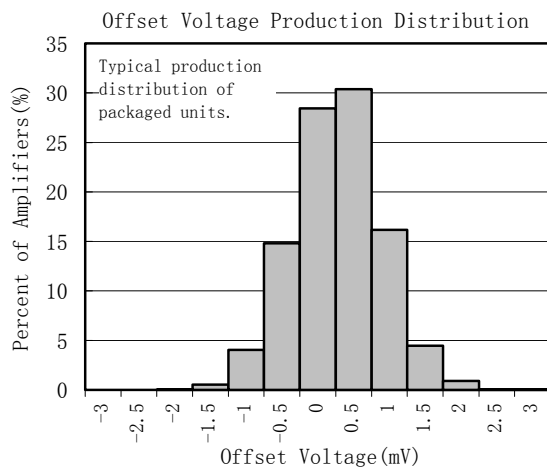
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(At $T_A = +25^\circ\text{C}$, $V_{CM} = V_S/2$, $R_L = 600\Omega$, unless otherwise noted)



APPLICATION NOTES

Driving Capacitive Loads

The SGM862x can directly drive 1000pF in unity-gain without oscillation. The unity-gain follower (buffer) is the most sensitive configuration to capacitive loading. Direct capacitive loading reduces the phase margin of amplifiers and this results in ringing or even oscillation. Applications that require greater capacitive drive capability should use an isolation resistor between the output and the capacitive load like the circuit in Figure 1. The isolation resistor R_{ISO} and the load capacitor C_L form a zero to increase stability. The bigger the R_{ISO} resistor value, the more stable V_{OUT} will be. Note that this method results in a loss of gain accuracy because R_{ISO} forms a voltage divider with the R_{LOAD} .

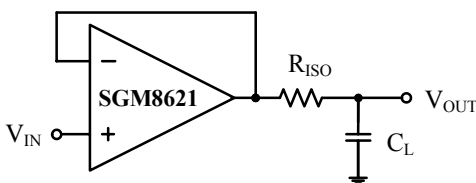


Figure 1. Indirectly Driving Heavy Capacitive Load

An improvement circuit is shown in Figure 2. It provides DC accuracy as well as AC stability. R_F provides the DC accuracy by connecting the inverting signal with the output. C_F and R_{ISO} serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving phase margin in the overall feedback loop.

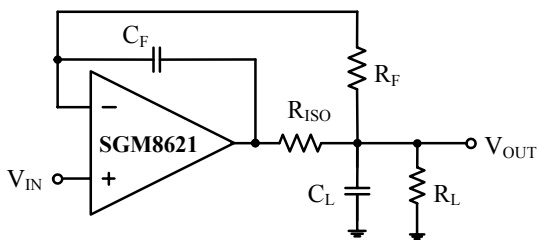


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

For no-buffer configuration, there are two others ways to increase the phase margin: (a) by increasing the amplifier's gain or (b) by placing a capacitor in parallel with the feedback resistor to counteract the parasitic capacitance associated with inverting node.

Power-Supply Bypassing and Layout

The SGM862x family operates from either a single +2.5V to +5.5V supply or dual $\pm 1.25V$ to $\pm 2.75V$ supplies. For single-supply operation, bypass the power supply V_{DD} with a 0.1 μF 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 μF ceramic capacitors. 2.2 μF 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 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).

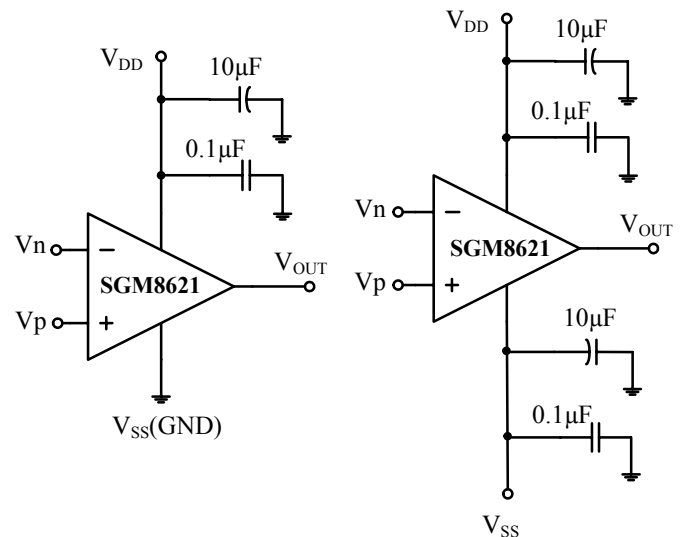


Figure 3. Amplifier with Bypass Capacitors

Grounding

A ground plane layer is important for SGM862x 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 4 performs the difference function. If the resistors ratios are equal ($R4 / R3 = R2 / R1$), then $V_{OUT} = (V_p - V_n) \times R2 / R1 + V_{ref}$.

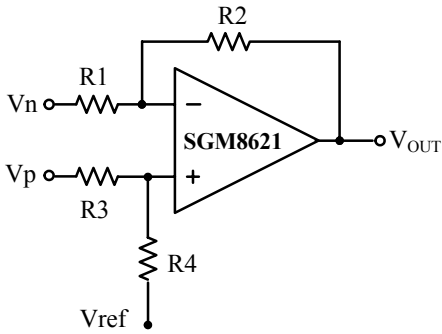


Figure 4. Differential Amplifier

Instrumentation Amplifier

The circuit in Figure 5 performs the same function as that in Figure 4 but with the high input impedance.

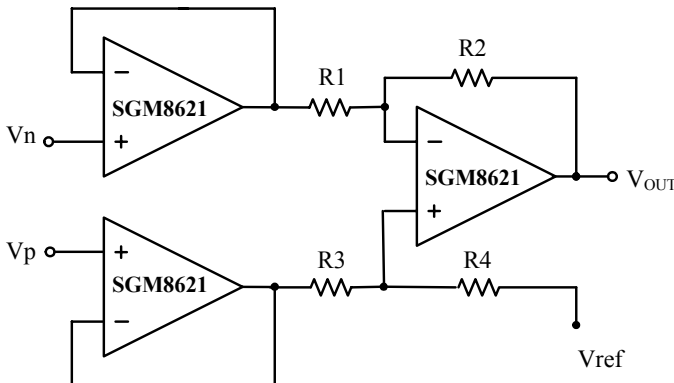


Figure 5. Instrumentation Amplifier

Low Pass Active Filter

The low pass filter shown in Figure 6 has a DC gain of $(-R2/R1)$ and the -3dB corner frequency is $1/2\pi R2C$. 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.

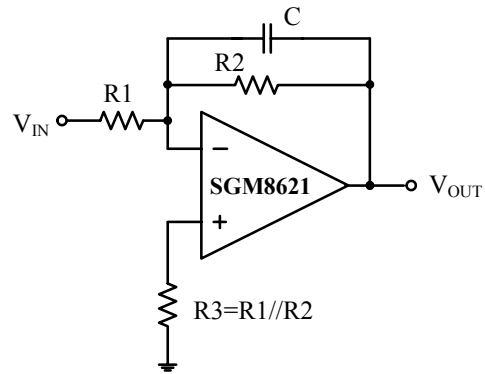
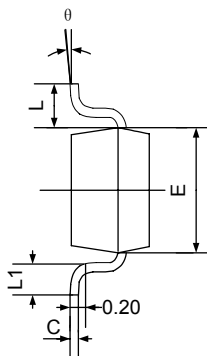
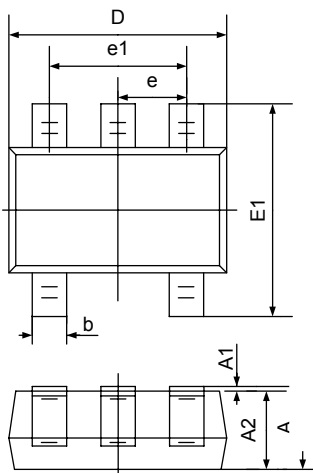


Figure 6. Low Pass Active Filter

PACKAGE OUTLINE DIMENSIONS

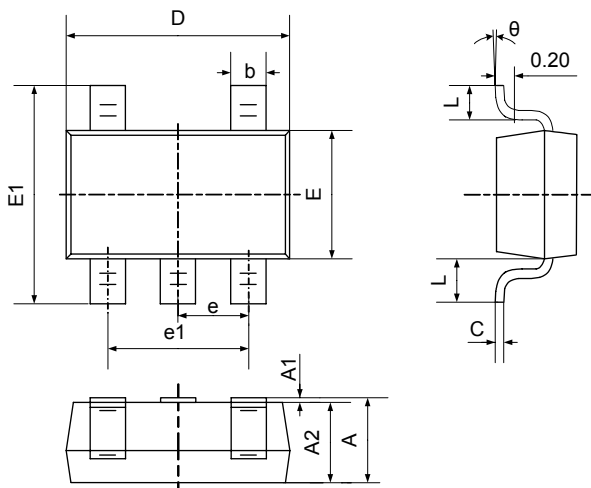
SC70-5



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|------------------------------|-------|-------------------------|-------|
| | Min | Max | Min | Max |
| A | 0.900 | 1.100 | 0.035 | 0.043 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 0.900 | 1.000 | 0.035 | 0.039 |
| b | 0.150 | 0.350 | 0.006 | 0.014 |
| c | 0.080 | 0.150 | 0.003 | 0.006 |
| D | 2.000 | 2.200 | 0.079 | 0.087 |
| E | 1.150 | 1.350 | 0.045 | 0.053 |
| E1 | 2.150 | 2.450 | 0.085 | 0.096 |
| e | 0.650TYP | | 0.026TYP | |
| e1 | 1.200 | 1.400 | 0.047 | 0.055 |
| L | 0.525REF | | 0.021REF | |
| L1 | 0.260 | 0.460 | 0.010 | 0.018 |
| θ | 0° | 8° | 0° | 8° |

PACKAGE OUTLINE DIMENSIONS

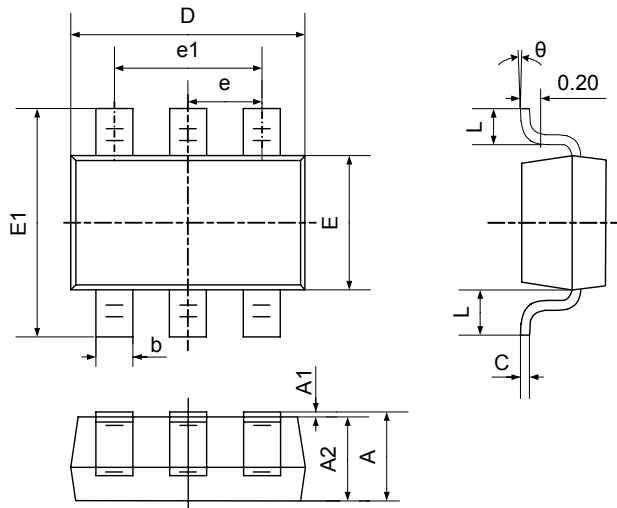
SOT23-5



| 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

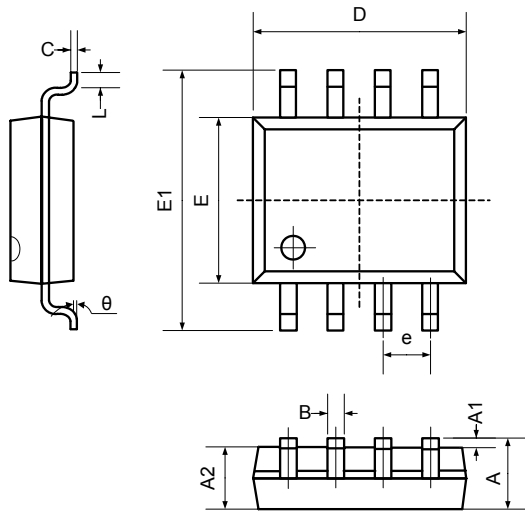
SOT23-6



| 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 |
| theta | 0° | 8° | 0° | 8° |

PACKAGE OUTLINE DIMENSIONS

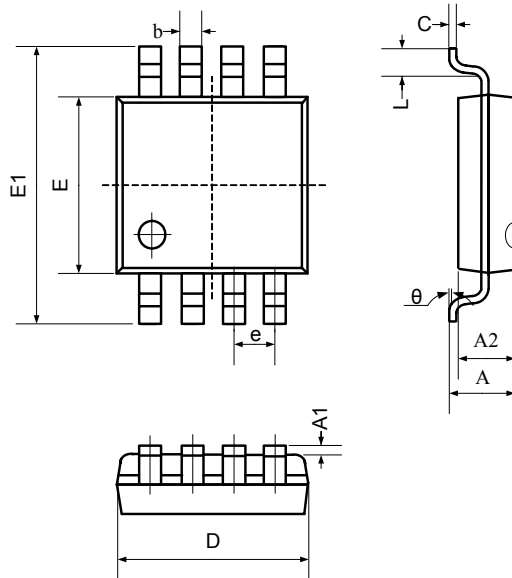
SO-8



| 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

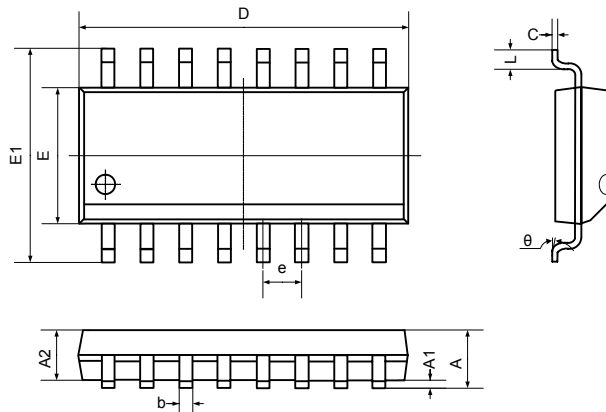
MSOP-8



| 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 |
| theta | 0° | 6° | 0° | 6° |

PACKAGE OUTLINE DIMENSIONS

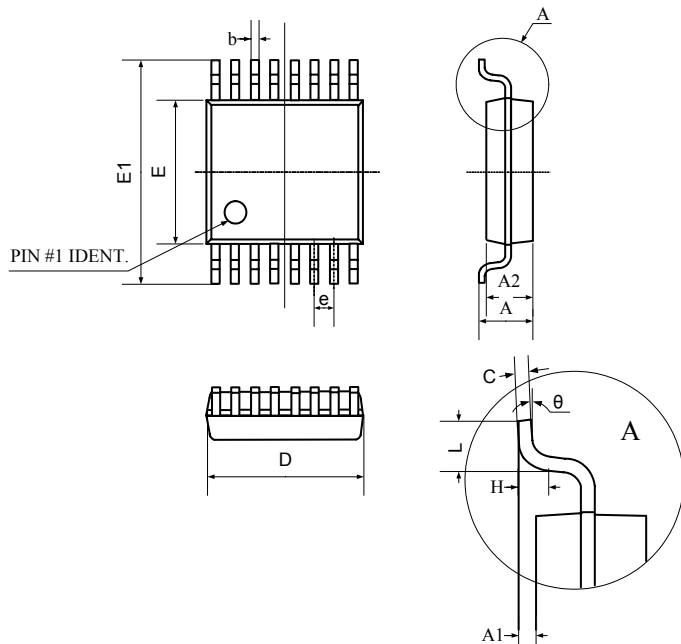
SO-16



| 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 | |
| Added SC70-5 PACKAGE | Universal |
| Changes to PRODUCT DESCRIPTION, FEATURES, and PIN CONFIGURATIONS | 1 |
| Updated PACKAGE/ORDERING INFORMATION..... | 3 |
| Changes to ABSOLUTE MAXIMUM RATINGS | 3 |

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