

SGM2324

1MHz, Quad, General Purpose CMOS Operational Amplifier

PRODUCT DESCRIPTION

The SGM2324 has quad rail-to-rail output voltage feedback amplifiers in one package. It takes the minimum operating supply voltage down to 3V and the maximum recommended supply voltage is 5.5V. SGM2324 is specified over the extended -40°C to +85°C temperature range.

The amplifier in SGM2324 provides 1MHz bandwidth; very low input bias currents of 10pA, these features enable SGM2324 to be used for integrators, photodiode amplifiers, and piezoelectric sensors. Rail-to-rail output feature is useful for designers to buffer ASIC in single-supply systems.

Applications of SGM2324 include safety monitoring, portable equipment, battery and power supply control, signal conditioning and interfacing for transducers in low power systems.

The SGM2324 is offered in SO-16, TSSOP-16, TSSOP-14 and SO-14 packages.

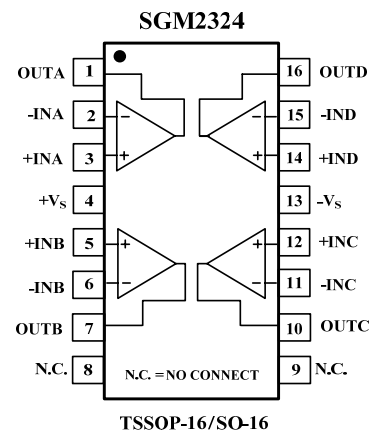
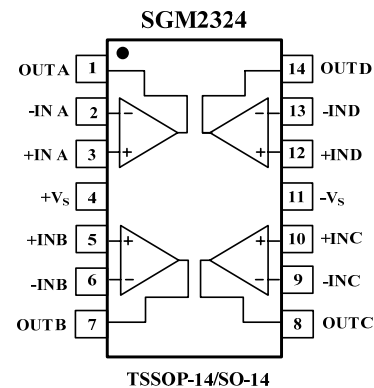
APPLICATIONS

ASIC Input or Output Amplifier
Sensor Interface
Piezo Electric Transducer Amplifier
Medical Instrumentation
Mobile Communication
Portable Systems
Smoke Detectors
Notebook PC
PCMCIA Cards
Battery-Powered Equipment
DSP Interface

FEATURES

- **Low Cost**
- **Rail-to-Rail Output**
1.7mV Typical V_{os}
- **Unity Gain Stable**
- **Gain Bandwidth Product: 1MHz**
- **Very Low Input Bias Currents: 10pA**
- **Input Common-Mode Voltage Range Includes Ground**
- **Operates from 3V to 5.5V**
- **Lead (Pb) Free Packages:**
SO-16, TSSOP-16, SO-14 and TSSOP-14

PIN CONFIGURATIONS (Top View)



ELECTRICAL CHARACTERISTICS: $V_S = +5V$

(At $R_L = 100K\Omega$ connected to $V_S/2$, and $V_{OUT} = V_S/2$, unless otherwise noted)

| PARAMETER | CONDITIONS | SGM2324 | | | | |
|---|---|---------|--------------------------|------------|----------------|---------|
| | | TYP | MIN/MAX OVER TEMPERATURE | | | |
| | | +25 | +25 | -40 to +85 | UNITS | MIN/MAX |
| INPUT CHARACTERISTICS | | | | | | |
| Input Offset Voltage (V_{OS}) | | 1.7 | 10 | 12 | mV | MAX |
| Input Bias Current (I_B) | | 10 | | | pA | TYP |
| Input Offset Current (I_{OS}) | | 10 | | | pA | TYP |
| Common-Mode Rejection Ratio (CMRR) | $V_S = 5V, V_{CM} = -0.1V$ to 3.3V | 88 | 65 | 50 | dB | MIN |
| Open-Loop Voltage Gain (A_{OL}) | $R_L = 2K\Omega, V_o = 0.1V$ to 4.9V | 100 | 85 | 80 | dB | MIN |
| | $R_L = 10K\Omega, V_o = 0.035V$ to 4.965V | 110 | 90 | 85 | dB | MIN |
| Input Offset Voltage Drift ($\Delta V_{OS}/\Delta T$) | | 3.5 | | | $\mu V/$ | TYP |
| OUTPUT CHARACTERISTICS | | | | | | |
| Output Voltage Swing from Rail | $R_L = 2K\Omega$ | 0.8 | | | V | TYP |
| | $R_L = 10K\Omega$ | 0.008 | | | V | TYP |
| Output Current (I_{OUT}) | | 43 | 28 | 24 | mA | MIN |
| POWER SUPPLY | | | | | | |
| Operating Voltage Range | | | 3.0 | 3.0 | V | MIN |
| | | | 5.5 | 5.5 | V | MAX |
| Power Supply Rejection Ratio (PSRR) | $V_S = +3V$ to + 5.5V | | | | | |
| | $V_{CM} = (-V_S) + 0.5V$ | 80 | 75 | 70 | dB | MIN |
| Quiescent Current / Amplifier (I_Q) | $I_{OUT} = 0$ | 0.65 | 1.2 | 1.3 | mA | MAX |
| DYNAMIC PERFORMANCE | | | | | | |
| Gain-Bandwidth Product (GBP) | | 1 | | | MHz | TYP |
| Slew Rate (SR) | G = +1, 2V Output Step | 0.65 | | | V/ μs | TYP |
| Settling Time to 0.1% (t_S) | G = +1, 2 V Output Step | 9.0 | | | μs | TYP |
| Overload Recovery Time | $V_{IN} \cdot \text{Gain} = V_S$ | 4.0 | | | μs | TYP |
| Crosstalk | 1kHz | -80 | | | dB | TYP |
| | 1MHz | -65 | | | dB | TYP |
| NOISE PERFORMANCE | | | | | | |
| Voltage Noise Density (e_n) | f = 1kHz | 42.0 | | | nV/\sqrt{Hz} | TYP |
| | f = 10kHz | 38.0 | | | nV/\sqrt{Hz} | TYP |

Specifications subject to changes without notice.

PACKAGE/ORDERING INFORMATION

| MODEL | ORDER NUMBER | PACKAGE DESCRIPTION | PACKAGE OPTION | MARKING INFORMATION |
|---------|-----------------|---------------------|---------------------|---------------------|
| SGM2324 | SGM2324YS/TR | SO-16 | Tape and Reel, 2500 | SGM2324YS |
| | SGM2324YTS/TR | TSSOP-16 | Tape and Reel, 3000 | SGM2324YTS |
| | SGM2324YS14/TR | SO-14 | Tape and Reel, 2500 | SGM2324YS14 |
| | SGM2324YTS14/TR | TSSOP-14 | Tape and Reel, 3000 | SGM2324YTS14 |

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V+ to V- 6V
 Storage Temperature Range -65 to +150
 Junction Temperature 160
 Operating Temperature Range -40 to +85
 Package Thermal Resistance @ T_A = 25
 SO-16, θ_{JA} 82 /W
 TSSOP-16, θ_{JA} 105 /W
 Lead Temperature Range (Soldering 10 sec)
 260
 ESD Susceptibility
 HBM 4000V
 MM 400V

CAUTION

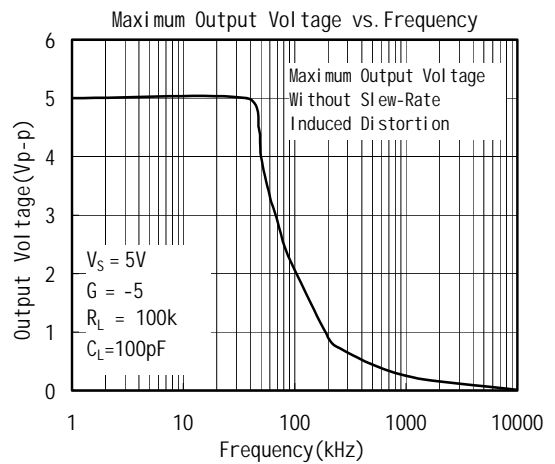
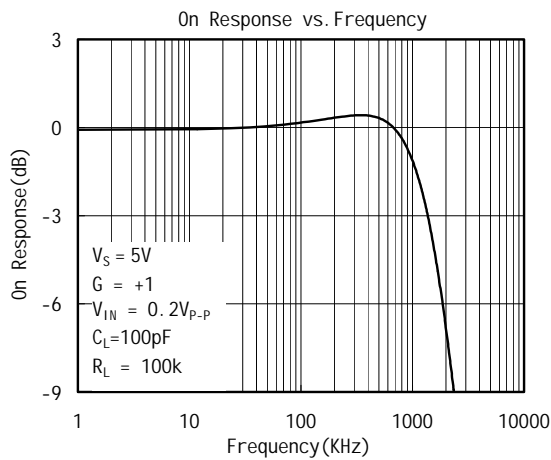
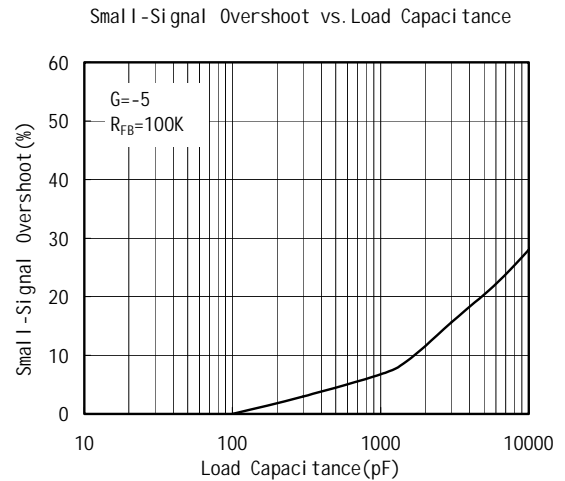
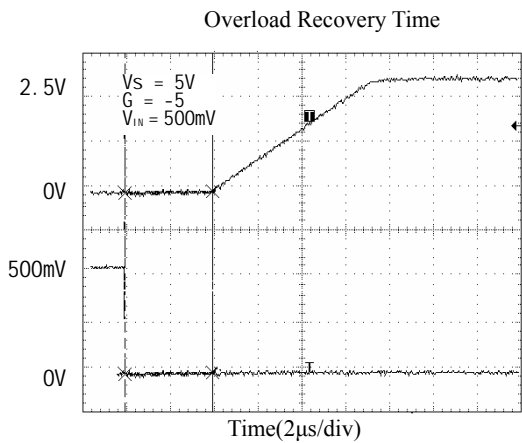
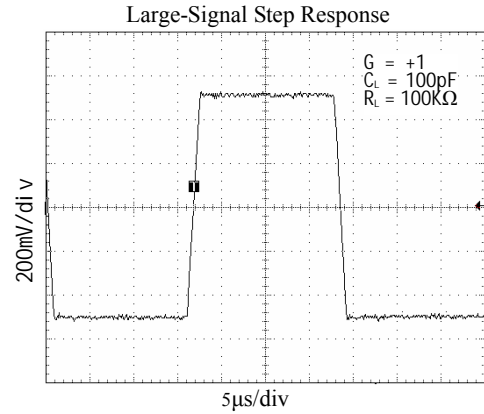
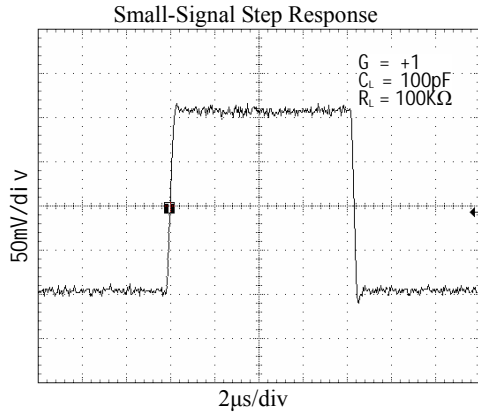
This integrated circuit can be damaged by ESD. SG Micro-electronics recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device 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.

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.

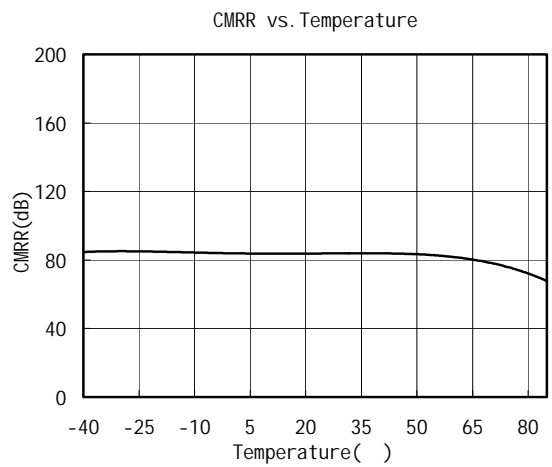
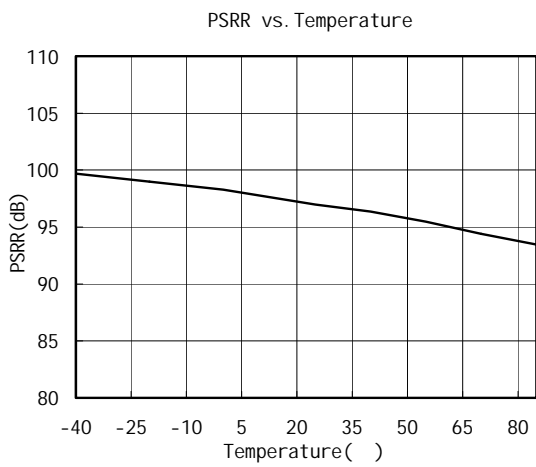
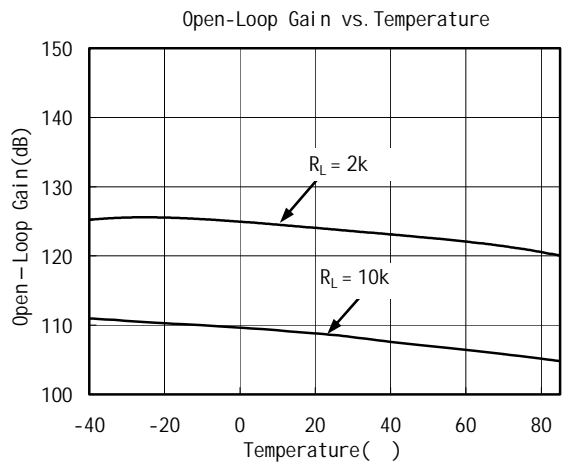
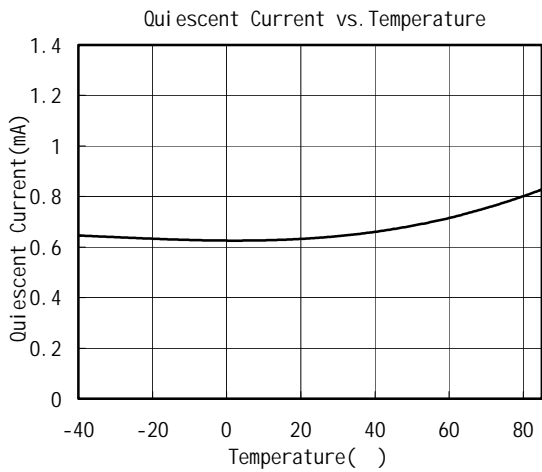
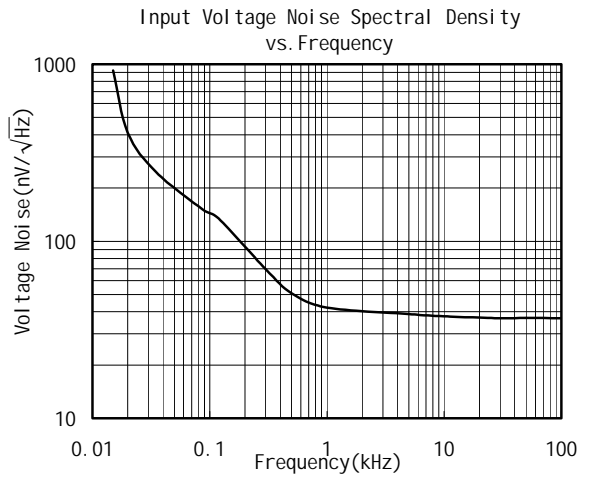
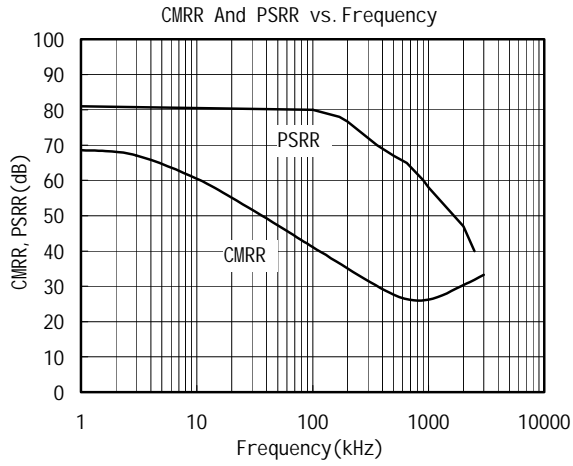
TYPICAL PERFORMANCE CHARACTERISTICS

At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, and $R_L = 100\text{K}\Omega$ connected to $V_S/2$, unless otherwise noted.



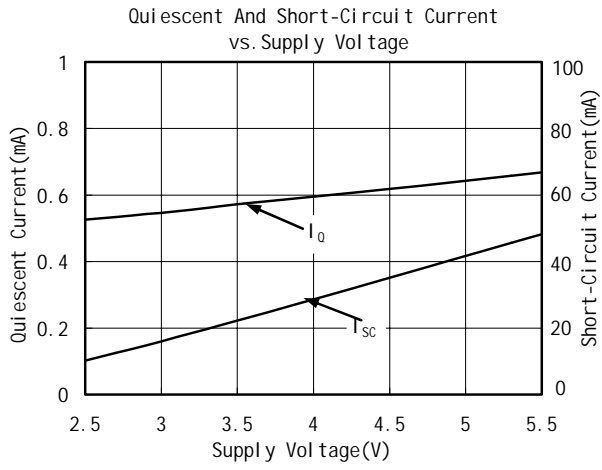
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At $T_A = +25^\circ\text{C}$, $V_S = +5\text{V}$, and $R_L = 100\text{K}\Omega$ connected to $V_S/2$, unless otherwise noted.



APPLICATION NOTES

Driving Capacitive Loads

The SGM2324 can directly drive 250pF 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} .

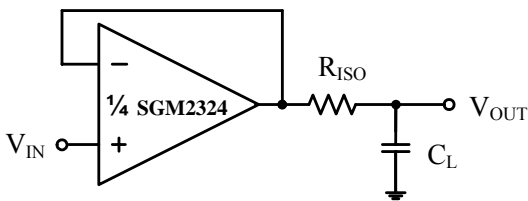


Figure 1. Indirectly Driving Heavy Capacitive Load

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.

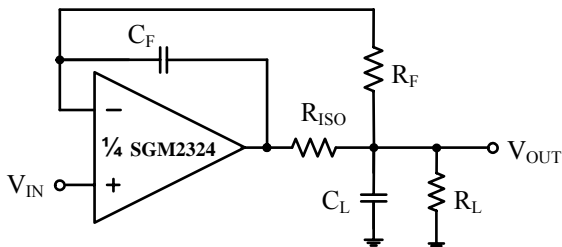


Figure 2. Indirectly Driving Heavy Capacitive Load with DC Accuracy

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 SGM2324 operates from a single +3V to +5.5V supply or dual $\pm 1.5V$ 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.

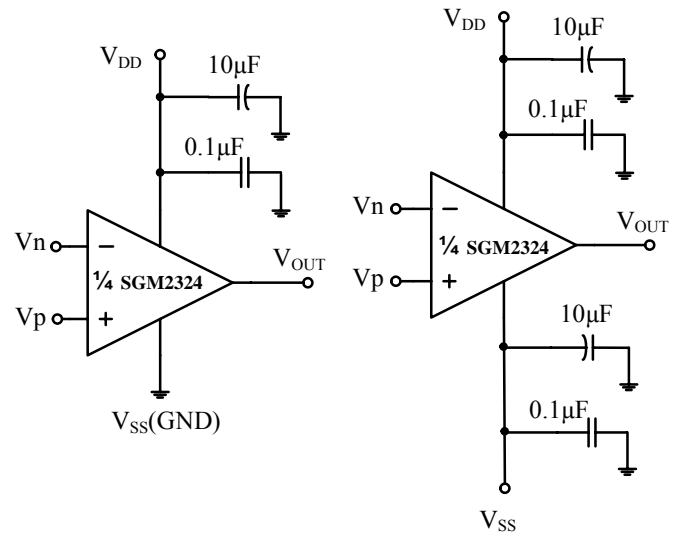


Figure 3. Amplifier with Bypass Capacitors

Typical Application Circuits

Differential Amplifier

The circuit shown in Figure 4 performs the difference function. If the resistors ratios are equal ($R_4 / R_3 = R_2 / R_1$), then $V_{OUT} = (V_p - V_n) \times R_2 / R_1 + V_{ref}$.

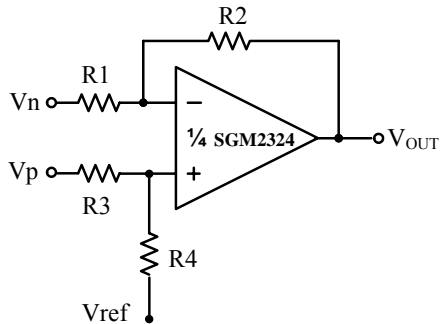


Figure 4. Differential Amplifier

Low Pass Active Filter

The low pass filter shown in Figure 6 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.

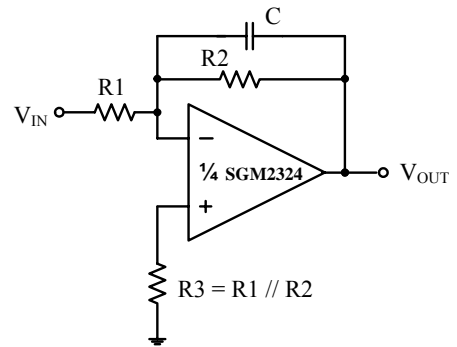


Figure 6. Low Pass Active Filter

Instrumentation Amplifier

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

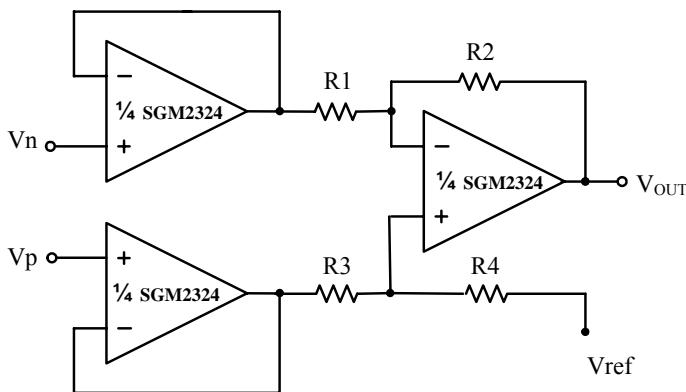
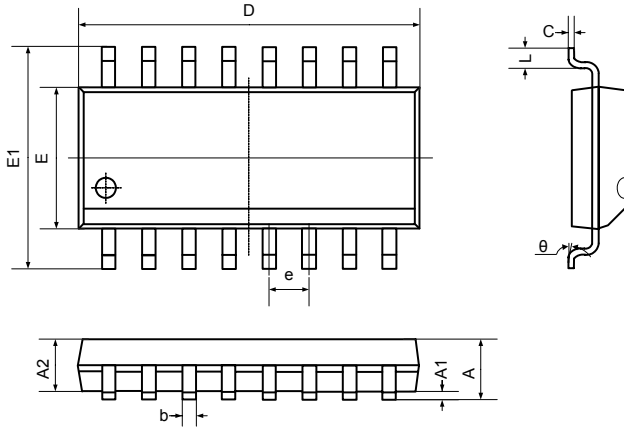


Figure 5. Instrumentation Amplifier

PACKAGE OUTLINE DIMENSIONS

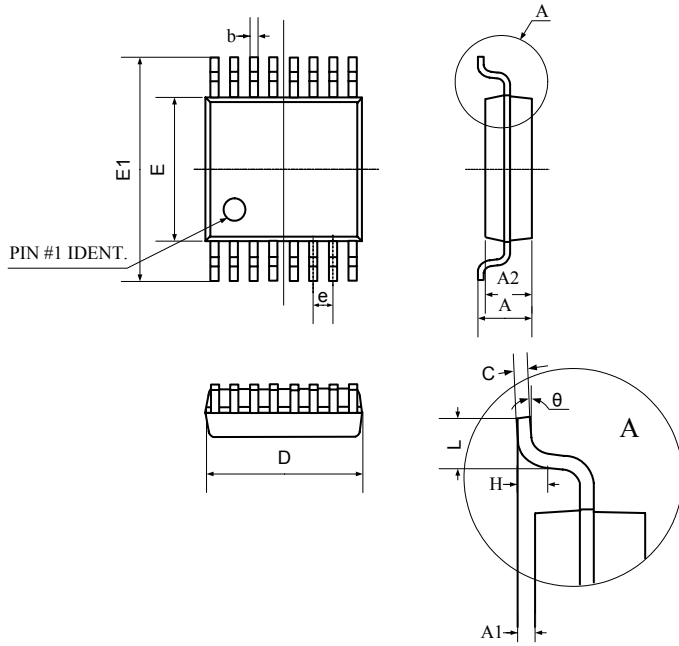
SO-16



| 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 |
| theta | 0° | 8° | 0° | 8° |

PACKAGE OUTLINE DIMENSIONS

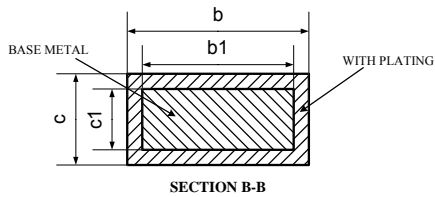
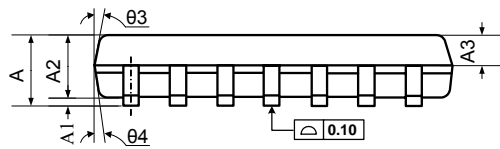
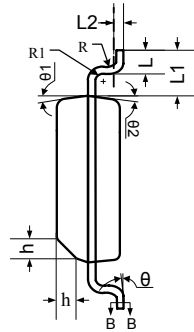
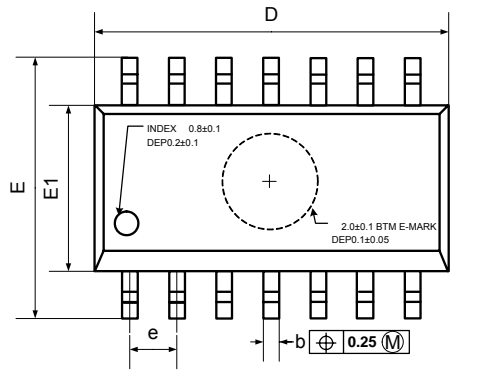
TSSOP-16



| 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° |

PACKAGE OUTLINE DIMENSIONS

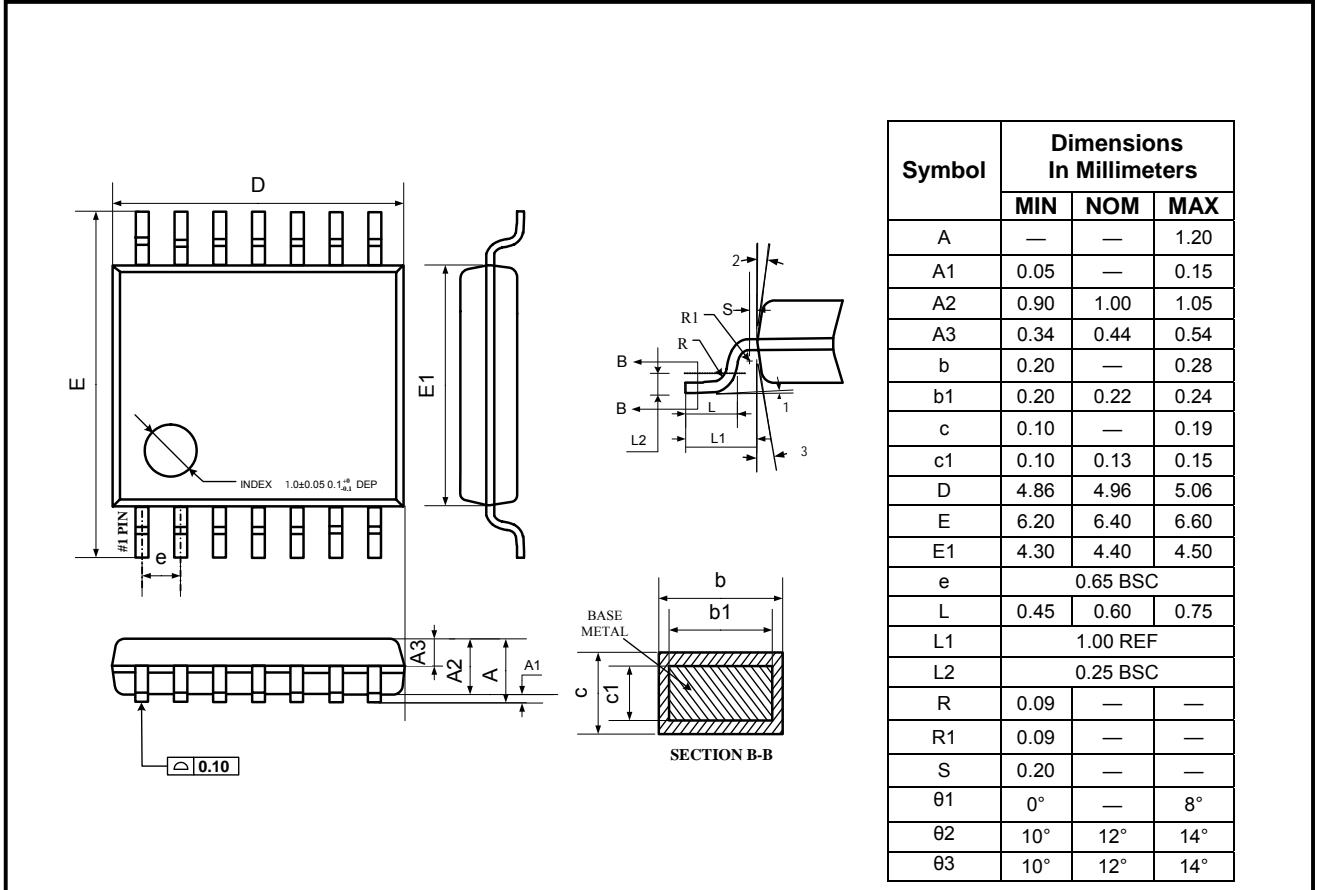
SO-14



| Symbol | Dimensions In Millimeters | | |
|--------|------------------------------|------|------|
| | MIN | NOM | MAX |
| A | 1.35 | 1.60 | 1.75 |
| A1 | 0.10 | 0.15 | 0.25 |
| A2 | 1.25 | 1.45 | 1.65 |
| A3 | 0.55 | 0.65 | 0.75 |
| b | 0.36 | | 0.49 |
| b1 | 0.35 | 0.40 | 0.45 |
| c | 0.16 | | 0.25 |
| c1 | 0.15 | 0.20 | 0.25 |
| D | 8.53 | 8.63 | 8.73 |
| E | 5.80 | 6.00 | 6.20 |
| E1 | 3.80 | 3.90 | 4.00 |
| e | 1.27 BSC | | |
| L | 0.45 | 0.60 | 0.80 |
| L1 | 1.04 REF | | |
| L2 | 0.25 BSC | | |
| R | 0.07 | | |
| R1 | 0.07 | | |
| h | 0.30 | 0.40 | 0.50 |
| θ | 0° | | 8° |
| θ1 | 6° | 8° | 10° |
| θ2 | 6° | 8° | 10° |
| θ3 | 5° | 7° | 9° |
| θ4 | 5° | 7° | 9° |

PACKAGE OUTLINE DIMENSIONS

TSSOP-14



REVISION HISTORY

| Location | Page |
|--|--------------|
| 10/2007— Data Sheet REV.A | |
| 02/2008— Data Sheet changed from REV. A to REV. B | |
| Added SO-14 and TSSOP-14 Packages | 1, 3, 11, 12 |

SG Micro Ltd.
A2608, NO.72 North Road
Xisanhuan, Haidian District,
Beijing, China 100037
Tel: 86-10-51798160/80
Fax: 86-10-51798180-803
www.sg-micro.com