



# SGM8965-1/SGM8965-2 50MHz, Low Distortion, Rail-to-Rail I/O, Single-Supply Operational Amplifiers

## GENERAL DESCRIPTION

The single SGM8965-1 and dual SGM8965-2 are high speed CMOS operational amplifiers with high input impedance, zero-crossover and low distortion. These devices can operate from 2.2V to 5.5V single supply.

The SGM8965-1/2 feature high speed and low noise. These devices support rail-to-rail input and output operation. They have a wide input common mode voltage range and output swing within 8mV. Furthermore, the SGM8965-1/2 provide high CMRR with zero-crossover and low distortion, which are designed to drive ADCs with high linearity. They can be used in a variety of applications.

The SGM8965-1 is available in Green SOT-23-5 and SOIC-8 packages. The SGM8965-2 is available in Green SOIC-8 and MSOP-8 packages. They are specified over the extended -40 °C to +125 °C temperature range.

## FEATURES

- **Gain-Bandwidth Product: 50MHz**
- **Slew Rate: 30V/μs**
- **Stable When Gain ≥ 4**
- **High CMRR: 100dB (TYP)**
- **Excellent THD+N: 0.00015%**
- **Low Offset Voltage: 250μV (MAX)**
- **Low Bias Current: 0.5pA (TYP)**
- **Low Input Voltage Noise: 4.5nV/√Hz at 100kHz**
- **Rail-to-Rail Input and Output**
- **Supply Voltage Range: 2.2V to 5.5V**
- **-40°C to +125°C Operating Temperature Range**
- **Small Packaging:**
  - **SGM8965-1 Available in Green SOT-23-5 and SOIC-8 Packages**
  - **SGM8965-2 Available in Green SOIC-8 and MSOP-8 Packages**

## APPLICATIONS

Audio  
Active Filter  
Signal Conditioning  
Sensor Amplification  
Data Acquisition  
Process Control  
Test Equipment  
Wideband Amplifier

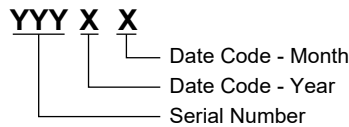
**PACKAGE/ORDERING INFORMATION**

| MODEL     | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER   | PACKAGE MARKING           | PACKING OPTION      |
|-----------|---------------------|-----------------------------|-------------------|---------------------------|---------------------|
| SGM8965-1 | SOT-23-5            | -40°C to +125°C             | SGM8965-1XN5G/TR  | SZ9XX                     | Tape and Reel, 3000 |
|           | SOIC-8              | -40°C to +125°C             | SGM8965-1XS8G/TR  | SGM<br>89651XS8<br>XXXXX  | Tape and Reel, 2500 |
| SGM8965-2 | SOIC-8              | -40°C to +125°C             | SGM8965-2XS8G/TR  | SGM<br>89652XS8<br>XXXXX  | Tape and Reel, 2500 |
|           | MSOP-8              | -40°C to +125°C             | SGM8965-2XMS8G/TR | SGM89652<br>XMS8<br>XXXXX | Tape and Reel, 4000 |

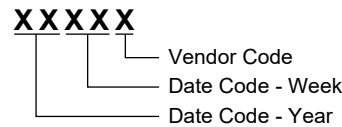
**MARKING INFORMATION**

NOTE: XX = Date Code. XXXXX = Date Code and Vendor Code.

**SOT-23-5**



**SOIC-8/MSOP-8**



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.....6V
- Signal Input Terminals, Voltage  
..... (-V<sub>S</sub>) - 0.3V to (+V<sub>S</sub>) + 0.3V
- Signal Input Terminals, Current ..... ±10mA
- Output Short-Circuit..... Continuous
- Junction Temperature.....+150°C
- Storage Temperature Range .....-65°C to +150°C
- Lead Temperature (Soldering, 10s).....+260°C
- ESD Susceptibility
- HBM..... 8000V
- MM..... 400V
- CDM ..... 1000V

**RECOMMENDED OPERATING CONDITIONS**

- Supply Voltage Range .....2.2V to 5.5V
- Operating Temperature Range.....-40°C to +125°C

**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**

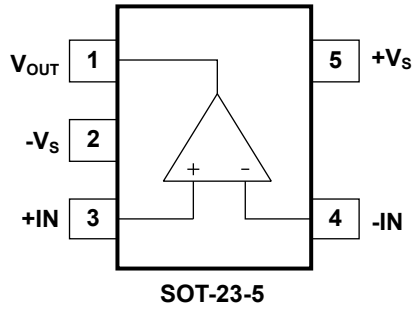
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

**DISCLAIMER**

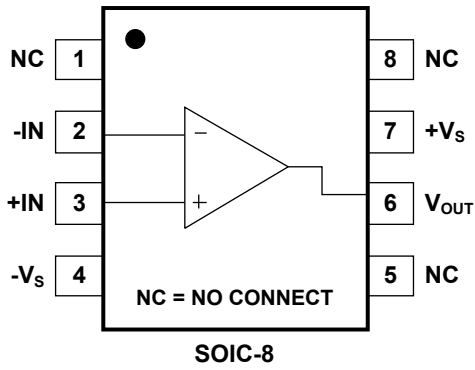
SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

**PIN CONFIGURATIONS**

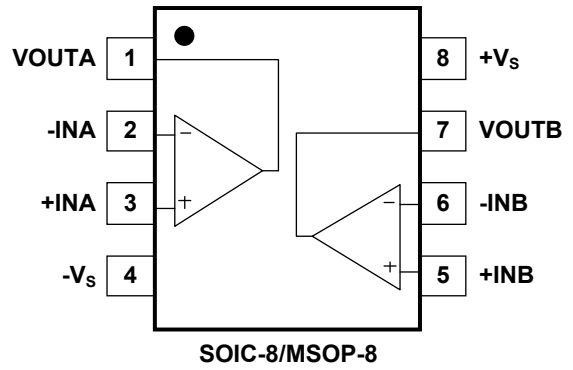
**SGM8965-1 (TOP VIEW)**



**SGM8965-1 (TOP VIEW)**



**SGM8965-2 (TOP VIEW)**



**ELECTRICAL CHARACTERISTICS**

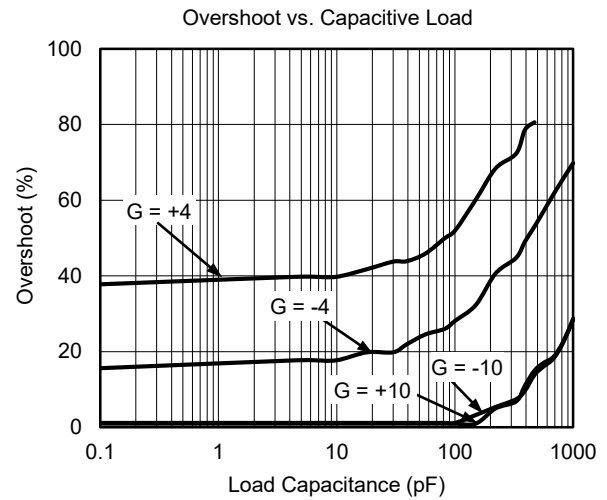
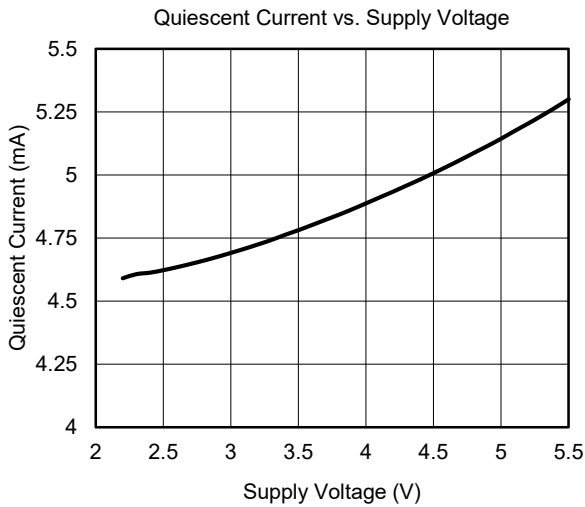
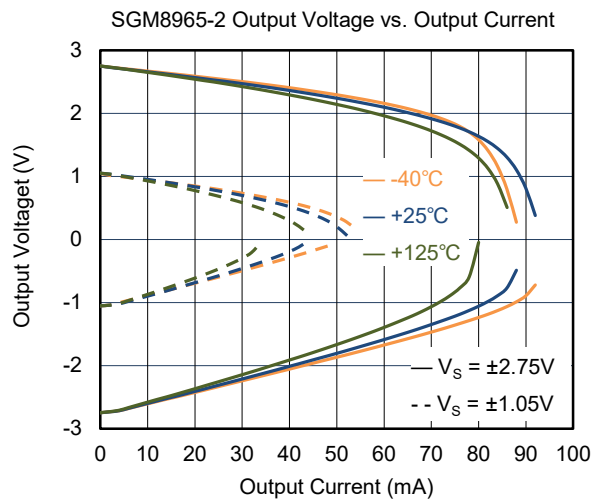
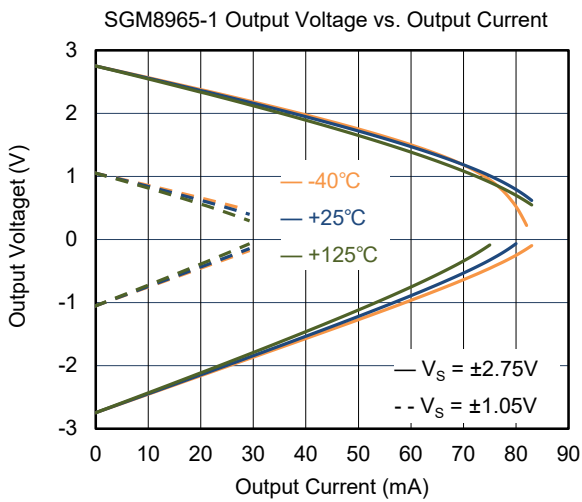
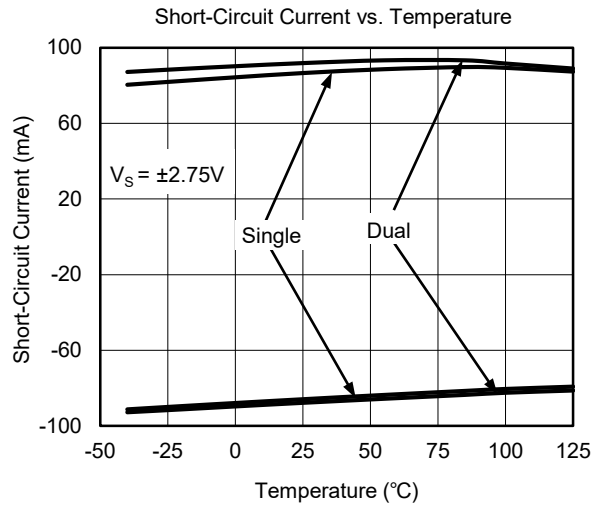
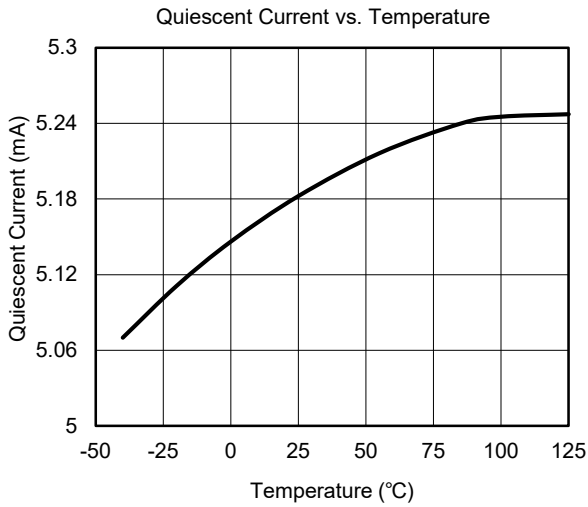
( $T_A = +25^\circ\text{C}$ ,  $V_S = 2.2\text{V}$  to  $5.5\text{V}$ ,  $V_{CM} = V_S/2$ ,  $V_{OUT} = V_S/2$  and  $R_L = 10\text{k}\Omega$  connected to  $V_S/2$ , unless otherwise noted.)

| PARAMETER  | SYMBOL                   | CONDITIONS   | MIN            | TYP     | MAX            | UNIT                         |
|--|--------------------------|--|----------------|---------|----------------|------------------------------|
| <b>Input Characteristics</b>                     |                          |  |                |         |                |                              |
| Input Offset Voltage                             | $V_{OS}$                 |  |                | 80      | 250            | $\mu\text{V}$                |
| Input Offset Voltage Drift                       | $\Delta V_{OS}/\Delta T$ | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$   |                | 1.2     |                | $\mu\text{V}/^\circ\text{C}$ |
| Power Supply Rejection Ratio                     | PSRR                     | $V_S = 2.2\text{V}$ to $5.5\text{V}$ , $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  |                | 6       | 90             | $\mu\text{V}/\text{V}$       |
| Input Bias Current                               | $I_B$                    |  |                | 0.5     |                | $\text{pA}$                  |
| Input Common Mode Voltage Range                  | $V_{CM}$                 |  | $(-V_S) - 0.1$ |         | $(+V_S) + 0.1$ | $\text{V}$                   |
| Common Mode Rejection Ratio                      | CMRR                     | $(-V_S) - 0.1\text{V} \leq V_{CM} \leq (+V_S) + 0.1\text{V}$ ,<br>$V_S = 5.5\text{V}$ , $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ | 82             | 100     |                | $\text{dB}$                  |
| Open-Loop Voltage Gain                           | $A_{OL}$                 | $R_L = 10\text{k}\Omega$ , $(-V_S) + 0.1\text{V} < V_O < (+V_S) - 0.1\text{V}$ ,<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$     | 94             | 115     |                | $\text{dB}$                  |
|  |                          | $R_L = 600\Omega$ , $(-V_S) + 0.2\text{V} < V_O < (+V_S) - 0.2\text{V}$<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$              | 94             | 105     |                |                              |
|  |                          | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$   | 90             |         |                |                              |
| <b>Output Characteristics</b>                    |                          |  |                |         |                |                              |
| Output Voltage Swing from Rail                   |                          | $R_L = 10\text{k}\Omega$ , $V_S = 5.5\text{V}$ ,<br>$-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$                                     |                | 8       | 22             | $\text{mV}$                  |
| Short-Circuit Current                            | $I_{SC}$                 | $V_S = 5\text{V}$  |                | 70      |                | $\text{mA}$                  |
| Open-Loop Output Impedance                       |                          | $f = 1\text{MHz}$ , $I_O = 0$  |                | 26      |                | $\Omega$                     |
| <b>Power Supply</b>                              |                          |  |                |         |                |                              |
| Operating Voltage Range                          | $V_S$                    |  | 2.2            |         | 5.5            | $\text{V}$                   |
| Quiescent Current/Amplifier                      | $I_Q$                    | $I_O = 0$  |                | 5.3     | 6.6            | $\text{mA}$                  |
|  |                          | $-40^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$   |                |         | 6.9            |                              |
| <b>Dynamic Performance</b>                       |                          |  |                |         |                |                              |
| Gain-Bandwidth Product                           | GBP                      | $V_S = 5\text{V}$  |                | 50      |                | $\text{MHz}$                 |
| Slew Rate  | SR                       | $V_S = 5\text{V}$ , $G = +1$   |                | 30      |                | $\text{V}/\mu\text{s}$       |
| Settling Time to 0.1%                            | $t_s$                    | $V_S = 5\text{V}$ , 4V Step, $G = +4$  |                | 220     |                | $\text{ns}$                  |
| Settling Time to 0.01%                           |                          | $V_S = 5\text{V}$ , 4V Step, $G = +4$  |                | 300     |                | $\text{ns}$                  |
| Overload Recovery Time                           |                          | $V_S = 5\text{V}$ , $V_{IN} \times \text{Gain} > V_S$  |                | < 0.1   |                | $\mu\text{s}$                |
| Total Harmonic Distortion + Noise <sup>(1)</sup> | THD+N                    | $V_S = 5\text{V}$ , $R_L = 600\Omega$ , $V_O = 4V_{PP}$ , $G = +1$ ,<br>$f = 1\text{kHz}$  |                | 0.00015 |                | $\%$                         |
| <b>Noise Performance</b>                         |                          |  |                |         |                |                              |
| Input Voltage Noise                              |                          | $f = 0.1\text{Hz}$ to $10\text{Hz}$  |                | 5       |                | $\mu\text{V}_{PP}$           |
| Input Voltage Noise Density                      | $e_n$                    | $f = 100\text{kHz}$  |                | 4.5     |                | $\text{nV}/\sqrt{\text{Hz}}$ |
| Input Current Noise Density                      | $i_n$                    | $f = 10\text{kHz}$   |                | 125     |                | $\text{fA}/\sqrt{\text{Hz}}$ |

NOTE: 1. 3rd-order filter; -3dB bandwidth: 80kHz.

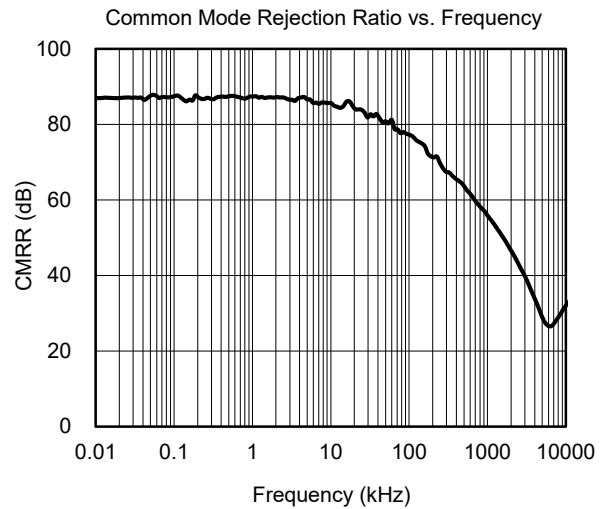
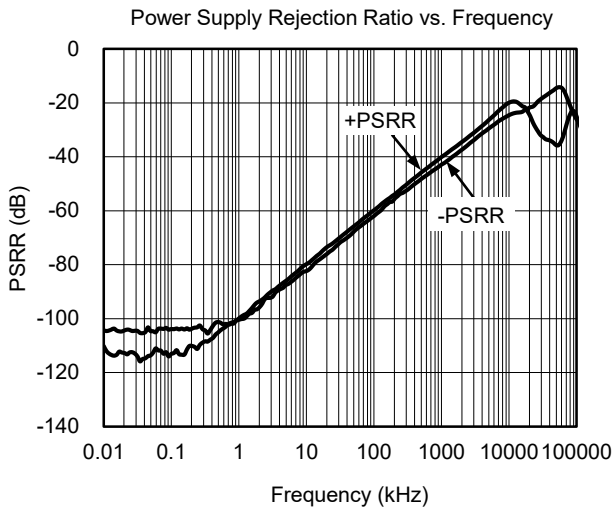
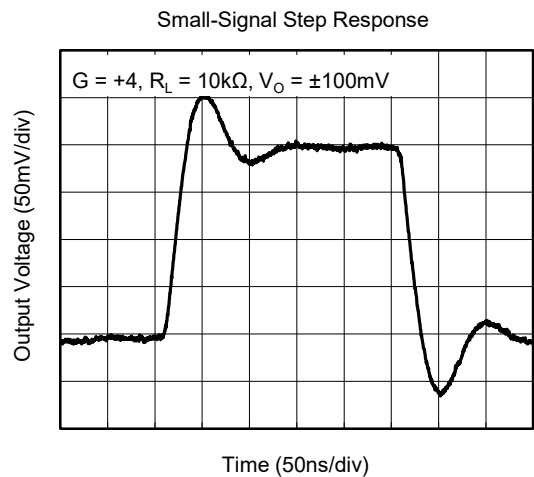
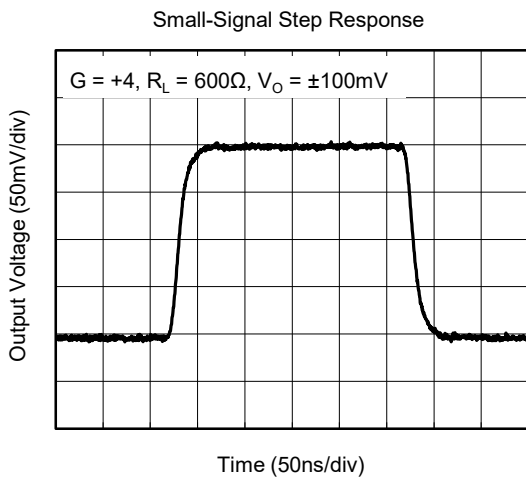
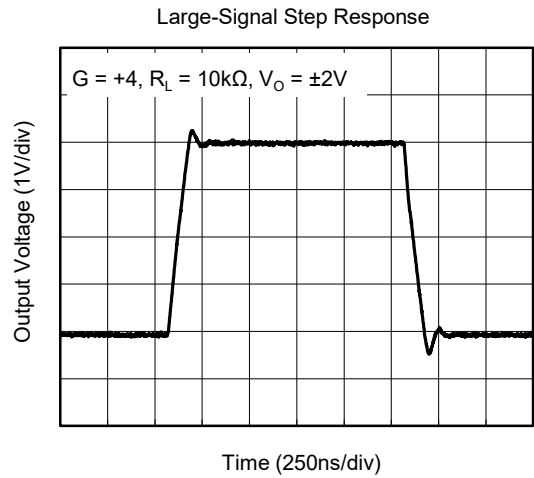
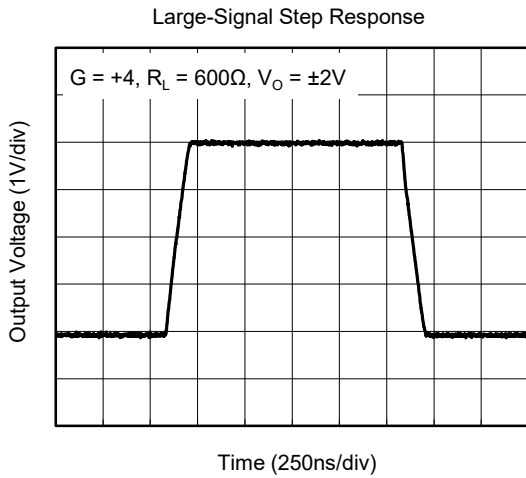
**TYPICAL PERFORMANCE CHARACTERISTICS**

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$  and  $C_L = 0\text{pF}$ , unless otherwise noted.



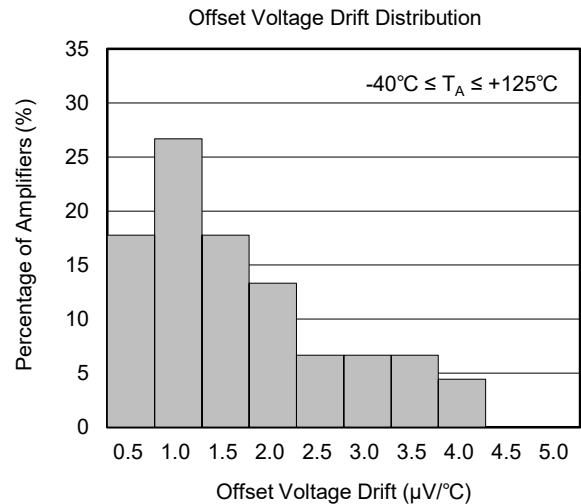
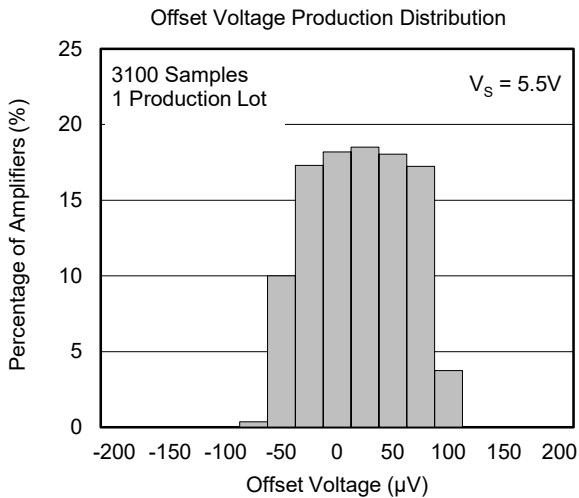
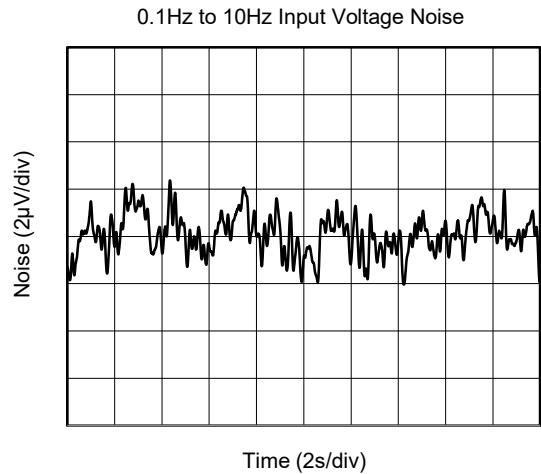
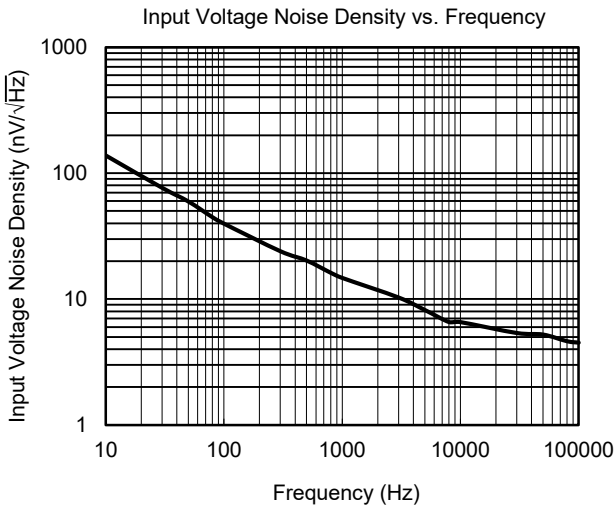
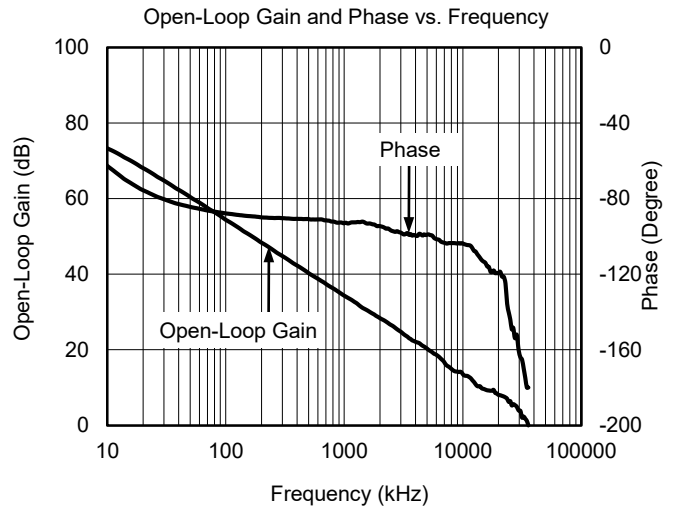
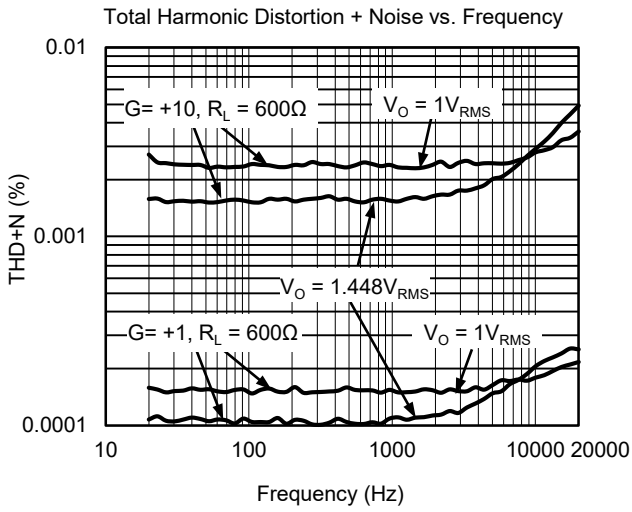
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$  and  $C_L = 0\text{pF}$ , unless otherwise noted.



**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5\text{V}$  and  $C_L = 0\text{pF}$ , unless otherwise noted.



## **REVISION HISTORY**

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

### **Changes from Original (DECEMBER 2016) to REV.A**

**Page**

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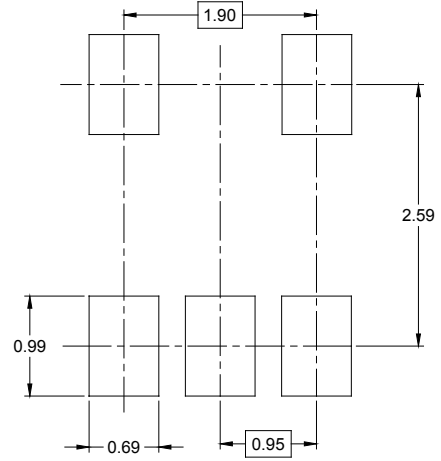
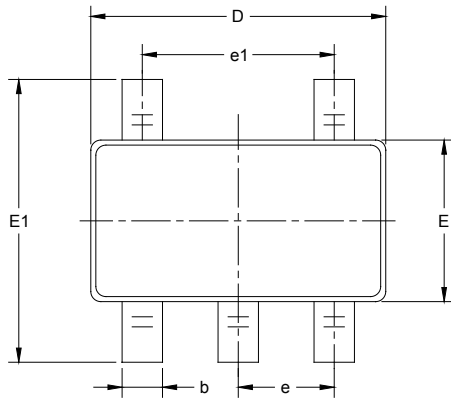
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| Changed from product preview to production data..... | All |
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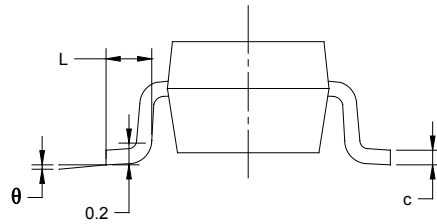


PACKAGE OUTLINE DIMENSIONS

SOT-23-5



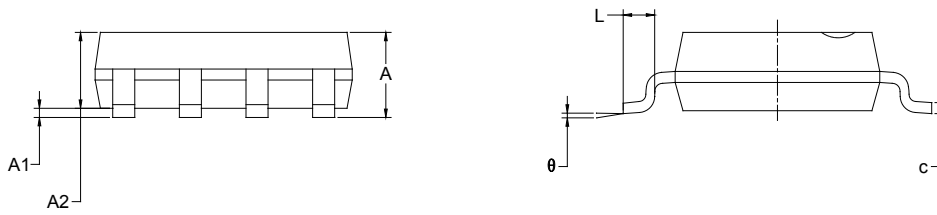
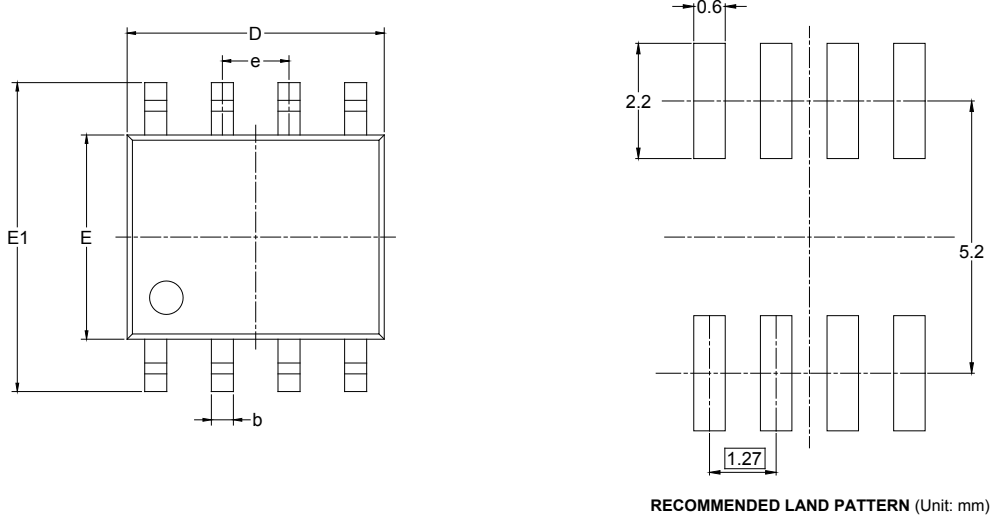
RECOMMENDED LAND PATTERN (Unit: mm)



| Symbol   | Dimensions<br>In Millimeters |       | Dimensions<br>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 |
| $\theta$ | 0°                           | 8°    | 0°                      | 8°    |

PACKAGE OUTLINE DIMENSIONS

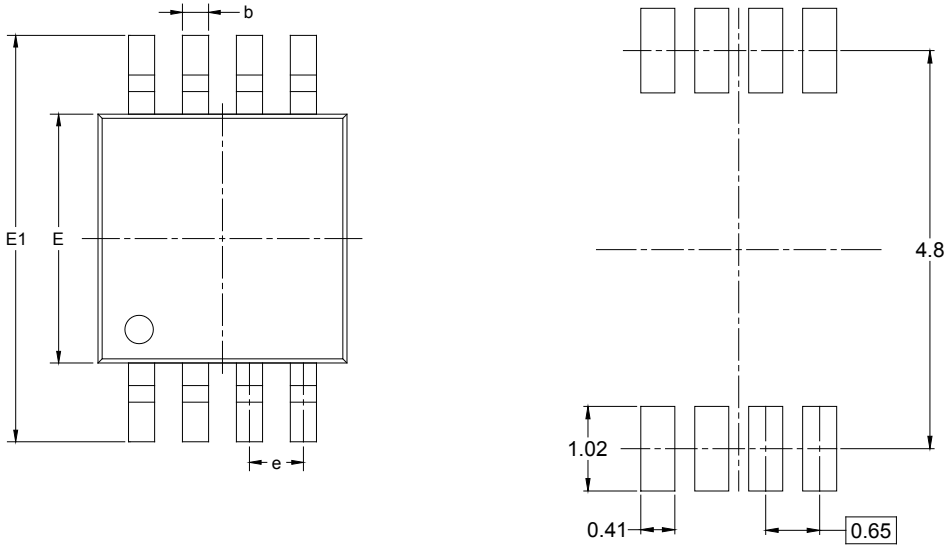
SOIC-8



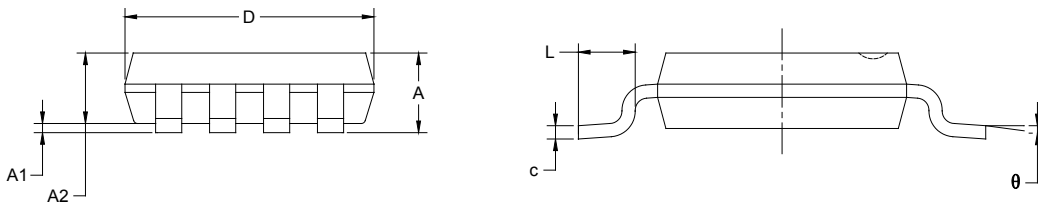
| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 1.350                        | 1.750 | 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<br>In Millimeters |       | Dimensions<br>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 INFORMATION

## 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            |
| 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            |

DD0001

# PACKAGE INFORMATION

## 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