

# SGM8558-1/SGM8558-2/SGM8558-3/SGM8558-4

## 15MHz, 8V/ $\mu$ s, High Output Drive, High Precision, Low Noise Operational Amplifiers

### GENERAL DESCRIPTION

The SGM8558-1 (single), SGM8558-2 (dual), SGM8558-3 (single with shutdown) and SGM8558-4 (quad) high output drive CMOS operational amplifiers feature a peak output current of 230mA, rail-to-rail output capability from a single 2.8V to 5.5V supply. These amplifiers exhibit a high slew rate of 8V/ $\mu$ s and a gain-bandwidth product (GBP) of 15MHz. The SGM8558-1/2/3/4 can drive typical headset levels (32 $\Omega$ ), as well as bias an RF power amplifier in wireless handset applications.

These operational amplifiers are designed to be part of the power amplifier control circuitry, biasing RF power amplifiers in wireless headsets. The SGM8558-3 offers a shutdown feature that drives the output low. This ensures that the RF power amplifier is fully disabled when needed, preventing unconverted signals to the RF antenna.

The SGM8558-1/2/3/4 also offer low input offset voltage, low input offset voltage drift, wide bandwidth and high output drive.

The SGM8558-1 is available in Green SOIC-8 and SOT-23-5 packages. The SGM8558-2 is available in Green TDFN-3 $\times$ 3-8L and SOIC-8 packages. The SGM8558-3 is available in a Green SOT-23-6 package. The SGM8558-4 is available in a Green SOIC-14 package. They operate over an ambient temperature range of -40 $^{\circ}$ C to +125 $^{\circ}$ C.

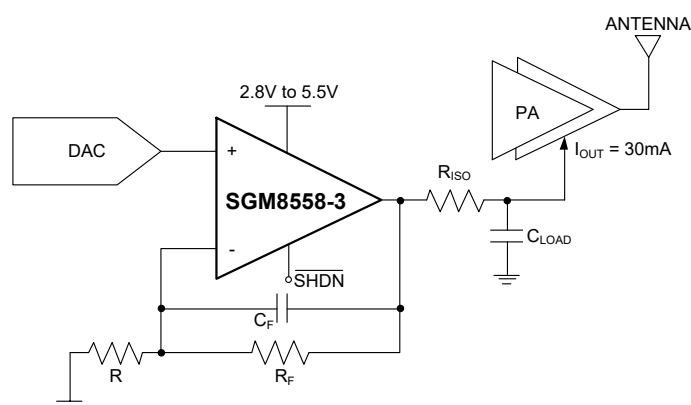
### APPLICATIONS

RF Power Amplifier Biasing Controls  
Portable/Battery-Powered Audio Applications  
Portable Headphone Speaker Drivers (32 $\Omega$ )  
Audio Hands-Free Car Phones (Kits)  
Laptop/Notebook Computers/TFT Panels  
Sound Ports/Cards  
Set-Top Boxes  
Digital-to-Analog Converter Buffers  
Transformer/Line Drivers  
Motor Drivers

### FEATURES

- 230mA Output Drive Capability
- Low Input Offset Voltage: 15 $\mu$ V (MAX)
- Low Noise: 8nV/ $\sqrt{\text{Hz}}$  at 1kHz
- 230mA Current Limitation
- Over-Temperature Protection
- Supply Voltage Range: 2.8V to 5.5V
- Supply Current:
  - 0.86mA/Amplifier (TYP)
  - 0.2 $\mu$ A (TYP) Shutdown Current for SGM8558-3
- Gain-Bandwidth Product: 15MHz
- High Slew Rate: 8V/ $\mu$ s
- Voltage Gain ( $R_L = 2\text{k}\Omega$ ): 139dB
- Power Supply Rejection Ratio: 130dB
- No Phase Reversal for Overdriven Inputs
- Unity-Gain Stable for Capacitive Loads to 780pF
- -40 $^{\circ}$ C to +125 $^{\circ}$ C Operating Temperature Range
- Small Packaging:
  - SGM8558-1 Available in Green SOIC-8 and SOT-23-5 Packages
  - SGM8558-2 Available in Green TDFN-3 $\times$ 3-8L and SOIC-8 Packages
  - SGM8558-3 Available in a Green SOT-23-6 Package
  - SGM8558-4 Available in a Green SOIC-14 Package

### TYPICAL APPLICATION



## PACKAGE/ORDERING INFORMATION

| MODEL     | PACKAGE DESCRIPTION  | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER    | PACKAGE MARKING          | PACKING OPTION      |
|-----------|----------------------|-----------------------------|--------------------|--------------------------|---------------------|
| SGM8558-1 | SOIC-8               | -40°C to +125°C             | SGM8558-1XS8G/TR   | SGM<br>85581XS8<br>XXXXX | Tape and Reel, 2500 |
|           | SOT-23-5             | -40°C to +125°C             | SGM8558-1XN5G/TR   | GFBXX                    | Tape and Reel, 3000 |
| SGM8558-2 | TDFN-3 $\times$ 3-8L | -40°C to +125°C             | SGM8558-2XTDB8G/TR | SGM<br>85582DB<br>XXXXX  | Tape and Reel, 4000 |
|           | SOIC-8               | -40°C to +125°C             | SGM8558-2XS8G/TR   | SGM<br>85582XS8<br>XXXXX | Tape and Reel, 2500 |
| SGM8558-3 | SOT-23-6             | -40°C to +125°C             | SGM8558-3XN6G/TR   | GFCXX                    | Tape and Reel, 3000 |
| SGM8558-4 | SOIC-14              | -40°C to +125°C             | SGM8558-4XS14G/TR  | SGM85584XS14<br>XXXXX    | Tape and Reel, 2500 |

## MARKING INFORMATION

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

### SOT-23-5/SOT-23-6

YYY X X

Date Code - Month  
 Date Code - Year  
 Serial Number

### SOIC-8/TDFN-3 $\times$ 3-8L/SOIC-14

XXXXX

Vendor Code  
 Date Code - Week  
 Date Code - Year

Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage, +V<sub>S</sub> to -V<sub>S</sub>.....6V  
 All Other Pins..... (-V<sub>S</sub> - 0.3V) to (+V<sub>S</sub> + 0.3V)  
 Junction Temperature .....+150°C  
 Storage Temperature Range.....-65°C to +150°C  
 Lead Temperature (Soldering, 10s) .....+260°C

## RECOMMENDED OPERATING CONDITIONS

Operating Temperature Range .....-40°C to +125°C  
 Operating Supply Voltage Range.....2.8V to 5.5V  
 ESD Susceptibility  
 HBM.....8000V  
 MM.....400V  
 CDM .....1000V

## OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods

may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

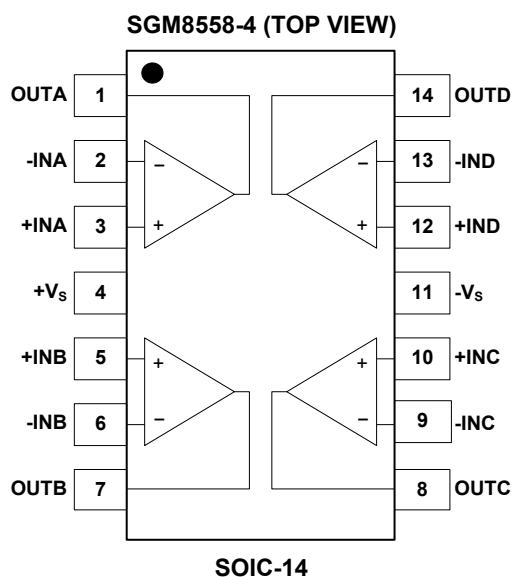
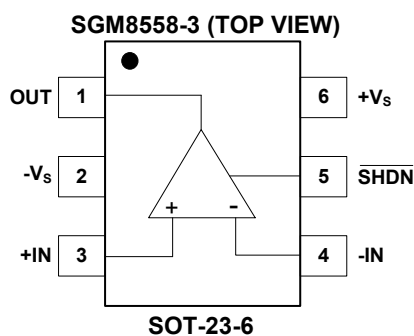
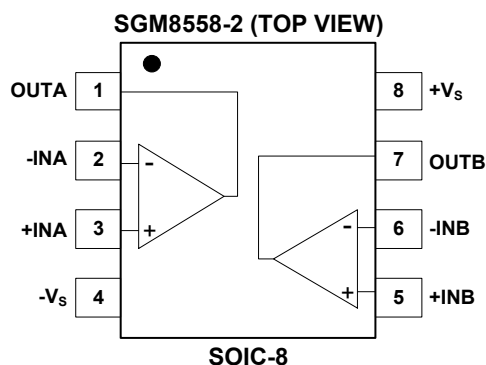
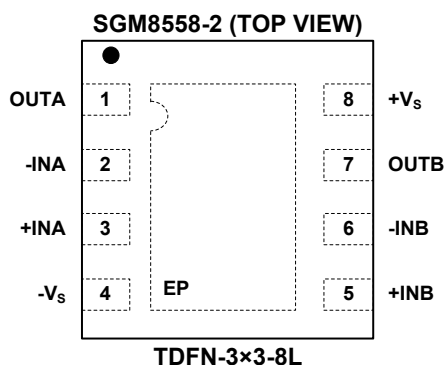
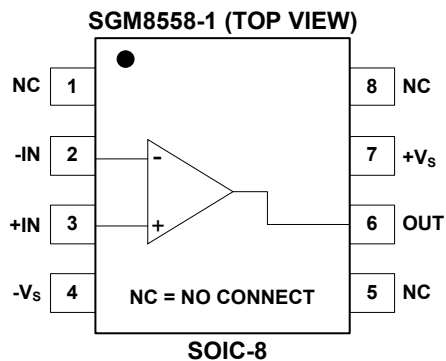
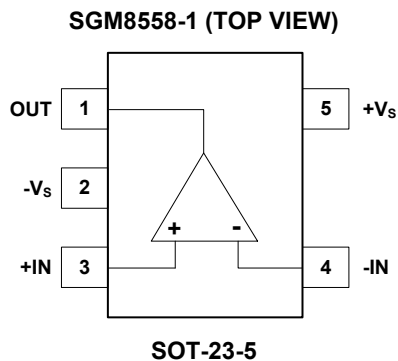
## ESD SENSITIVITY CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

## DISCLAIMER

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

## PIN CONFIGURATIONS



NOTE: For all packages, connect thermal die pad to  $-V_s$  or floating. Soldering the thermal pad improves heat dissipation and provides specified performance.

## ELECTRICAL CHARACTERISTICS

(At  $T_A = +25^\circ\text{C}$ , Full =  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ ,  $V_S = 2.8\text{V}$ ,  $-V_S = 0\text{V}$ ,  $V_{CM} = +V_S/2$ ,  $V_{OUT} = +V_S/2$ , unless otherwise noted.)

| PARAMETER                                          | CONDITIONS                                                                                      | TEMP  | MIN                      | TYP | MAX                      | UNITS             |
|----------------------------------------------------|-------------------------------------------------------------------------------------------------|-------|--------------------------|-----|--------------------------|-------------------|
| INPUT CHARACTERISTICS                              |                                                                                                 |       |                          |     |                          |                   |
| Input Offset Voltage (V <sub>OS</sub> )            |                                                                                                 | +25°C |                          | 1.5 | 15                       | μV                |
| Input Common Mode Voltage Range (V <sub>CM</sub> ) |                                                                                                 | +25°C | (-V <sub>S</sub> ) - 0.1 |     | (+V <sub>S</sub> ) + 0.1 | V                 |
| Common Mode Rejection Ratio (CMRR)                 | (-V <sub>S</sub> ) - 0.1V < V <sub>CM</sub> < (+V <sub>S</sub> ) + 0.1V                         | +25°C | 96                       | 118 |                          | dB                |
|                                                    |                                                                                                 | Full  | 90                       |     |                          |                   |
| Open-Loop Voltage Gain (A <sub>OL</sub> )          | (-V <sub>S</sub> ) + 0.1V < V <sub>OUT</sub> < (+V <sub>S</sub> ) - 0.1V, R <sub>L</sub> = 2kΩ  | +25°C | 108                      | 131 |                          | dB                |
|                                                    |                                                                                                 | Full  | 105                      |     |                          |                   |
|                                                    | (-V <sub>S</sub> ) + 0.1V < V <sub>OUT</sub> < (+V <sub>S</sub> ) - 0.1V, R <sub>L</sub> = 200Ω | +25°C | 106                      | 130 |                          |                   |
|                                                    |                                                                                                 | Full  | 103                      |     |                          |                   |
| OUTPUT CHARACTERISTICS                             |                                                                                                 |       |                          |     |                          |                   |
| Output Voltage Swing from Rail                     | R <sub>L</sub> = 2kΩ                                                                            | +25°C |                          | 5   | 11                       | mV                |
|                                                    |                                                                                                 | Full  |                          |     | 12                       |                   |
|                                                    | R <sub>L</sub> = 200Ω                                                                           | +25°C |                          | 45  | 55                       |                   |
|                                                    |                                                                                                 | Full  |                          |     | 66                       |                   |
| Output Short-Circuit Current (I <sub>SC</sub> )    |                                                                                                 | +25°C | 96                       | 120 |                          | mA                |
|                                                    |                                                                                                 | Full  | 75                       |     |                          |                   |
| POWER SUPPLY                                       |                                                                                                 |       |                          |     |                          |                   |
| Specified Voltage Range (V <sub>S</sub> )          |                                                                                                 | +25°C | 2.8                      |     | 5.5                      | V                 |
| Quiescent Current/Amplifier (I <sub>Q</sub> )      | I <sub>OUT</sub> = 0                                                                            | +25°C |                          | 827 | 1250                     | μA                |
|                                                    |                                                                                                 | Full  |                          |     | 1450                     |                   |
| Power Supply Rejection Ratio (PSRR)                | V <sub>S</sub> = 2.8V to 5.5V, V <sub>CM</sub> = 0.2V                                           | +25°C | 102                      | 130 |                          | dB                |
|                                                    |                                                                                                 | Full  | 100                      |     |                          |                   |
| DYNAMIC PERFORMANCE                                |                                                                                                 |       |                          |     |                          |                   |
| Gain-Bandwidth Product                             | G = +100, C <sub>L</sub> = 100pF                                                                | +25°C |                          | 14  |                          | MHz               |
| Slew Rate                                          | G = +1, V <sub>OUT</sub> = 2V <sub>P-P</sub>                                                    | +25°C |                          | 8   |                          | V/μs              |
| NOISE                                              |                                                                                                 |       |                          |     |                          |                   |
| Input Voltage Noise                                | f = 0.1Hz to 10Hz                                                                               | +25°C |                          | 0.3 |                          | μV <sub>P-P</sub> |
| Input Voltage Noise Density                        | f = 1kHz                                                                                        | +25°C |                          | 11  |                          | nV/√Hz            |
|                                                    | f = 10kHz                                                                                       | +25°C |                          | 11  |                          |                   |

## ELECTRICAL CHARACTERISTICS (continued)

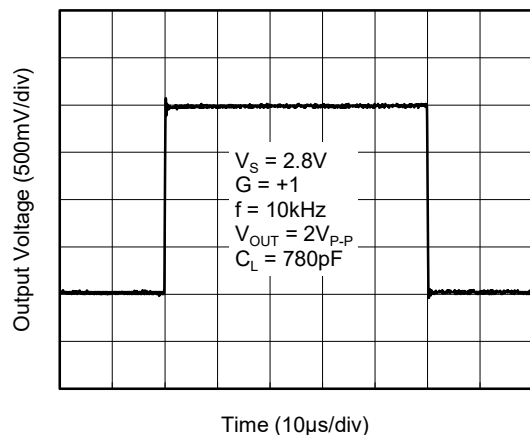
(At  $T_A = +25^\circ\text{C}$ , Full =  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ ,  $V_S = 5\text{V}$ ,  $-V_S = 0\text{V}$ ,  $V_{CM} = +V_S/2$ ,  $V_{OUT} = +V_S/2$ , unless otherwise noted.)

| PARAMETER                                          | CONDITIONS                                                                                      |               | TEMP  | MIN                      | TYP | MAX                      | UNITS             |
|----------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------|-------|--------------------------|-----|--------------------------|-------------------|
| INPUT CHARACTERISTICS                              |                                                                                                 |               |       |                          |     |                          |                   |
| Input Offset Voltage (V <sub>OS</sub> )            |                                                                                                 |               | +25°C |                          | 1.5 | 15                       | μV                |
| Input Offset Voltage Drift (ΔV <sub>OS</sub> /ΔT)  |                                                                                                 |               | Full  |                          | 13  | 66                       | nV/°C             |
| Input Bias Current (I <sub>B</sub> )               |                                                                                                 |               | +25°C |                          | 0.6 | 3                        | nA                |
| Input Offset Current (I <sub>OS</sub> )            |                                                                                                 |               | +25°C |                          | 1.2 | 5.2                      | nA                |
| Input Common Mode Voltage Range (V <sub>CM</sub> ) |                                                                                                 |               | +25°C | (-V <sub>S</sub> ) - 0.1 |     | (+V <sub>S</sub> ) + 0.1 | V                 |
| Common Mode Rejection Ratio (CMRR)                 | (-V <sub>S</sub> ) - 0.1V < V <sub>CM</sub> < (+V <sub>S</sub> ) + 0.1V                         | +25°C         | 102   | 126                      |     |                          | dB                |
|                                                    |                                                                                                 | Full          | 97    |                          |     |                          |                   |
| Open-Loop Voltage Gain (A <sub>OL</sub> )          | (-V <sub>S</sub> ) + 0.1V < V <sub>OUT</sub> < (+V <sub>S</sub> ) - 0.1V, R <sub>L</sub> = 2kΩ  | +25°C         | 116   | 139                      |     |                          | dB                |
|                                                    |                                                                                                 | Full          | 113   |                          |     |                          |                   |
|                                                    | (-V <sub>S</sub> ) + 0.1V < V <sub>OUT</sub> < (+V <sub>S</sub> ) - 0.1V, R <sub>L</sub> = 200Ω | +25°C         | 114   | 136                      |     |                          |                   |
|                                                    |                                                                                                 | Full          | 110   |                          |     |                          |                   |
| OUTPUT CHARACTERISTICS                             |                                                                                                 |               |       |                          |     |                          |                   |
| Output Voltage Swing from Rail                     | R <sub>L</sub> = 2kΩ                                                                            | +25°C         |       | 7                        | 16  |                          | mV                |
|                                                    |                                                                                                 | Full          |       |                          | 18  |                          |                   |
|                                                    | R <sub>L</sub> = 200Ω                                                                           | +25°C         |       | 63                       | 88  |                          |                   |
|                                                    |                                                                                                 | Full          |       |                          | 104 |                          |                   |
| Output Short-Circuit Current (I <sub>SC</sub> )    |                                                                                                 | +25°C         | 193   | 230                      |     |                          | mA                |
|                                                    |                                                                                                 | Full          | 173   |                          |     |                          |                   |
| POWER-DOWN DISABLE (SGM8558-3 Only)                |                                                                                                 |               |       |                          |     |                          |                   |
| Logic Threshold                                    | V <sub>IH</sub>                                                                                 | Normal mode   | +25°C | 2.0                      |     |                          | V                 |
|                                                    | V <sub>IL</sub>                                                                                 | Shutdown mode | +25°C |                          |     | 0.8                      |                   |
| Shutdown Supply Current                            | V <sub>EN</sub> = 0V                                                                            |               | +25°C |                          | 0.2 | 1.5                      | μA                |
| POWER SUPPLY                                       |                                                                                                 |               |       |                          |     |                          |                   |
| Specified Voltage Range (V <sub>S</sub> )          |                                                                                                 |               | +25°C | 2.8                      |     | 5.5                      | V                 |
| Quiescent Current/Amplifier (I <sub>Q</sub> )      | I <sub>OUT</sub> = 0                                                                            |               | +25°C |                          | 860 | 1280                     | μA                |
|                                                    |                                                                                                 |               | Full  |                          |     | 1500                     |                   |
| DYNAMIC PERFORMANCE                                |                                                                                                 |               |       |                          |     |                          |                   |
| Gain-Bandwidth Product                             | G = +100, C <sub>L</sub> = 100pF                                                                |               | +25°C |                          | 15  |                          | MHz               |
| Slew Rate                                          | G = +1, V <sub>OUT</sub> = 2V <sub>P-P</sub>                                                    |               | +25°C |                          | 8   |                          | V/μs              |
| NOISE                                              |                                                                                                 |               |       |                          |     |                          |                   |
| Input Voltage Noise                                | f = 0.1Hz to 10Hz                                                                               |               | +25°C |                          | 0.2 |                          | μV <sub>P-P</sub> |
| Input Voltage Noise Density                        | f = 1kHz                                                                                        |               | +25°C |                          | 8   |                          | nV/√Hz            |
|                                                    | f = 10kHz                                                                                       |               | +25°C |                          | 8   |                          |                   |

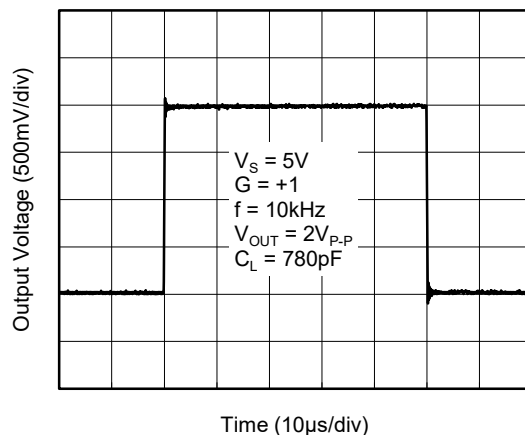
## TYPICAL PERFORMANCE CHARACTERISTICS

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5.0\text{V}$ , unless otherwise noted.

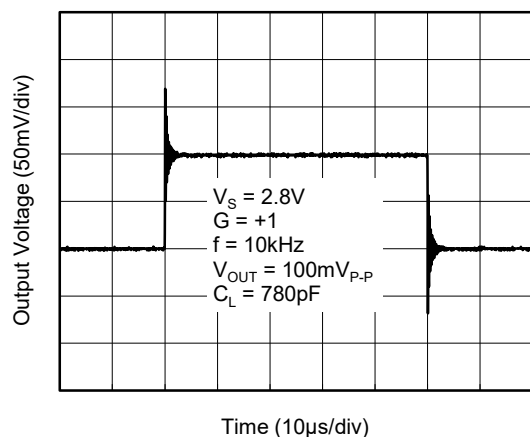
Large-Signal Transient Response with Capacitive Load



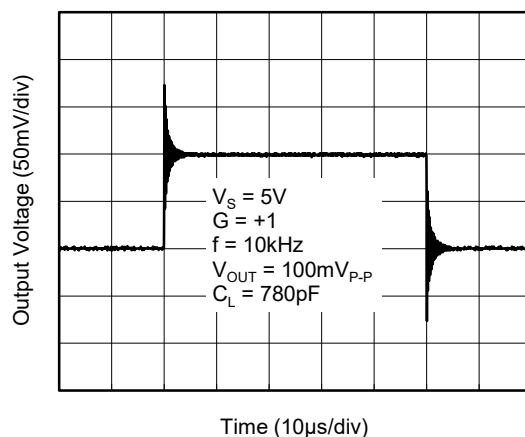
Large-Signal Transient Response with Capacitive Load



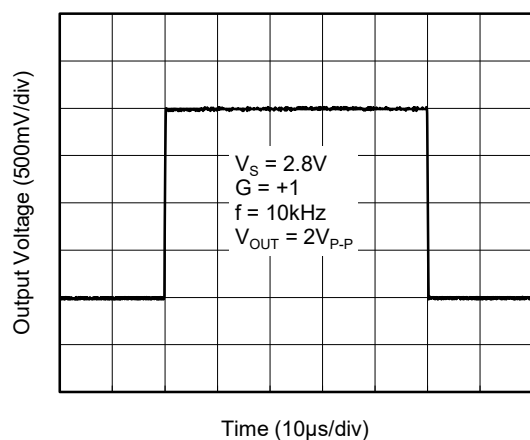
Small-Signal Transient Response with Capacitive Load



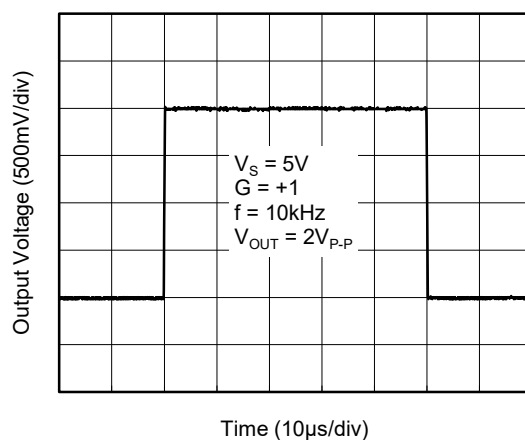
Small-Signal Transient Response with Capacitive Load



Large-Signal Step Response



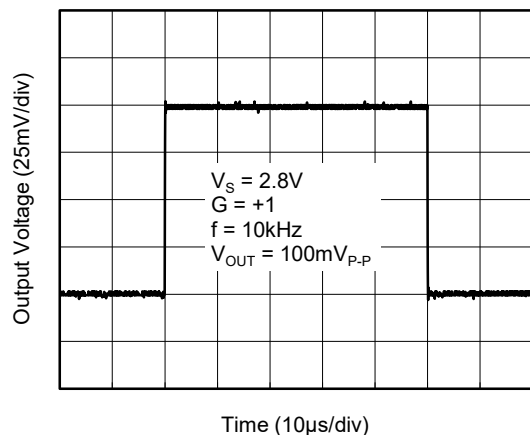
Large-Signal Step Response



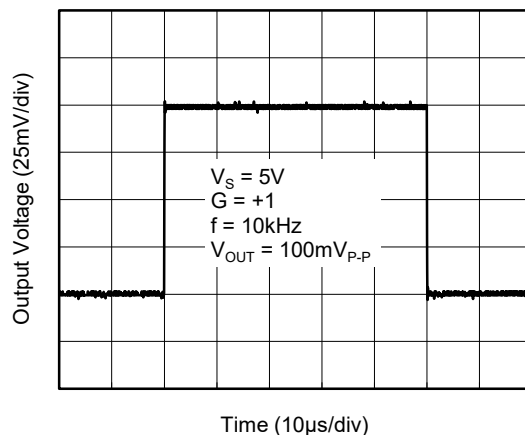
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5.0\text{V}$ , unless otherwise noted.

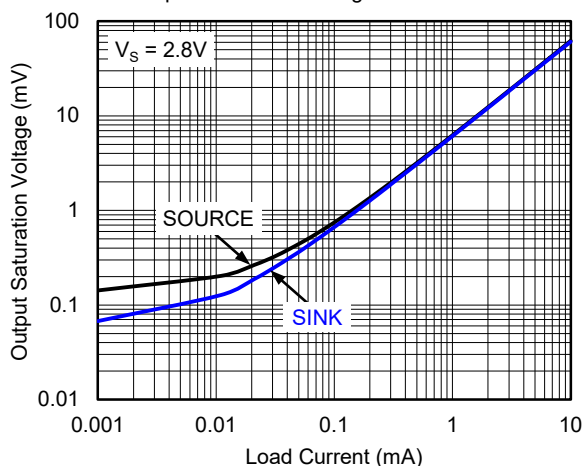
Small-Signal Step Response



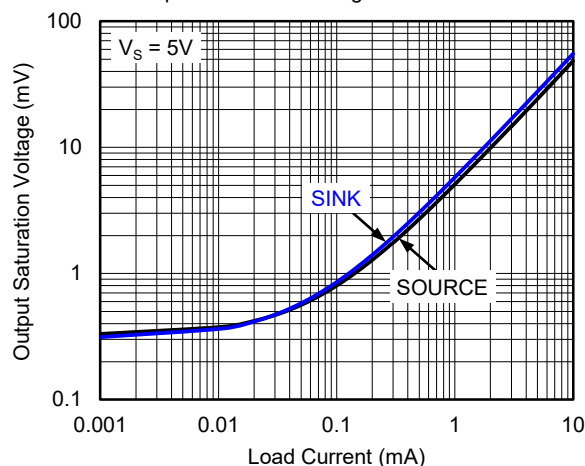
Small-Signal Step Response



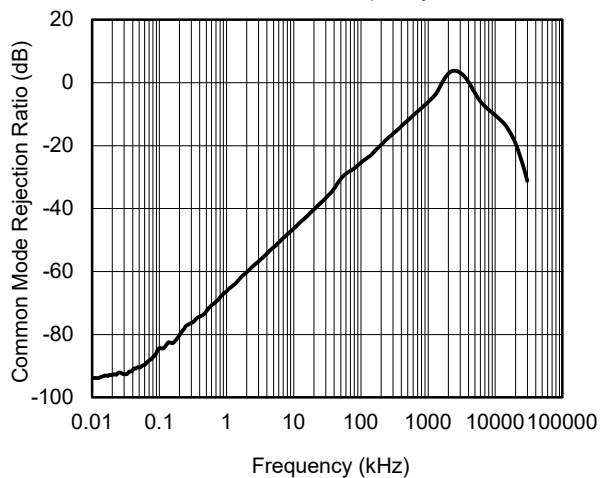
Output Saturation Voltage vs. Load Current



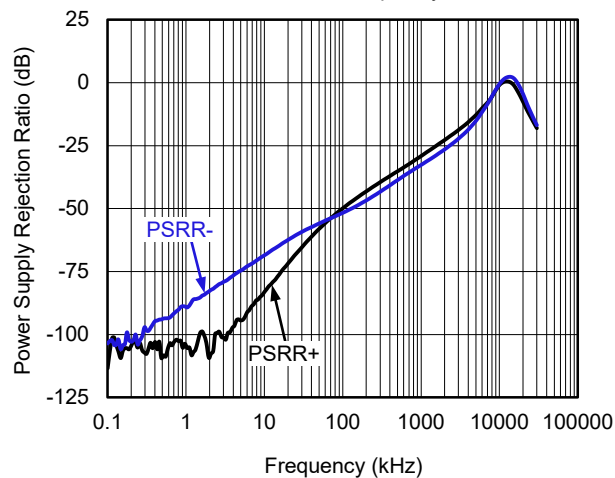
Output Saturation Voltage vs. Load Current



CMRR vs. Frequency

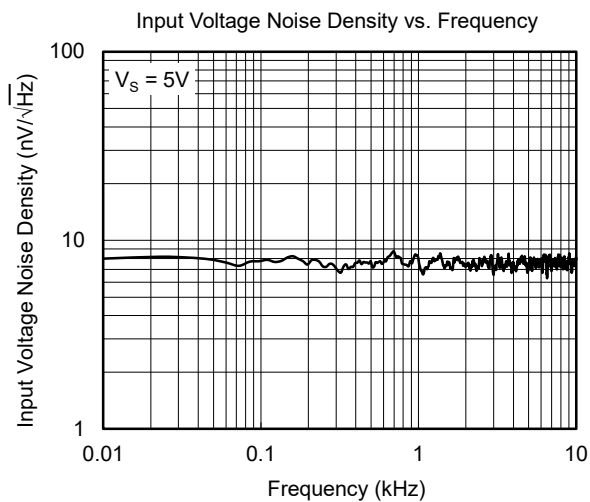
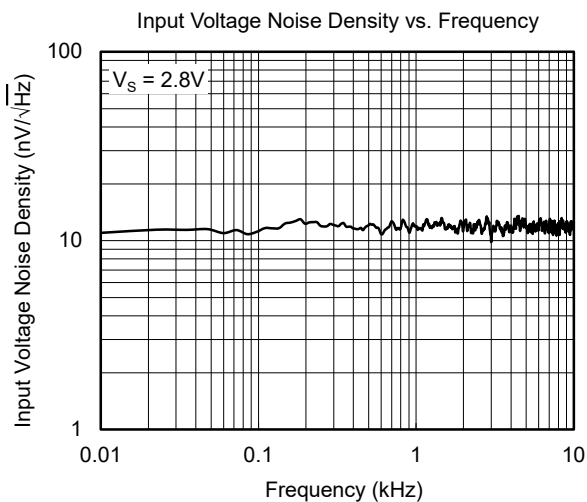
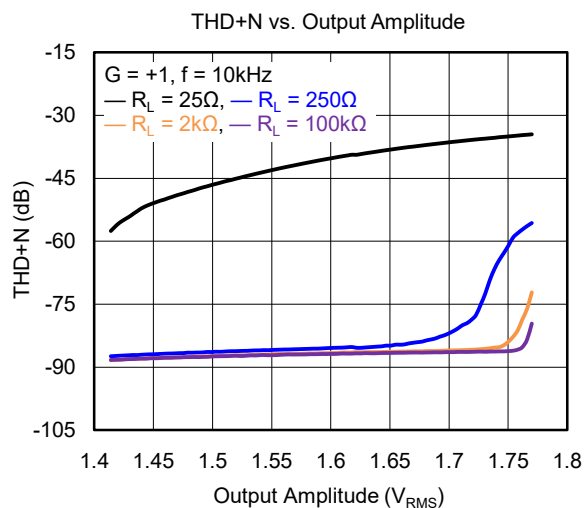
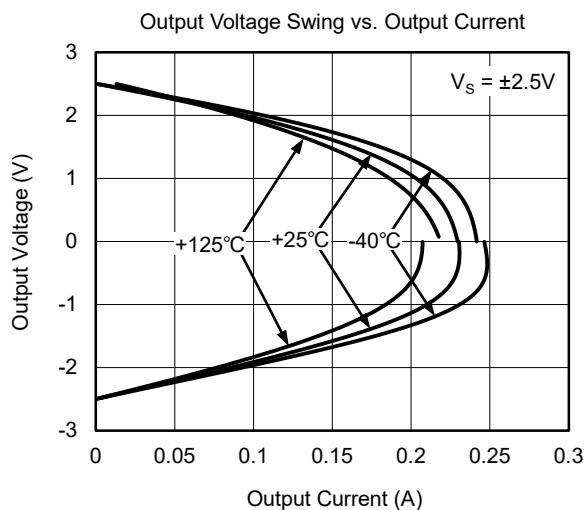
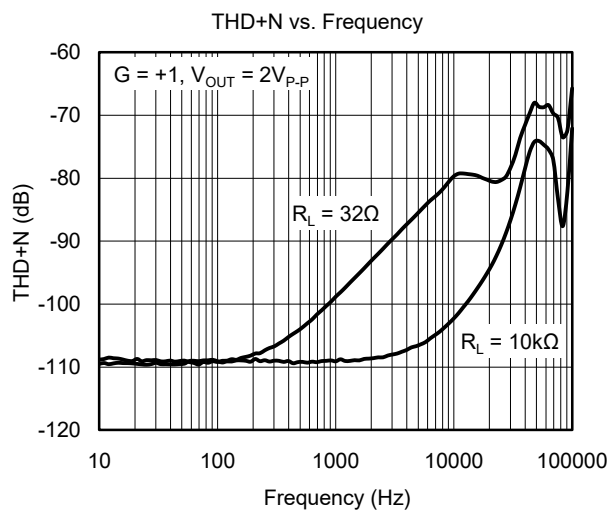
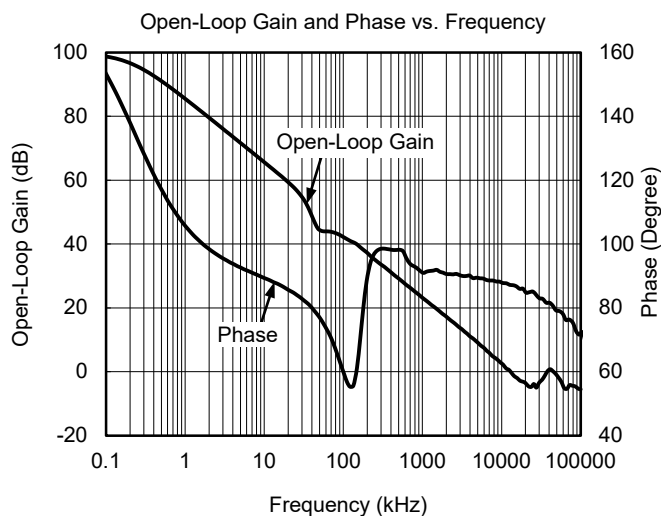


PSRR vs. Frequency



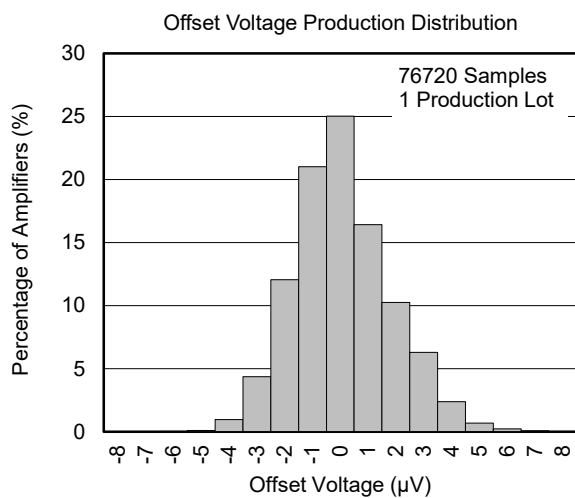
## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5.0\text{V}$ , unless otherwise noted.



## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

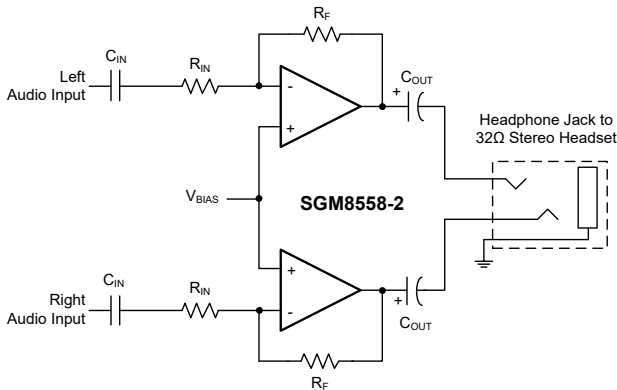
At  $T_A = +25^\circ\text{C}$ ,  $V_S = 5.0\text{V}$ , unless otherwise noted.



## APPLICATION INFORMATION

### 60mW Single-Supply Stereo Headphone Driver

The SGM8558-2 can be used as a single supply, stereo headphone driver.



**Figure 1. Circuit Example: A Single-Supply, Stereo Headphone Driver**

The input capacitor ( $C_{IN}$ ), in conjunction with  $R_{IN}$ , forms a high-pass filter that removes the DC bias from the incoming signal. The -3dB point of the high-pass filter is given by:

$$f_{-3dB} = \frac{1}{2\pi R_{IN} C_{IN}}$$

Choose gain-setting resistors  $R_{IN}$  and  $R_F$  according to the amount of desired gain, keeping in mind the maximum output amplitude. The output coupling capacitor ( $C_{OUT}$ ), blocks the DC component of the amplifier output, preventing DC current flowing to the load. The output capacitor and the load impedance form a high-pass filter with the -3dB point determined by:

$$f_{-3dB} = \frac{1}{2\pi R_L C_{OUT}}$$

For a 32 $\Omega$  load, a 100 $\mu$ F aluminum electrolytic capacitor gives a low-frequency pole at 50Hz.

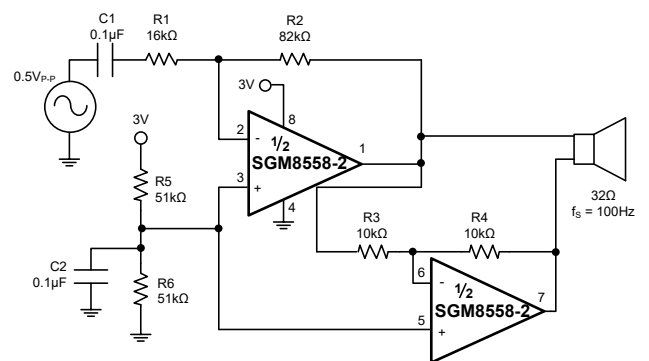
### Rail-to-Rail Output Stage

The minimum output is within millivolts of ground for single-supply operation, where the load is referenced to ground ( $-V_S$ ). The maximum output voltage swing is load dependent.

Observe the Absolute Maximum Ratings for power dissipation and output short-circuit duration because the output current can exceed 230mA.

### Bridge Amplifier

The circuit shown in Figure 2 uses an SGM8558-2 to implement a 3V, 200mW amplifier suitable for use in size-constrained applications. This configuration eliminates the need for the large coupling capacitor required by the single operational amplifier speaker driver when single-supply operation is necessary. Voltage gain is set to 10V/V; however, it can be changed by adjusting the 82k $\Omega$  resistor value.



**Figure 2. SGM8558-2 Bridge Amplifier for 200mW at 3V**

### Input Capacitance

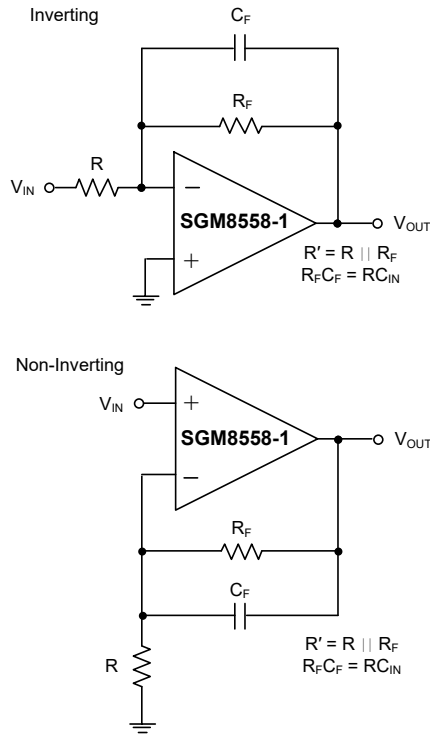
One consequence of the parallel-connected differential input stages is a relatively large input capacitance  $C_{IN}$  (20pF TYP). This introduces a pole at frequency  $(2\pi R' C_{IN})^{-1}$ , where  $R'$  is the parallel combination of the gain-setting resistors for the inverting or non-inverting amplifier configuration (Figure 3). If the pole frequency is less than or comparable to the unity-gain bandwidth (15MHz), the phase margin is reduced, and the amplifier exhibits degraded AC performance through either ringing in the step response or sustained oscillations. The pole frequency is 10MHz when  $R' = 2k\Omega$ . To maximize stability,  $R' \ll 2k\Omega$  is recommended.

## APPLICATION INFORMATION (continued)

To improve step response when  $R' > 2k\Omega$ , connect small capacitor  $C_F$  between the inverting input and output. Choose  $C_F$  as follows:

$$C_F = 8(R/R_F) \text{ [pF]}$$

where  $R_F$  is the feedback resistor and  $R$  is the gain-setting resistor (Figure 3).

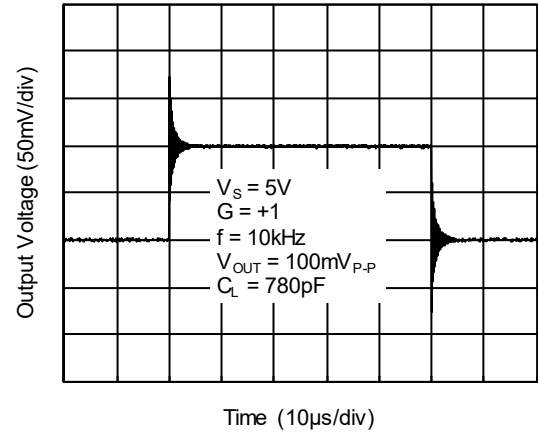


**Figure 3. Inverting and Non-Inverting Amplifiers with Feedback Compensation**

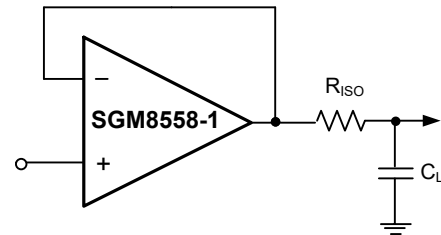
### Driving Capacitive Loads

The SGM8558-1/2/3/4 have a high tolerance for capacitive loads. They are stable with capacitive loads up to 780pF. Figure 4 shows the transient response with capacitive loads (780pF), without the addition of an isolation resistor in series with the output. Figure 5 shows a typical non-inverting capacitive-load-driving circuit in the unity-gain configuration.

The resistor improves the circuit's phase margin by isolating the load capacitor from the operational amplifier's output.



**Figure 4. Small-Signal Transient Response with Capacitive Load**



**Figure 5. Capacitive-Load-Driving Circuit**

### Power Supplies and Layout

The SGM8558-1/2/3/4 can operate from a single 2.8V to 5.5V supply, or from dual  $\pm 1.4V$  to  $\pm 2.75V$  supplies. For single-supply operation, bypass the power supply with a 0.1 $\mu$ F ceramic capacitor. For dual-supply operation, bypass each supply to ground. Good layout improves performance by decreasing the amount of stray capacitance at the operational amplifiers' inputs and outputs. Decrease stray capacitance by placing external components close to the operational amplifiers' pins, minimizing trace and lead lengths.

REVISION HISTORY

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

JANUARY 2019 – REV.A to REV.A.1

|                       |    |
|-----------------------|----|
| Changed Figure 2..... | 10 |
|-----------------------|----|

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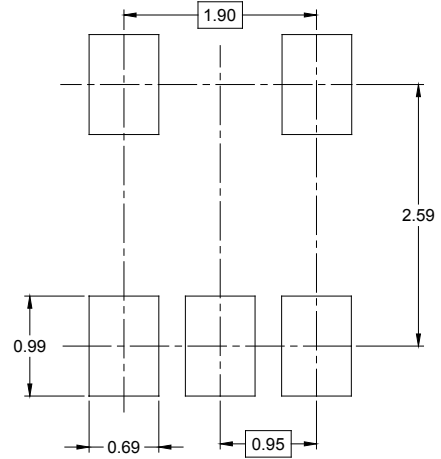
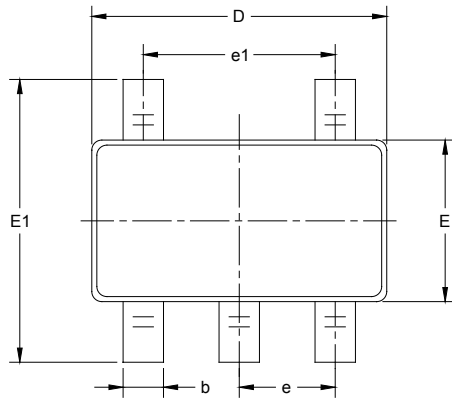
Changes from Original (SEPTEMBER 2018) to REV.A

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

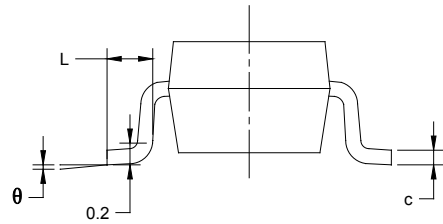
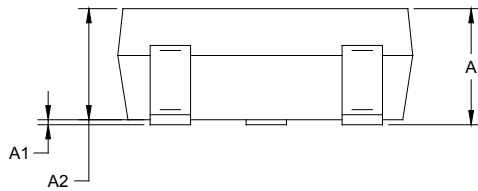
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## PACKAGE OUTLINE DIMENSIONS

### SOT-23-5



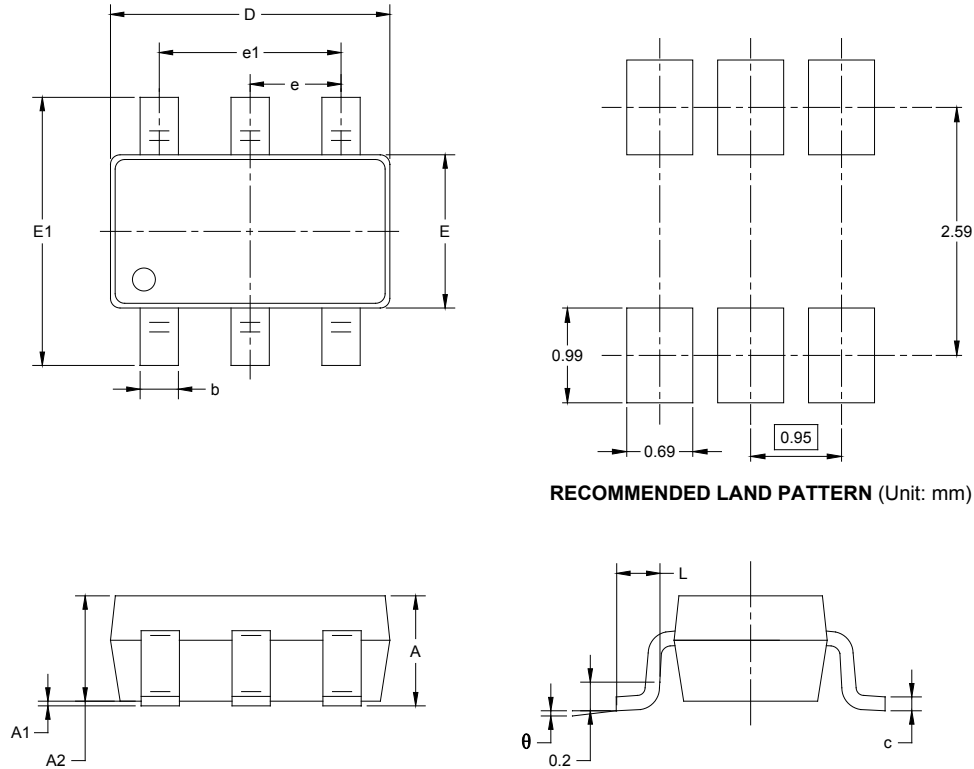
RECOMMENDED LAND PATTERN (Unit: mm)



| 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

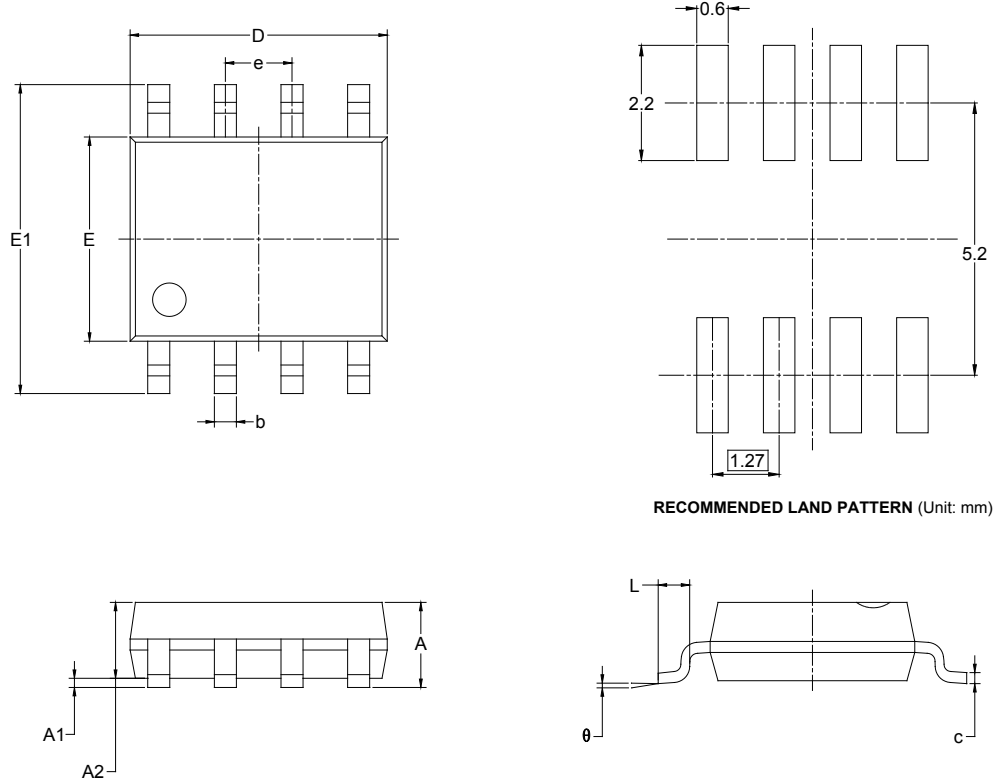
### SOT-23-6



| 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

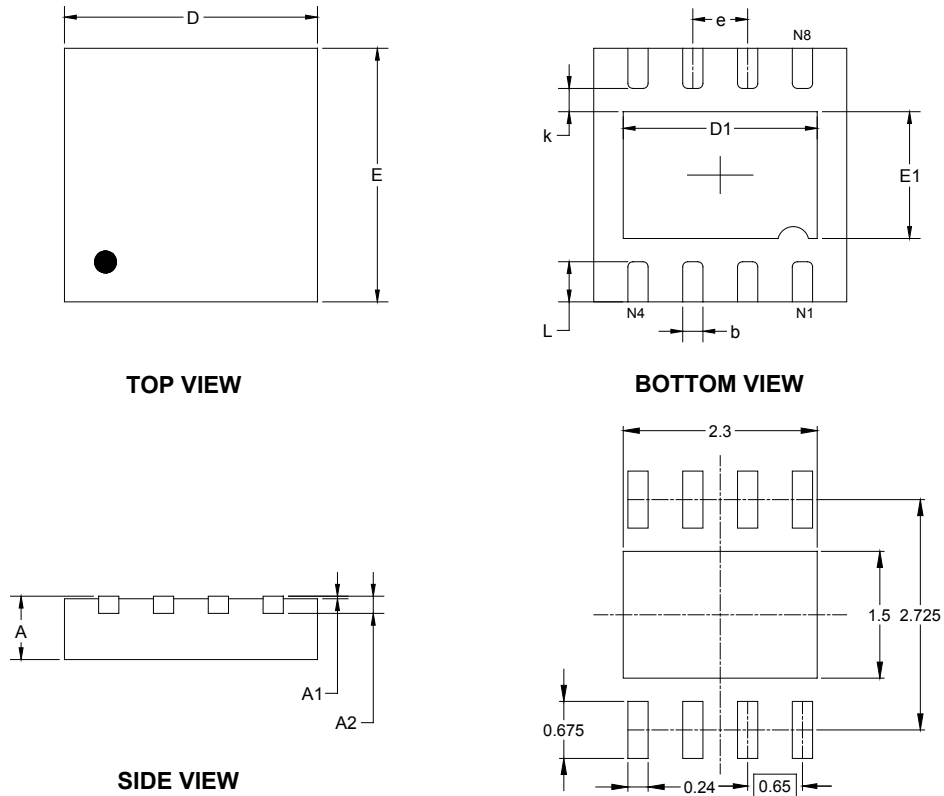


| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 1.350                        | 1.750 |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

### PACKAGE OUTLINE DIMENSIONS

#### TDFN-3×3-8L

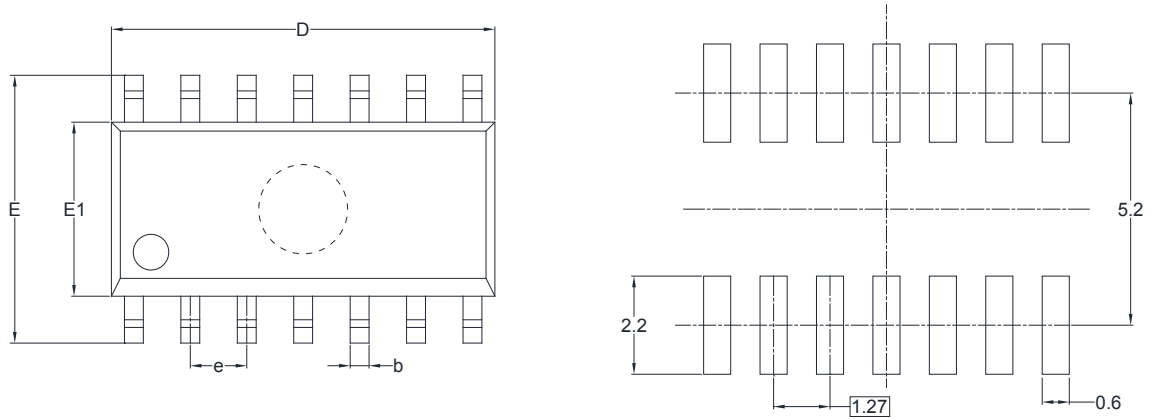


RECOMMENDED LAND PATTERN (Unit: mm)

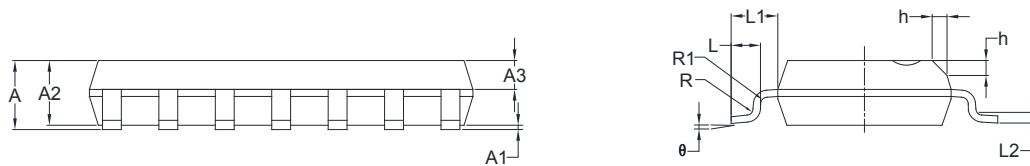
| Symbol | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|--------|------------------------------|-------|-------------------------|-------|
|        | MIN                          | MAX   | MIN                     | MAX   |
| A      | 0.700                        | 0.800 | 0.028                   | 0.031 |
| A1     | 0.000                        | 0.050 | 0.000                   | 0.002 |
| A2     | 0.203 REF                    |       | 0.008 REF               |       |
| D      | 2.900                        | 3.100 | 0.114                   | 0.122 |
| D1     | 2.200                        | 2.400 | 0.087                   | 0.094 |
| E      | 2.900                        | 3.100 | 0.114                   | 0.122 |
| E1     | 1.400                        | 1.600 | 0.055                   | 0.063 |
| k      | 0.200 MIN                    |       | 0.008 MIN               |       |
| b      | 0.180                        | 0.300 | 0.007                   | 0.012 |
| e      | 0.650 TYP                    |       | 0.026 TYP               |       |
| L      | 0.375                        | 0.575 | 0.015                   | 0.023 |

## PACKAGE OUTLINE DIMENSIONS

### SOIC-14



RECOMMENDED LAND PATTERN (Unit: mm)

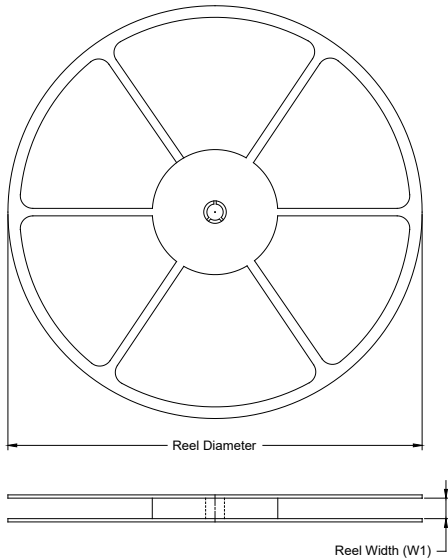


| Symbol | Dimensions<br>In Millimeters |      | Dimensions<br>In Inches |       |
|--------|------------------------------|------|-------------------------|-------|
|        | MIN                          | MAX  | MIN                     | MAX   |
| A      | 1.35                         | 1.75 | 0.053                   | 0.069 |
| A1     | 0.10                         | 0.25 | 0.004                   | 0.010 |
| A2     | 1.25                         | 1.65 | 0.049                   | 0.065 |
| A3     | 0.55                         | 0.75 | 0.022                   | 0.030 |
| b      | 0.36                         | 0.49 | 0.014                   | 0.019 |
| D      | 8.53                         | 8.73 | 0.336                   | 0.344 |
| E      | 5.80                         | 6.20 | 0.228                   | 0.244 |
| E1     | 3.80                         | 4.00 | 0.150                   | 0.157 |
| e      | 1.27 BSC                     |      | 0.050 BSC               |       |
| L      | 0.45                         | 0.80 | 0.018                   | 0.032 |
| L1     | 1.04 REF                     |      | 0.040 REF               |       |
| L2     | 0.25 BSC                     |      | 0.01 BSC                |       |
| R      | 0.07                         |      | 0.003                   |       |
| R1     | 0.07                         |      | 0.003                   |       |
| h      | 0.30                         | 0.50 | 0.012                   | 0.020 |
| θ      | 0°                           | 8°   | 0°                      | 8°    |

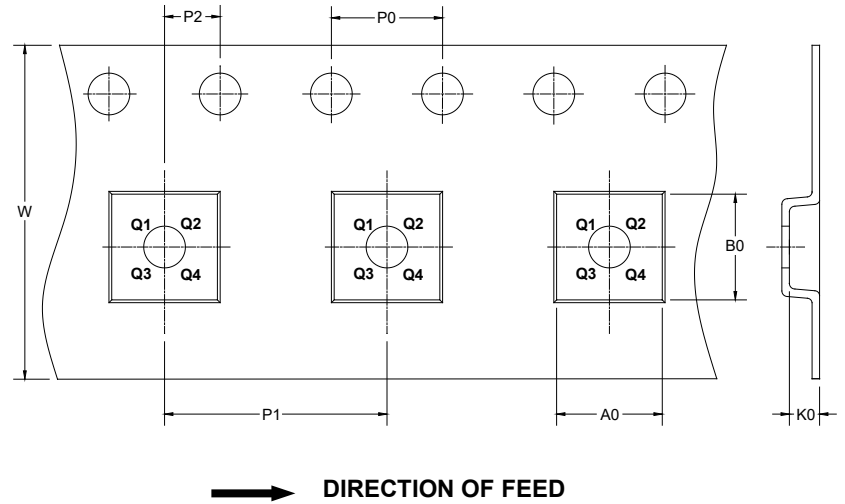
## PACKAGE INFORMATION

### TAPE AND REEL INFORMATION

#### REEL DIMENSIONS



#### TAPE DIMENSIONS



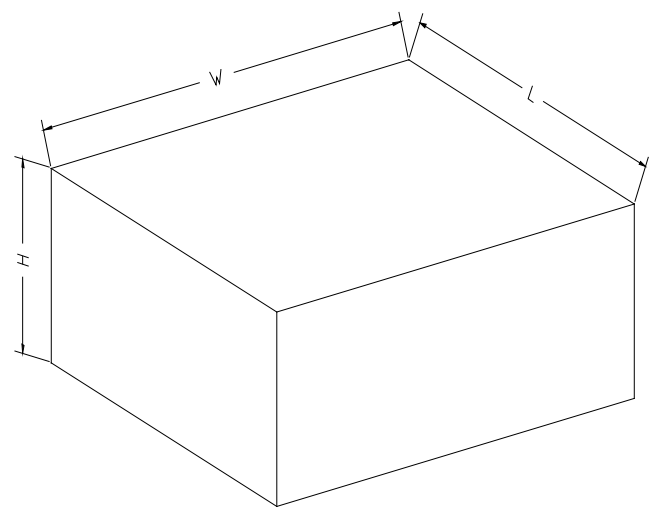
NOTE: The picture is only for reference. Please make the object as the standard.

#### 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            |
| SOT-23-6     | 7"            | 9.5                | 3.17    | 3.23    | 1.37    | 4.0     | 4.0     | 2.0     | 8.0    | Q3            |
| SOIC-8       | 13"           | 12.4               | 6.40    | 5.40    | 2.10    | 4.0     | 8.0     | 2.0     | 12.0   | Q1            |
| TDFN-3×3-8L  | 13"           | 12.4               | 3.35    | 3.35    | 1.13    | 4.0     | 8.0     | 2.0     | 12.0   | Q1            |
| SOIC-14      | 13"           | 16.4               | 6.60    | 9.30    | 2.10    | 4.0     | 8.0     | 2.0     | 16.0   | Q1            |

DD0001

CARTON BOX DIMENSIONS



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

KEY PARAMETER LIST OF CARTON BOX

| Reel Type   | Length (mm) | Width (mm) | Height (mm) | Pizza/Carton |
|-------------|-------------|------------|-------------|--------------|
| 7" (Option) | 368         | 227        | 224         | 8            |
| 7"          | 442         | 410        | 224         | 18           |
| 13"         | 386         | 280        | 370         | 5            |

DD00002