

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

15MHz, 8V/ μ 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/ μ s and a gain-bandwidth product (GBP) of 15MHz. The SGM8558-1/2/3/4 can drive typical headset levels (32 Ω), 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.

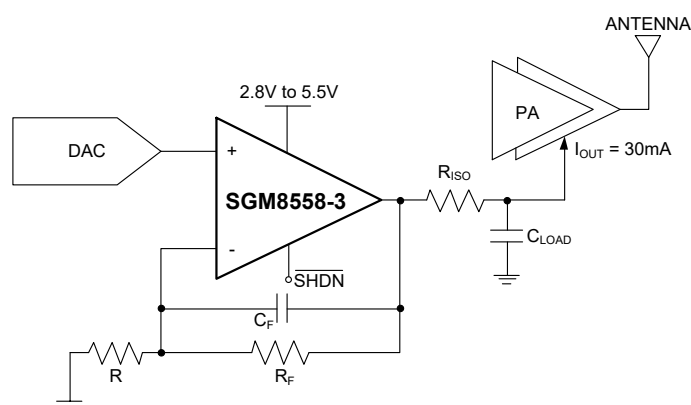
APPLICATIONS

RF Power Amplifier Biasing Controls
Portable/Battery-Powered Audio Applications
Portable Headphone Speaker Drivers (32 Ω)
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

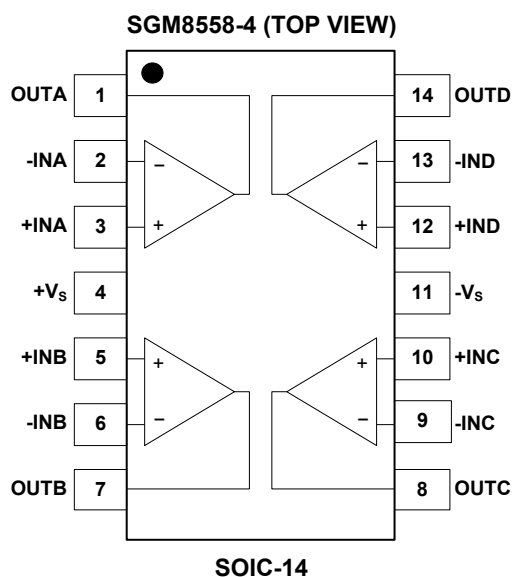
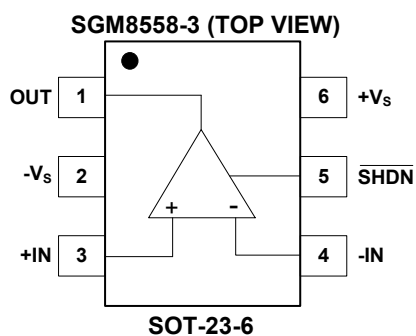
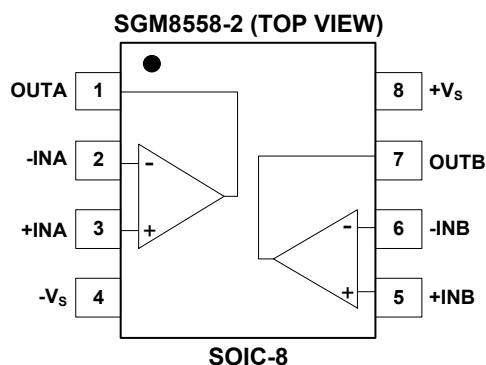
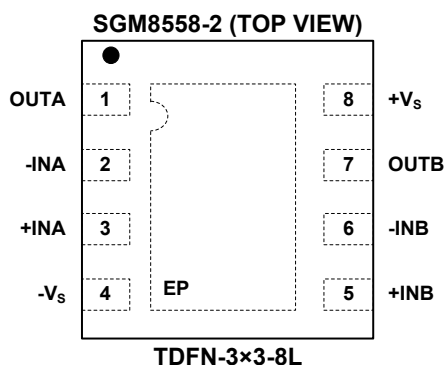
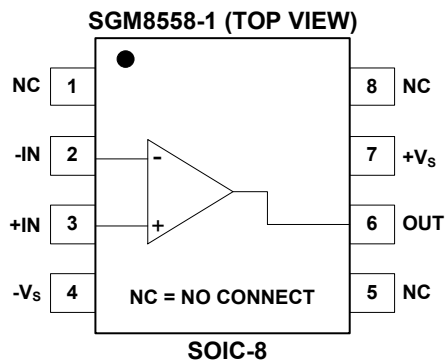
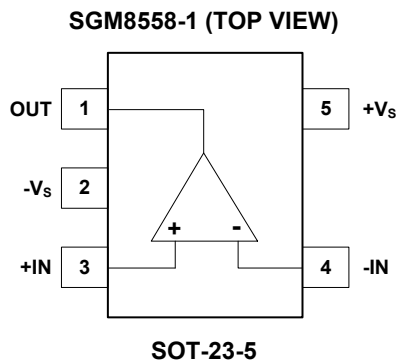
FEATURES

- 230mA Output Drive Capability
- Low Input Offset Voltage: 15 μ 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 μ A (TYP) Shutdown Current for SGM8558-3
- Gain-Bandwidth Product: 15MHz
- High Slew Rate: 8V/ μ 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



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°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_{OS})		$+25^\circ\text{C}$		1.5	15	μV
Input Common Mode Voltage Range (V_{CM})		$+25^\circ\text{C}$	$(-V_S) - 0.1$		$(+V_S) + 0.1$	V
Common Mode Rejection Ratio (CMRR)	$(-V_S) - 0.1\text{V} < V_{CM} < (+V_S) + 0.1\text{V}$	$+25^\circ\text{C}$	96	118		dB
		Full	90			
Open-Loop Voltage Gain (A_{OL})	$(-V_S) + 0.1\text{V} < V_{OUT} < (+V_S) - 0.1\text{V}$, $R_L = 2\text{k}\Omega$	$+25^\circ\text{C}$	108	131		dB
		Full	105			
	$(-V_S) + 0.1\text{V} < V_{OUT} < (+V_S) - 0.1\text{V}$, $R_L = 200\Omega$	$+25^\circ\text{C}$	106	130		
		Full	103			
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	$R_L = 2\text{k}\Omega$	$+25^\circ\text{C}$		5	11	mV
		Full			12	
	$R_L = 200\Omega$	$+25^\circ\text{C}$		45	55	
		Full			66	
Output Short-Circuit Current (I_{SC})		$+25^\circ\text{C}$	96	120		mA
		Full	75			
POWER SUPPLY						
Specified Voltage Range (V_S)		$+25^\circ\text{C}$	2.8		5.5	V
Quiescent Current/Amplifier (I_Q)	$I_{OUT} = 0$	$+25^\circ\text{C}$		827	1250	μA
		Full			1450	
Power Supply Rejection Ratio (PSRR)	$V_S = 2.8\text{V}$ to 5.5V , $V_{CM} = 0.2\text{V}$	$+25^\circ\text{C}$	102	130		dB
		Full	100			
DYNAMIC PERFORMANCE						
Gain-Bandwidth Product	$G = +100$, $C_L = 100\text{pF}$	$+25^\circ\text{C}$		14		MHz
Slew Rate	$G = +1$, $V_{OUT} = 2V_{P-P}$	$+25^\circ\text{C}$		8		V/ μs
NOISE						
Input Voltage Noise	$f = 0.1\text{Hz}$ to 10Hz	$+25^\circ\text{C}$		0.3		μV_{P-P}
Input Voltage Noise Density	$f = 1\text{kHz}$	$+25^\circ\text{C}$		11		nV/ $\sqrt{\text{Hz}}$
	$f = 10\text{kHz}$	$+25^\circ\text{C}$		11		

ELECTRICAL CHARACTERISTICS (continued)

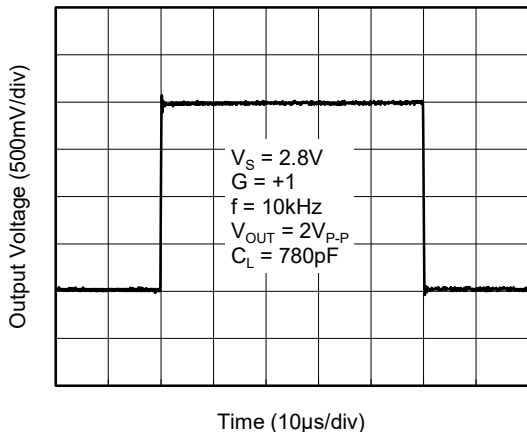
(At $T_A = +25^\circ\text{C}$, Full = -40°C to $+125^\circ\text{C}$, $V_S = 5\text{V}$, $-V_S = 0\text{V}$, $V_{CM} = +V_S/2$, $V_{OUT} = +V_S/2$, unless otherwise noted.)

PARAMETER	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS						
Input Offset Voltage (V_{OS})		+25°C		1.5	15	μV
Input Offset Voltage Drift ($\Delta V_{OS}/\Delta T$)		Full		13	66	nV/ $^\circ\text{C}$
Input Bias Current (I_b)		+25°C		0.6	3	nA
Input Offset Current (I_{OS})		+25°C		1.2	5.2	nA
Input Common Mode Voltage Range (V_{CM})		+25°C	$(-V_S) - 0.1$		$(+V_S) + 0.1$	V
Common Mode Rejection Ratio (CMRR)	$(-V_S) - 0.1\text{V} < V_{CM} < (+V_S) + 0.1\text{V}$	+25°C	102	126		dB
		Full	97			
Open-Loop Voltage Gain (A_{OL})	$(-V_S) + 0.1\text{V} < V_{OUT} < (+V_S) - 0.1\text{V}$, $R_L = 2\text{k}\Omega$	+25°C	116	139		dB
		Full	113			
	$(-V_S) + 0.1\text{V} < V_{OUT} < (+V_S) - 0.1\text{V}$, $R_L = 200\Omega$	+25°C	114	136		
		Full	110			
OUTPUT CHARACTERISTICS						
Output Voltage Swing from Rail	$R_L = 2\text{k}\Omega$	+25°C		7	16	mV
		Full			18	
	$R_L = 200\Omega$	+25°C		63	88	
		Full			104	
Output Short-Circuit Current (I_{SC})		+25°C	193	230		mA
		Full	173			
POWER-DOWN DISABLE (SGM8558-3 Only)						
Logic Threshold	V_{IH}	Normal mode	+25°C	2.0		V
	V_{IL}	Shutdown mode	+25°C		0.8	
Shutdown Supply Current	$V_{EN} = 0\text{V}$	+25°C		0.2	1.5	μA
POWER SUPPLY						
Specified Voltage Range (V_S)		+25°C	2.8		5.5	V
Quiescent Current/Amplifier (I_Q)	$I_{OUT} = 0$	+25°C		860	1280	μA
		Full			1500	
DYNAMIC PERFORMANCE						
Gain-Bandwidth Product	$G = +100$, $C_L = 100\text{pF}$	+25°C		15		MHz
Slew Rate	$G = +1$, $V_{OUT} = 2V_{P-P}$	+25°C		8		V/ μs
NOISE						
Input Voltage Noise	$f = 0.1\text{Hz}$ to 10Hz	+25°C		0.2		μV_{P-P}
Input Voltage Noise Density	$f = 1\text{kHz}$	+25°C		8		nV/ $\sqrt{\text{Hz}}$
	$f = 10\text{kHz}$	+25°C		8		

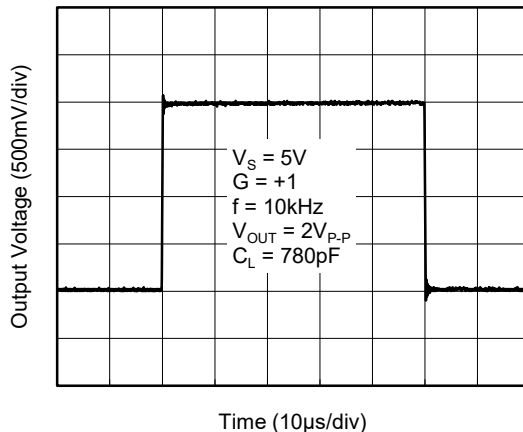
TYPICAL PERFORMANCE CHARACTERISTICS

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

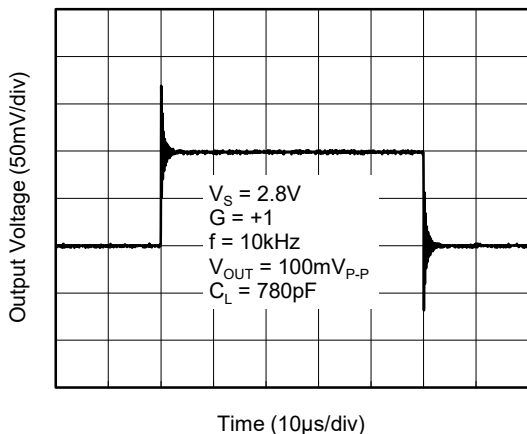
Large-Signal Transient Response with Capacitive Load



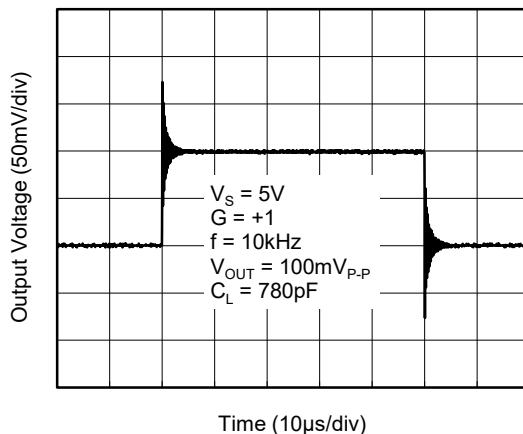
Large-Signal Transient Response with Capacitive Load



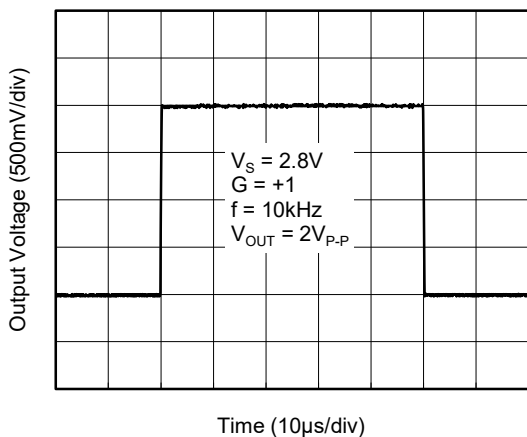
Small-Signal Transient Response with Capacitive Load



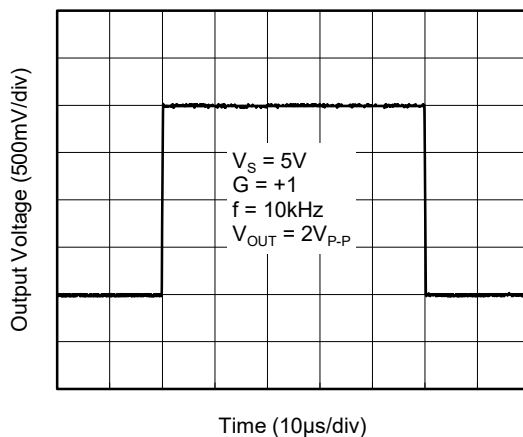
Small-Signal Transient Response with Capacitive Load



Large-Signal Step Response



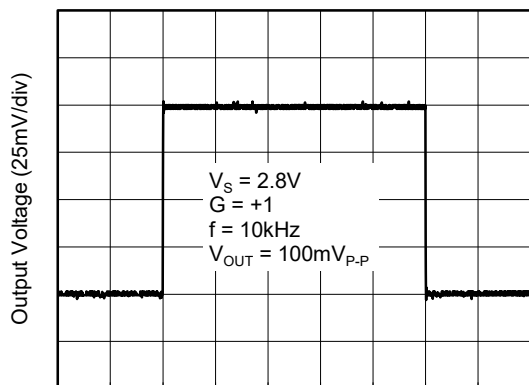
Large-Signal Step Response



TYPICAL PERFORMANCE CHARACTERISTICS (continued)

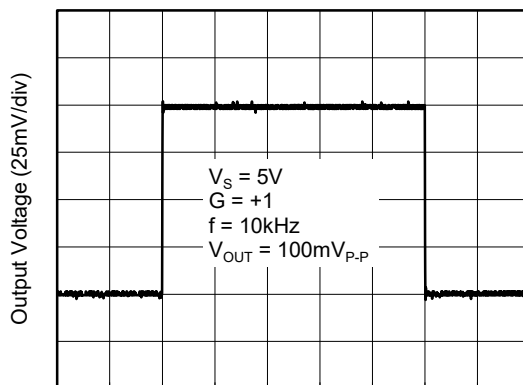
At $T_A = +25^\circ\text{C}$, $V_S = 5.0\text{V}$, unless otherwise noted.

Small-Signal Step Response



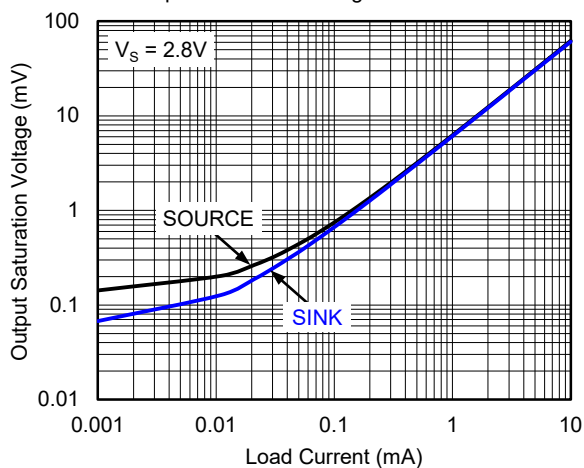
Time (10 μ s/div)

Small-Signal Step Response

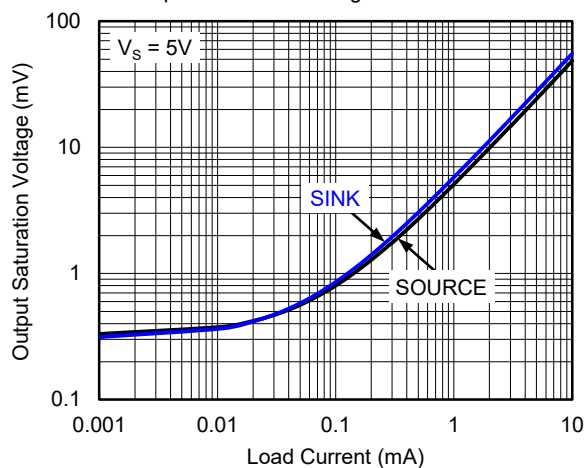


Time (10 μ s/div)

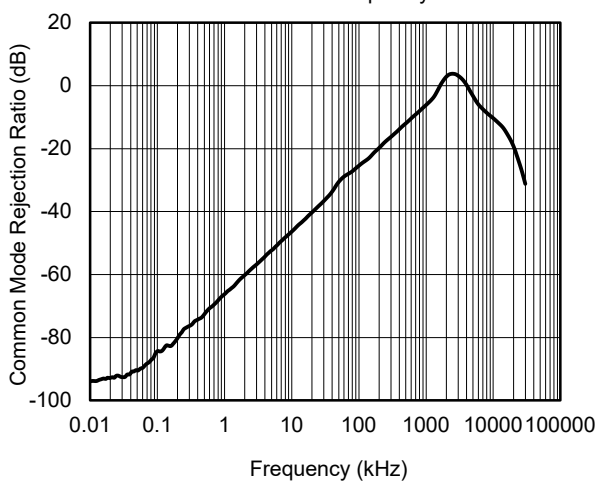
Output Saturation Voltage vs. Load Current



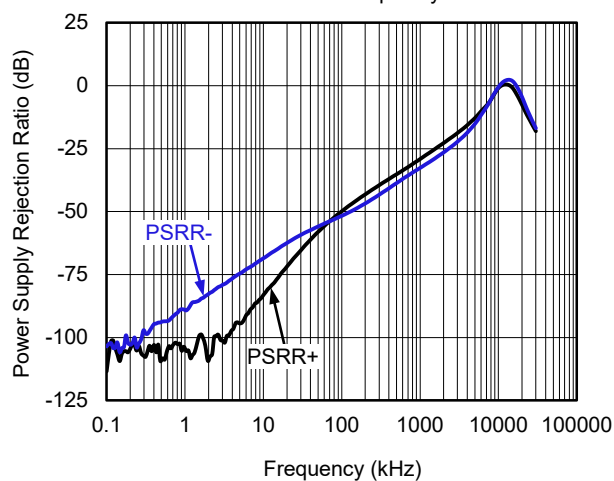
Output Saturation Voltage vs. Load Current



CMRR vs. Frequency

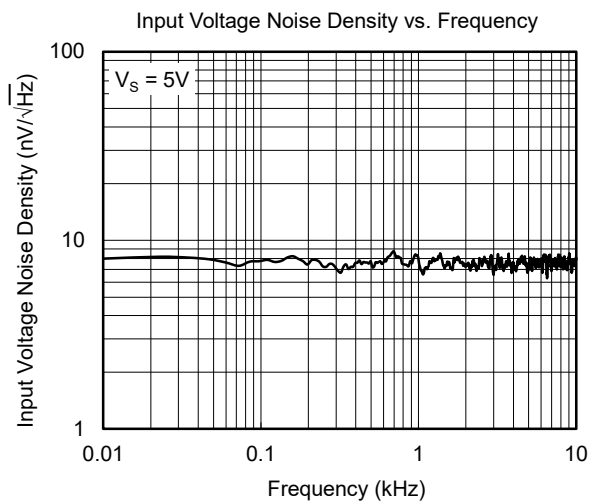
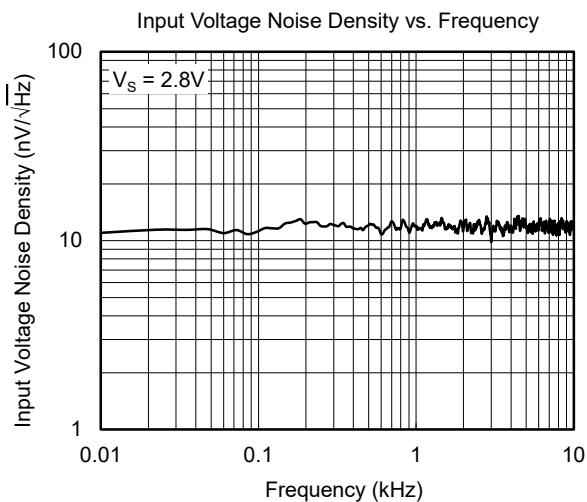
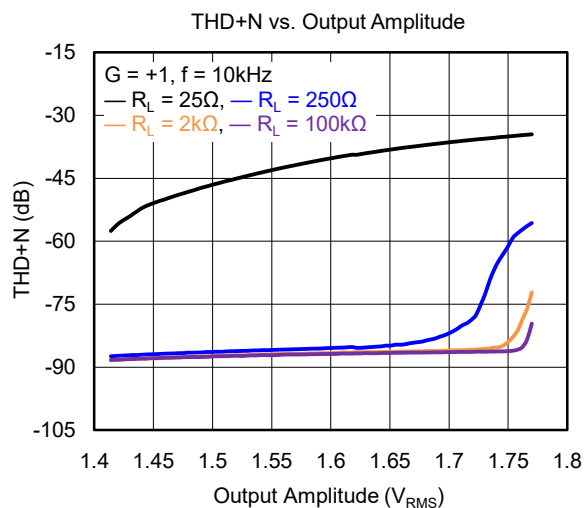
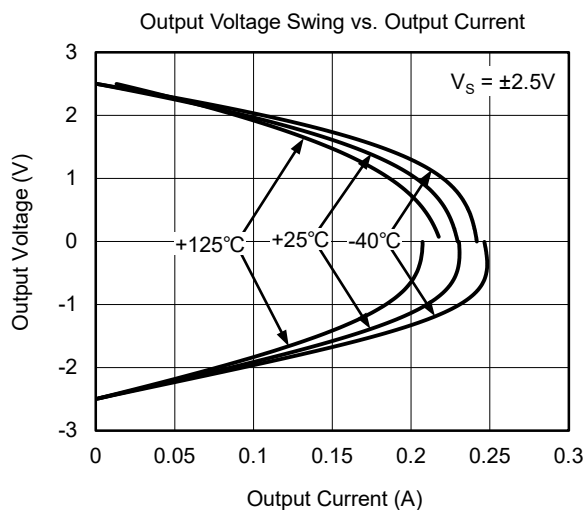
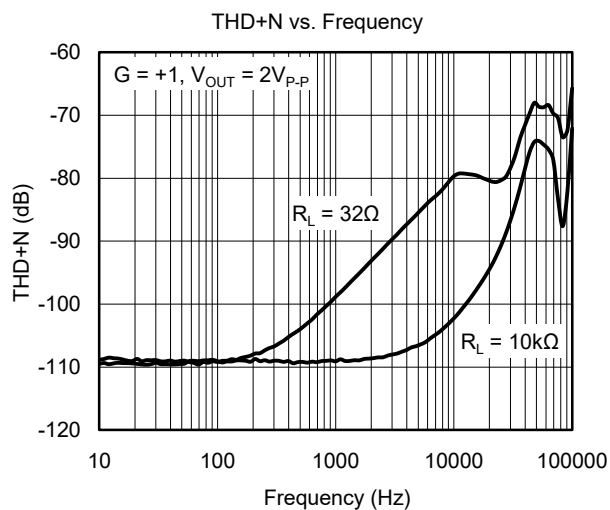
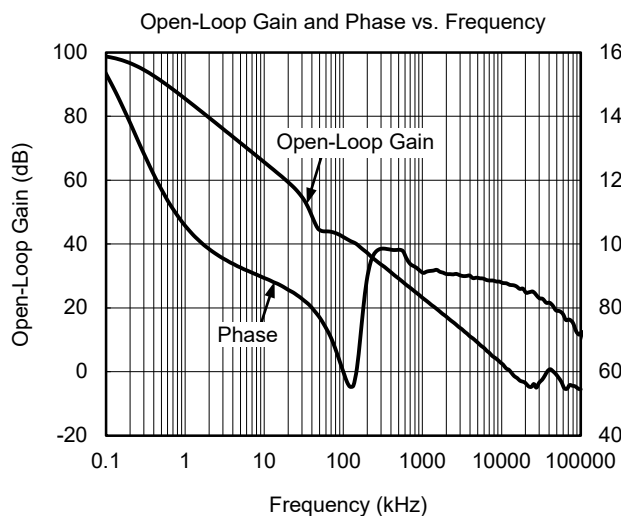


PSRR vs. Frequency



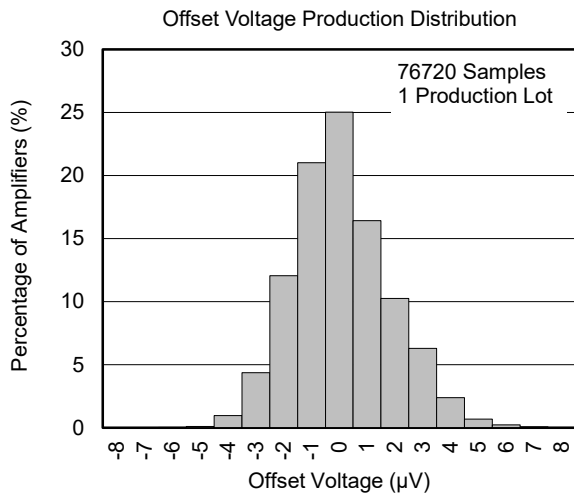
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

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.

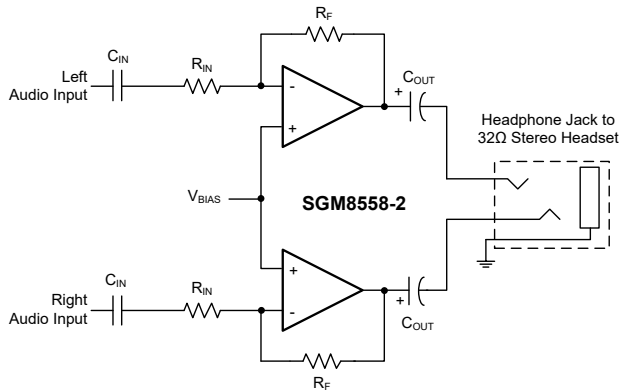


Figure 1. Circuit Example: A Single-Supply, Stereo Headphone Driver

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 Ω load, a 100 μ 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 Ω resistor value.

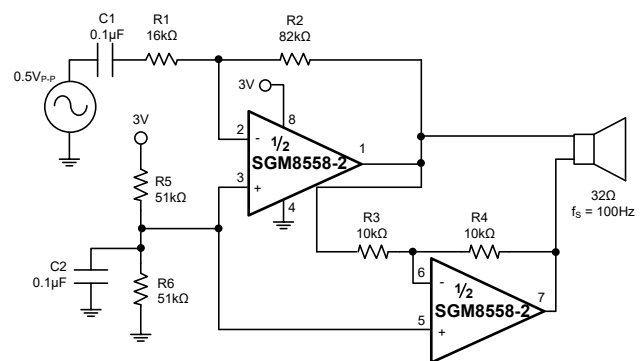


Figure 2. SGM8558-2 Bridge Amplifier for 200mW at 3V

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).

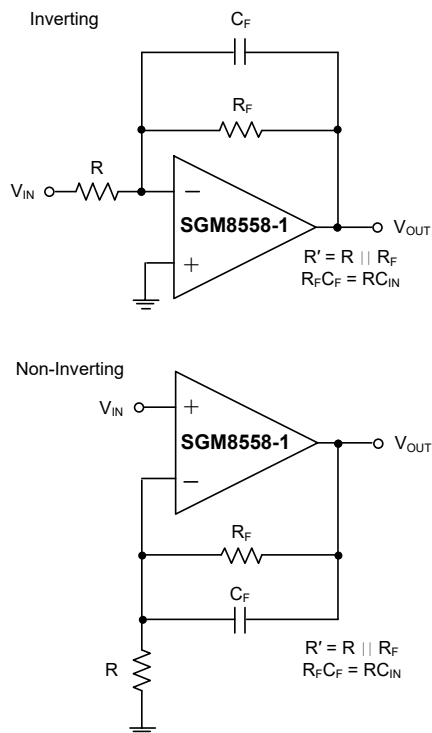


Figure 3. Inverting and Non-Inverting Amplifiers with Feedback Compensation

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.

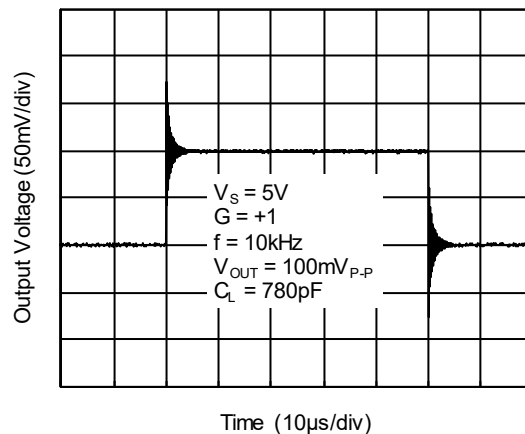


Figure 4. Small-Signal Transient Response with Capacitive Load

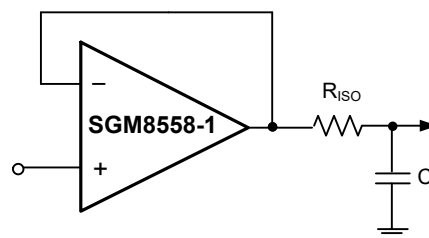


Figure 5. Capacitive-Load-Driving Circuit

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 μ 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

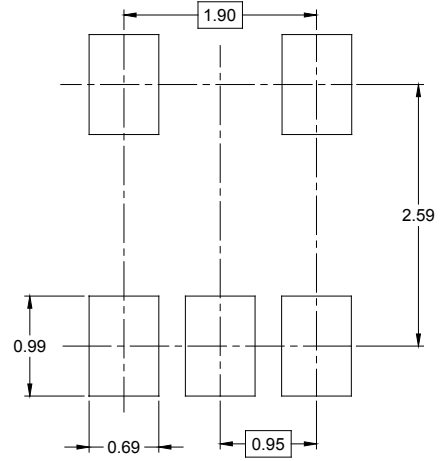
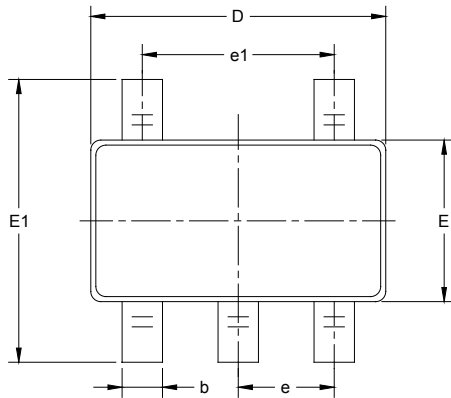
Changes from Original (SEPTEMBER 2018) to REV.A

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

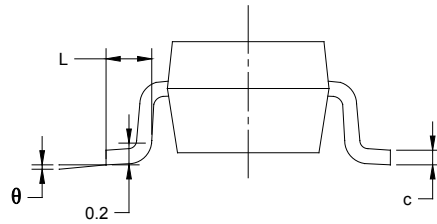
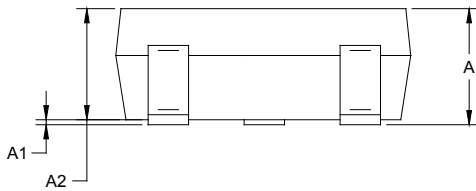
PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

SOT-23-5



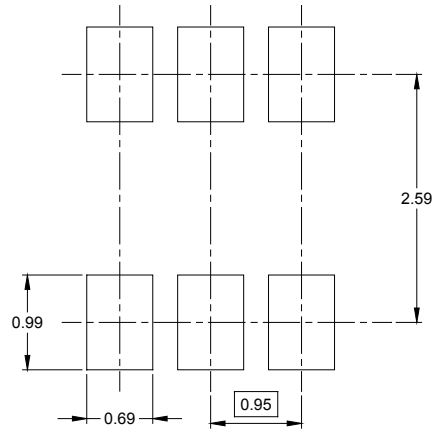
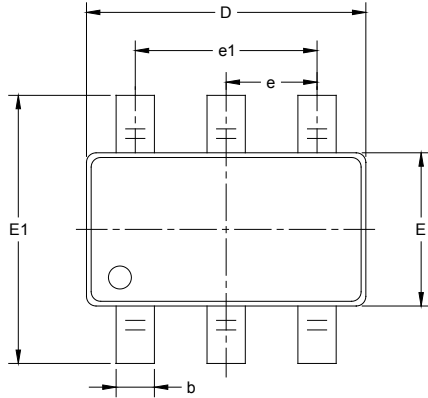
RECOMMENDED LAND PATTERN (Unit: mm)



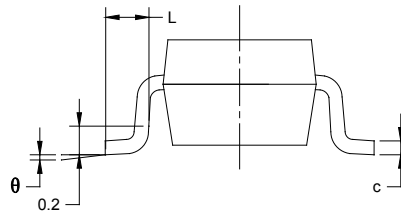
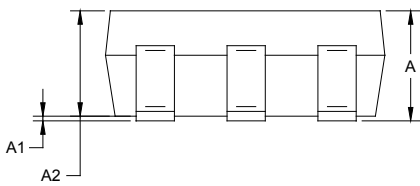
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

PACKAGE OUTLINE DIMENSIONS

SOT-23-6



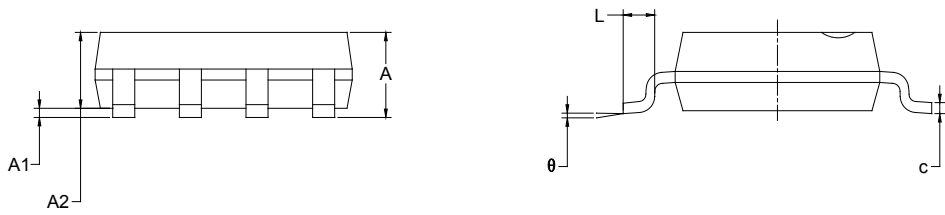
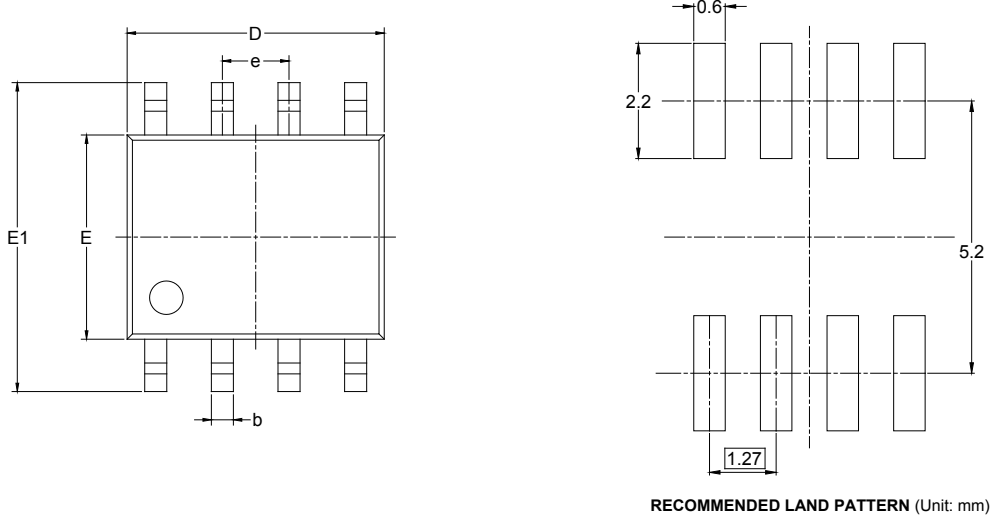
RECOMMENDED LAND PATTERN (Unit: mm)



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	0.500	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
θ	0°	8°	0°	8°

PACKAGE OUTLINE DIMENSIONS

SOIC-8

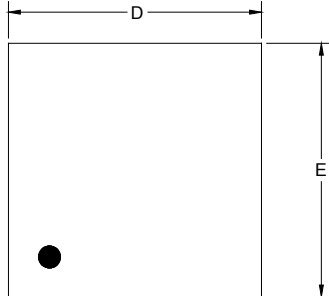


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

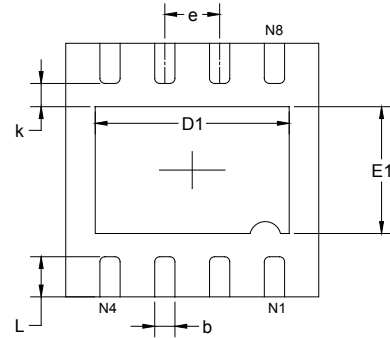
PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

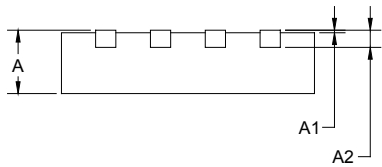
TDFN-3x3-8L



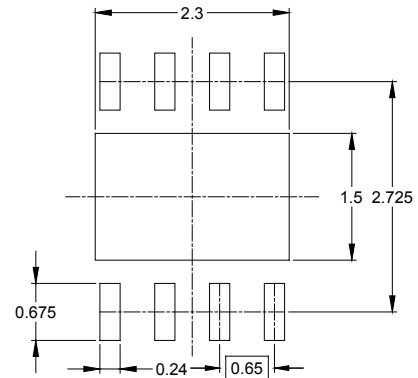
TOP VIEW



BOTTOM VIEW



SIDE VIEW



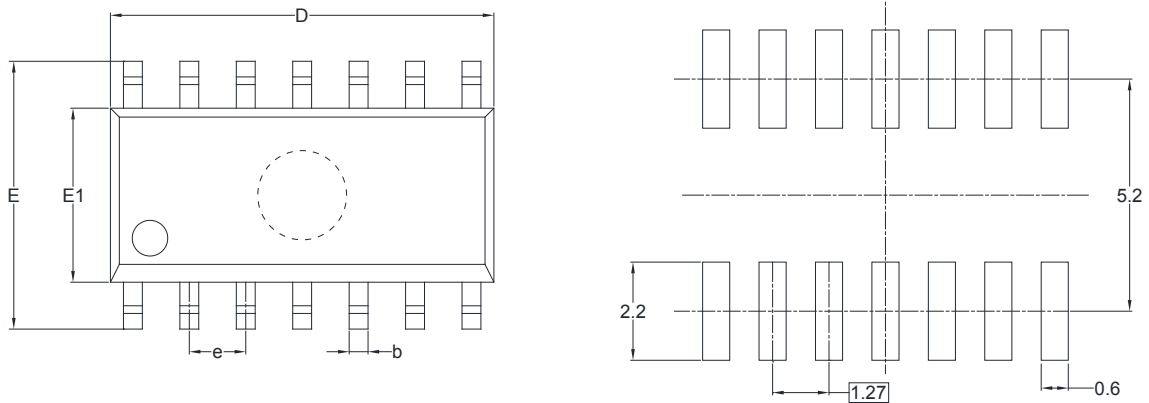
RECOMMENDED LAND PATTERN (Unit: mm)

Symbol	Dimensions In Millimeters		Dimensions 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

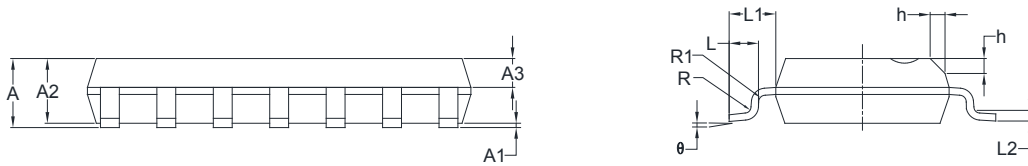
PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

SOIC-14



RECOMMENDED LAND PATTERN (Unit: mm)

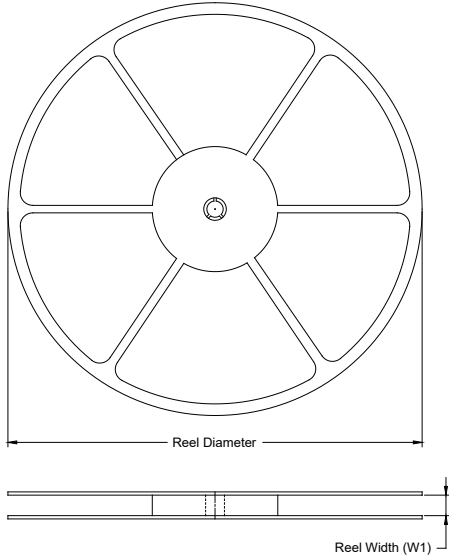


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80	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°

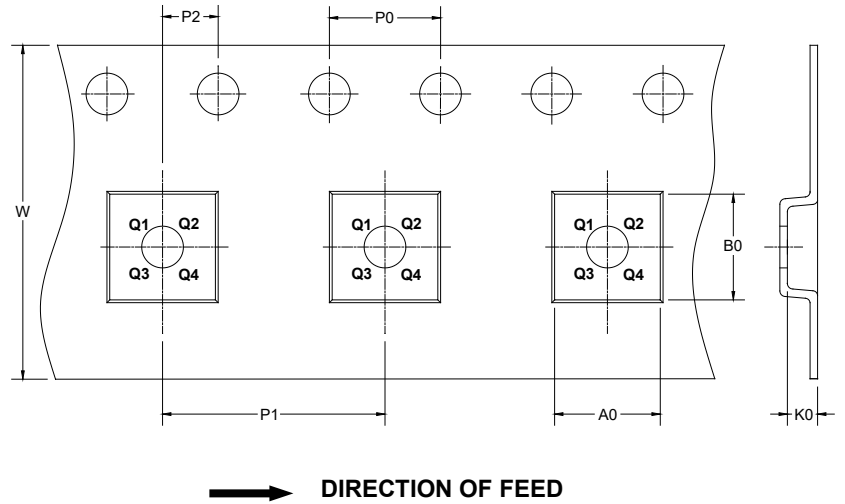
PACKAGE INFORMATION

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



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

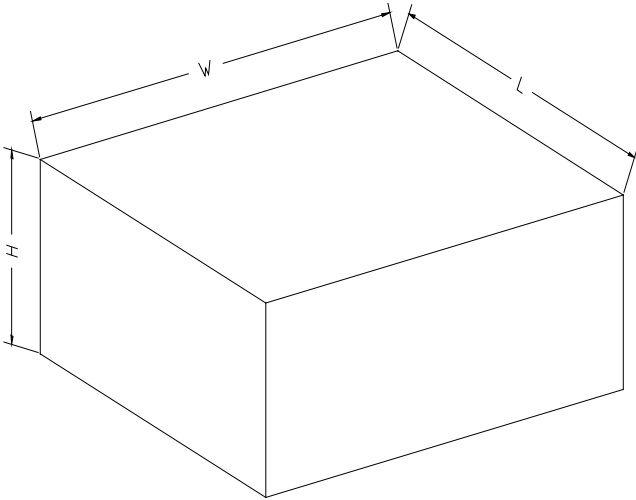
KEY PARAMETER LIST OF TAPE AND REEL

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

D200001

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