



# SGM8295-1/SGM8295-2/SGM8295-4 9MHz, Low Noise, High Voltage, Precision Operational Amplifiers

## GENERAL DESCRIPTION

The SGM8295-1 (single), SGM8295-2 (dual) and SGM8295-4 (quad) are low noise, low offset voltage and high voltage operational amplifiers, which can be designed into a wide range of applications. The SGM8295-1/2/4 have a high gain-bandwidth product of 9MHz, a slew rate of 8V/ $\mu$ s, and a quiescent current of 1.5mA/amplifier at wide power supply range.

The SGM8295-1/2/4 are designed to provide optimal performance in low noise systems. They provide rail-to-rail output swing into heavy loads.

The single version SGM8295-1 is available in Green SOT-23-5 and SOIC-8 packages. The dual version SGM8295-2 is available in Green SOIC-8 and MSOP-8 packages. The quad version SGM8295-4 is available in Green SOIC-14 package. They are specified over the extended -40°C to +125°C temperature range.

## FEATURES

- **Low Noise:** 4.5nV/ $\sqrt{\text{Hz}}$
- **Rail-to-Rail Output**
- **Very Low Offset Voltage:** 250 $\mu$ V (MAX)
- **Low Bias Current:**  $\pm$ 1nA (TYP)
- **High Gain-Bandwidth Product:** 9MHz
- **High Slew Rate:** 8V/ $\mu$ s
- **High Open-Loop Gain:** 130dB at  $V_S = \pm$ 15V
- **High PSRR:** 145dB
- **Settling Time to 0.1% with 1V Step:** 1 $\mu$ s
- **Overload Recovery Time:** 10 $\mu$ s
- **Operating Voltage Range:**  
3.6V to 36V or  $\pm$ 1.8V to  $\pm$ 18V
- **Input Common Mode Voltage Range:**  
 $(-V_S) + 1.5V$  to  $(+V_S) - 2V$
- **Low Supply Current:**  
1.5mA/Amplifier (TYP)
- **-40°C to +125°C Operating Temperature Range**
- **Small Packaging:**  
SGM8295-1 Available in Green SOT-23-5 and SOIC-8 Packages  
SGM8295-2 Available in Green SOIC-8 and MSOP-8 Packages  
SGM8295-4 Available in Green SOIC-14 Package

## APPLICATIONS

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

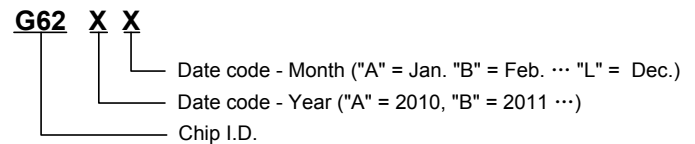
**PACKAGE/ORDERING INFORMATION**

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8295-1	SOT-23-5	-40°C to +125°C	SGM8295-1XN5G/TR	G62XX	Tape and Reel, 3000
	SOIC-8	-40°C to +125°C	SGM8295-1XS8G/TR	SGM 82951XS8 XXXXX	Tape and Reel, 2500
SGM8295-2	SOIC-8	-40°C to +125°C	SGM8295-2XS8G/TR	SGM 82952XS8 XXXXX	Tape and Reel, 2500
	MSOP-8	-40°C to +125°C	SGM8295-2XMS8G/TR	SGM82952 XMS8 XXXXX	Tape and Reel, 4000
SGM8295-4	SOIC-14	-40°C to +125°C	SGM8295-4XS14G/TR	SGM82954XS14 XXXXX	Tape and Reel, 2500

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

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.

**MARKING INFORMATION**



For example: G62GA (2016, January)

**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage, +V <sub>s</sub> to -V <sub>s</sub> .....	40V
Input Common Mode Voltage Range .....	(-V <sub>s</sub> ) - 0.3V to (+V <sub>s</sub> ) + 0.3V
Storage Temperature Range .....	-65°C to +150°C
Junction Temperature .....	+150°C
Lead Temperature (Soldering 10sec) .....	+260°C
ESD Susceptibility	
HBM .....	4000V
MM .....	200V
CDM .....	1000V

**RECOMMENDED OPERATING CONDITIONS**

Supply Voltage Range .....	3.6V to 36V
Operating Temperature Range .....	-40°C to +125°C

**OVERSTRESS CAUTION**

Stresses beyond those listed may cause permanent damage to the device. Functional operation of the device at these or any other conditions beyond those indicated in the operational section of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

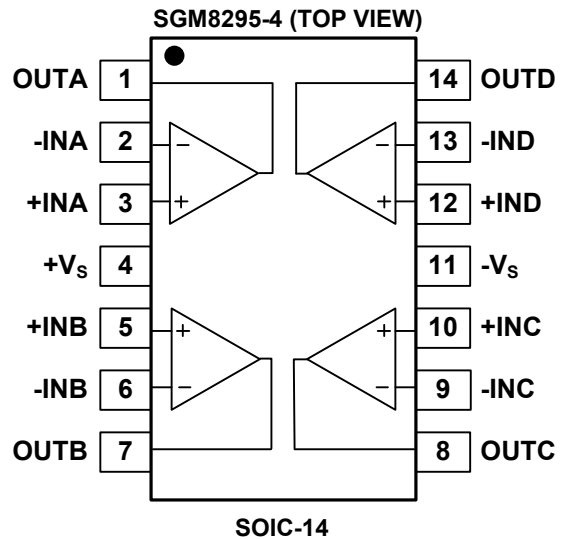
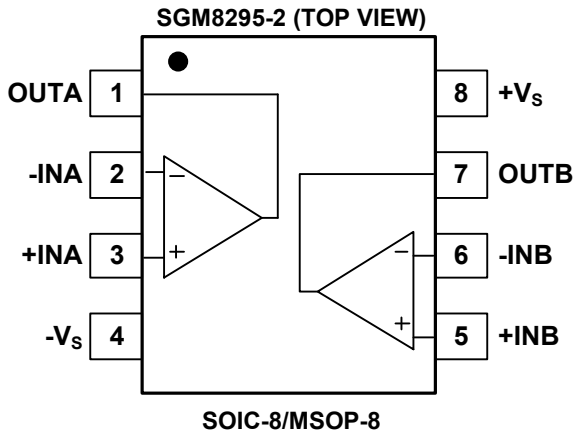
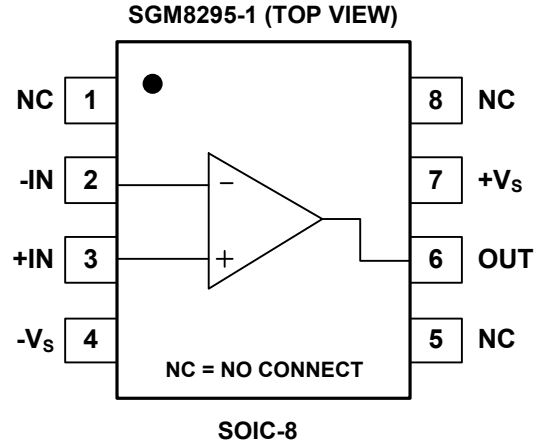
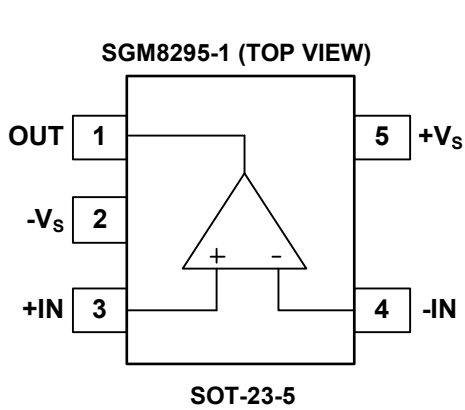
**ESD SENSITIVITY CAUTION**

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, specification or other related things if necessary without notice at any time.

**PIN CONFIGURATIONS**



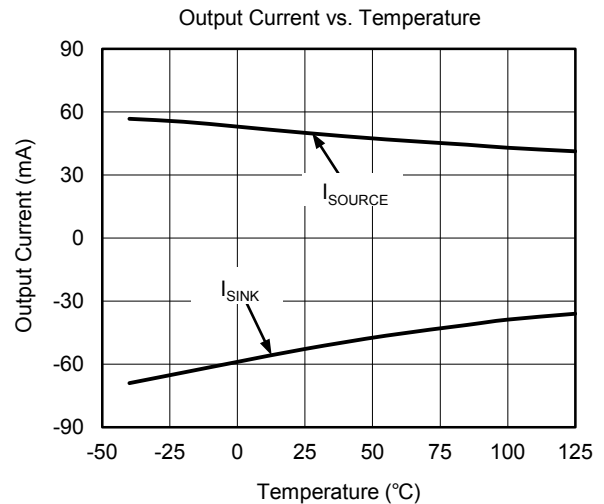
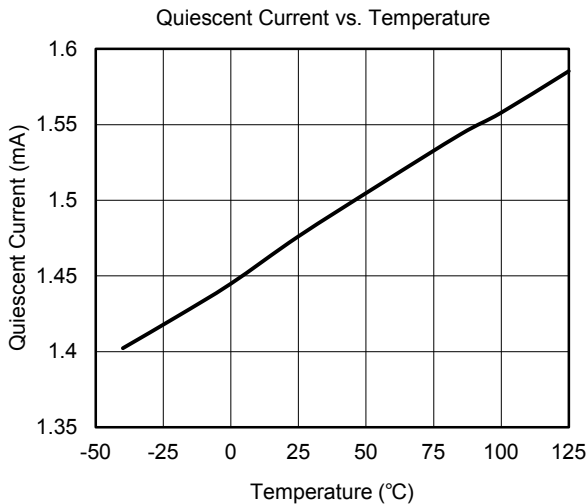
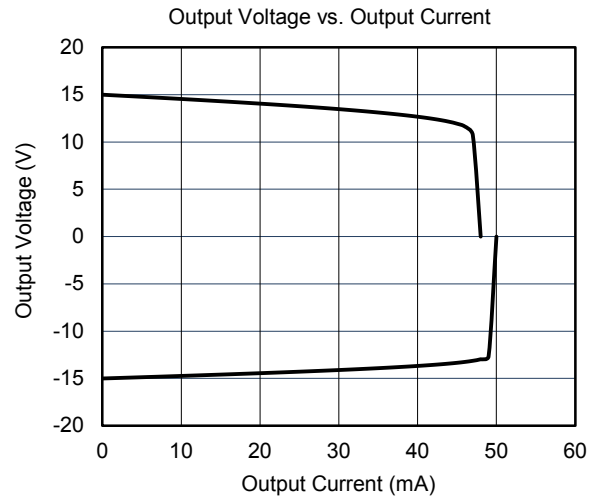
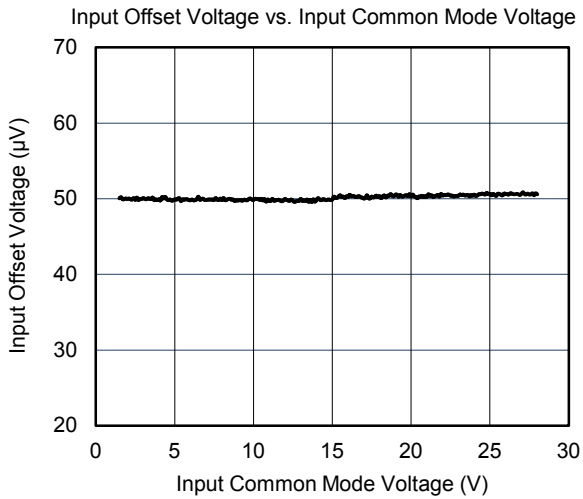
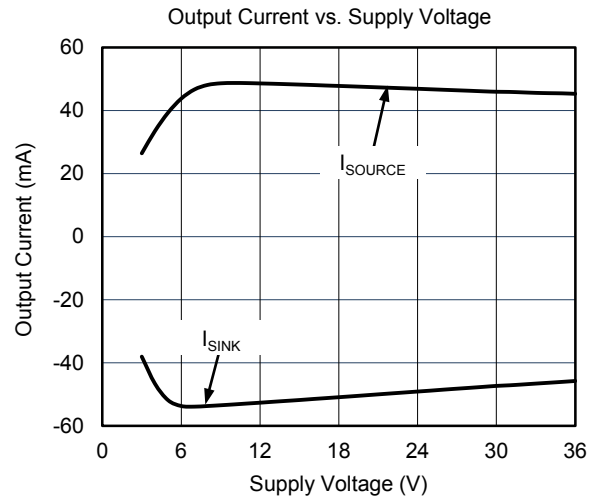
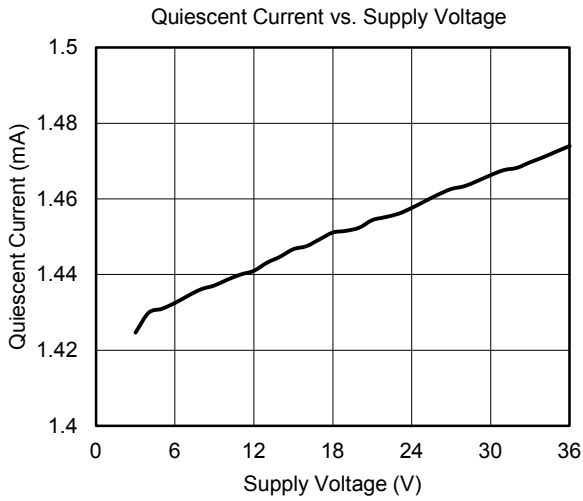
**ELECTRICAL CHARACTERISTICS**

(At  $T_A = +25^\circ\text{C}$ ,  $V_S = \pm 5\text{V}$  to  $V_S = \pm 15\text{V}$ ,  $V_{CM} = 0\text{V}$ ,  $V_{OUT} = 0\text{V}$  and  $R_L$  connected to  $0\text{V}$ , Full =  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
<b>INPUT CHARACTERISTICS</b>							
Input Offset Voltage	$V_{OS}$		+25°C		50	250	$\mu\text{V}$
			Full			360	
Input Bias Current	$I_B$	$V_{CM} = V_S/2$	+25°C		$\pm 1$	$\pm 17$	nA
			Full			$\pm 52$	
Input Offset Current	$I_{OS}$	$V_{CM} = V_S/2$	+25°C		$\pm 1$	$\pm 21$	nA
			Full			$\pm 45$	
Input Common Mode Voltage Range	$V_{CM}$		Full	$(-V_S) + 1.5$		$(+V_S) - 2$	V
Common Mode Rejection Ratio	CMRR	$(-V_S) + 1.5\text{V} \leq V_{CM} \leq (+V_S) - 2\text{V}$	+25°C	112	140		dB
			Full	110			
Open-Loop Voltage Gain	$A_{OL}$	$V_S = \pm 5\text{V}, V_{OUT} = \pm 2.5\text{V}, R_L = 10\text{k}\Omega$	+25°C	118	135		dB
			Full	116			
		$V_S = \pm 15\text{V}, V_{OUT} = \pm 10\text{V}, R_L = 10\text{k}\Omega$	+25°C	124	140		
			Full	122			
		$V_S = \pm 5\text{V}, V_{OUT} = \pm 2.5\text{V}, R_L = 2\text{k}\Omega$	+25°C	108	130		
			Full	106			
		$V_S = \pm 15\text{V}, V_{OUT} = \pm 10\text{V}, R_L = 2\text{k}\Omega$	+25°C	118	130		
			Full	110			
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		Full		0.4		$\mu\text{V}/^\circ\text{C}$
<b>OUTPUT CHARACTERISTICS</b>							
Output Voltage Swing from Rail	$V_{OUT}$	$V_S = \pm 15\text{V}, R_L = 10\text{k}\Omega$	+25°C		65	95	mV
			Full			125	
		$V_S = \pm 15\text{V}, R_L = 2\text{k}\Omega$	+25°C		310	450	
			Full			600	
Output Short-Circuit Current	$I_{SC}$		+25°C	$\pm 28$	$\pm 50$		mA
<b>POWER SUPPLY</b>							
Operating Voltage Range	$V_S$		Full	3.6		36	V
Quiescent Current/Amplifier	$I_Q$	$I_{OUT} = 0\text{mA}$	+25°C		1.5	2	mA
			Full			2.2	
Power Supply Rejection Ratio	PSRR	$V_S = 3\text{V to } 38\text{V}$	+25°C	121	145		dB
			Full	119			
<b>DYNAMIC PERFORMANCE</b>							
Gain-Bandwidth Product	GBP	$V_{OUT} = 100\text{mV}_{P-P}, R_L = 2\text{k}\Omega$	+25°C		9		MHz
Slew Rate	SR	$R_L = 2\text{k}\Omega$	+25°C		8		$\text{V}/\mu\text{s}$
Settling Time to 0.1%	$t_s$	$V_{IN} = 1\text{V Step}, R_L = 2\text{k}\Omega, G = +1$	+25°C		1		$\mu\text{s}$
Overload Recovery Time		$R_L = 2\text{k}\Omega, V_{IN} \times G = V_S$	+25°C		10		$\mu\text{s}$
Phase Margin	$\phi_O$	$V_{OUT} = 100\text{mV}_{P-P}, R_L = 2\text{k}\Omega, C_L = 10\text{pF}$	+25°C		45		°
Total Harmonic Distortion + Noise	THD+N	$V_{IN} = 1\text{V}_{RMS}, G = +1, R_L = 2\text{k}\Omega, f = 1\text{kHz}$	+25°C		0.0001		%
<b>NOISE</b>							
Input Voltage Noise		$f = 0.1\text{Hz to } 10\text{Hz}$	+25°C		280		$\text{nV}_{P-P}$
Input Voltage Noise Density	$e_n$	$f = 1\text{kHz}$	+25°C		4.5		$\text{nV}/\sqrt{\text{Hz}}$
Input Current Noise Density	$i_n$	$f = 1\text{kHz}$	+25°C		2		$\text{pA}/\sqrt{\text{Hz}}$

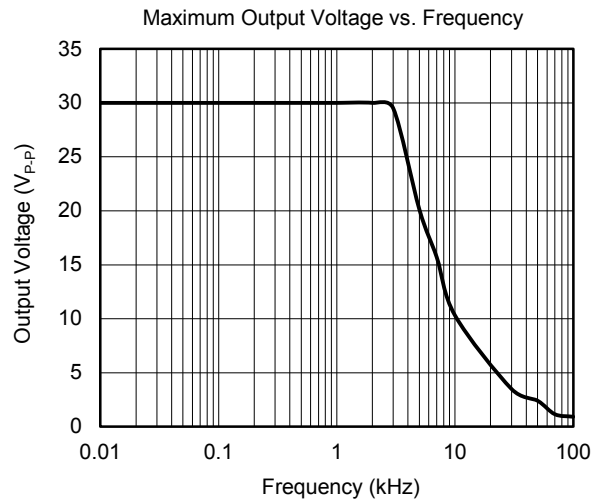
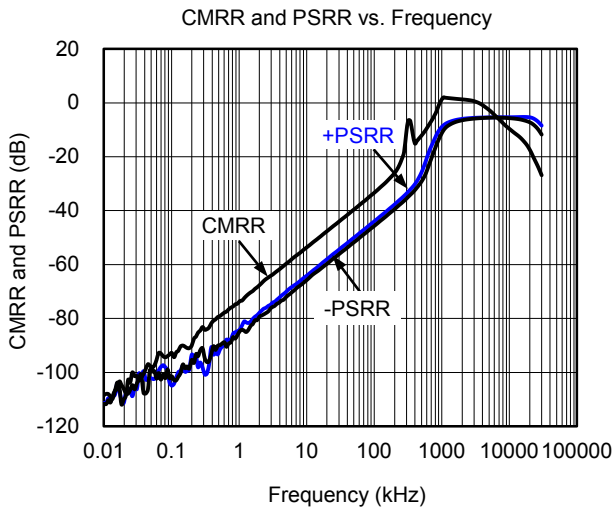
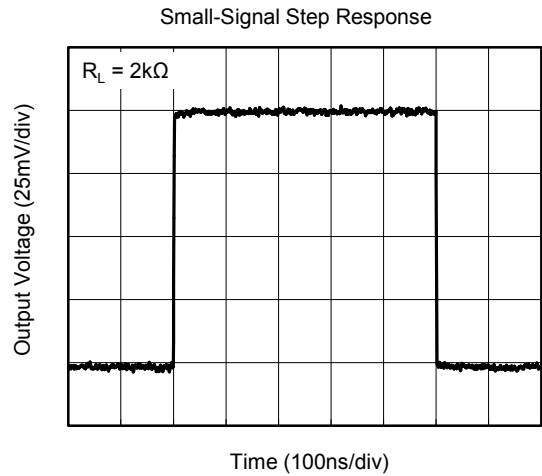
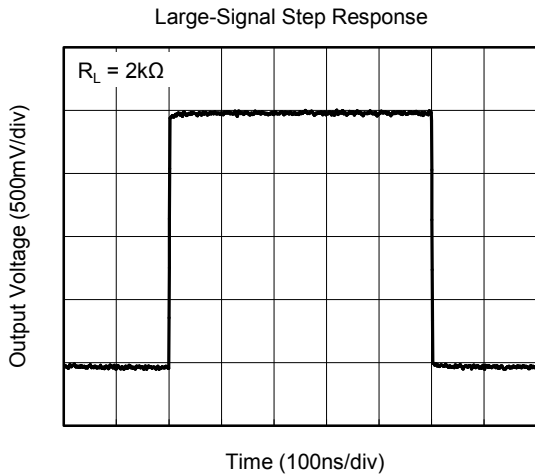
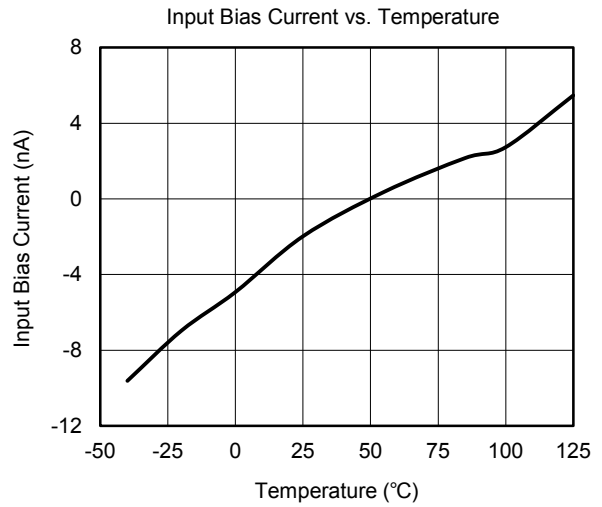
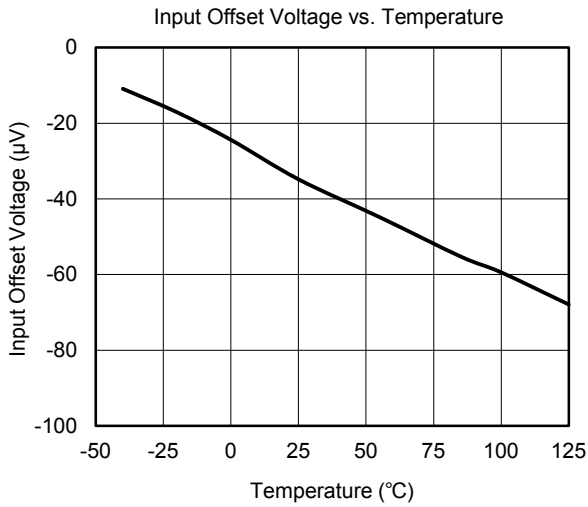
**TYPICAL PERFORMANCE CHARACTERISTICS**

At  $T_A = +25^\circ\text{C}$  and  $V_S = \pm 15\text{V}$ , unless otherwise noted.



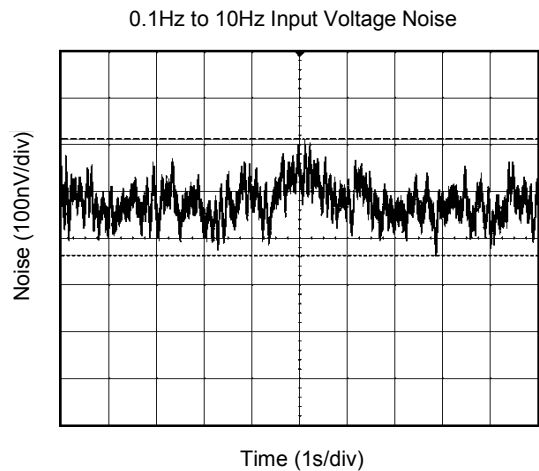
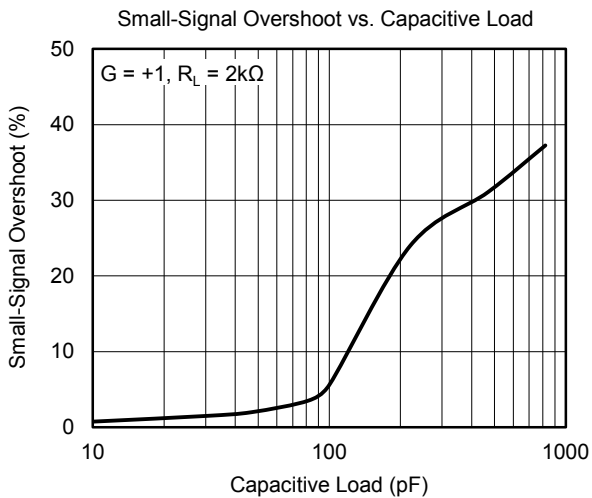
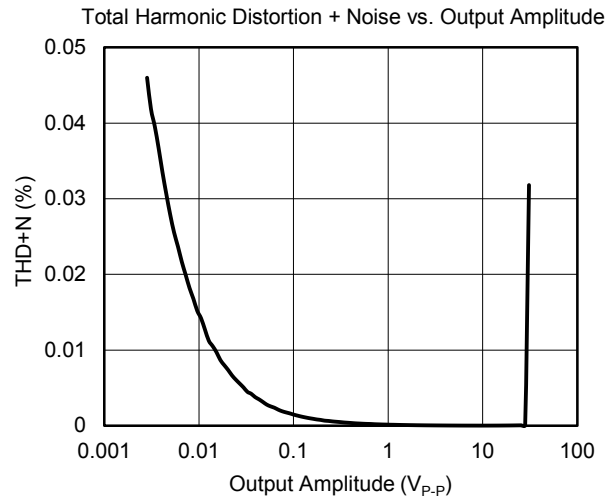
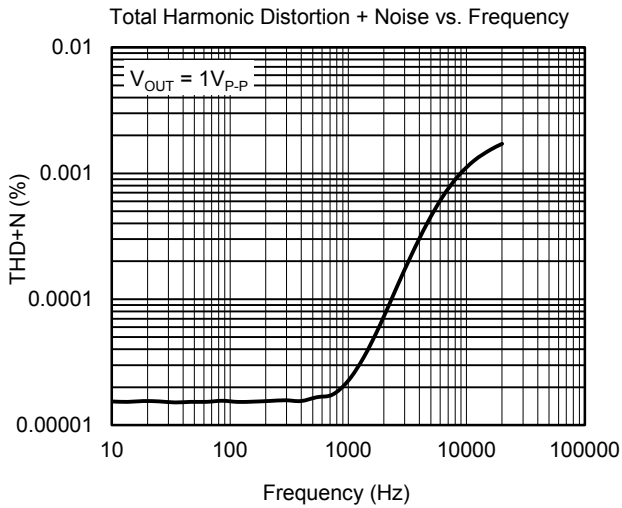
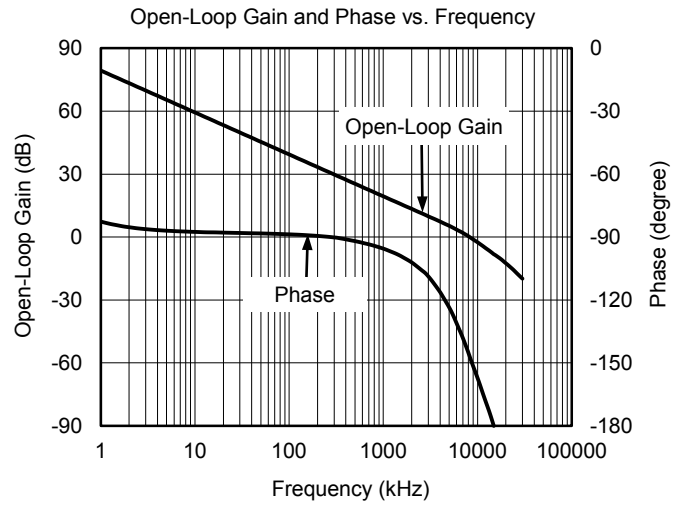
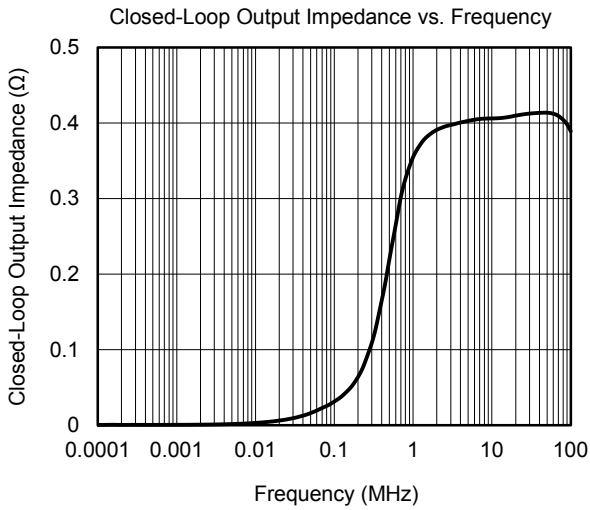
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

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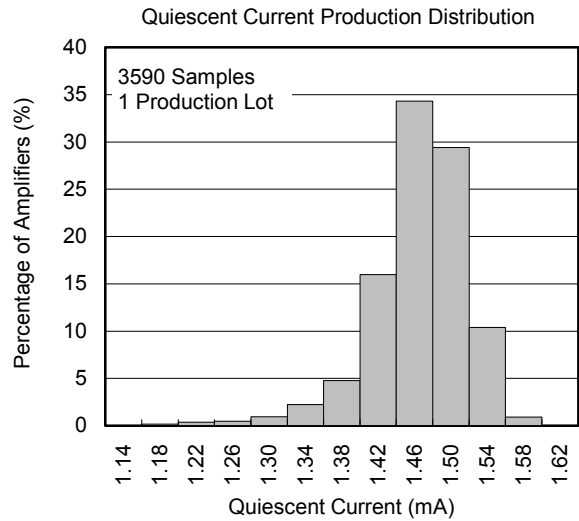
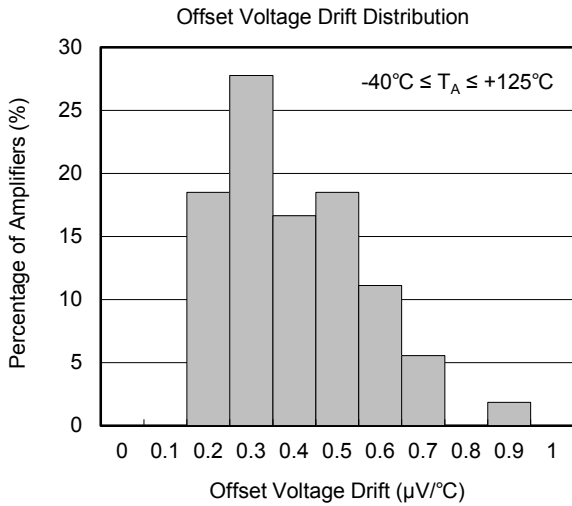
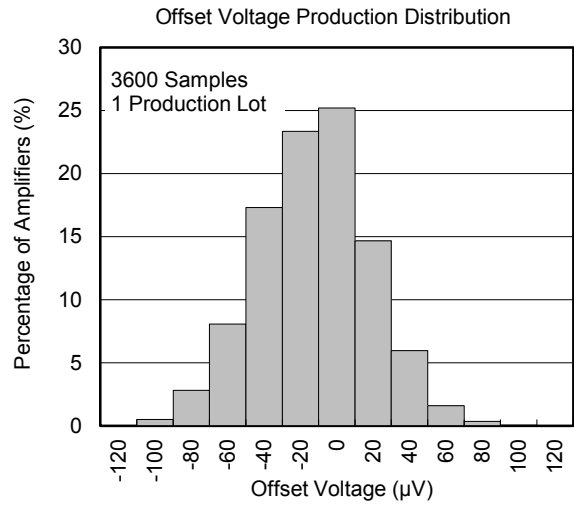
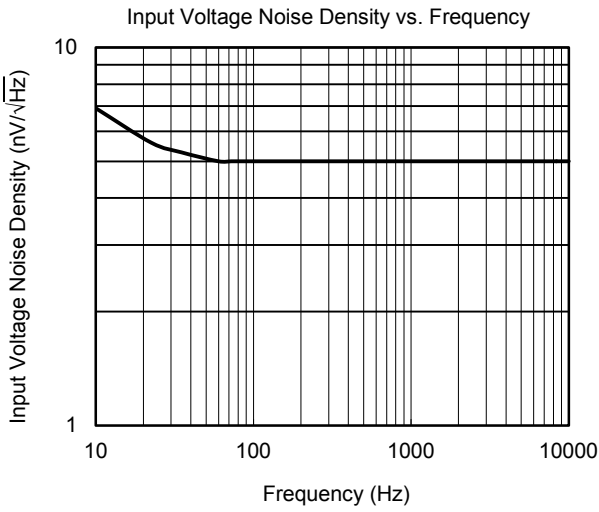
**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = +25^\circ\text{C}$  and  $V_S = \pm 15\text{V}$ , unless otherwise noted.



**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

At  $T_A = +25^\circ\text{C}$  and  $V_S = \pm 15\text{V}$ , unless otherwise noted.





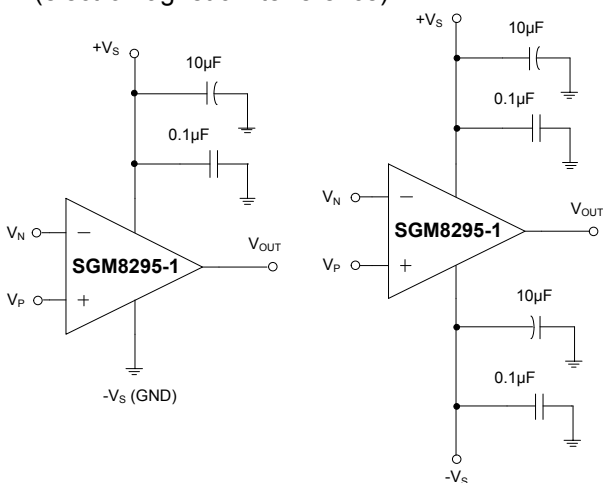
**APPLICATION NOTES**

**Power-Supply Bypassing and Layout**

The SGM8295-1/2/4 operate from either a single 3.6V to 36V supply or dual  $\pm 1.8V$  to  $\pm 18V$  supplies. For single-supply operation, bypass the power supply  $+V_S$  with a  $0.1\mu F$  ceramic capacitor which should be placed close to the  $+V_S$  pin. For dual-supply operation, both the  $+V_S$  and the  $-V_S$  supplies should be bypassed to ground with separate  $0.1\mu F$  ceramic capacitors. A  $10\mu F$  tantalum capacitor can be added for better performance.

Good PCB layout techniques optimize performance by decreasing the amount of stray capacitance at the operational amplifier’s inputs and output. To decrease stray capacitance, minimize trace lengths and widths by placing external components as close to the device as possible. Use surface-mount components whenever possible.

For the operational amplifier, soldering the part to the board directly is strongly recommended. Try to keep the high frequency current loop area small to minimize the EMI (electromagnetic interference).



**Figure 1. Amplifier with Bypass Capacitors**

**Grounding**

A ground plane layer is important for SGM8295-1/2/4 circuit design. The length of the current path in an inductive ground return will create an unwanted voltage noise. Broad ground plane areas will reduce the parasitic inductance.

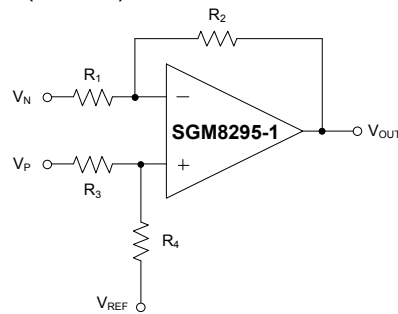
**Input-to-Output Coupling**

To minimize capacitive coupling, the input and output signal traces should not be in parallel. This helps reduce unwanted positive feedback.

**Differential Amplifier**

The circuit shown in Figure 2 performs the difference function. If the resistor ratios are equal ( $R_4/R_3 = R_2/R_1$ ),

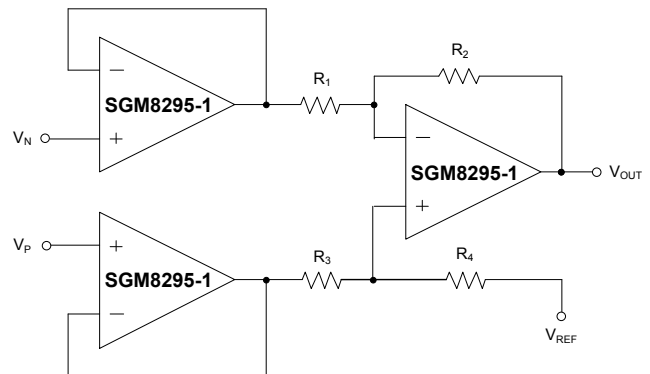
then  $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$ .



**Figure 2. Differential Amplifier**

**Instrumentation Amplifier**

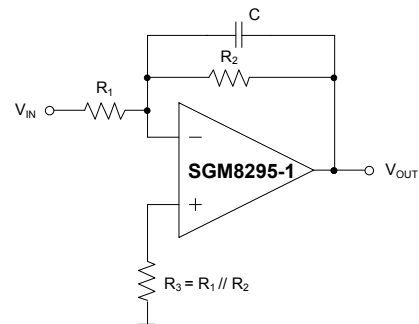
The circuit in Figure 3 performs the same function as that in Figure 2 but with a high input impedance.



**Figure 3. Instrumentation Amplifier**

**Active Low-Pass Filter**

The low-pass filter shown in Figure 4 has a DC gain of  $(-R_2/R_1)$  and the  $-3dB$  corner frequency is  $1/2\pi R_2 C$ . Make sure the filter bandwidth is within the bandwidth of the amplifier. Feedback resistors with large values can couple with parasitic capacitance and cause undesired effects such as ringing or oscillation in high-speed amplifiers. Keep resistor values as low as possible and consistent with output loading consideration.



**Figure 4. Active Low-Pass Filter**

## **REVISION HISTORY**

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

### **AUGUST 2017 – REV.A to REV.A.1**

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Updated open-loop gain and phase vs. frequency ..... 7

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### **Changes from Original (AUGUST 2017) to REV.A**

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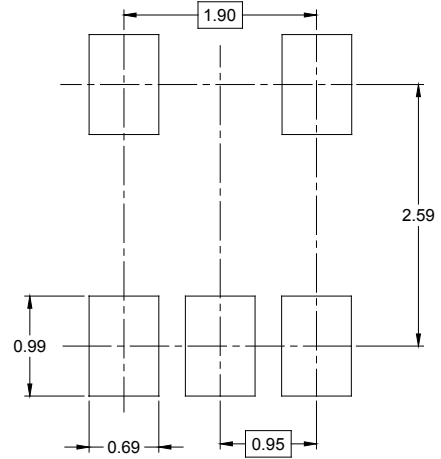
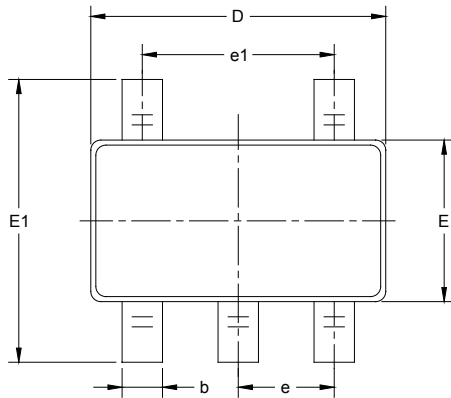
Changed from product preview to production data ..... All

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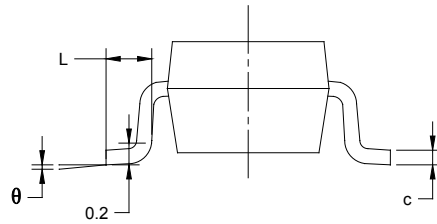
# PACKAGE INFORMATION

## PACKAGE OUTLINE DIMENSIONS

### SOT-23-5



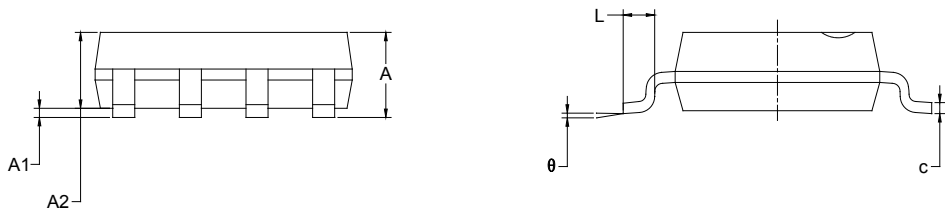
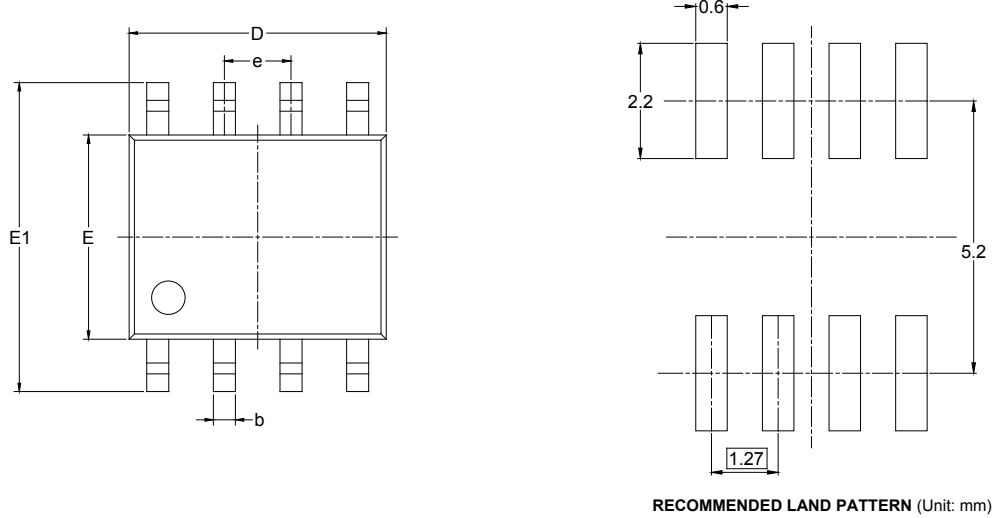
RECOMMENDED LAND PATTERN (Unit: mm)



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
$\theta$	0°	8°	0°	8°

PACKAGE OUTLINE DIMENSIONS

SOIC-8



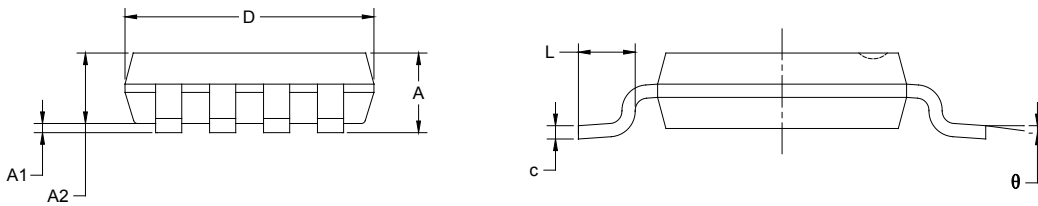
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

PACKAGE OUTLINE DIMENSIONS

MSOP-8



RECOMMENDED LAND PATTERN (Unit: mm)

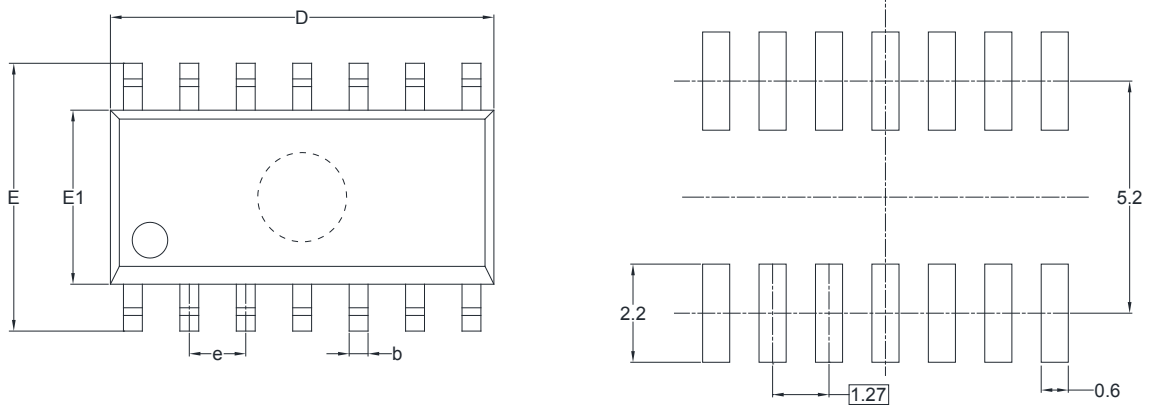


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
θ	0°	6°	0°	6°

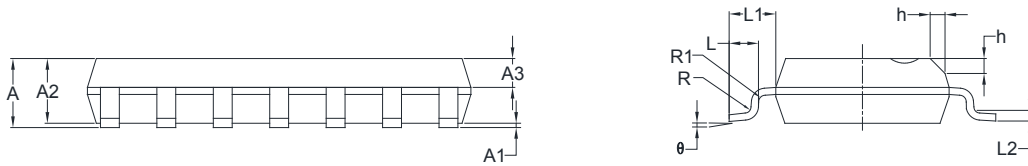
# PACKAGE INFORMATION

## PACKAGE OUTLINE DIMENSIONS

### SOIC-14



RECOMMENDED LAND PATTERN (Unit: mm)

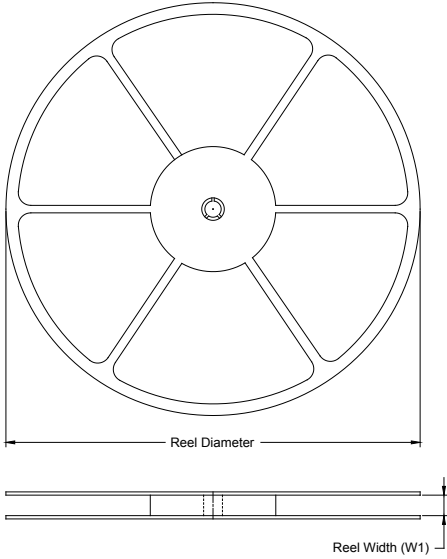


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80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

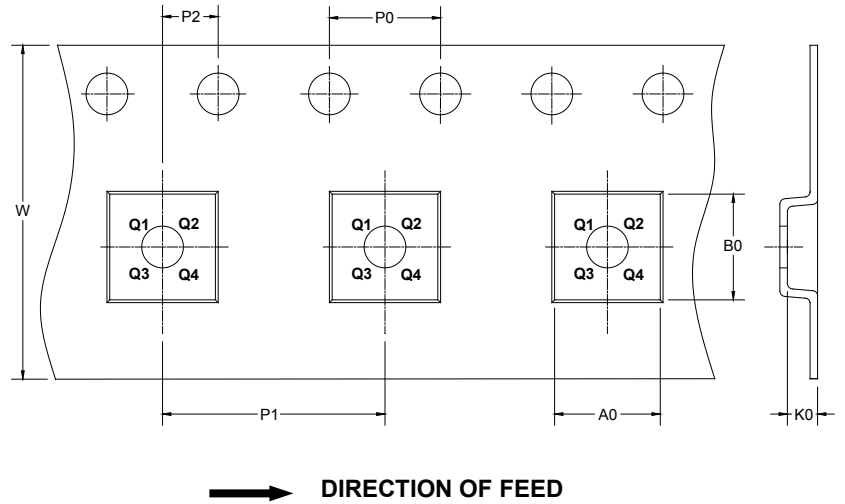
# PACKAGE INFORMATION

## 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
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
SOIC-14	13"	16.4	6.60	9.30	2.10	4.0	8.0	2.0	16.0	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