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

GENERAL DESCRIPTION

The SGM8295-1/2/4 are a family of single, dual and quad operational amplifiers, which are optimized for high voltage, low noise and low offset voltage operation. These devices can operate from 3.6V to 36V single supply or from ±1.8V to ±18V dual supplies, while consuming only 1.5mA quiescent current per amplifier.

They exhibit a high gain-bandwidth product of 9MHz and a slew rate of 8V/μs. The output swing is rail-to-rail with heavy loads. These specifications make the operational amplifiers appropriate for various applications.

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

FEATURES

- **Low Noise: 4.5nV/$\sqrt{Hz}$**
- **Input Offset Voltage: 250μV (MAX)**
- **Low Bias Current: ±1nA (TYP)**
- **High Open-Loop Gain: 130dB at V_S = ±15V**
- **High PSRR: 145dB**
- **High Gain-Bandwidth Product: 9MHz**
- **High Slew Rate: 8V/μs**
- **Settling Time to 0.1% with 1V Step: 1μs**
- **Overload Recovery Time: 10μs**
- **Rail-to-Rail Output**
- **Support Single or Dual Power Supplies:**
  3.6V to 36V or ±1.8V to ±18V
- **Input Common Mode Voltage Range:**
  ($-V_S$) + 1.5V to ($+V_S$) - 2V
- **Low Supply Current: 1.5mA/Amplifier (TYP)**
- **-40℃ to +125℃ 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 a Green SOIC-14 Package

APPLICATIONS

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

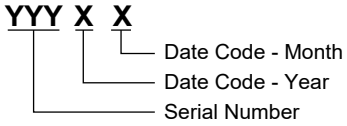
PACKAGE/ORDERING INFORMATION

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

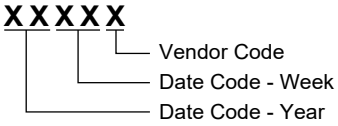
MARKING INFORMATION

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

SOT-23-5



SOIC-8/MSOP-8/SOIC-14



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, $+V_S$ to $-V_S$ 40V
Input Common Mode Voltage Range
..... ($-V_S$) - 0.3V to ($+V_S$) + 0.3V
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 4000V
MM 200V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

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

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

ESD SENSITIVITY CAUTION

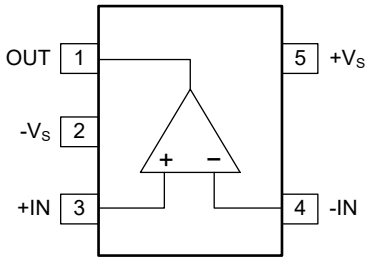
This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance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

DISCLAIMER

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

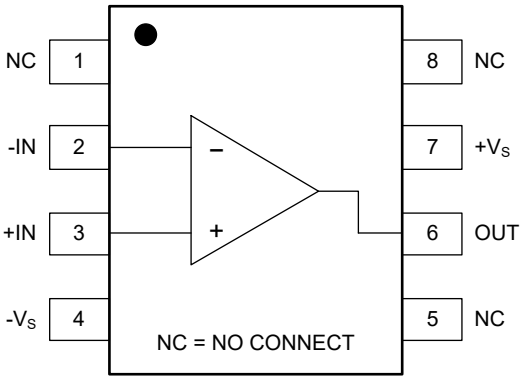
PIN CONFIGURATIONS

SGM8295-1 (TOP VIEW)



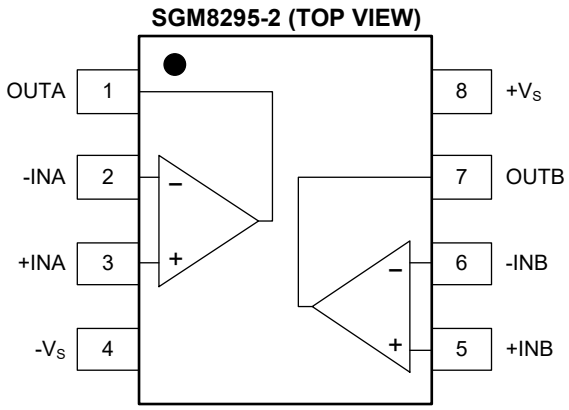
SOT-23-5

SGM8295-1 (TOP VIEW)



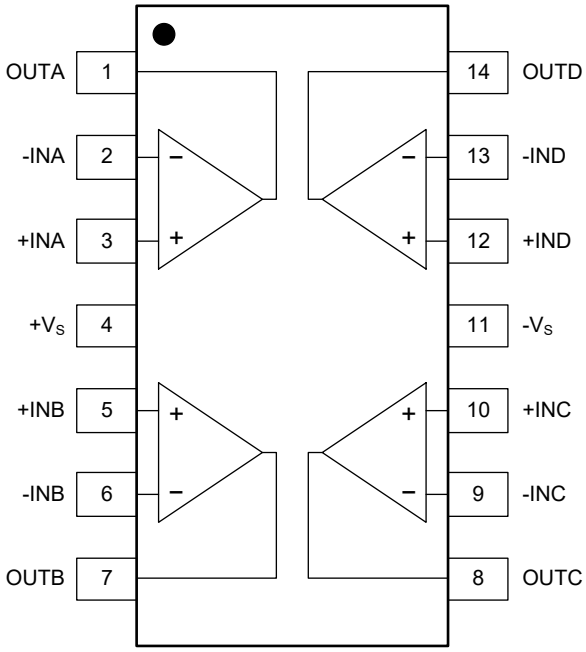
SOIC-8

SGM8295-2 (TOP VIEW)



SOIC-8/MSOP-8

SGM8295-4 (TOP VIEW)



SOIC-14

ELECTRICAL CHARACTERISTICS

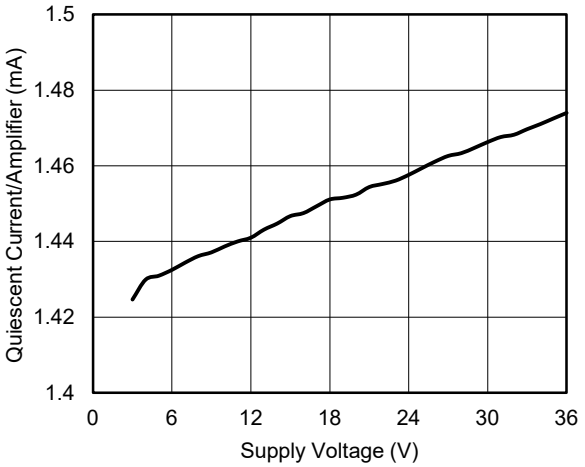
(V_S = ±5V to V_S = ±15V, V_{CM} = 0V, V_{OUT} = 0V and R_L connected to 0V, Full = -40℃ to +125℃, typical values are at T_A = +25℃, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
Input Characteristics							
Input Offset Voltage	V_{OS}		+25℃		50	250	μV
			Full			360	
Input Bias Current	I_B	V_{CM} = V_S/2	+25℃		±1	±17	nA
			Full			±52	
Input Offset Current	I_{OS}	V_{CM} = V_S/2	+25℃		±1	±21	nA
			Full			±45	
Input Common Mode Voltage Range	V_{CM}		Full	$(-V_S)$ + 1.5		$(+V_S)$ - 2	V
Common Mode Rejection Ratio	CMRR	$(-V_S)$ + 1.5V ≤ V_{CM} ≤ $(+V_S)$ - 2V	+25℃	112	140		dB
			Full	110			
Open-Loop Voltage Gain	A_{OL}	V_S = ±5V, V_{OUT} = ±2.5V, R_L = 10kΩ	+25℃	118	135		dB
			Full	116			
		V_S = ±15V, V_{OUT} = ±10V, R_L = 10kΩ	+25℃	124	140		
			Full	122			
		V_S = ±5V, V_{OUT} = ±2.5V, R_L = 2kΩ	+25℃	108	130		
			Full	106			
		V_S = ±15V, V_{OUT} = ±10V, R_L = 2kΩ	+25℃	118	130		
			Full	110			
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$		Full		0.4		μV/℃
Output Characteristics							
Output Voltage Swing from Rail	V_{OUT}	V_S = ±15V, R_L = 10kΩ	+25℃		65	95	mV
			Full			125	
		V_S = ±15V, R_L = 2kΩ	+25℃		310	450	
			Full			600	
Output Short-Circuit Current	I_{SC}		+25℃	±28	±50		mA
Power Supply							
Operating Voltage Range	V_S		Full	3.6		36	V
Quiescent Current/Amplifier	I_Q	I_{OUT} = 0mA	+25℃		1.5	2	mA
			Full			2.2	
Power Supply Rejection Ratio	PSRR	V_S = 3V to 38V	+25℃	121	145		dB
			Full	119			
Dynamic Performance							
Gain-Bandwidth Product	GBP	V_{OUT} = 100mV_{P-P}, R_L = 2kΩ	+25℃		9		MHz
Slew Rate	SR	R_L = 2kΩ	+25℃		8		V/μs
Settling Time to 0.1%	t_S	V_{IN} = 1V Step, R_L = 2kΩ, G = +1	+25℃		1		μs
Overload Recovery Time		R_L = 2kΩ, V_{IN} × G = V_S	+25℃		10		μs
Phase Margin	φ_O	V_{OUT} = 100mV_{P-P}, R_L = 2kΩ, C_L = 10pF	+25℃		45		°
Total Harmonic Distortion + Noise	THD+N	V_{IN} = 1V_{RMS}, G = +1, R_L = 2kΩ, f = 1kHz	+25℃		0.0001		%
Noise							
Input Voltage Noise		f = 0.1Hz to 10Hz	+25℃		280		nV_{P-P}
Input Voltage Noise Density	e_n	f = 1kHz	+25℃		4.5		$nV/\sqrt{Hz}$
Input Current Noise Density	i_n	f = 1kHz	+25℃		2		$pA/\sqrt{Hz}$

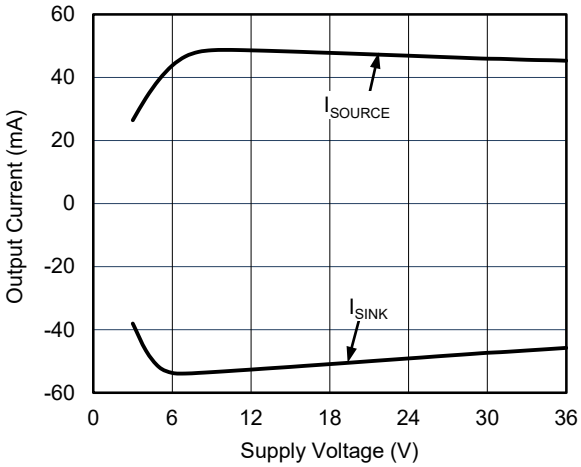
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃ and V_S = ±15V, unless otherwise noted.

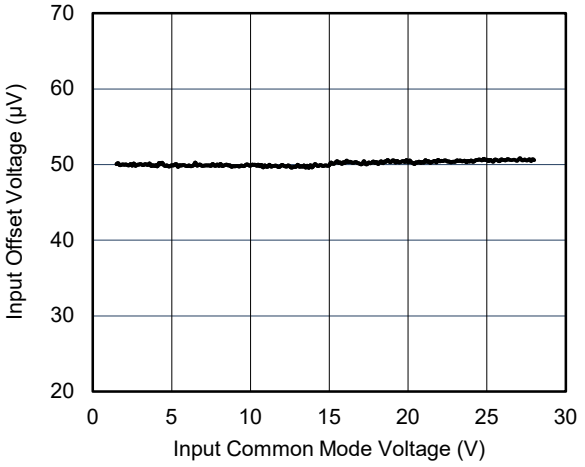
Quiescent Current vs. Supply Voltage



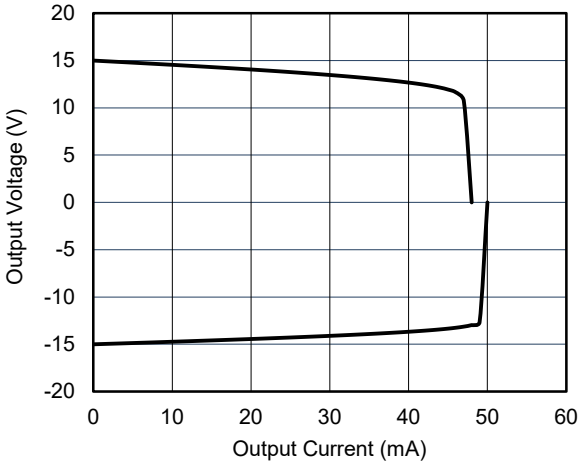
Output Current vs. Supply Voltage



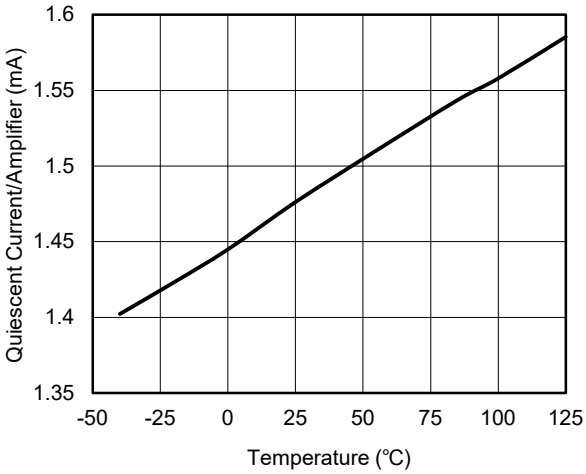
Input Offset Voltage vs. Input Common Mode Voltage



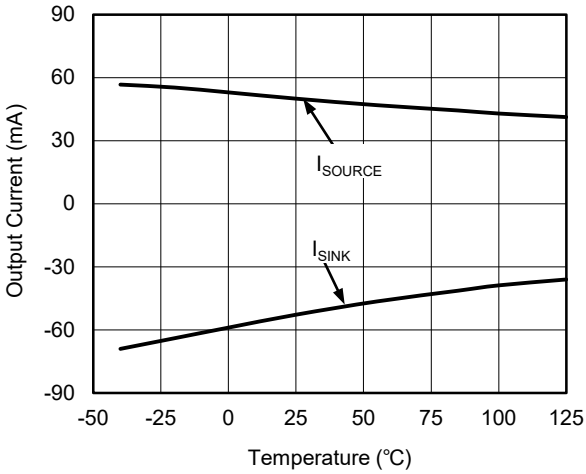
Output Voltage vs. Output Current



Quiescent Current vs. Temperature



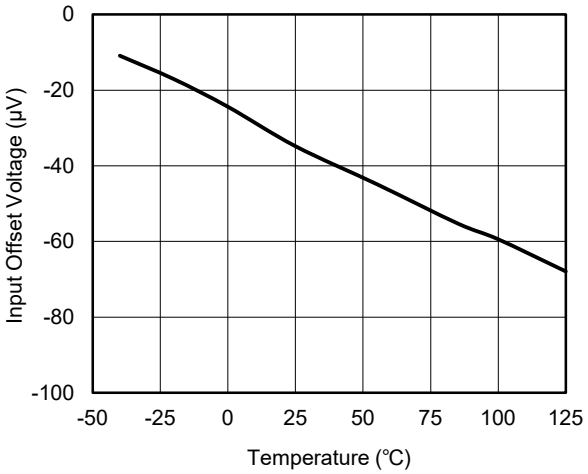
Output Current vs. Temperature



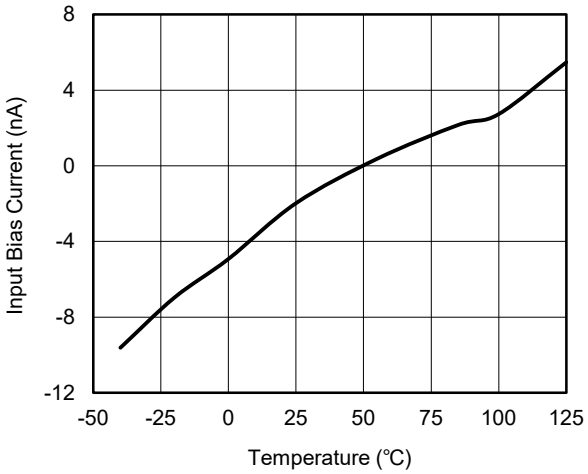
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃ and V_S = ±15V, unless otherwise noted.

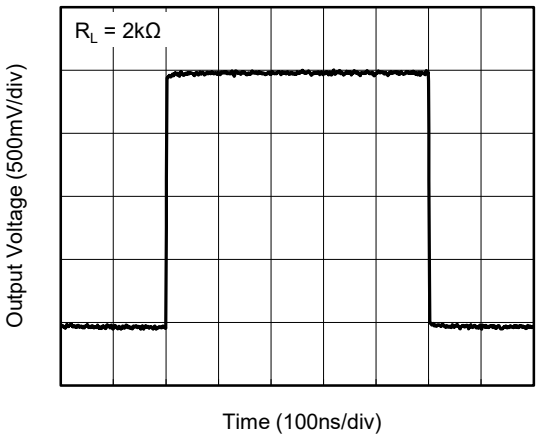
Input Offset Voltage vs. Temperature



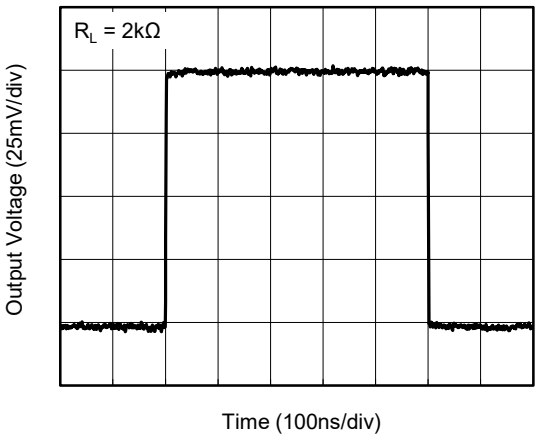
Input Bias Current vs. Temperature



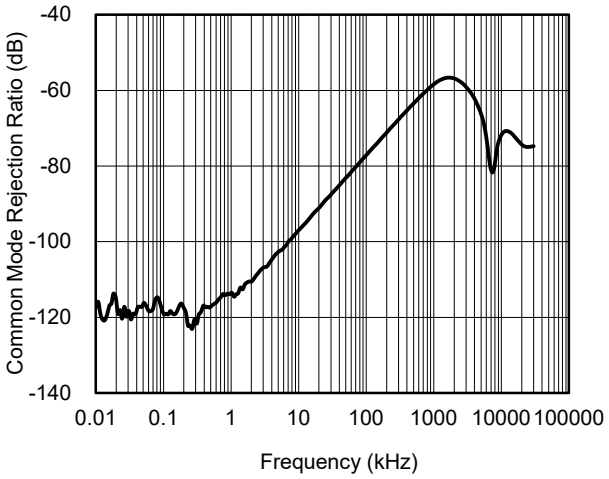
Large-Signal Step Response



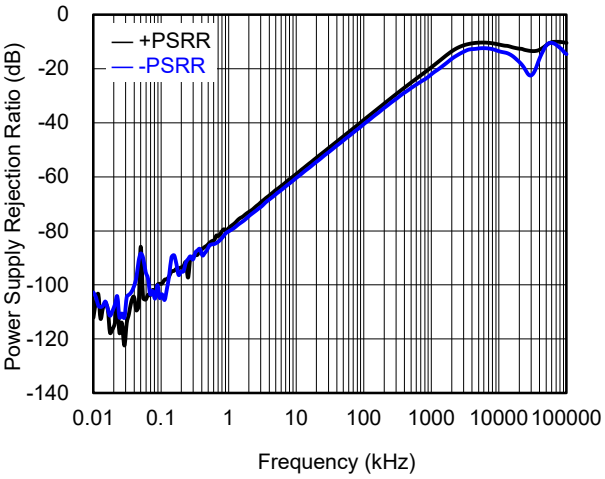
Small-Signal Step Response



CMRR vs. Frequency



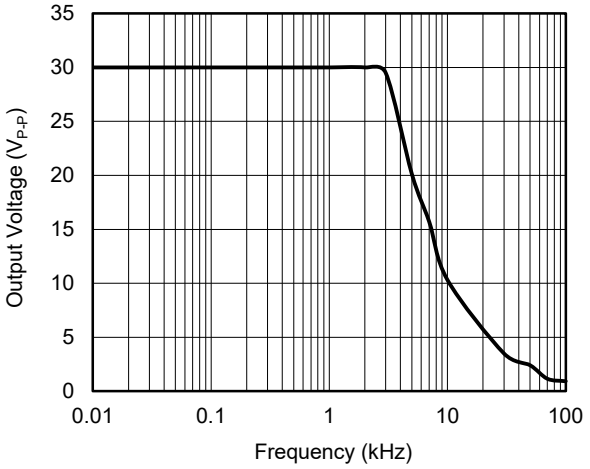
PSRR vs. Frequency



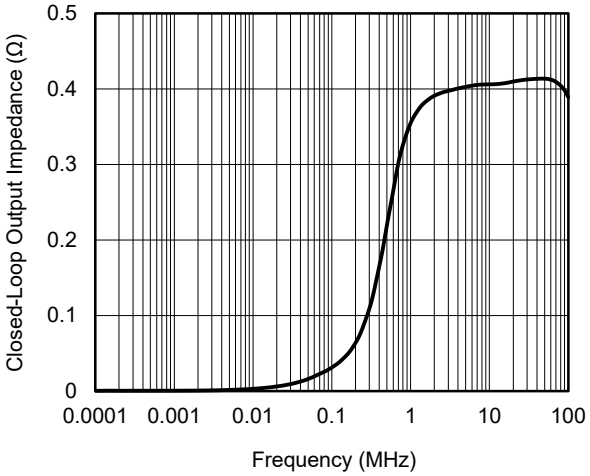
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃ and V_S = ±15V, unless otherwise noted.

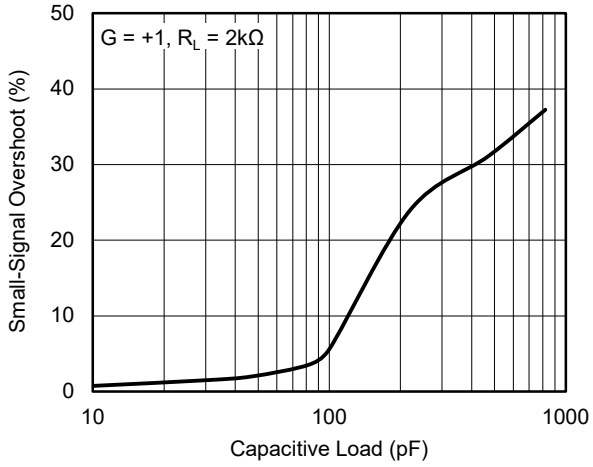
Maximum Output Voltage vs. Frequency



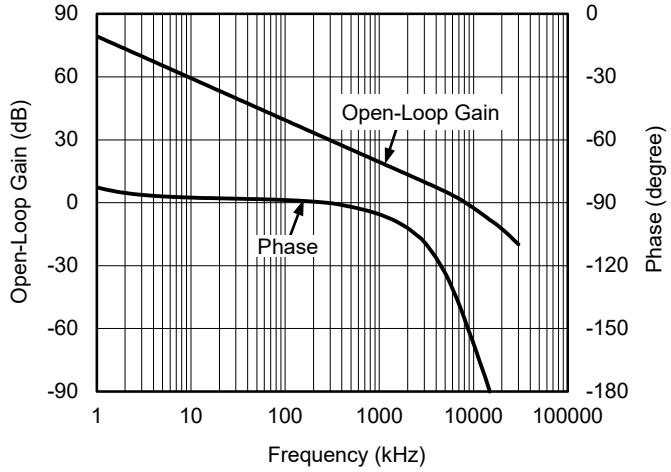
Closed-Loop Output Impedance vs. Frequency



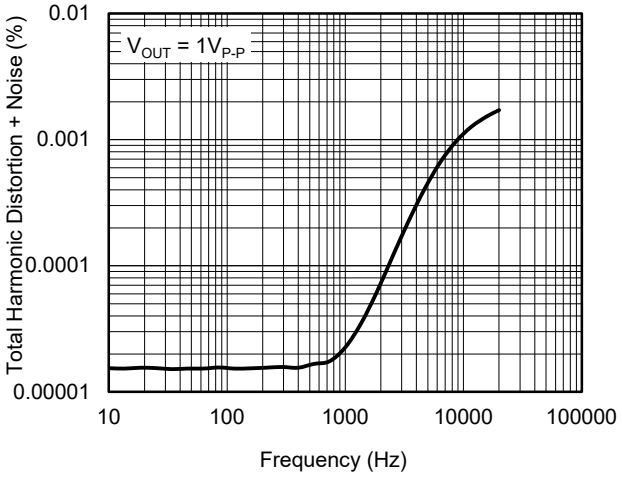
Small-Signal Overshoot vs. Capacitive Load



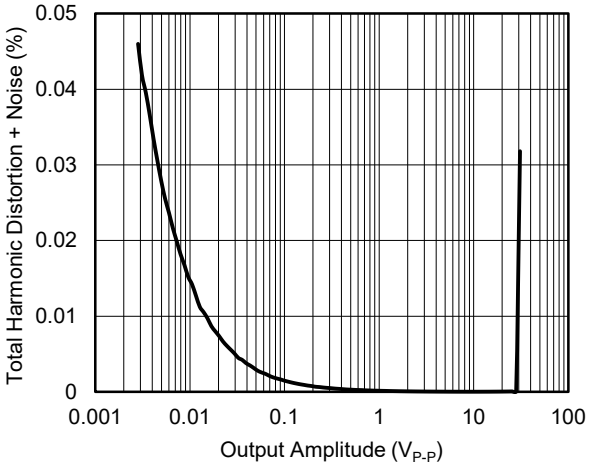
Open-Loop Gain and Phase vs. Frequency



THD+N vs. Frequency



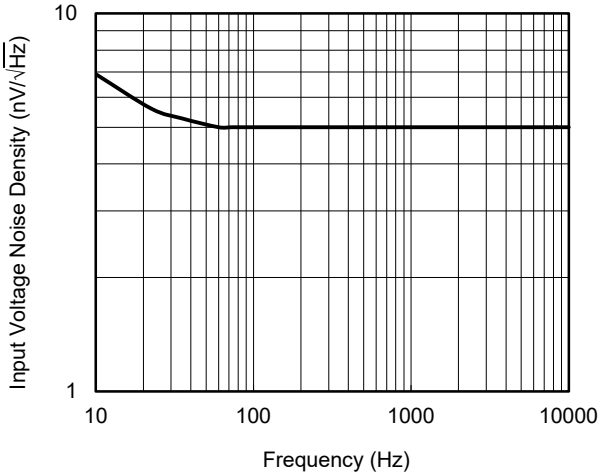
THD+N vs. Output Amplitude



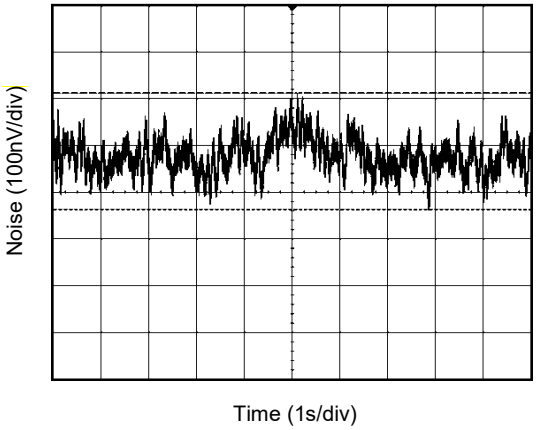
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃ and V_S = ±15V, unless otherwise noted.

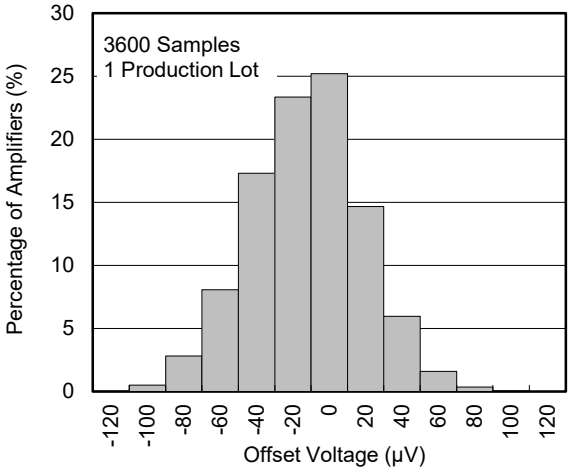
Input Voltage Noise Density vs. Frequency



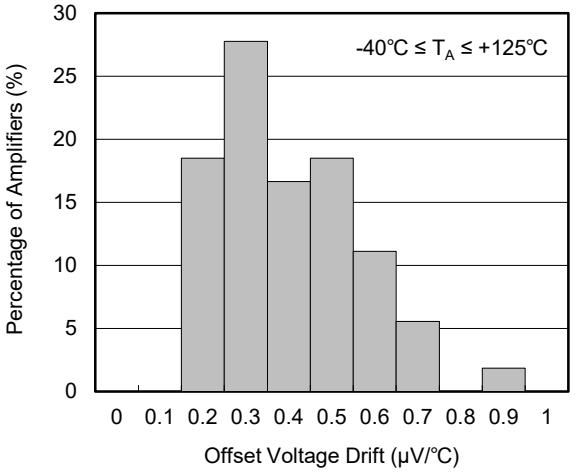
0.1Hz to 10Hz Input Voltage Noise



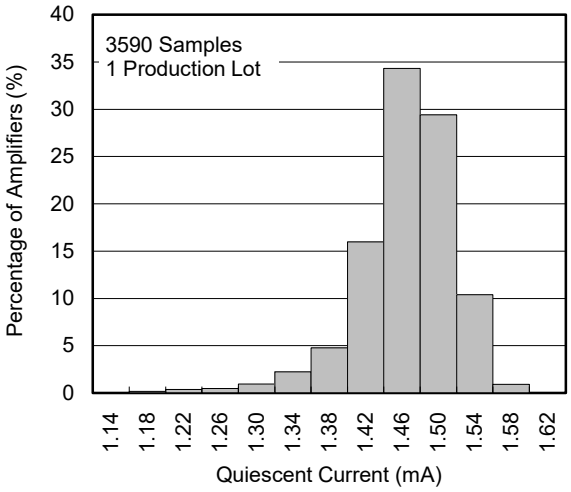
Offset Voltage Production Distribution



Offset Voltage Drift Distribution



Quiescent Current Production Distribution



APPLICATION INFORMATION

Power Supply Decoupling and Layout

A clean and low noise power supply is very important in amplifier circuit design, besides of input signal noise, the power supply is one of important source of noise to the amplifiers through $+V_S$ and $-V_S$ pins. Power supply bypassing is an effective method to clear up the noise at power supply, and the low impedance path to ground of decoupling capacitor will bypass the noise to GND. In application, 10μF ceramic capacitor paralleled with 0.1μF or 0.01μF ceramic capacitor is used in Figure 1. The ceramic capacitors should be placed as close as possible to $+V_S$ and $-V_S$ power supply pins.

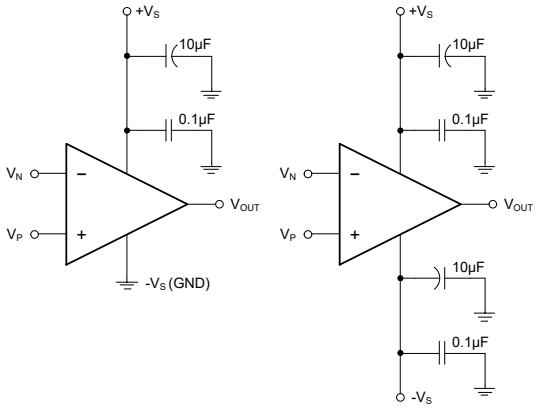


Figure 1. Amplifier Power Supply Bypassing

Grounding

In low speed application, one node grounding technique is the simplest and most effective method to eliminate the noise generated by grounding. In high speed application, the general method to eliminate noise is to use a complete ground plane technique, and the whole ground plane will help distribute heat and reduce EMI noise pickup.

Reduce Input-to-Output Coupling

To reduce the input-to-output coupling, the input traces must be placed as far away from the power supply or output traces as possible. The sensitive trace must not be placed in parallel with the noisy trace in same layer. They must be placed perpendicularly in different layers to reduce the crosstalk. These PCB layout techniques will help to reduce unwanted positive feedback and noise.

Typical Application Circuits

Difference Amplifier

The circuit in Figure 2 is a design example of classical difference amplifier. If $R_4/R_3 = R_2/R_1$, then $V_{OUT} = (V_P - V_N) \times R_2/R_1 + V_{REF}$.

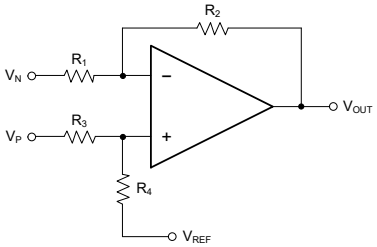


Figure 2. Difference Amplifier

High Input Impedance Difference Amplifier

The circuit in Figure 3 is a design example of high input impedance difference amplifier, the added amplifiers at the input are used to increase the input impedance and eliminate drawback of low input impedance in Figure 2.

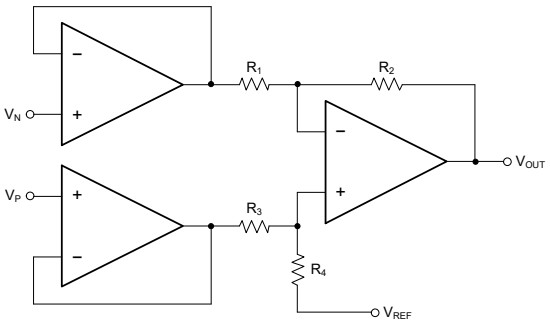


Figure 3. High Input Impedance Difference Amplifier

Active Low-Pass Filter

The circuit in Figure 4 is a design example of active low-pass filter, the DC gain is equal to $-R_2/R_1$ and the -3dB corner frequency is equal to $1/2\pi R_2 C$. In this design, the filter bandwidth must be less than the bandwidth of the amplifier, the resistor values must be selected as low as possible to reduce ringing or oscillation generated by the parasitic parameters in PCB layout.

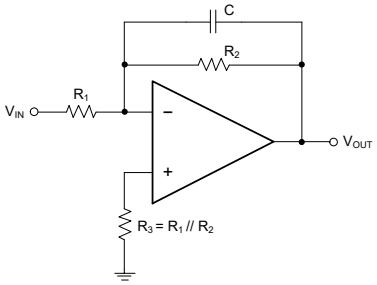


Figure 4. Active Low-Pass Filter

REVISION HISTORY

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

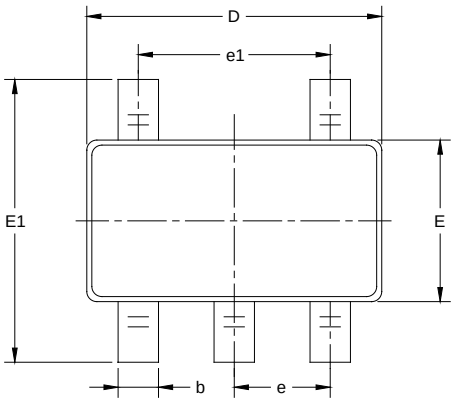
MARCH 2023 – REV.A.1 to REV.A.2	**Page**
Updated Typical Performance Characteristics section	6

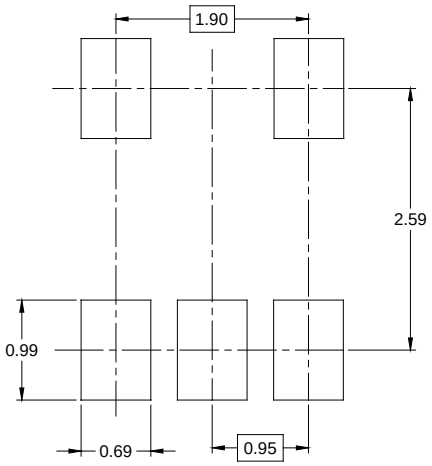
AUGUST 2017 – REV.A to REV.A.1	**Page**
Updated open-loop gain and phase vs. frequency	7

Changes from Original (AUGUST 2017) to REV.A	**Page**
Changed from product preview to production data	All

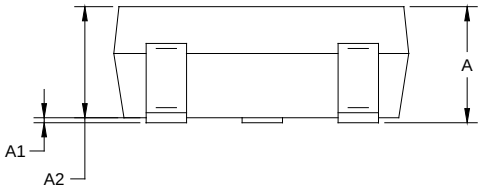
PACKAGE OUTLINE DIMENSIONS

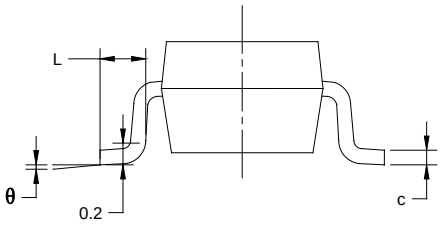
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)



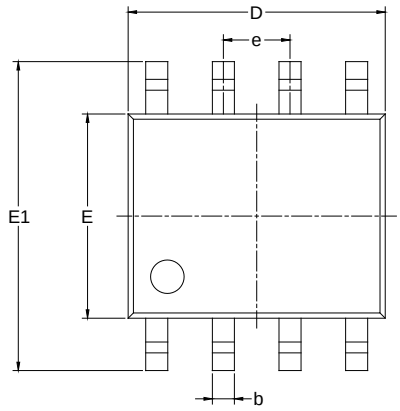


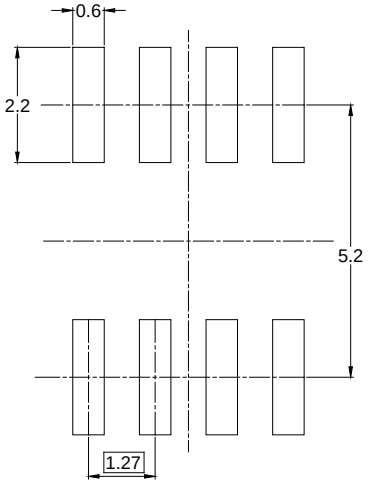
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

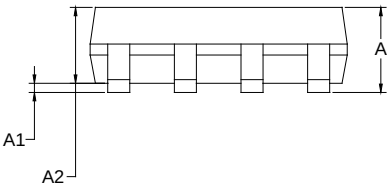
PACKAGE OUTLINE DIMENSIONS

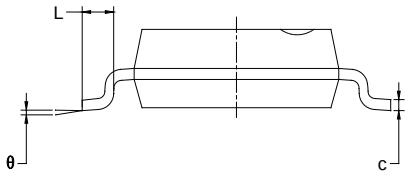
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)



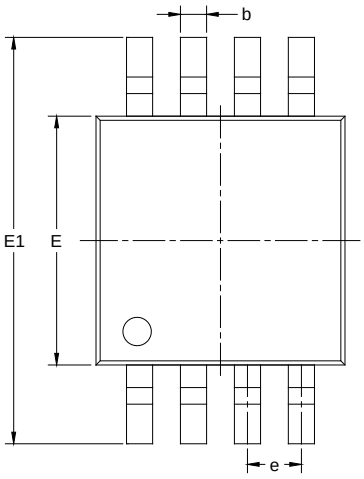


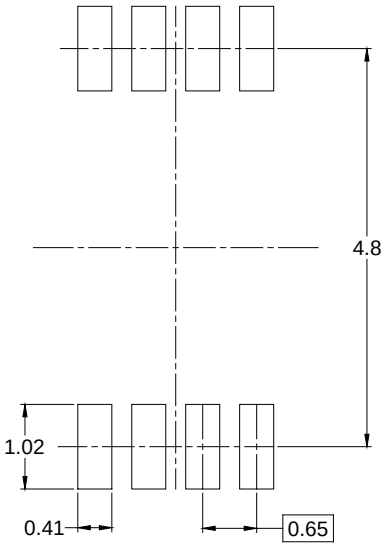
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

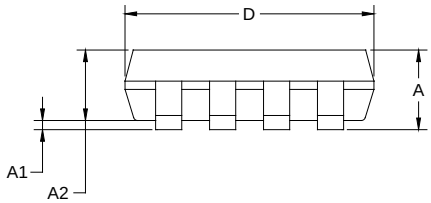
PACKAGE OUTLINE DIMENSIONS

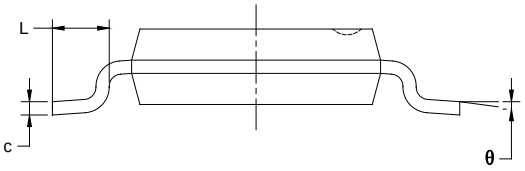
MSOP-8





RECOMMENDED LAND PATTERN (Unit: mm)



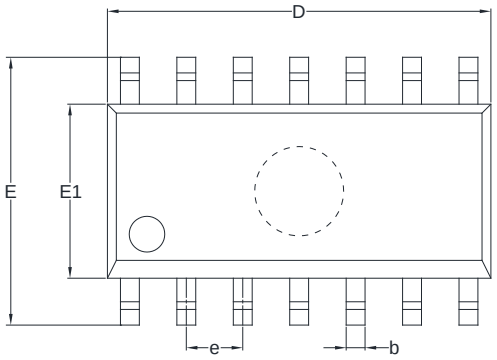


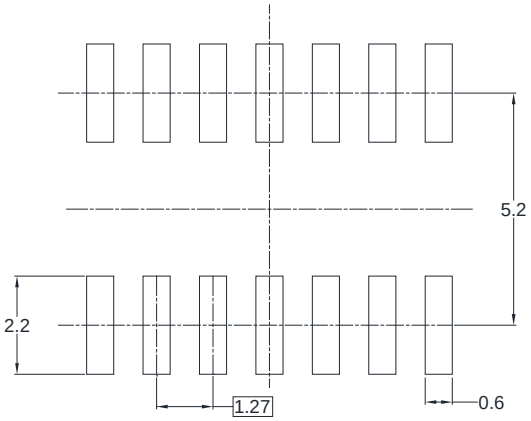
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026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

NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

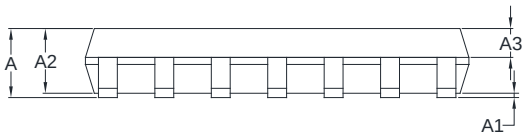
PACKAGE OUTLINE DIMENSIONS

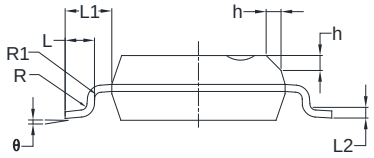
SOIC-14





RECOMMENDED LAND PATTERN (Unit: mm)



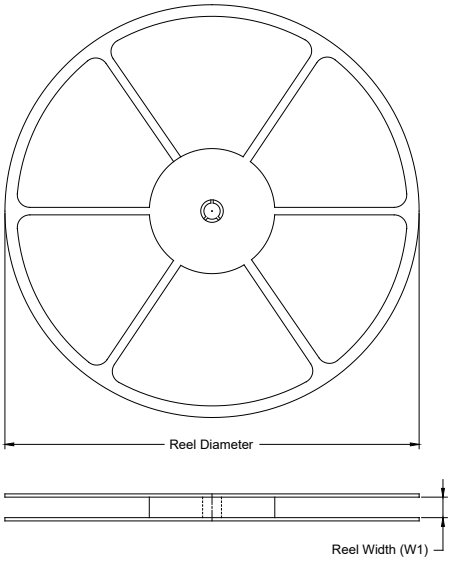


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
A2	1.25	1.65	0.049	0.065
A3	0.55	0.75	0.022	0.030
b	0.36	0.49	0.014	0.019
D	8.53	8.73	0.336	0.344
E	5.80	6.20	0.228	0.244
E1	3.80	4.00	0.150	0.157
e	1.27 BSC		0.050 BSC	
L	0.45	0.80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

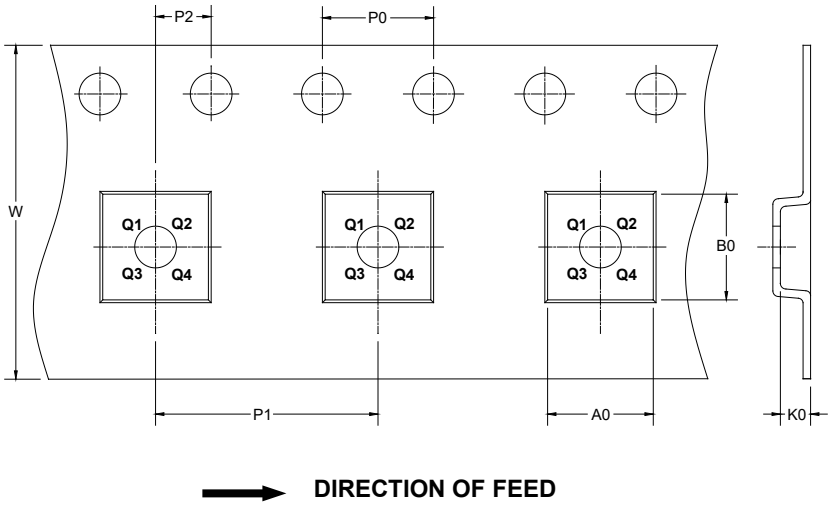
NOTES:
1. Body dimensions do not include mode flash or protrusion.
2. This drawing is subject to change without notice.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



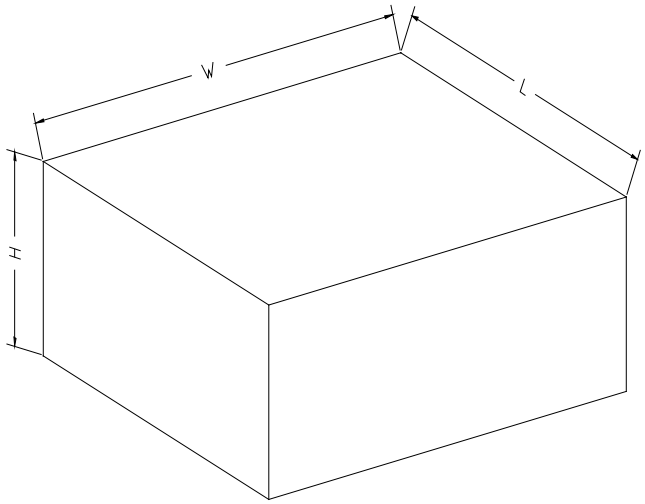
NOTE: The picture is only for reference. Please make the object as the standard.

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

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