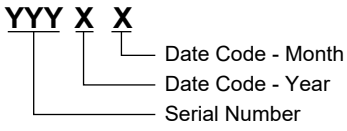
PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKING OPTION
SGM8049-1	SOT-23-5	-40℃ to +125℃	SGM8049-1XN5G/TR	SVAXX	Tape and Reel, 3000
	SC70-5	-40℃ to +125℃	SGM8049-1AXC5G/TR	SZAXX	Tape and Reel, 3000
	SC70-5	-40℃ to +125℃	SGM8049-1BXC5G/TR	SUEXX	Tape and Reel, 3000
	TDFN-2×2-6L	-40℃ to +125℃	SGM8049-1XTDI6G/TR	SZC XXXX	Tape and Reel, 3000
SGM8049-2	SOT-23-8	-40℃ to +125℃	SGM8049-2XN8G/TR	SVBXX	Tape and Reel, 3000
	SOIC-8	-40℃ to +125℃	SGM8049-2XS8G/TR	SGM 80492XS8 XXXXX	Tape and Reel, 2500
SGM8049-4	TSSOP-14	-40℃ to +125℃	SGM8049-4XTS14G/TR	SGM80494 XTS14 XXXXX	Tape and Reel, 4000

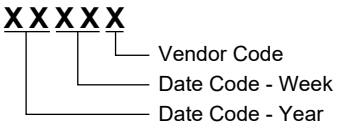
MARKING INFORMATION

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

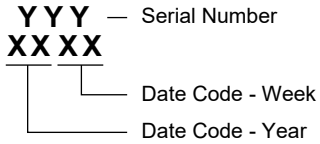
SOT-23-5/SC70-5/SOT-23-8



SOIC-8/TSSOP-14



TDFN-2×2-6L



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 $-V_S$ 6V
Signal Input Terminals, Voltage
..... $(-V_S)$ - 0.3V to $(+V_S)$ + 0.3V
Signal Input Terminals, Current ..... ±10mA
Output Short-Circuit Current 30mA
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM 6000V
MM 400V
CDM 1000V

RECOMMENDED OPERATING CONDITIONS

Input Voltage Range ..... 1.8V to 5.5V
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

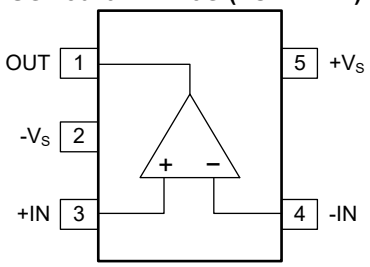
This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance 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.

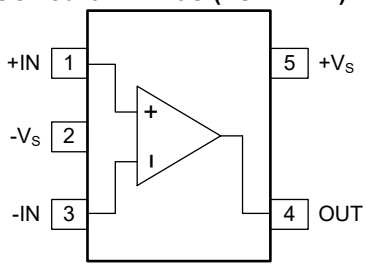
PIN CONFIGURATIONS

SGM8049-1XN5G
SGM8049-1AXC5G (TOP VIEW)



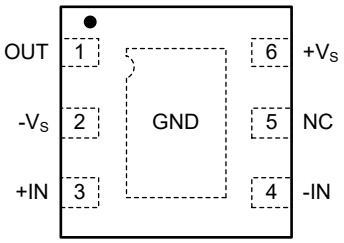
SOT-23-5/SC70-5

SGM8049-1BXC5G (TOP VIEW)



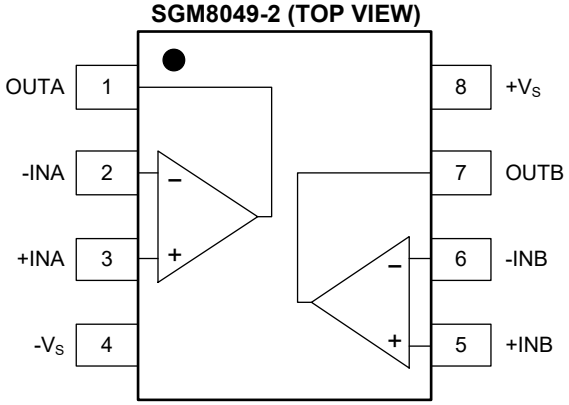
SC70-5

SGM8049-1 (TOP VIEW)



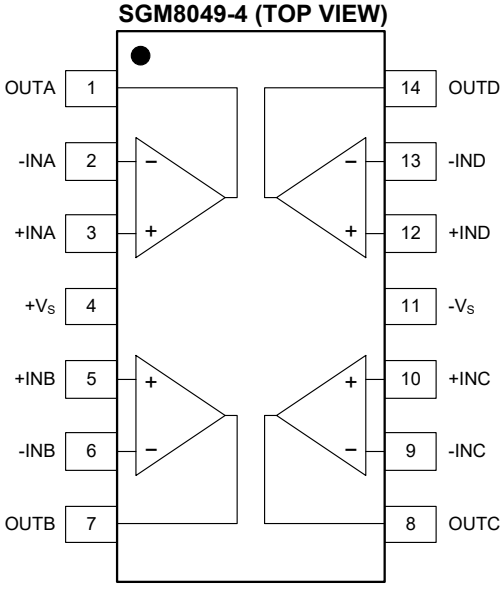
TDFN-2×2-6L

SGM8049-2 (TOP VIEW)



SOIC-8/SOT-23-8

SGM8049-4 (TOP VIEW)



TSSOP-14

ELECTRICAL CHARACTERISTICS

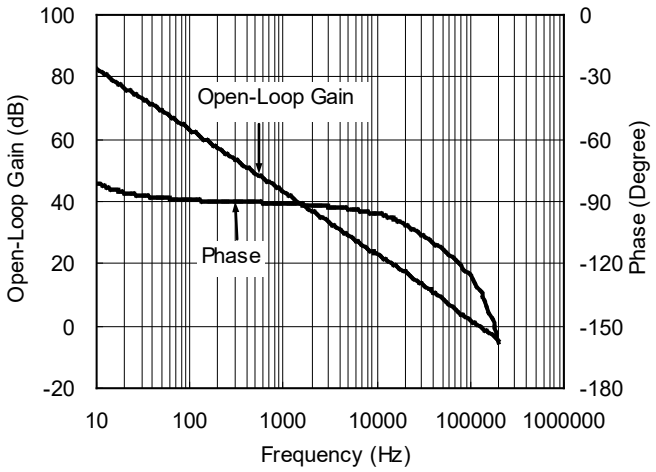
(At T_A = +25℃, V_S = 1.8V to 5.5V, R_L = 25kΩ connected to V_S/2 and V_{CM} < (+V_S) - 1.2V, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Characteristics						
Input Offset Voltage	V_{OS}	V_S = 5V		0.2	0.85	mV
		-40℃ ≤ T_A ≤ +125℃			1	
Input Bias Current	I_B	V_S = 5V, V_{CM} ≤ V_S/2		±1		pA
Input Offset Current	I_{OS}	V_S = 5V		±1		pA
Input Common Mode Voltage Range	V_{CM}		(-V_S) - 0.1		(+V_S) + 0.1	V
Common Mode Rejection Ratio	CMRR	-V_S < V_{CM} < (+V_S) - 1.2V	81	100		dB
		-40℃ ≤ T_A ≤ +85℃	80			
		-40℃ ≤ T_A ≤ +125℃	75			
Open-Loop Voltage Gain	A_{OL}	V_S = 5V, R_L = 25kΩ, 100mV < V_{OUT} < (+V_S) - 100mV	100	118		dB
		-40℃ ≤ T_A ≤ +125℃	98			
		V_S = 5V, R_L = 5kΩ, 500mV < V_{OUT} < (+V_S) - 500mV	100	116		
		-40℃ ≤ T_A ≤ +125℃	98			
Input Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	-40℃ ≤ T_A ≤ +85℃		0.5		μV/℃
		-40℃ ≤ T_A ≤ +125℃		0.6		
Output Characteristics						
Output Voltage Swing from Rail		R_L = 25kΩ		5	14	mV
		-40℃ ≤ T_A ≤ +125℃			15.5	
		R_L = 5kΩ		25	40	
		-40℃ ≤ T_A ≤ +125℃			46	
Output Short-Circuit Current	I_{SC}	V_S = 5V		20		mA
Power Supply						
Operating Voltage Range	V_S		1.8		5.5	V
Quiescent Current/Amplifier	I_Q	V_S = 5.5V, I_{OUT} = 0mA		2.5	4.2	μA
		-40℃ ≤ T_A ≤ +125℃			6.5	
Power Supply Rejection Ratio	PSRR	V_S = 1.8V to 5.5V, V_{CM} = 0.6V		2.5	12	μV/V
		-40℃ ≤ T_A ≤ +125℃			14	
Dynamic Performance (C_{LOAD} = 30pF)						
Gain-Bandwidth Product	GBP			120		kHz
Slew Rate	SR	G = +1		0.08		V/μs
Overload Recovery Time		V_{IN} × G > V_S		25		μs
Turn-On Time	t_{ON}			0.2		ms
Noise						
Input Voltage Noise		f = 0.1Hz to 10Hz		3.5		μV_{PP}
Input Voltage Noise Density	e_n	f = 1kHz		75		nV/$\sqrt{Hz}$
Input Current Noise Density	i_n	f = 1kHz		0.2		pA/$\sqrt{Hz}$

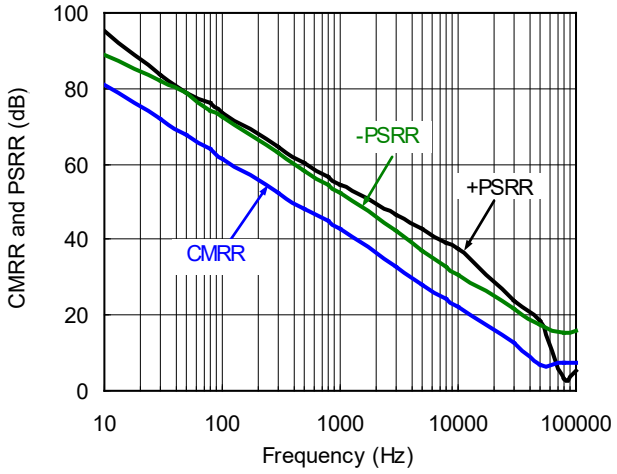
TYPICAL PERFORMANCE CHARACTERISTICS

At T_A = +25℃, V_S = 5V and R_L = 25kΩ connected to V_S/2, unless otherwise noted.

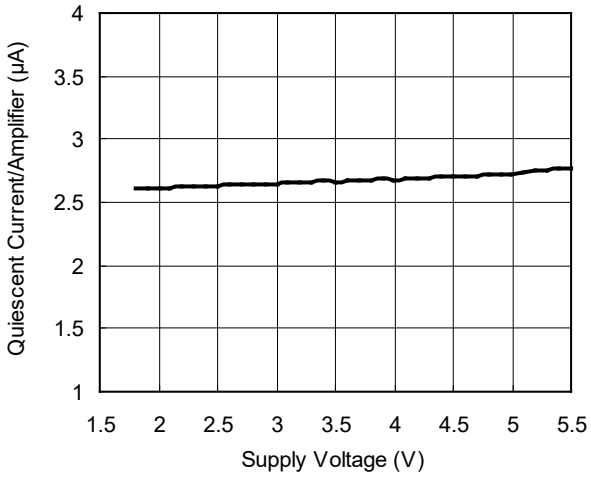
Open-Loop Gain and Phase vs. Frequency



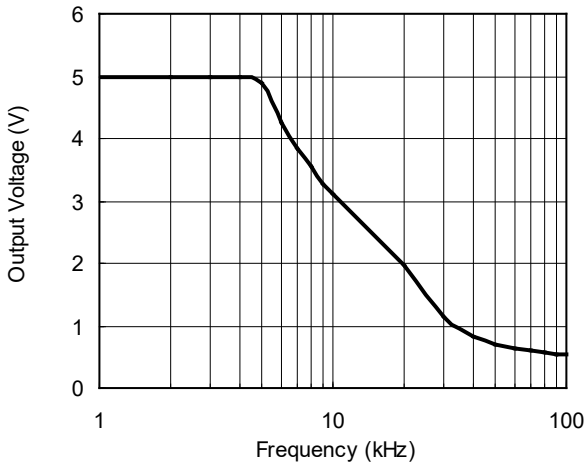
CMRR and PSRR vs. Frequency



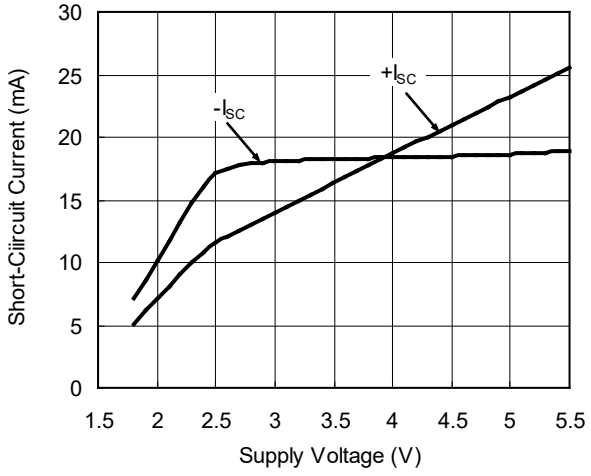
Quiescent Current vs. Supply Voltage



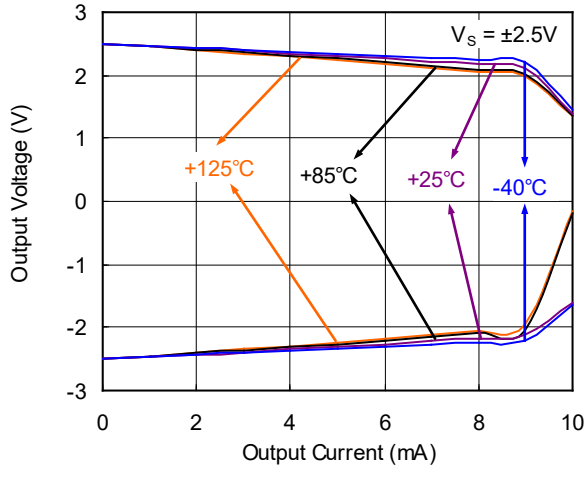
Maximum Output Voltage vs. Frequency



Short-Circuit Current vs. Supply Voltage



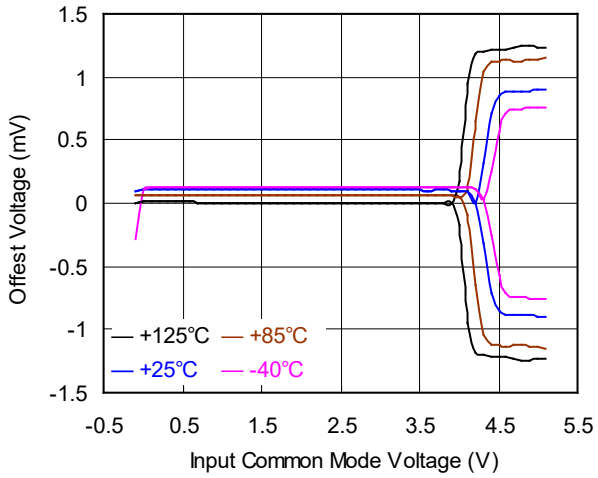
Output Voltage vs. Output Current



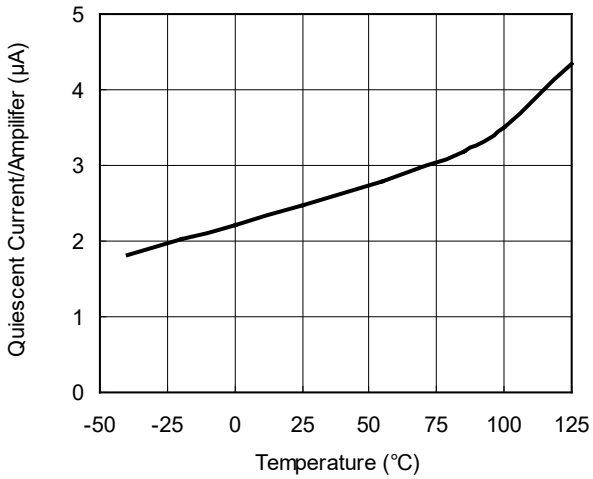
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V and R_L = 25kΩ connected to V_S/2, unless otherwise noted.

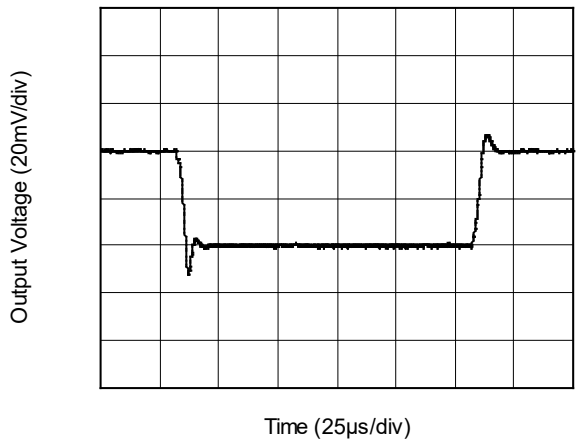
Offset Voltage vs. Input Common Mode Voltage



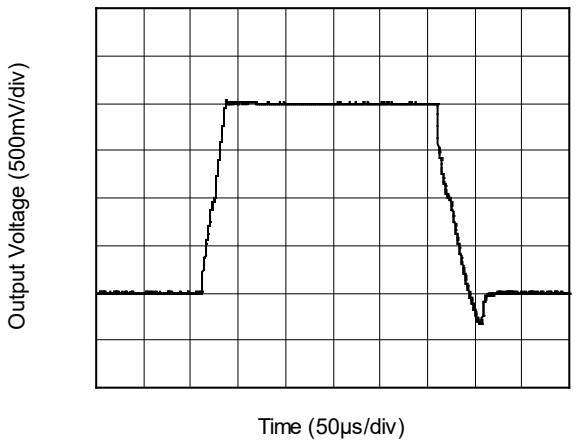
Quiescent Current vs. Temperature



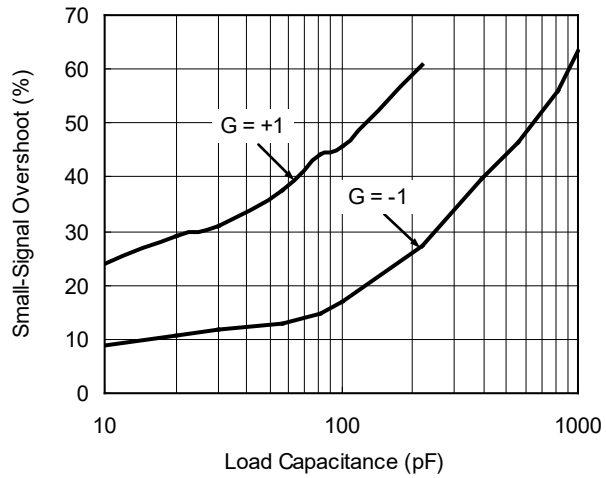
Small-Signal Step Response



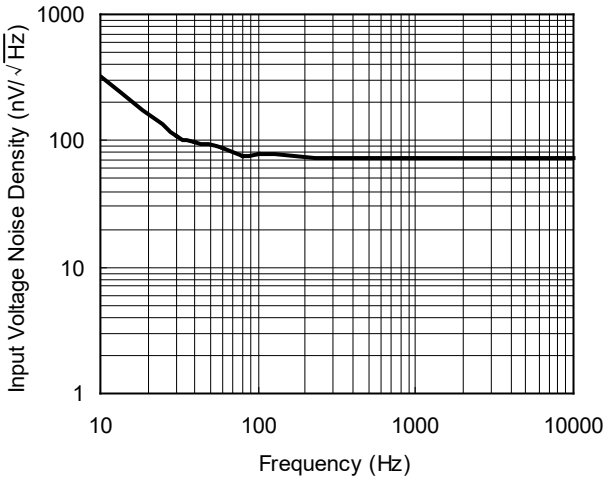
Large-Signal Step Response



Small-Signal Overshoot vs. Capacitive Load



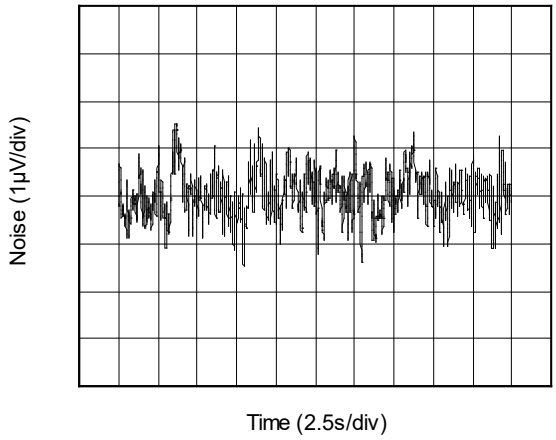
Input Voltage Noise Density vs. Frequency



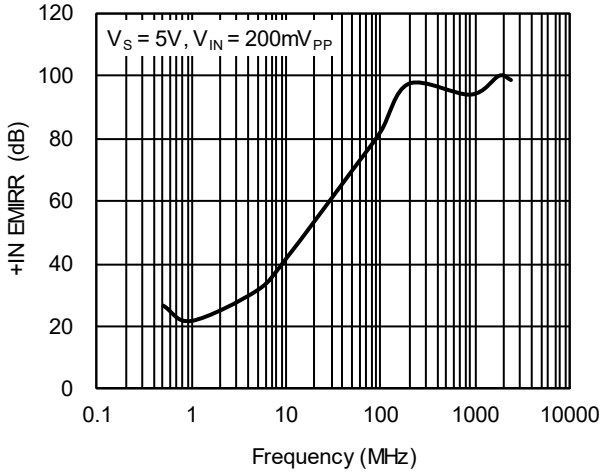
TYPICAL PERFORMANCE CHARACTERISTICS (continued)

At T_A = +25℃, V_S = 5V and R_L = 25kΩ connected to V_S/2, unless otherwise noted.

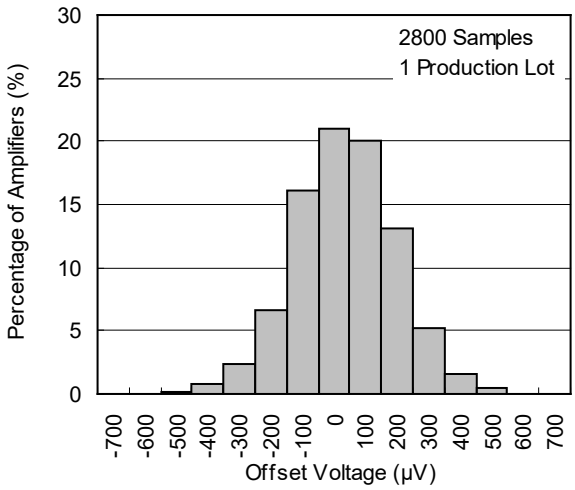
0.1Hz to 10Hz Noise



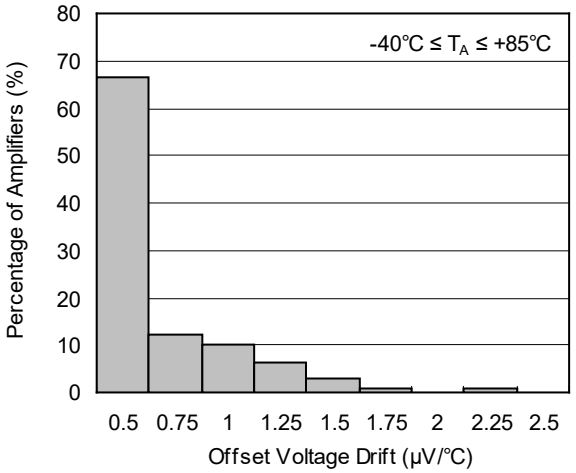
+IN EMIRR vs. Frequency



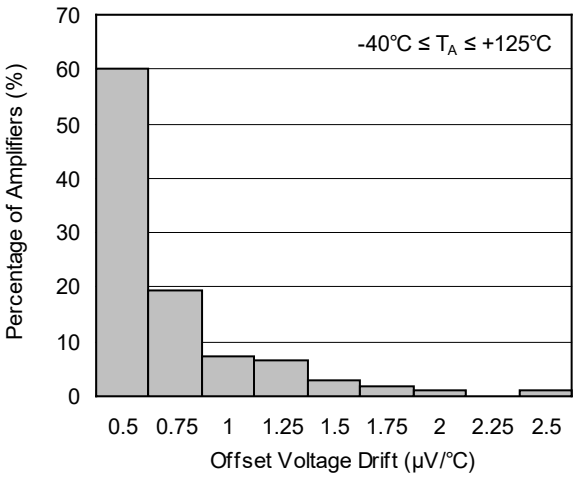
Offset Voltage Production Distribution



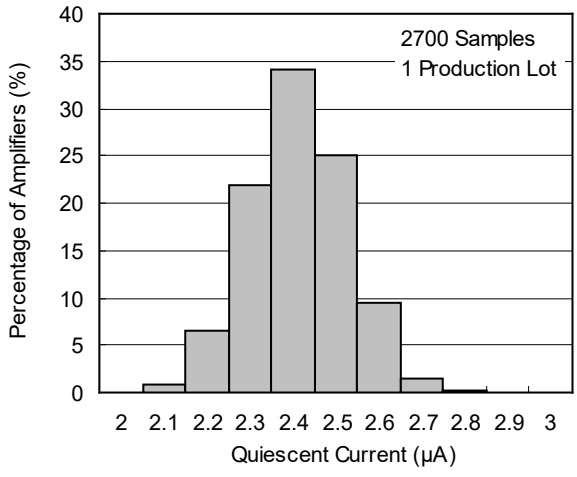
Offset Voltage Drift Distribution



Offset Voltage Drift Distribution



Quiescent Current Production Distribution



APPLICATION INFORMATION

The SGM8049-1/2/4 operational amplifiers minimize power consumption without compromising bandwidth or noise. Typical values of power supply rejection ratio (PSRR), common mode rejection ratio (CMRR), and open-loop gain (A_{OL}) are 100dB or better.

When designing for ultra low power applications, choose system components carefully. To minimize current consumption, select large value resistors. Any resistors will react with stray capacitance in the circuit and the input capacitance of the operational amplifiers. These parasitic RC combinations can affect the stability of the overall system. A feedback capacitor may be required to assure stability and limit overshoot or gain peaking.

Good layout practice mandates the use of a 0.1μF bypass capacitor placed closely across the supply pins.

Operating Voltage

SGM8049-1/2/4 operational amplifiers are fully specified and tested from 1.8V to 5.5V or ±0.9V to ±2.75V.

Input Common Mode Voltage Range

The input common mode voltage range of the SGM8049-1/2/4 is from ($-V_S$) - 0.1V to ($+V_S$) + 0.1V. This rail-to-rail input is achieved using a complementary input stage. CMRR is specified from the negative rail to 1.2V below the positive rail. Between ($-V_S$) - 0.1V to ($+V_S$) + 0.1V, the amplifier operates with higher offset voltage because of the transition region of the input stage.

Protecting Inputs from Over-Voltage

Normally, input currents are 1pA. However, a large voltage input (greater than 500mV beyond the supply rails) can cause excessive current to flow in or out of the input pins. Therefore, as well as keeping the input voltage below the maximum rating, it is also important to limit the input current to less than 10mA. This limiting is easily accomplished with an input voltage resistor, as shown in Figure 2.

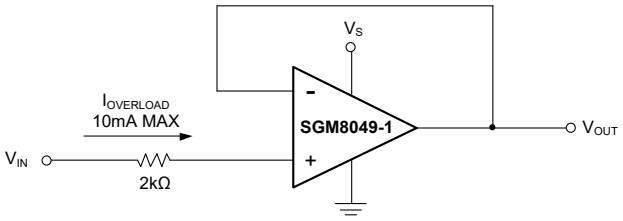


Figure 2. Input Current Protection for Voltages Exceeding the Supply Voltage

Noise

Although micro-power amplifiers frequently have high wideband noise, the SGM8049-1/2/4 offer excellent noise performance. Resistors should be chosen carefully because the SGM8049-1/2/4 have only 3.5μV_{PP} of 0.1Hz to 10Hz noise, and 75nV/$\sqrt{Hz}$ of wideband noise; otherwise, they can become the dominant source of noise.

Capacitive Load and Stability

Follower configurations with load capacitance in excess of 30pF can produce extra overshoot and ringing in the output signal. Increasing the gain enhances the ability of the amplifier to drive greater capacitive loads. In unity-gain configurations, capacitive load drive can be improved by inserting a small (10Ω to 20Ω) resistor, R_S, in series with the output, as shown in Figure 3. This resistor significantly reduces ringing while maintaining direct current (DC) performance for purely capacitive loads. However, if there is a resistive load in parallel with the capacitive load, a voltage divider is created, introducing a DC error at the output and slightly reducing the output swing. The error introduced is proportional to the ratio R_S/R_L, and is generally negligible.

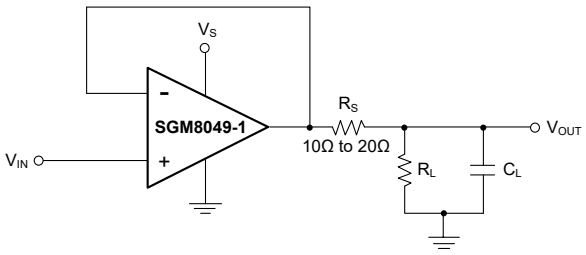


Figure 3. Series Resistor in Unity-Gain Buffer Configuration Improves Capacitive Load Drive

APPLICATION INFORMATION (continued)

In unity-gain inverting configuration, phase margin can be reduced by the reaction between the capacitance at the operational amplifier input and the gain setting resistors. Best performance is achieved by using smaller valued resistors. However, when large valued resistors cannot be avoided, a small (4pF to 6pF) capacitor, C_{FB}, can be inserted in the feedback, as shown in Figure 4. This configuration significantly reduces overshoot by compensating the effect of capacitance, C_{IN}, which includes the amplifier input capacitance and printed circuit board (PCB) parasitic capacitance.

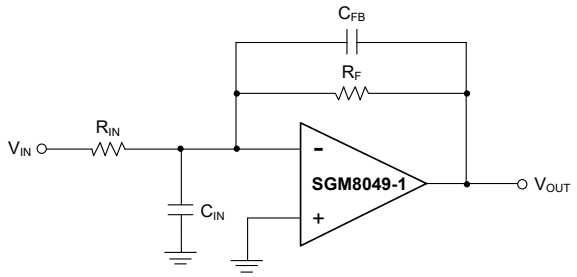


Figure 4. Improving Stability for Large R_F and R_{IN}

Figure 5 through Figure 9 illustrate some low power application examples.

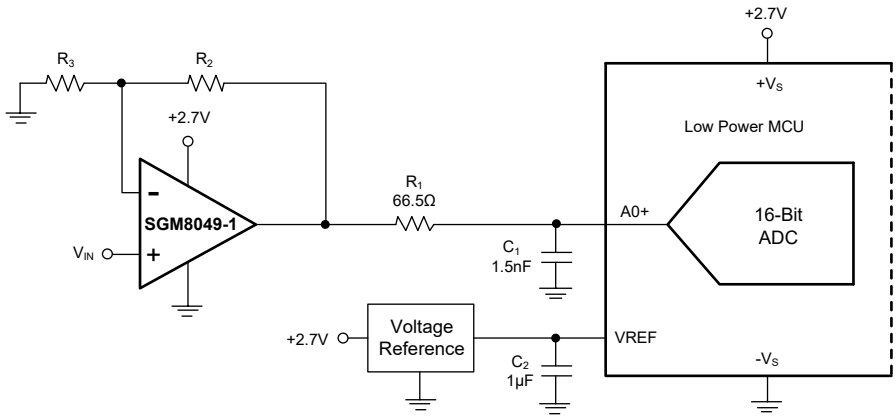


Figure 5. Unipolar Signal Chain Configuration

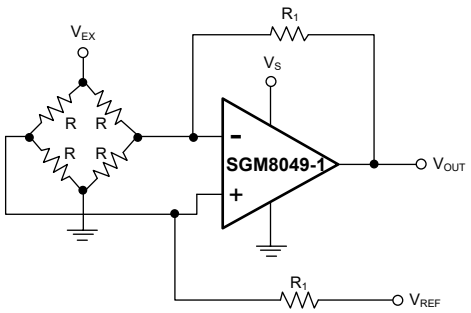
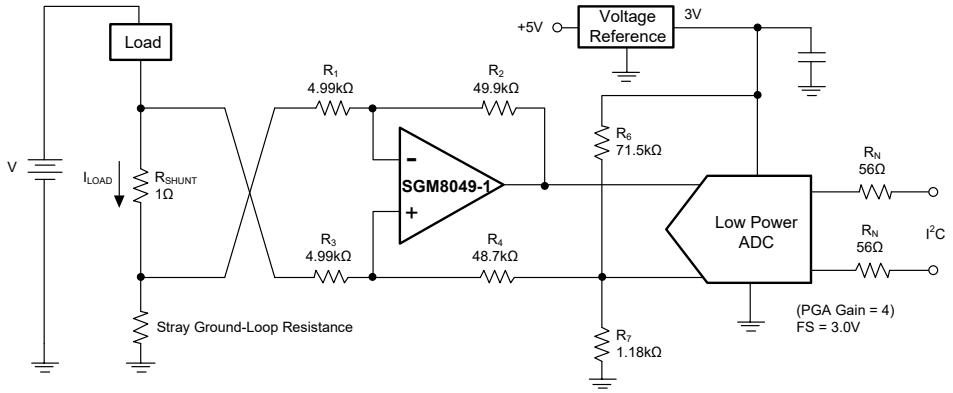


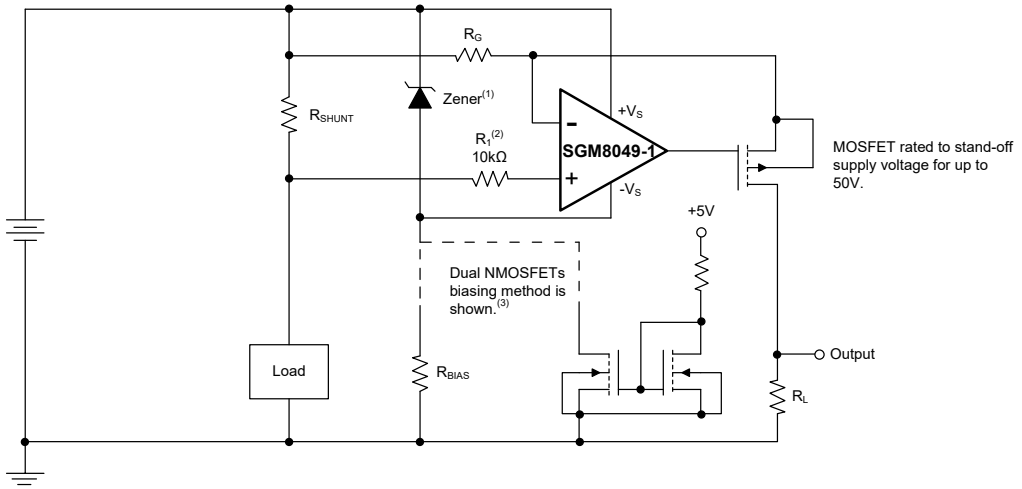
Figure 6. Single Operational Amplifier Bridge Amplifier

APPLICATION INFORMATION (continued)



NOTE: 1% resistors provide adequate common mode rejection at small ground-loop errors.

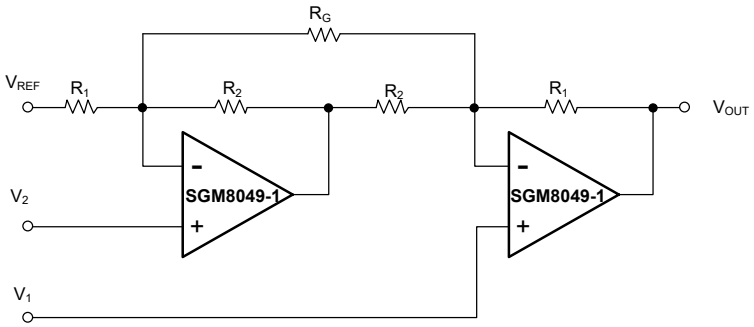
Figure 7. Low-side Current Shunt Monitor



NOTES:

1. Zener rated for operational amplifier supply capability (that is, 5.6V for SGM8049-1/2/4).
2. Current-limit resistor.
3. Choose Zener biasing resistor or dual NMOSFETs.

Figure 8. High-side Current Measurement



$$V_{OUT} = (V_1 - V_2)\ (1 + R_1/R_2 + 2R_1/R_G) + V_{REF}$$

Figure 9. Two Operational Amplifiers Low Power Instrumentation Amplifier

REVISION HISTORY

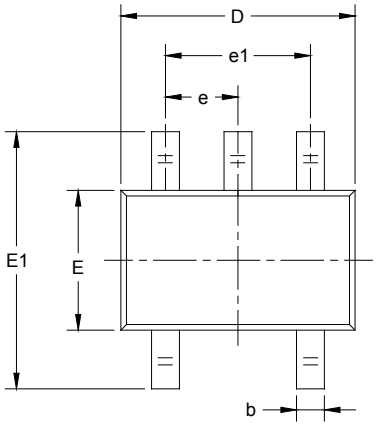
NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

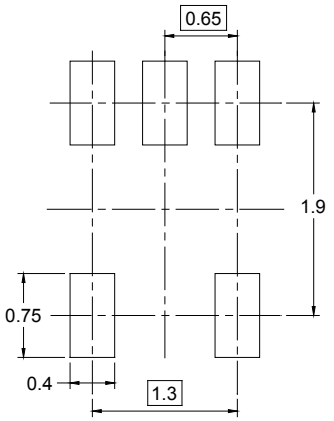
AUGUST 2017 – REV.A to REV.A.1	**Page**
Added +IN EMIRR vs. Frequency	8

Changes from Original (NOVEMBER 2015) to REV.A	**Page**
Changed from product preview to production data	All

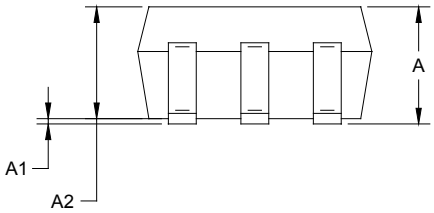
PACKAGE OUTLINE DIMENSIONS

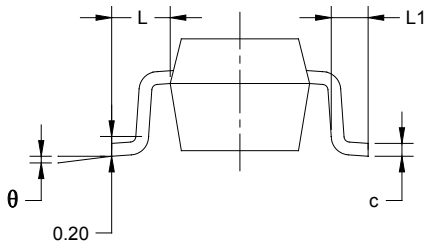
SC70-5





RECOMMENDED LAND PATTERN (Unit: mm)

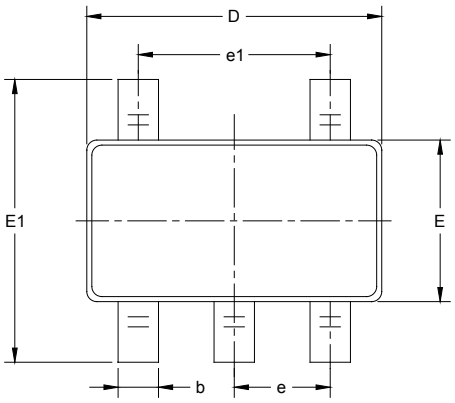


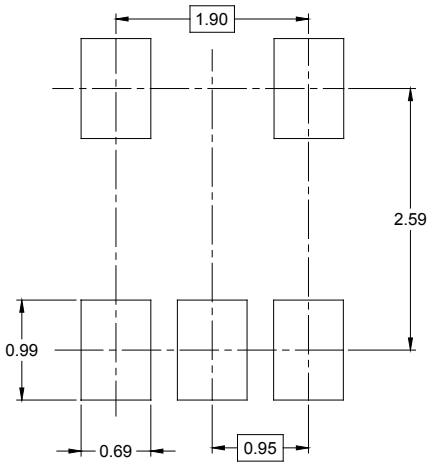


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	0.900	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.900	1.000	0.035	0.039
b	0.150	0.350	0.006	0.014
c	0.080	0.150	0.003	0.006
D	2.000	2.200	0.079	0.087
E	1.150	1.350	0.045	0.053
E1	2.150	2.450	0.085	0.096
e	0.65 TYP		0.026 TYP	
e1	1.300 BSC		0.051 BSC	
L	0.525 REF		0.021 REF	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

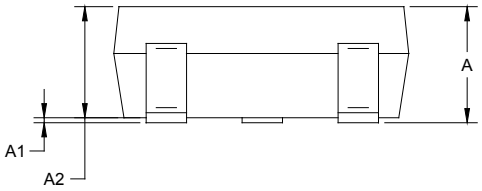
PACKAGE OUTLINE DIMENSIONS

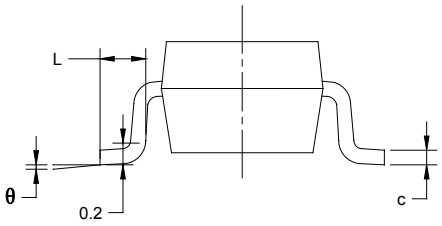
SOT-23-5





RECOMMENDED LAND PATTERN (Unit: mm)

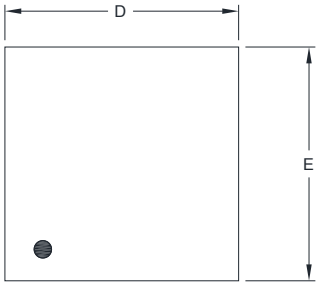




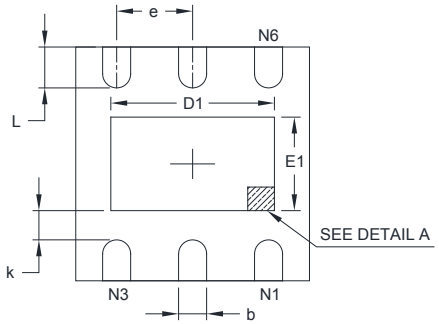
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037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

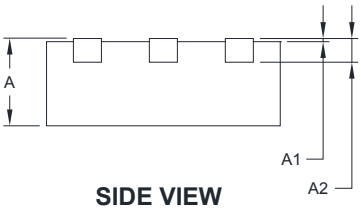
TDFN-2×2-6L



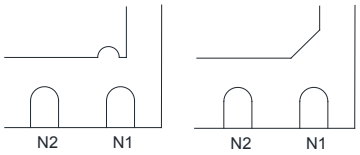
TOP VIEW



BOTTOM VIEW



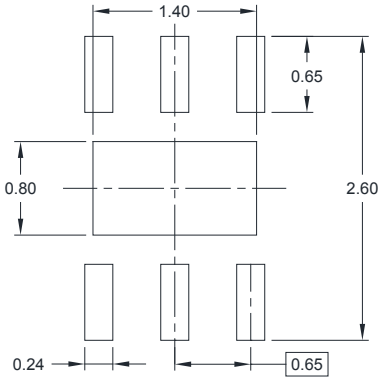
SIDE VIEW



DETAIL A

Pin #1 ID and Tie Bar Mark Options

NOTE: The configuration of the Pin #1 identifier is optional, but must be located within the zone indicated.

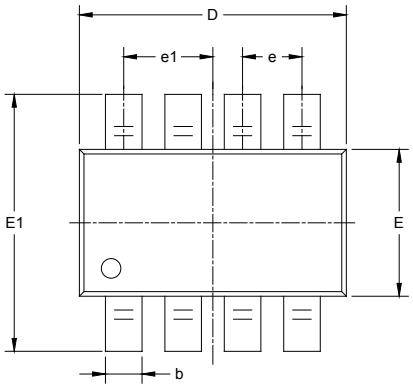


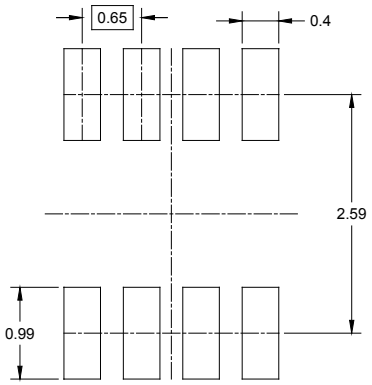
RECOMMENDED LAND PATTERN (Unit: mm)

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	1.900	2.100	0.075	0.083
D1	1.100	1.450	0.043	0.057
E	1.900	2.100	0.075	0.083
E1	0.600	0.850	0.024	0.034
k	0.200 MIN		0.008 MIN	
b	0.180	0.300	0.007	0.012
e	0.650 TYP		0.026 TYP	
L	0.250	0.450	0.010	0.018

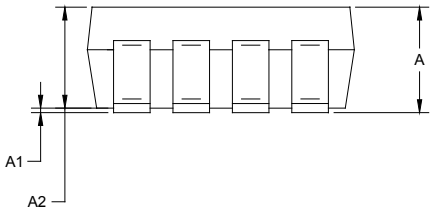
PACKAGE OUTLINE DIMENSIONS

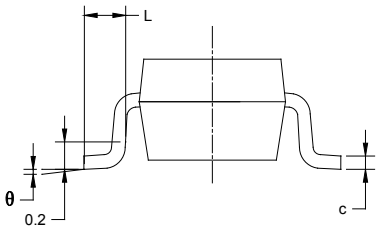
SOT-23-8





RECOMMENDED LAND PATTERN (Unit: mm)

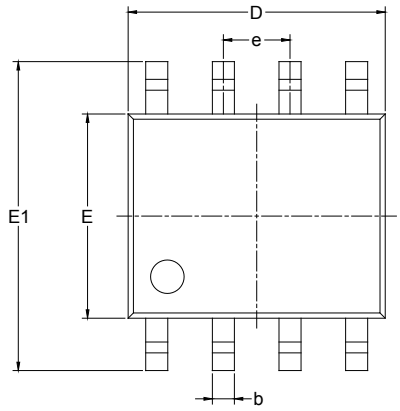


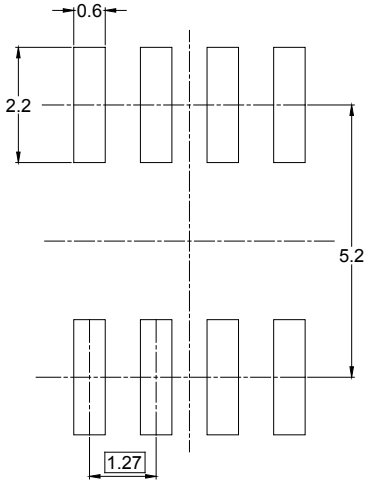


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.650 BSC		0.026 BSC	
e1	0.975 BSC		0.038 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

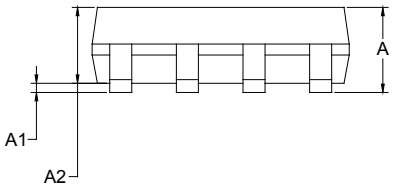
PACKAGE OUTLINE DIMENSIONS

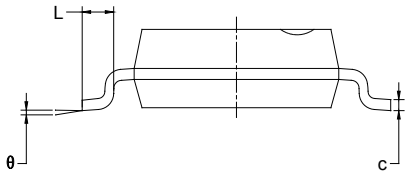
SOIC-8





RECOMMENDED LAND PATTERN (Unit: mm)

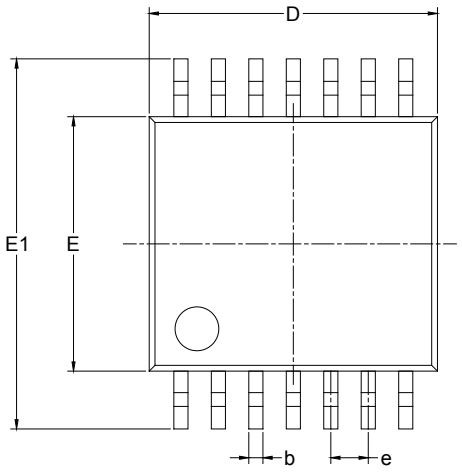


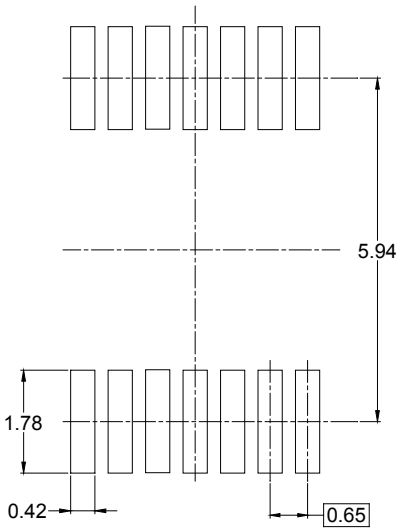


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050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

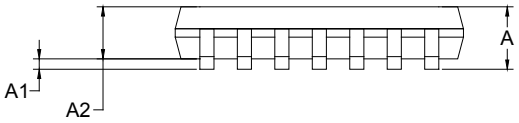
PACKAGE OUTLINE DIMENSIONS

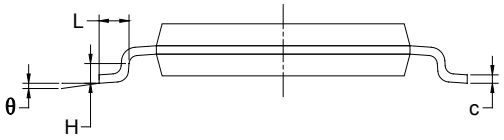
TSSOP-14





RECOMMENDED LAND PATTERN (Unit: mm)

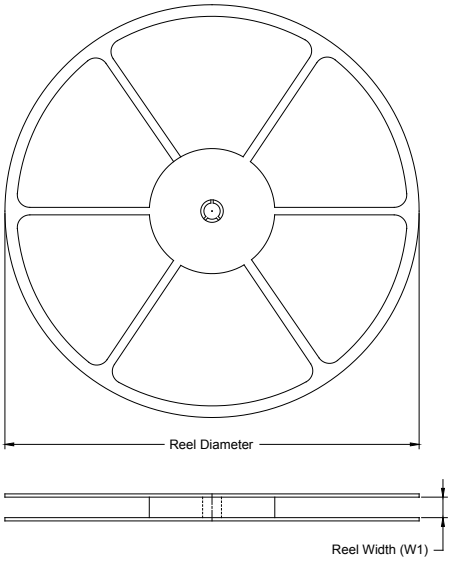




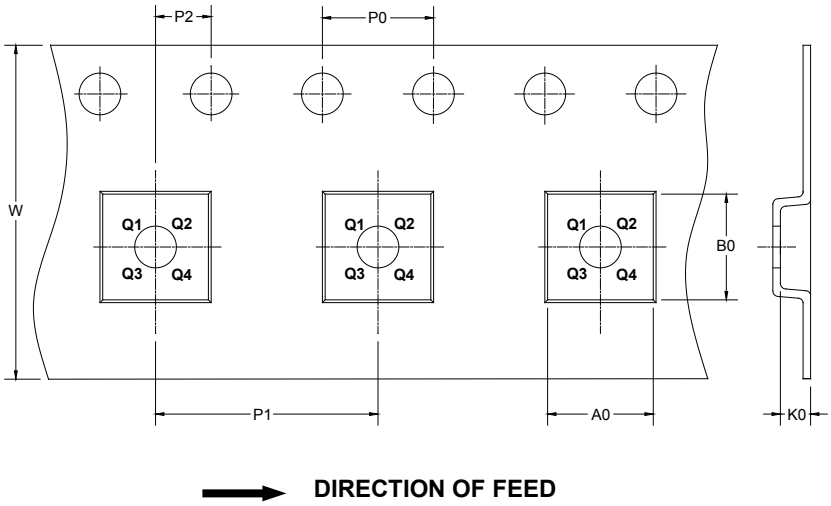
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.800	1.050	0.031	0.041
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.860	5.100	0.191	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
θ	1°	7°	1°	7°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



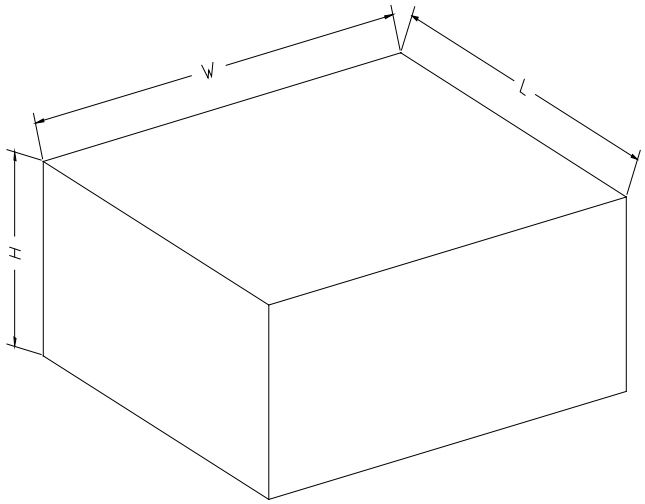
NOTE: The picture is only for reference. Please make the object as the standard.

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
SC70-5	7″	9.5	2.25	2.55	1.20	4.0	4.0	2.0	8.0	Q3
SOT-23-5	7″	9.5	3.20	3.20	1.40	4.0	4.0	2.0	8.0	Q3
TDFN-2×2-6L	7″	9.5	2.30	2.30	1.10	4.0	4.0	2.0	8.0	Q1
SOT-23-8	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
TSSOP-14	13″	12.4	6.95	5.60	1.20	4.0	8.0	2.0	12.0	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